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The New Castle Manufacturing Company

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The New Castle Manufacturing Company, of New Castle, Del., was one of the earliest locomotive builders of the United States, and during its operation, which extended over a period of more than twenty years, the character and extent of its product were such as to merit a fuller recognition of its place in the development of the American locomotive than it would appear to have received. As in the case of other early locomotive builders, its records and drawings have long since disappeared, and few of those who had personal knowledge and recollection of its work are now living. The work of the reviewer must therefore be necessarily limited to the presentation of such scattered data bearing upon it as have resulted from his research.

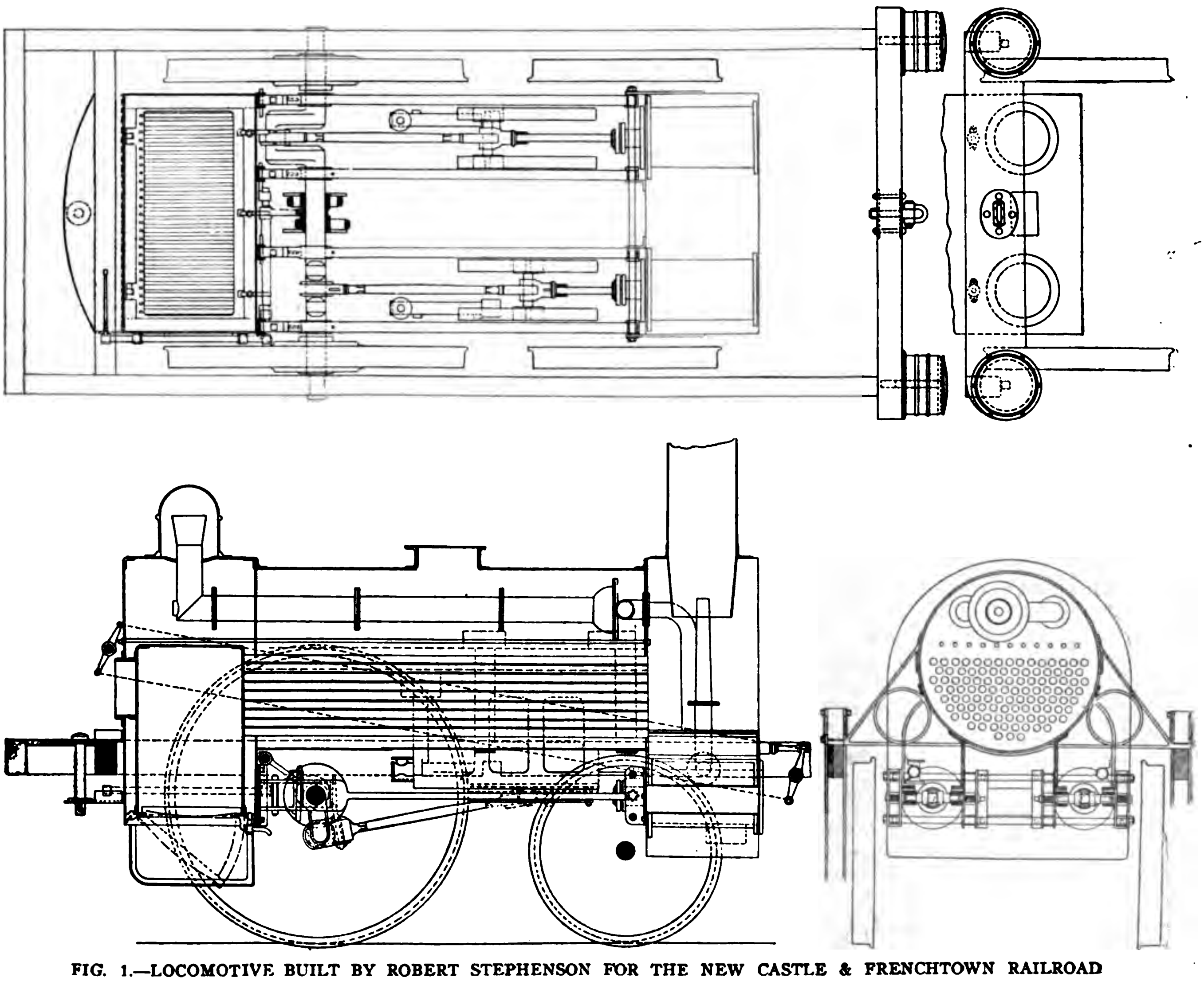


FIG. 1.—LOCOMOTIVE BUILT BY ROBERT STEPHENSON FOR THE NEW CASTLE & FRENCHTOWN RAILROAD

The earliest mention which has been found, in a publication, of the New Castle Manufacturing Company, appears in the *"Report upon the Locomotive Engines* *and the Police and Management of several of the Principal Railroads of the Northern and Eastern States,"* by J. Knight, chief engineer, and Benjamin H. Latrobe, engineer of location and construction, Baltimore & Ohio Railroad, Baltimore, 1838. The report is dated, May 14, 1838, and in the section referring to the New Castle & Frenchtown R. R., the following statement is made (p. 33):

"The company had their engines repaired at a shop of their own in New Castle, until the last few months, within which time the repairs have been executed at the engine manufactory of the New Castle Company."

The New Castle & Frenchtown Railroad extended from New Castle, on the Delaware River, to Frenchtown, on the Elk River, a tributary of Chesapeake Bay, a distance of about 16 miles, and was intended to form "part of the great highway between the cities of Philadelphia and Baltimore." The road was opened with a single track in February, 1832. It was for some years thereafter operated in connection with steamboats between Philadelphia and New Castle, and between Frenchtown and Baltimore, the trip occupying from 7 o'clock A. M., to "an early hour in the afternoon," as indefinitely stated in a newspaper advertisement of March, 1834.

The New Castle & Frenchtown Railroad is stated to have been "one of the first railroads in the United States to make regular passenger movements in cars drawn by locomotive engine power." In the report of Knight and Latrobe before referred to, the company is said to have then had six locomotives, a list of which is given on page 34, five having been made by Robert Stephenson, of Newcastle, England, and one by E. A. G. Young, of New Castle. The first of the Stephenson engines, which was operated on the opening of the road, is briefly described in Wood's *"Practical Treatise on Railroads,"* First American edition, Philadelphia, 1832, as follows:

"A locomotive engine of the latest pattern (made by Robert Stevenson, of Newcastle-upon-Tyne, England), has been imported by the company. The spokes of the wheels are wrought-iron *tubes,* bell-shaped at their extremities; the rim and hub cast on them—the union being effected by means of borax. The wheels are encircled by a wrought-iron *tire* and flange—the latter is very diminutive, and will require enlargement. The weight of the engine is not adapted to a railway of slender proportions, composed of timber and light rails" (page 532).

The accompanying illustration, Fig. 1, is a reduced reproduction of a print which was furnished to the writer by Messrs. Robert Stephenson & Co., Ltd., Darlington, England, and is believed by them to represent the first locomotive built by Robert Stephenson for the New Castle & Frenchtown Railroad.

The letter which accompanied the print gives the following particulars of the locomotive, viz.:

Makers No. 23. Ordered, 2nd Janr. 1831, sent away 1st Oct. Boiler diam. 3′—0″, length, 6′—6″, No. of tubes, 97. Firebox, 2′—3″ long. Wheels, Fore 3′—1″. Aft, 5′—0″. Centre & Centre, 5′—2″. Width of Ry. 4′—8½″. Cylinders, Diam. 11″, stroke, 16″. Frame, Breadth, 6′—3″, length, 15′—1½″. Cranked Axle, 4 ins. diam. in the centre part and bearings just out side of the cranks. Crank Pin, 3⅞″; End Bearing, 3″ diam. and 6″ long; 8 inch cranks, 2′—7″ centre and centre. Plain axle, 3½″ diameter.

Knight and Latrobe's report states that the weight of this locomotive was 9 tons, of which 6 tons was on the driving wheels, and gives the following particulars of the Stephenson engines of the New Castle and Frenchtown Railroad:

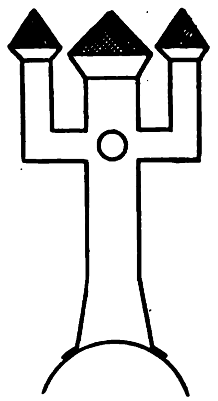


FIG. 2—YOUNG PATENT OF 1833. A DEVICE FOR PREVENTING EMISSION OF SPARKS

"The cylindrical part of the boilers of these engines is of plate 7/16 inches in thickness. The boiler heads are of ½ inch plates, and the copper of the tubes is 1/16 in. thickness. The working effective steam pressure in the boiler is said to be 75 lbs. per square inch."

It was further stated that "one cord of wood is consumed by a passenger engine in a circular trip of 33 miles, inclusive of that burnt in lighting up the fire, and raising the steam, and in waiting upon the steam boats."

These locomotives are of interest as illustrating the English practice of their early date, which was substantially duplicated in the "Old Ironsides" built by M. W. Baldwin, of Philadelphia, in 1832, the Locks and Canals Co. of Lowell, Mass., and other manufacturers in this country, whose operations began about that time. Cranked axles were then practically universal, and it is probable that they were fitted in the first locomotives built by the New Castle Manufacturing Company.

Edward A. G. Young, of New Castle, who was the maker of one of the locomotives (the "New Castle"), listed in Knight and Latrobe's report as being in service on the New Castle & Frenchtown Railroad, in 1838, had been building locomotives at New Castle, for some years earlier, and seems to have been favorably known at that time. In the description of the Allegheny Portage Railroad, a part of the original Main Line of the public works of the State of Pennsylvania, which appears in William Bender Wilson's *History of the Pennsylvania Railroad Company,* Philadelphia, 1899, it is stated (vol. 1, p. 122), that two of the three locomotives, which were ready for service on the opening of the road for the movement of traffic in the season of 1835, were the "Delaware" and "Allegheny," which were built by Edward A. G. Young. Regarding these engines, it is further stated that they—

"reached Hollidaysburg April 15, 1835, and were sent to Johnstown where the parts were fitted together and the necessary alterations made at an ordinary blacksmith's shop, there being no machine shop in operation at the time. Their contract price was $5,500 each, and it cost $158 additional per locomotive to transport them from Philadelphia to Hollidaysburg. The builder had had several years' experience in the use of locomotive engines."

No description of these locomotives is given other than that the "Delaware" had a crank axle, and it is probable that both of them, as well as the "New Castle," were built on the general plan of the Stephenson locomotives shown in Fig. 1.

The only other matter that the writer has been able to develop as to E. A. G. Young is that a Patent was granted to him July 22, 1833, for "Preventing the emission of Sparks from the 'Chimney of Locomotives or other Steam Engines.'" This Patent was among those that were destroyed in the Patent Office fire of 1836, and were not restored, and therefore no record of it is available. The following brief notice of it, however, appears in the *Journal of the Franklin Institute,* Vol XIII, N. S. 1834, p. 36, from which, and the accompanying diagrammatic illustration, Fig. 2, the design can be understood:

"The main flue is to be covered with fine wire gauge, and there are to be four, or any other number of, additional flues, which may proceed from the upper part of the main flue, and be elbowed so as to have their mouths upwards; these also are to be covered with wire gause, allowing the smoke to pass, and detaining the sparks."

The Young spark arresters were in service on the New Castle & Frenchtown Railroad. The elbowed arms were removed, at intervals, to be cleaned, the engine being pushed near an overhanging platform for the purpose.

As appears from the report of Knight and Latrobe, the New Castle Manufacturing Company had its engine manufactory in New Castle in operation, at least a "few months" prior to the date of that report, May 21, 1838, and the writer believes that this manufactory was that which had previously been operated by E. A. G. Young, although no record evidence to that effect seems to be obtainable.

The New Castle Manufacturing Company was incorporated by the Legislature of Delaware on June 25, 1833. It is curious that the first section of the Act reads: "Be it enacted . . . that a company shall be established for the purpose of carrying on the manufacture of cotton, wool, grain, plaster of Paris and other materials, in or near the town of New Castle," etc. This evidences how little the industrial future was appreciated at that date. Mr. Andrew C. Gray, then a young lawyer, practicing in New Castle, became interested as a subscriber to the stock of the company, and about 1840, or shortly thereafter, was elected its President, occupying that position throughout its operation which continued until about 1859. Mr. Gray afterwards became a director and president of the New Castle & Frenchtown Railroad, and he was the father of the eminent jurist, Hon. George Gray, now of Wilmington, Del., whose public services have caused him to be known as Delaware's foremost citizen. Judge Gray personally stated to the writer that he remembered seeing, when a boy, the old Stephenson locomotives of the New Castle & Frenchtown Railroad, and his recollection of the design and performance of the later engines built by the New Castle Manufacturing Company is remarkably clear and accurate.

The official records of the New Castle Manufacturing Company not being avail-

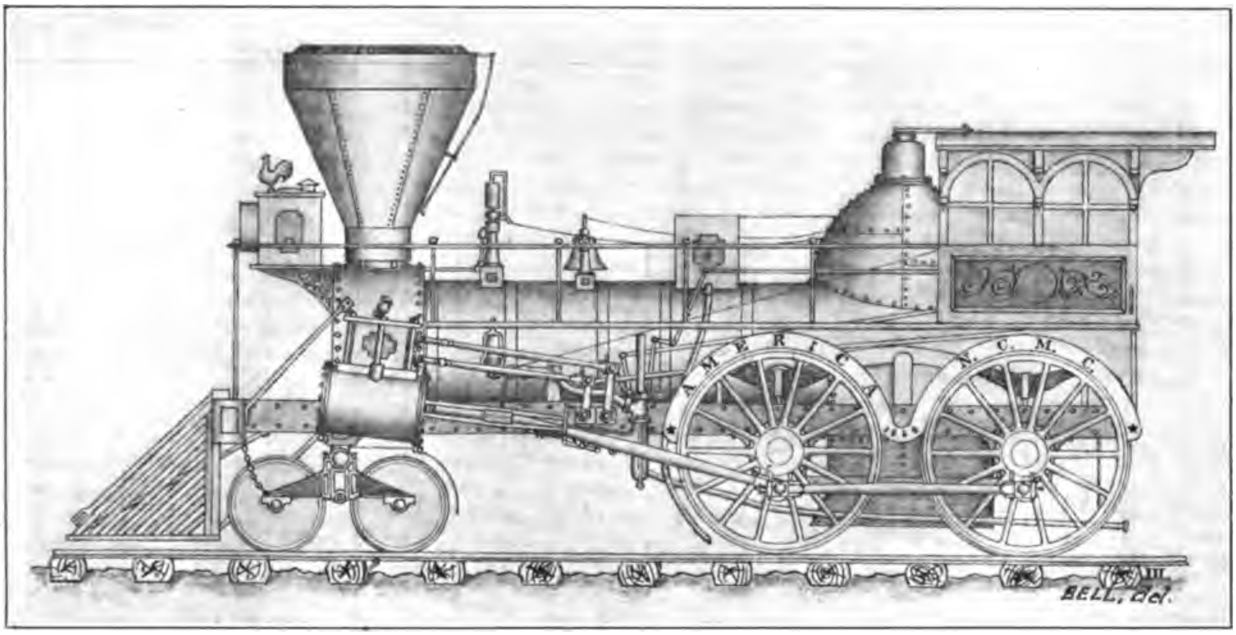


FIG. 3. LOCOMOTIVE "AMERICA" BUILT FOR THE PHILADELPHIA, WASHINGTON & BALTIMORE RAILROAD IN 1854

ence, which is doubtful, a complete history of the company's manufacture would be impossible, and even a general reference thereto, imperfect and insufficient, being dependent wholly upon the recollection of the reviewer and the extent to which he has been aided by publications in which the work of the Company has been referred to. From these sources the following is presented, as comprising all the data that the writer has found it possible to develop:

The first locomotive made by the New Castle Manufacturing Co. that has been found of record is the "Arrow," No. 28, built for the Baltimore & Ohio R. R., and put in service February, 1840. The only reference to this locomotive is the statement in the Twenty-fourth Annual Report of the road, 1850, that "Engine 'Arrow' had new crank shaft, new truck frame, etc." This engine being thus shown to be inside connected, differed from four others subsequently built for the same road by the New Castle Manufacturing Co. these being the "New Castle," No. 47, December, 1846; "Delaware," No. 48, January, 1847; No. 122, December, 1852, and No. 164, July, 1853. These four engines were all of the New Castle Co.'s standard design of the "American" (4-4-0) type.

Thatcher Perkins, Master of Machinery of the Baltimore & Ohio R. R., designed an eight coupled (0-8-0) locomotive, the "Hero," No. 54, which was built at the company's Mount Clare shops in Baltimore, and placed on the road in May, 1848. Five more locomotives of this special design were built in outside shops, two of them, the "Saturn," No. 56, and "Memnon," No. 57, by the New Castle Co. in June and October, 1848, respect-

Samuel J. Hayes, then Master of Machinery of the same road, designed a class of locomotives (4-6-0) type, known as the "Hayes ten wheelers," the first of which was put in service in May, 1853. One locomotive of this design, No. 139, was built by the New Castle Co. and put in service in May, 1853.

In 1863, a locomotive of this company's build, the "Virginia," No. 1, was sent to the B. & O. R. R. Co.'s Mount Clare shops, and was scrapped. It is believed that this engine came from the Hempfield Railroad, which then extended from Wheeling to Washington, Pa.

Up to that year, 1861, almost the entire locomotive equipment of the Philadelphia, Wilmington & Baltimore Railroad had been constructed by the New Castle Manufacturing Company, 19 of the 32 locomotives on the road at the close of the fiscal year, October 31, 1861, being listed, with their dates, in Wilson's *History of the Pennsylvania Railroad Company,* Vol. 1, pp. 323, 324, and stated to have been built by that Company. These locomotives were the "Victory," 1847; "Boston," 1848; "Delaware," 1851; "Philadelphia," 1852; "New Castle," 1852; "Wilmington," 1852; "Cincinnati," 1853; "Maryland," 1853; "Samson," 1853; "Golish," 1853; "Pennsylvania," 1853; "America," 1854; "Constitution," 1854; "C. W. Morris," 1854; "Virginia," 1854; "William Penn," 1855; "Thomas Clayton," 1857; and "Princess Anne," 1858. Investigation of the old reports of the Philadelphia, Wilmington & Baltimore R. R. Co., develops five more locomotives that were built by the New Castle Manufacturing Company, and were in service on that road, these being the "Orion," 1846; "Meteor," 1849; "Minerva," 1849; "Union," 1851, and "United

It will, therefore, appear that 25 of 28 locomotives which the P., W. & B. R. R. had in service prior to 1858, were built by the New Castle Manufacturing Company. Two of the other three, the "Empire" and "Magnolia," were built by the P., W. & B. R. R. Co., and were in substantial accordance with the standard design of the New Castle Company, as embodied in the 20 locomotives specified above. The characteristic features of this design will be recalled to those who were familiar with it by reference to Fig. 3, which is a reproduction of a hand sketch, made by the writer many years ago, of the P., W. & B. R. R. locomotive "America." While the drawing was not made to scale, its proportions are approximately correct.

As shown in the illustration, the standard "American," or 4-4-0 type design of the New Castle Manufacturing Company, embodied a boiler, the firebox of which had a hemispherical or "Bury" dome at its top; combined wooden and iron plate frames; a truck, having closely set axles and springs which formed its side frame members and were connected at their ends to the journal boxes; inclined cylinders, set entirely above the truck wheels; main distribution valves operated by hook motion; and independent cut off valves.

The following details of the "America" are of record, viz.: Weight, 51,000 lbs.; weight on driving wheels, 35,500 lbs.; diameter of driving wheels, 66 inches; diameter of cylinders, 17 inches; stroke, 22 inches; weight of tender, 35,510 lbs. It will be observed that the locomotive was a comparatively large one, at its early date, 1854, and it is stated that it was run on what was called the "Lightning Train" between Philadelphia and Baltimore.

It is much to be regretted that the loss or destruction of records, and the passing away of those whose recollection might supplement them, have limited the narration of the career of the New Castle Manufacturing Company to the imperfect and fragmentary matter which is here presented. The work of the Company fully entitles it to honorable mention in the history of American locomotive engineering, and to a much more complete and detailed description than it has been possible for the writer to make.

New Type of Oil-Fuel Burner

A demonstration of the working of a new type of oil-fuel burner was recently given at the works of Messrs. James Erskine & Co., Glasgow. The appliance, which is known as the "Reid-Erskine liquid fuel atomizer and burner," is of simple construction and has no fine quantities of fuel. It is thus specially useful where unskilled labor is employed. The burner, it is claimed, renders possible the production of heat from liquid fuels in a ing, gasifying, and burning of the oil within controllable temperature and independent of any lower heating effects existing within the places set apart for final combustion. In operating the burner, liquid fuel under low pressure is projected into the central energy point of the air or steam cone jet, and is there atomized in an efficient manner, at any capacity under which the burner is called upon to work. The fuel after atomization forms a circular stream of equal density, fuel atoms making a combustible mixture. To increase the efficiency of combustion, this mixture, in place of being fed direct to the fire box is directed into a circular iron vessel partly lined with fire clay, and can there be initially ignited by the application of a crude torch, such as a piece of waste dipped in oil. On passing through the heated fire-clay-lined portion of the vessel the mixture is formed into a highly combustible gas. Among the advantages claimed for this type of burner are the high efficiency and economy it possesses, due to the complete atomization of the liquid fuel, and the transformation of the atomized fuel into a light inflammable gas, thereby producing complete combustion.

Uniform Gauge in Australia

Once again the question of converting the railways of Australia to a uniform gauge is being considered seriously. The enormous expense prevents the adoption of the scheme as always. Each time the proposal is considered the cost of the alteration is considerably higher than previously.

The foundation of all this trouble arose from the, at the time, trivial circumstance of a change of engineers of the Sydney Railroad and Tramway Company in 1852. In 1846 Mr. W. E. Gladstone, then Colonial Secretary, in a dispatch to the Governor of New South Wales, recommended that all railways built in Australia should be of the 4 foot 8½ inch gauge. In 1850, however, the engineer of the Sydney Railroad and Tramway Company strongly advocated the adoption of the 5-foot 3-inch gauge, and in 1852 an act was passed making it compulsory for the wider gauge to be adopted on all railway lines built in New South Wales, and the governors of Victoria and South Australia were duly informed of this decision. In the same year the Sydney company changed its engineer, and the new officer induced the company to alter its former views on the gauge question. In 1853 the company succeeded in having the 1852 Act repealed, and in passing another making the 4-foot 8½-inch gauge compulsory. This step was taken without the concurrence of the other States, and a considerable amount of ill-feeling arose, especially in Victoria, where two private companies had already placed large orders for rolling stock to be constructed to the broad gauge originally quence Victoria, having gone so far, decided to adhere to the broad gauge as the standard for the State, while New South Wales adopted the 4-foot 8½-inch gauge. The Queensland Government from the outset adopted the 3-foot 6-inch gauge as being best suited to the colony's requirements.

A conference between the Premiers of all the mainland States and the Prime Minister has now decided that thousands of miles of railways, some of 5-foot 3-inch gauge and some of 3-foot 6-inch, shall be taken up and relaid to the 4-foot 8½-inch gauge, in order to bring about uniformity throughout the commonwealth. This will be an enormous undertaking. It has been officially estimated that it will cost £57,000,000 to make all lines conform to the 4-foot 8½-inch gauge, and that a smaller scheme, applying only to the main line forming interstate railway communication between Brisbane and Perth *via* Sydney, Melbourne and Adelaide would cost £22,000,000.

Interesting Figures of Equipment Maintenance on the Baltimore & Ohio

A noteworthy feature of the Baltimore & Ohio's annual report is the comparative figures which are given for the years 1911 to 1920. A perusal of the several tables showing these figures brings out details which explain strikingly the reason for the net railway operating deficit which the road experienced in 1920. The tables develop the interesting fact that the wages of engine crews in 1913 averaged $10.88 per 100 locomotive-miles. In 1919 they averaged $18.70 and in 1920, $24.43. Fuel per 100 locomotive-miles in 1913 was $9.58; in 1919 it was $22.96 and in 1920, $36.81. The total cost per 100 locomotive-miles in 1913 was $36.66; in 1919 it was $100.78 and in 1920, $122.98.

President Hanna's New Year's Message

D. B. Hanna, President, Canadian National Rys., issued the following message, Dec. 22, 1921: "In my first Christmas message to Canadian National Rys. employes three years ago, I asked for your co-operation in making a success of Government owned railways, and stated that our duties to that end should be regarded as a public trust. I am glad to say that I feel we have had the loyal support of all employes in our efforts to make the Canadian National Rys. an efficient transportation system. The improvement in operating results in the last few months, and the better relative position which the National System enjoys, are gratifying to the management and reassuring to the Canadian public, and I desire to express my hearty appreciation of the co-operative efforts of officers and employes. We can only hope to succeed through the whole hearted efforts of our organization, and the work in the main

Economical Speed of Freight Trains

The full horsepower capacity of modern freight train locomotives is probably not reached at speeds much under 30 to 35 miles per hour, and in operating such engines on the basis of capacity, the most economical fuel consumption rate is, in all probability, not to be reached short of these speeds. This matter is of importance in considering the economical speed of freight trains for the reason that the conditions which fix the maximum tonnage usually apply for a comparatively small portion of the total distance covered; hence, if the full horsepower capacity of the locomotive is to be utilized with the reduced tractive effort required over the remaining portions of the district it can only be done by increasing the speed. In discussing this matter from the standpoint of American locomotive conditions, a case may be cited of a modern 2-8-2 type locomotive capable of developing about 65 per cent of its maximum tractive effort at a speed of 25 miles an hour. It can do so only at the expense of a 36 per cent increase in the amount of fuel per unit of work produced, over the amount required to maintain the same tractive effort at 20 miles per hour, while the increase in the fuel consumption per unit of work required to maintain the maximum speed of 25 miles an hour over that required to operate at 15 miles an hour is about 55 per cent.

Reorganization of the Spanish Railways

As the railroad situation is one of the greatest problems now facing the Spanish government, a move towards ultimate ownership by the government is receiving the most careful consideration. The project provides for the operation of the roads by their owners jointly with the government, but the latter shall make and pay for in accordance with the law all acquisitions of material which may be needed for the railways at present and for construction of new lines in every way as an owner. A council of 15 members is provided to administer and supervise the exploitation of both government and privately owned roads, and to fix rates. Six members of this council are to be representatives of and named by the present privately owned roads; all others are to be more or less representatives of the Government and named by it.

Perpetual concessions to private companies are to be reduced to a period of 99 years, and the right of the Government to take over the roads at the termination of the concession is recognized. Under certain conditions, concessions may revert to the State prior to the termination of the stipulated period, and restrictions as to disposal of railway properties now held by individuals are embodied. Points of timely interest are the provisions for re- with a view to better commercial service and increased strategic value; definite measures for retirement of laborers on pension; and the council's right of establishing or revising the tariff. In the latter case the council shall be animated by two considerations: First, the best interests of the company in question; second, the general interest, with a special view to the effect of the new tariff on through rates having to do with two or more lines.

Latest Returns on American Railroad Investments

Official investigations made during the closing days of December show that the net income of Class 7 American railroads for 1921 will be approximately $561,665,221. This is $584,004,000 better than 1920. This still falls $131,347,000 short of meeting the fixed charges of the carriers.

To put it another way, the net operating income for this year yields a return of about 3 per cent on the tentative valuation of $18,900,000,000 made by the Interstate Commerce Commission to base rates upon in July, 1920. This 3 per cent may be measured against the 6 per cent return contemplated by the transportation act. The returns are only one-half what the law allows, but at that the showing is far better than some of the gloomy pictures painted by the executives during the recent wage controversy.

The deficit of the roads for 1920 was $715,351,000, while for 1921 it will be about $131,347,000. so Mr. Thompson's computations show. This is about the most encouraging view of the progress of the railways back toward normalcy so far presented.

Fixed charges of the railways this year amount to $693,012,379, the bureau's figures show. The tables show the roads slashed $1,257,909,000 off their operating expenses this year.

New Rule Affecting Overtime

On December 14 the United States Labor Board issued an additional appeal affecting over half a million railroad men. Under the new ruling time and one-half rates are to be paid after the tenth hour of work instead of after the eighth, as under the old national working agreement. The finding reaffirms the "basic" eight-hour day. It sets forth that "except as otherwise provided in these rules eight consecutive hours, exclusive of the meal period, shall constitute a day's work." That is word for word from the old rules. But punitive overtime rates do not begin until after ten hours' work. For the ninth and tenth hours pay is to be at the regular hourly rate. After that the 50 per cent extra goes on.

While this a pronounced change, the old national agreement applied the same prin- way employes. Under the old rules the time and one-half rate began after the tenth hour for laborers employed in extra or floating gangs, whose employment is seasonal and temporary, when engaged in work not customarily done by regular section gangs. In the new rules the board extends this principle to regular track hands.

Recovery of Unburned Fuel

Serious attention is being given to the recovery of unburned fuel from boiler furnace refuse, and a recent report issued by the United States Bureau of Mines shows that as much as 20 per cent of fuel was recovered in two special tests. The report states that the washed fuel had an ash content of 25.5 per cent and an average calorific value of 9,754 B. t. u. The heating value of the dry screenings ordinarily fired at the plant is about 10,000 B. t. u. to 11,000 B. t. u., and the ash content 18 per cent to 22 per cent. The yield of the plant is one ton of fuel from every five tons of refuse handled. A one-table plant which would handle six tons to eight tons of raw coal per hour would treat five tons per hour of boiler furnace refuse, and by continuous operation 120 tons of refuse per 24 hours. The working of the installation would require only a part of the time of one man, and in most cases the freight charges on coal purchased in place of the recoverable unburned fuel would be more than sufficient to cover the cost of operation.

Eastern Railroads Submit Scale of Reductions in Wages

About the middle of December last letters were sent out by the fifty-two Eastern railroads to the local chairmen of the railway unions that gave for the first time the new wage scale as proposed for the various classes of employees. In a general way the reductions contemplated range from 10 per cent for train service employees to as much as 30 per cent for so-called unskilled workers. Conferences on the proposed cuts are scheduled to start on January 16.

It is proposed to put trainmen back to the wage level that prevailed prior to May 1, 1920. Switch tenders will get a minimum of $3.20 a day and a maximum of $4. Passenger service engineers will get from $5.60 to $6.40 per 100 miles run; firemen, $4 to $4.88; freight engineers, $6.10 to $7.22, and firemen, $4.24 to $5.44.

Passenger and train conductors, under the reductions contemplated, will receive $6 a day; ticket collectors, $4.82; baggagemen handling express, $4.50; ordinary baggagemen, $4; freight service conductors, $5.92; brakemen, $4.48; yard service engineers, $5.60 to $6.08; yard service trainmen, $4.16 to $4.56; conductors, $5.33 –

Improvement in the Manufacture of Rails

As is generally known the top end of an ordinary steel ingot—that is the end which is uppermost during the pouring of the steel—suffers generally from a defective character. As the metal cools down and solidifies from the exterior of the ingot inwards, bubbles of gas or air enclosed in the molten steel during the pouring are forced inwards and upwards until they collect in a central "pipe," which extends a certain distance downwards from the top of the ingot. On this account it is essential that during the rolling a sufficient percentage of the rolled-out bloom shall be cut from the end representing the top end of the original ingot to insure soundness in the remainder. This crop is, of course, waste steel, and it is the desire of the steelmaker to reduce it to the smallest limit reasonably possible.

It is surprising that more detailed attention has not been paid hitherto to the question of producing thoroughly sound ingots. Among experiments recently made there is one that has attracted considerable attention. It consists of appliances whereby, after the ingot has been poured, the top has been kept hot by means of an air-blast playing on a layer of charcoal, held in a specially designed "sand-head" fitted on to the mould, for a period of from 20 to 40 minutes, until the metal in the head has finally set. This "sink-head" process has the effect of feeding molten metal into and thus practically eliminating the central pipe in the ingot, so that virtually the whole of the metal under the sink-head itself is sound steel. This is known as the Hadfield process, and its effectiveness has recently received striking confirmation from a series of tests carried out by the Pennsylvania Railroad under the supervision of a committee who decided to purchase 100 tons of Hadfield sink-head ingots from Hadfields of Sheffield, England, and to have rolled into rails. The rolling was carried out by the Maryland Steel Company, of Sparrows Point, Md., at the same time that a number of ingots were rolled into rails for the same company in order that a detailed comparison might be made, more especially as to the actual percentage of each ingot that was finally available as serviceable rails.

The Hadfield ingots numbered 37 in all; they were made in a small Bessemer acid converter, and each ingot represents a separate heat. Deoxidization was effected in the moulds with aluminum; the ingots were cast bottom upwards, *i. e.*, with the sink-head above the large end of each ingot. The Maryland comparison ingots numbered 15, and represented portions of three different heats from basic open-hearth dates. For the purpose of making the comparison as complete as possible, each group of five comparison ingots received different treatment in casting. Ingots M1-M5 were of "rising" steel, and were chilled on top with iron caps but not deoxidized with aluminum; ingots M6-M10 were also of rising steel, but deoxidized with aluminum, and chilled on top in this case with water; ingots M11-M15 were made from quiet or "killed" steel deoxidized with aluminum but not chilled. The sink-head ingots weighed 5,300 lbs. each, and the comparison ingots, 7,300 lbs. Comparison was thus made between four different kinds of steel—different, that is to say, as regards the casting practice employed—and of two types of ingot form. Chemical composition and test properties of all the ingots were on the average very similar, except that the comparison ingots contained a mean percentage of 0.75 nickel and 0.28 chromium, both of which elements were absent in the sink-head ingots.

Stress is laid in the report on the uniform chemical composition of the sink-head ingots. An analysis taken from the rails at a position just under one of the top corners of the head reveals an average carbon content of 0.648 per cent., with an average deviation from mean as low as 0.017 per cent. The average phosphorus content in the same position was 0.032 per cent., with an average deviation of 0.002, and sulphur 0.047, with a deviation averaging 0.004 per cent. Manganese, averaging 0.89 per cent., and silicon, were also very uniformly distributed. Carbon estimated from the same position in the rails from the comparison ingots averaged 0.645 per cent., but the average deviation from mean was 0.036 per cent. Manganese in the comparison rails averaged 0.70 per cent., and phosphorus the low figure of 0.019; in group M11-M15, however, the phosphorus was at an average level of 0.028 per cent., which closely compares with the figure of the sink-head ingots, and for this reason, as well as the method of casting adopted in the case of M11-M15 ingots, this sub-group is really the best for comparison with the sink-head ingots. Sulphur in the comparison ingots reached high.

The section into which the ingots were rolled was the 100 lb. per yard Pennsylvania Railroad standard rail, and the reduction from ingot to rail was effected by 13 passes through the blooming rolls, after which each ingot, now of 8 inch by 8⅛ inch section, was cut into two blooms; there then followed with no intermediate re-heating six passes through the roughing rolls, four through the intermediate rolls, and one finishing pass—total 24 material, both serviceable rails, rejected rails and discard in the mill, was weighed with great care, in order to arrive at an exact estimate as to the proportion of each ingot which was ultimately serviceable. The customary surface inspection of the finished rails for defects was made in the ordinary way by the inspectors of the Pennsylvania Railroad Company.

It is now of interest to look at the results obtained from the examination of the rails. The actual extent of piping and segregation was arrived at by cutting back the top rails from each ingot, in five-foot lengths, until there was no further piping visible, and the segregation was within the maximum limit of 12 per cent., which constituted one of the controlling factors in the test. This was described as the "discard to sound steel." Owing to uncertainty as to the actual location of the sink-head junction it was found that an arbitrary allowance would require to be made in cropping these ingots in the mill, as otherwise there would be the risk of having the rails from the top of the ingot rejected. Thus an 8 per cent. discard only was found to occasion surface defects in at least one-half the "A" rails, caused by the junction between sink-head and ingot, the sink-head alone requiring an average discard of 9.1 per cent. All trace of piping appeared to be eliminated with an average discard of 11 per cent., and the effect of carbon segregation in excess of the 12 per cent. allowance was but little in evidence at this limit of discard. It should be added that any steel showing more than 12 per cent. segregation of carbon, either positive or negative, was discarded as unfit for use.

In the final analysis an average of 4.3 per cent. was cropped in the mill from the top of the sink-head ingots, and 2.5 per cent. from the bottom, at the blooming mill. At the hot-saw the percentage loss on account of hot-saw crops from both ends of the bloom, and the special test pieces cut in all cases, amounted to 3 per cent. In the examination of the rails 9.1 per cent. was discarded on account of the sink-head; in all, 11.5 per cent. of the sink-head steel was discarded for chemical and 7.2 per cent. for physical unsoundness. The steel finally available for rails amounted to 81.6 per cent., on the average of each original ingot, and this result would have been improved were it not that the reheating of these ingots from the cold condition necessarily involved loss of weight averaging some 2.9 per cent., owing to the additional length of time occupied in the soaking pits.

An elaborate series of metallographic tests was also made and threw additional light on the question of segregation and ence of slag inclusions, streaks and seams. The smoothness and evenness of tone of the sulphur prints of rails rolled from the Hadfield sink-head ingots was characteristic of all the prints made, and was in striking contrast to the markedly irregular prints obtained from the comparison ingot rails, some of which, from the bottom of the ingot, showed the existence of well-defined pipes. In the matter of microstructure the rails from the sink-head ingots also showed the greater uniformity, especially as regards the upper portion of the ingot, where the superiority of the sink-head type was to be expected. The general structure of the steel in both cases was, however, fairly uniform, except that in the comparison rails the ferrite network is less pronounced, and in some cases almost absent. In addition, a detailed chemical examination was made of a sink-head ingot and of sink-head and comparison blooms, which was split in half longitudinally for this purpose. Although there was a high degree of segregation at the extreme top of the sink-head ingot, it was proved that about 9 per cent. discard would leave a steel entirely free from piping or appreciable segregation. Sulphur prints taken from the sink-head bloom showed an even tone throughout, as compared with decided irregularities in the case of the comparison bloom; the latter, in addition had an enclosed pipe extending to 12 per cent. below the top.

A chemical survey showed the analyses of both blooms as fairly uniform all through, except as regards sulphur in the comparison bloom, which, at a point even 21 per cent. from the top was as high as 0.12 per cent.

The rails manufactured during these tests were laid at two different locations on the Pennsylvania system, where a very heavy traffic is carried; at the first, after 11 months' wear, the Hadfield rails had lost by abrasion 0.42 sq. in. of their cross-section, and the Maryland rails 0.37 sq. in.; at the second the rails were still in service at the same date, and the loss was then 16.1 per cent. for the Hadfield rails and 9.7 per cent. by the Maryland rails. The latter were, therefore, evidently capable of the harder wear, although the report admits that this superiority is probably due to their nickel-chromium content, which is absent in the case of the rails from the sink-head ingots. Emphasis is also placed on the fact that it would be unfair to draw any general conclusions as to relative performance in service from so few rails as this investigation furnished. None of the Hadfield or the Maryland rails had failed during their period of service, but a limited test of this nature was not conclusive but, it is reported, will be repeated in the near future.

In conclusion, the report establishes the fact that after removal of the top discard of 13 per cent. the Hadfield type of sink-head ingot is free from piping and undue segregation, whereas the ordinary type of ingot, cast small end up without sink-head, as is usual in the case of rail ingots, requires an average top discard of 26 per cent., and even then the remainder of the ingot is liable to contain enclosed piping and excessive segregation.

The Railroad Section of the American Society of Mechanical Engineers

It is not so very many years since a paper on a railroad topic was an unheard-of event at the annual meeting of the American Society of Mechanical Engineers. The broad general character of the interests of the society did not attract railroad men who had their own mechanical associations which fully met all their needs. But as the ranks of the mechanical departments became more or less occupied by technically trained men, these men trickled into the society's membership and then naturally wanted something at the annual meeting to interest them; and when the sectional system of holding the technical sessions was introduced, the railroad section at once took on a vigorous life, and the papers presented to it were of an exceedingly high order. This excellence was very manifest in the three papers read at the December meeting, a second one of which is published in abstract in this issue.

The meeting this year throughout all of the sections was devoted to the elimination of waste in the various industries, and the same policy was held in connection with the railroad section. The paper published in December on the "Container Car," marks the recommendation of a decided departure from the old methods of handling package freight and one somewhat approaching the small car and warehouse method of loading that has been the practice in England. It avoids the detailed handling of small packages in unloading at stations and only needs a and reloading of the main or "parent" car as it is called. It will take some time for the railroads and the public to become accustomed to such an innovation, but when once started its popularity should grow rapidly as a means of not only effecting a prompt delivery, but of avoiding the damage inflicted on small packages and the innumerable claims resulting therefrom.

Mr. Elmer's paper, in this issue, is a masterly analysis of the means of getting the most possible work out of a locomotive for the least amount of money. The diagrammatic method of presenting the various steps and of recording the results obtained in operation are quick, accurate and scientific. The method of graphic representation of the virtual grades of a road should appeal to every engineer, and the speed curves indicating the speed at which the several sections of a line should be traversed by the several locomotives available, when hauling their full tonnage, would be of great use to a despatcher if worked out for the whole length of a division.

There is just one fly in the ointment of this meeting and that is the paucity of discussion. An author who presents a paper having the merit of any one of the three offered at this meeting, likes to have a full discussion upon it. He has devoted much time and hard work to its preparation, and naturally feels an interest in learning how his point of view strikes his colleagues. The lack of dis- of lack of interest on the part of those present, but from lack of time. The whole period allotted to the presentation and discussion of all three of these papers could very profitably have been devoted to any one of them; while to crowd the three into the short space of less than three hours made it impossible to do justice to any of them.

It is very easy, of course, to criticize, but to suggest a remedy is quite another matter. The papers are arranged for in advance. The committee makes as careful a selection as possible, but they cannot tell decidedly as to their character until they are in hand, and even then there is doubt as to the discussion that they will elicit. An advance computation of the time that should be allowed is more than difficult, and it is well not to have a flat session, so a surplus of papers is, perhaps, the safe rule to follow.

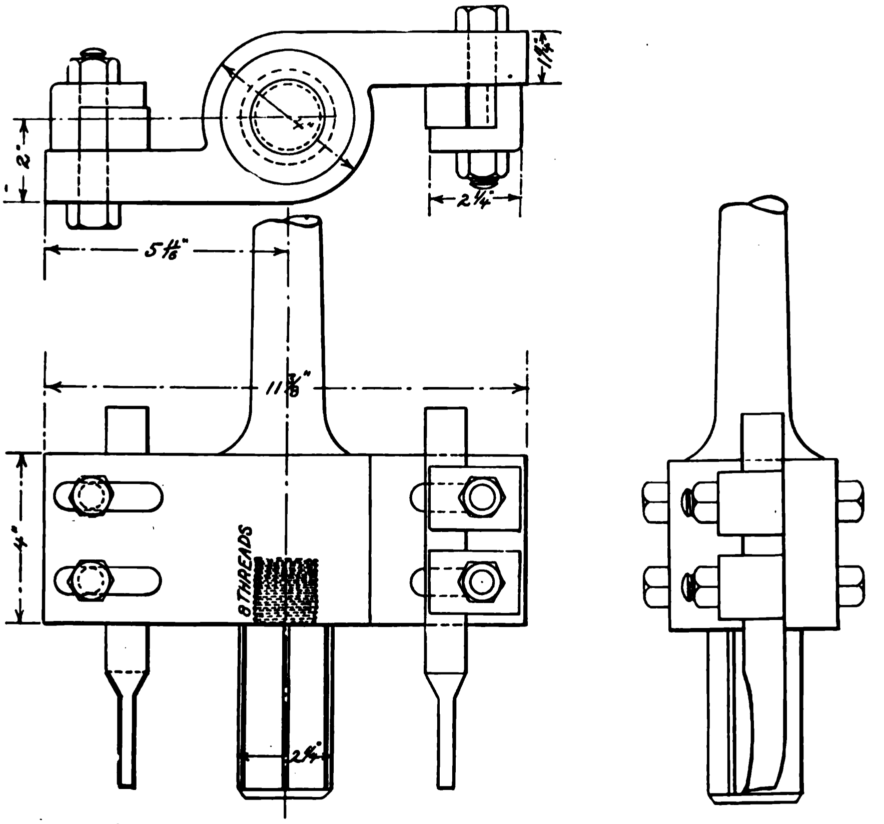
The only thing is that it may possibly be safe to trust to past experience. For the past few years it has been the rule that not enough time has been allowed for discussion. Why not risk a little more another year?

As for the authors of this year's papers, while they may be individually disappointed at the comparatively scant attention that their papers received, they must know from what has been said to them that they have presented remarkably fine specimens of work, and that this, like virtue, should be its own reward and it is likely that more attention will be given to

Devices in Use in Locomotive Repair Shops

Tool for Boring Side Rod Bushings—A Shoe and Wedge Spreader—Tool Post for Slotter

Boring the holes for side rod bushings is no longer the slow piece of work that it was when done with the ordinary bor-



TOOL FOR BORING SIDE ROD BUSHINGS

ing bar. It is now common practice to bore these holes on a drill press with a tool similar to that used for boring the large holes in a tubesheet for the superheater tubes.

The illustration shows a substantial tool designed for that purpose.

The spindle is turned to the taper of a standard No. 5 shank. The tool-holding portion is made so that the arms drop back and follow the tools, the cutting edges of which are nearly on the line of the same diameter so that if there is any springing of these supporting arms, while at work the effect will be to draw the tool in towards the center and make the hole smaller.

The cutting tool is held in place by an L-shaped strap and two ⅝-in. bolts for each. These bolts pass through slotted holes in the body, so that a radial adjustment of 1⅞ ins. of the tool is possible.

Shoe and Wedge Spreader

This is merely a small and rugged jack that stands only nine inches high over all when the screw is run home. There is a circular base four inches in diameter

the head of the screw is brought against the other and both are forced and held firmly in place.

The outside of the body is finished, and over it a tramming stem is made to slip easily. The stem itself is only ⅝ in. in diameter, and the band to which it is attached is only one inch wide and carries a brass set screw by which it can be fastened in any desired position.

After the screw has been run out so as to hold the wedges and shoe in place the stem is adjusted so that it stands centrally between the two, with the stem projecting outwardly. By having one of these spreaders between each set of shoes and wedges on a locomotive the distances from center to center of the pedestals can be readily trammed by setting the tram point in the center punch mark in the end of the stem.

Then if adjustments have to be made the screw of the spreader can be slackened back, the wedge moved, the stem reset to the new center and the distances again trammed. It can readily be seen that this method of adjusting the wedges is far more rapid than the old way of calipering and scribing a center line on the side of the frame, which may soon become a mass of indistinguishable center punch marks.

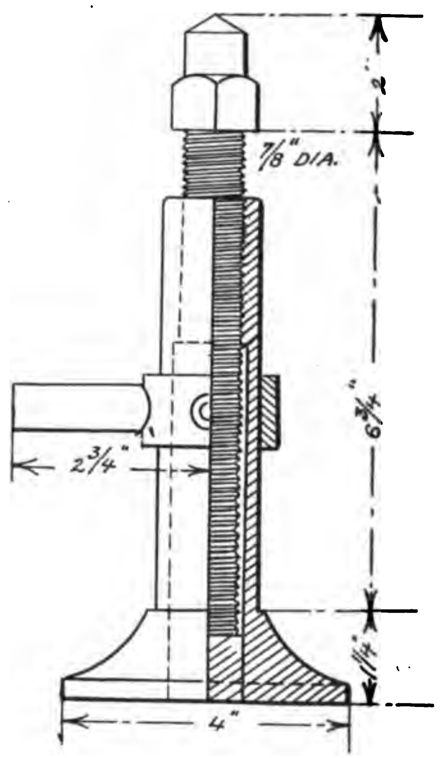
the frame at all, and the centers for the trams are always convenient and at the same level.

Tool Post for Slotter

This slotter tool post serves to carry three tools and is used for slotting out the spade handle of rod straps. The body of the post *D* is 3½ inches wide and 1 9/16 inches thick, and ends at the point marked *E* in a projecting lug 11/16 in. thick.

The upper tool *A* is held in a hole, passing through the body of the post by a wedge *F*, which is driven in above it. Below this are the two tools *B* and *C*. These are held in place by a washer *G* that slips over the stud *I*, and is tightened by the unit *H;* the stud being screwed into the body of the post.

As the tool *A* projects farther out from the post than *B* or *C*, it leads when the whole is fed into the metal and roughs out the center of the slot. Then *B* and



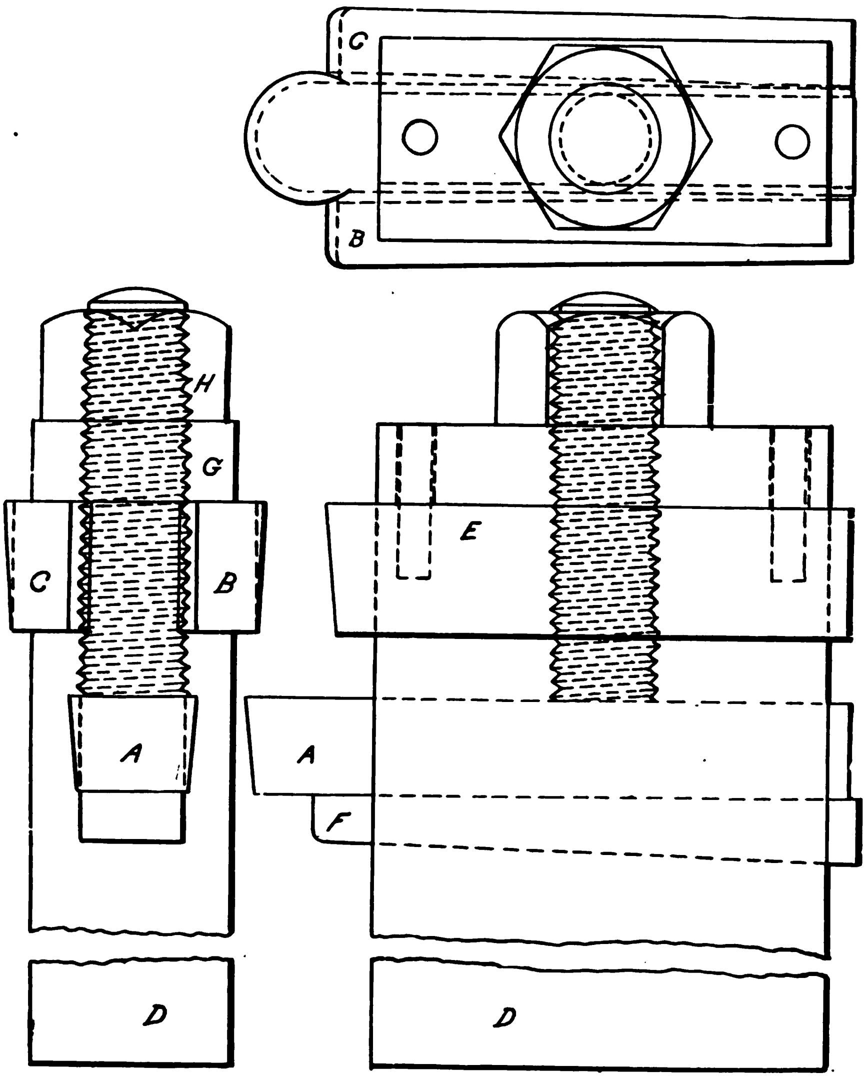
SHOE AND WEDGE SPREADER

C follow, and as they are adjusted so that their overall width is equal to that of the slot which it is desired to cut, they finish the sides so that the whole work is done with one set of tools and one setting.

When the tool *A* has cut to the bottom of the slot, its wedge is driven out and the tool removed, and then *B* and *C* tom of the slot. As these tools are rounded on their outer corners they leave the necessary fillet at the bottom of the slot.

Case Hardening

A case-hardening compound has recently been favorably reported upon consisting of 25 per cent water, 5.5 per cent cyanide of potassium, 2.25 per cent glue or gelatine, 27.5 per cent graphite or coke powder, 9 per cent wood or animal charcoal, 5 per cent calcium fluoride, 9.5 per cent potassium ferro-cyanide, 6.25 per cent carbonate of potash or soda or both, 5.5 per cent silicon dioxide, and 4.5 per cent ammonium carbonate or carbamate or both. The gelatine or glue is dissolved in the water and the potassium cyanide added. The other ingredients are added as a dry mixture and the whole stirred to form a paste. This paste is applied to the surface of the article to be carburized, which is previously heated to a temperature of about 150° C., and the whole is then raised to



TOOL POST FOR SLOTTER

Heating is continued for a period of time depending on the depth of penetration required, after which the article may be hardened by quenching in the usual manner.

Renewing Worn Files

Perhaps the best method of renewing old files consists first in cleaning them with a "file card" after which they are placed in a mixture of four ounces of washing soda and one quart of very hot water, in which mixture they are then scrubbed with a brush to remove oil, dirt, etc. The acid mixture to which the files are then transferred consists of four ounces of sulphuric acid in one quart of water. It should be remembered that when diluting sulphuric acid with water sudden heat is developed such that if the water is poured upon the acid dangerous spattering will occur. The acid should always be poured into the water very slowly and the solution stirred with a piece of wood or a glass rod. The old files remain covered in the solution for

thoroughly washed in water, dried and oiled.

Development of the Asbestos Industry in Canada

A recent discovery was made of asbestos-bearing rock which gives promise of being of considerable value. Consul Norton F. Brand in a recent report states that the deposit is located in the serpentine rocks of the Canadian Pacific Railway connecting Revelstoke and Arrowhead and is about four miles north of Arrowhead.

The Montreal *Daily Star* recently announced that a large manufacturing plant for making asbestos products is about to be constructed in the Province of Quebec. According to this article about 80 per cent of the asbestos produced in Canada has heretofore been exported to the United States, while nearly all of the Dominion's requirements of asbestos products has been reexported from this country. It is understood that asbestos constitutes about one-half of the mineral production of the Province of Quebec.

Burning Coal Dust

Owing to the high cost of coal great attention is being given by engineers to the burning of coal in the form of dust. This process involves, of course, the thorough pulverising of the coal, and its success depends largely upon the efficiency and economy of the machinery for drying of coal and reducing it to an extremely fine powder. In order to meet this problem, a British inventor had devised a very compact plant on novel lines for pulverising coal. The machine consists of a cast-iron casing inside which a steel disc rotates at a very high speed. On both sides of this disc are mounted four concentric rings of projecting steel studs. which intermesh with those on the disc. The coal is fed into the machine in the form of small lumps, and when it impinges on the disc it is thrown outwards away from the shafts, and between the fixed and revolving rings of studs. Any desired amount of fineness can be produced by this machine, which also dries the coal through the action of a fan, which draws air into the casing. The inventor of this machine has also discovered that by mixing the coal dust with a little oil, it is possible to get a remarkable degree of heat out of very inferior fuels.

Safety of Railway Passengers

The Interstate Commerce Commission reports that the railways of the United States carried in 1920 about 1,300,000,000 passengers, with one killed for each group of 5,673,000 carried, while in a total of 472,000,000 people carried in 1889, the death rate was one in 1,523,000. The danger to life of railway travelers in 1920 was therefore less than one-third of what it was in 1889, most of the reduction ac-

Train Resistance

In all development, evolution tends to work from the simple to the complex, from the amœba to man, as it were. In the later forties of the last century, General Moran made some investigations as to frictional resistance. They were very elaborate for their day and generation, and from then he enunciated certain simple laws of frictional resistance that were held as final for nearly forty years. Then came the Westinghouse-Galton investigations that knocked Moran's rules out of the ring, as it were, and we learned that frictional resistance varied with speed, temperature, time of contact and a lot of other factors which have kept our laboratories busy ever since with the end very far from being in sight. So with train resistance we started out with a very simple formula. Speed was the only variable. We squared it, divided this square by 171, added 6 and there we had the resistance in lbs. per ton on a straight and level track. Add half a pound per ton for each degree of curvature and the percentage of the grade times 2,000 for uphill work and the whole problem was solved, in short order and to the satisfaction of the man who was content to use the formula.

Then came the more extended use of the dynamometer car, and it developed that length of train as well as weight of train had its effect on the total resistance. It appeared, after a time, that a long train required more of an effort to pull the same tonnage around a curve than a short train. Then the relation of curve to tangent began to make its influence felt as well as length of curve, until the whole problem seemed possible of statement only by the use of a mass of variables. Well, if we are to become a man instead of remaining an amœba, we must put up with complexity and involved conditions.

In his paper before the December, 1921, meeting of the American Society of Mechanical Engineers, Mr. William Elmer, division superintendent of the Pennsylvania R. R. at Altoona, gives a formula for train resistance, which may be regarded as the latest development in that line.

In this the resistance of the locomotive is very properly separated from that of the train. That is, in the formula for train resistance, he excludes the locomotive machinery and head on resistance but includes the remainder of the resistance of the locomotive, that is its rolling resistance, the total resistance of the tender and the cars behind the tender. This is represented by R.

The formula as it has been developed for total train resistance, with the exclusions noted above, for a train hauled by a mikado (2-8-2) locomotive is as

$$R = 100\,N + 1.5\,W + .01\,(V + 16)\,V\sqrt{WN} + (C + 20\,G)\,W$$

in which

R = Total train resistance (with exceptions noted),

N = Number of cars behind tender plus three (3), as the equivalent of the locomotive and tender,

W = Weight of entire train in tons of 2,000 lbs., including locomotive and tender,

V = Speed in miles per hour,

C = Curvature of track at 1 lb. per ton per degree of curve,

G = Grade as expressed in per cent.

This is for a mikado locomotive. The use of another type would presumably change the formula. Length of curve has its effect, but where the curve varies in the length of the train as it almost always does under present day conditions, where a train may be running over several curves at once, apparently the only way to develop the total resistance of a train is to plot a vertical profile over the actual profile, as explained in Mr. Elmer's paper, which practically eliminates the C from the formula.

The next step in the development of the formula will be to determine the effect of length of train on curve resistance. That it has an effect there is no doubt, the point is to determine what it is. So our simple little formula that would have been so satisfactory had it been sufficiently accurate must, like Moran's laws of friction, be relegated to the realm of the has-beens with due regard for the usefulness which it once possessed.

Bascule Bridge at Chicago

Unusual conditions are attending the construction at Chicago of a double-deck double-leaf trunnion bascule bridge over the Chicago River.

Each of the leaves is being built in an upright position arching the tracks and framework of the old bridge, and when they are completed it is proposed to swing the old central pier bridge out into the river, cut a V-shaped hole in it with oxy-acetylene torches, and then lower the new bridge into the hole and across the river.

The structure measures 268 ft. between trunnion centres, and 3,600 tons of steel are required, with 2,600 tons of counterweight. For working it four 100 h.p. electric motors will be provided, the machinery weighing approximately 300 tons. The actual time required for opening will be one minute, and the way will be open in 2¾ minutes after a steamer whistles for passage. The work when completed will greatly facilitate the traffic in the

Coal Miners Wages and Output in England

Although the price for British coal for export has decreased, it is still too high to create a sufficient demand, the industry being in that peculiar condition where a surplus of coal is piling up on every hand while prices are still so high that few will buy, says a report from Trade Commissioner Alexander V. Dye, London, to the Department of Commerce. Unemployment is a natural result, and there is an appeal on behalf of the miners' unions for Government relief to tide over the situation. Taking the South Wales district as an example, wages for the month of November were adjusted at a meeting of the South Wales Joint District Coal Board at Cardiff on November 1 on the basis of the auditors' report. Wages will be reduced almost to the minimum under the recent agreement—that is, the wages will be about equivalent to only 20 per cent increase on the average earnings in July, 1914.

On the matter of increased efficiency of the industry the two lines of thought which are being followed are economy in coal waste and the increased use of labor-saving machinery. At the present time about 15 per cent of the coal mined in Great Britain is mined by machinery, as against about 59 per cent in the United States. Doubtless a great deal can be done toward increasing the sale in this country of labor-saving machinery in coal mining, and it is significant that those American machinery exports which have survived the stress of the present depression and are still doing a fairly good business are those which consist of mining machines which contribute to the lower cost of mining.

Railway Construction in Portuguese East Africa and Nyassaland

The railroad from Beira and the east coast of Portuguese East Africa to the interior has been completed to the Zanque River, a distance of 159 miles. Here an iron bridge, with five spans of 90 feet each, must be constructed across the river. This line eventually is to reach into the interior of Africa, with Chinde on the Zambezi River as terminus for a few years. The new line is proposed to connect this part of southern Africa with Lake Nyassa and the promising country thereabouts. It is to be 125 miles in length and will call for special engineering and a large amount of material, including some bridge construction. The interior of Africa for which Beira is the outlet is very rich in natural resources, and offers a splendid opening for American capital in extensive development work that would greatly assist American trade in that part of the world and which has been to a very considerable extent overlooked in the past but will be

Mikado Type Locomotive for the Missouri Pacific Railway

In the issue of this paper for September, 1921, there was published a description of three types of locomotives that had just been completed at the time. The list included three engines, but was incomplete in that it lacked a mikado locomotive the description of which was promised for a later issue. These mikado locomotives, of which twenty-five were built, were designed to develop approximately 60,000 lbs. tractive force. Two of the engines were fitted with boosters and the others were without it. It has been found that the engines fitted with the booster will handle, on an average, 13.5 per cent more tonnage than the sister engines not so equipped. These mikado locomotives have displaced the light government type mikado locomotives which were allocated to the Missouri Pacific Railroad during the war. These government mikados, it will be remembered, had a tractive effort of approximately 55,000 lbs. These new engines have therefore, approximately 10 per cent more tractive effort and are handling about the same additional amount of tonnage.

MIKADO 2-8-2 TYPE LOCOMOTIVE FOR THE MISSOURI PACIFIC RAILWAY
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

The engines are also fitted with the circular plate designed by Mr. Charles Harter, the mechanical engineer of the road, and it is considered that the increase of evaporative power thus obtained in the boiler, by this means, is responsible for the possibility of the high performance that has been obtained. The boiler itself is of the ordinary type having a combustion chamber 23 in. deep. The circulator was designed for the purpose of making a material addition to the capacity of the boiler, and it is estimated that this addition amounts to about 11.8 per cent.

In some tests made with the engines, they have been run with the reverse lever in full gear position, the throttle wide open and the engine drawing a full tonnage train at a speed of about 10 miles an hour up a ruling grade of 1.5 per cent with the injector on and holding the steam at the maximum pressure.

This point made by the officials is that the circulation plate makes it possible to use the booster when it is most needed, at a speed of 10 miles an hour without drawing on the boiler beyond its capacity; for if the boiler were not capable of supplying sufficient steam to both the locomotive and the booster under these conditions the utility of the booster would be very materially lessened. The ruling grade where these booster tests were made is about five miles long, and it is contended that, if the boiler were unable to furnish all of the steam needed for both the locomotive itself and the booster, the fact would have been developed in that distance.

The booster is calculated to have added about 10,000 lbs. to the tractive effort of the locomotive. In the estimates of the builders (The American Locomotive Co.), the factor of adhesion of the locomotive without the booster is put at 3.9; for those having the booster it is placed at 4 for the driving wheels and 6 for the trailing wheels to which the booster is attached.

Another difference brought about by the booster is a redistribution of the weights and an increase of the total weight in working order. This is raised from 320,000 lbs. to 327,000 lbs.; that on the drivers was raised from 233,000 lbs. to 237,500 lbs., and that on the trailing wheels from 56,500 lbs. to 60,000 lbs., while the weight on the leading truck was reduced from 30,500 lbs. to 29,500 lbs.

One of the incidental details used in these locomotives is that of a floating bushing for the middle connection bearing, which is considered to be a great improvement over the stationary bushing for engines of this size.

The general dimensions of the engines in addition to those already given are:

Wheel base driving wheels	16 ft. 6 in.
Wheel base total	36 ft. 3 in.
Wheel base engine and tender	71 ft. 1½ in.
Steam pressure	190 lbs.
Fire box width	84¼ in.
Fire box length	114¼ in.

All of the firebox sheets are ⅜ in. thick except the tube sheet which is ⅝ in. thick.

The water spaces at the sides and back are 4½ in. wide and 5½ in. at the front.

Tubes length	19 ft.
Tubes diameter	2¼ in.
Tubes spacing	¾ in.
Tubes number	199
Superheater flues diameter	5½ in.
Superheater flues number	45
Heating surface tubes	2,214 sq. ft.
Heating surface flues	1,223 " "
Heating surface firebox	263 " "
Heating surface arch tubes	27 " "
Heating surface total	3,727 " "
Superheater surface	1,051 " "
Grate area	67 " "
Diameter driving wheels	63 in.
Diameter front truck wheels	33 in.
Diameter trailing truck wheels	43 in.
Tank capacity water	10,000 gallons
Tank capacity coal	16 tons

The engine is fitted with piston valves 14 in. in diameter, having a travel of 7 in. and an outside full gear of ⅛ in. They are set line and line on the exhaust ports.

The engines which are not fitted with the booster are equipped with the Delta truck arranged for a future attachment of the booster, and the Madden ashpan is also arranged with the same purpose in view.

The following is a list of the specialties that were used:

Miner draft gear; National dust guards; Duplex type "D" stoker; Hanlon sander; Okadee blowoff cock; water gauges, No. 5 Reflex; electric headlight, Pyle on 15 and Sunbeam on 10 engines; O'Connor firedoor flange; Unit Safety drawbar, Franklin; engines equipped with hand as well as air sanders; Barco smokebox fittings; Jimco unit spark arrester; Okadee tender hose complete with strainer; steam gauges, Ashton Valve Co.; safety valves including bushings, Consolidated Safety Valve Co.; injector checks, Hancock vertical; constant resistance type engine truck with cast steel frame; Franklin adjustable driving box shoes and wedges, driving box shoes of bronze; Chambers throttle valve; Linstrom tank syphon; King U. S. Metallic Packing; Renu Gauge Cocks; Barco Flexible Joints; Chicago flange oilers; Nathan special A main steam turret valve; Nathan reverse gear air and steam throttle valve; Nathan whistle; Tender brake beams, Buffalo Brake Beam Co.; Franklin No. 9 firedoor; Alco reverse gear; Alco flexible staybolts and flexible expansion stays; Franklin radial buffer; Commonwealth engine bumper beam; Franklin grate shaker; Franklin (Elvin) driving box lubricators; Johns-Manville boiler and cylinder lagging and pipe covering; Firebrick, American Arch Co.; injectors, Nathan simplex No. 11 type R 5,000 gal. lifting; lubricator, Nathan 6 feed type No. 166 with single booster attachment; Klinger No. 5 Reflex water gauge, Nathan; Woods tender side bearings; Edna coal sprinkler.

A blow-off valve is applied in the back of the dome.

Nickel Steel in Bridge Construction

Commenting on the use of alloy steel in bridge building *The Canadian Engineer* in a comprehensive article claims that it would naturally be expected that the first step in the development of improved steel for bridge building would be the adoption of a metal of higher carbon content. Economical results were obtained by so doing in the Hell Gate arch bridge, completed in 1917. The materials used in this structure had an ultimate tensile strength of from 66,000 to 76,000 lb. per sq. in., an elongation in 8 in. of generally 20 per cent, and an average reduction in area of 45 per cent. The rather small increase in strength attained through a higher carbon content would generally leave the so-called hard steels at a disadvantage with respect to nickel steel, but as the price of nickel steel at the time of the construction of the Hell Gate bridge was excessively high, high carbon steel was found to be more economical. In the 644-ft. riveted truss span over the Ohio River at Louisville, Ky., built in 1919 by the Pennsylvania Railroad, this same grade of high carbon steel was used for all main truss members.

More extensive use has been made of nickel steel than of any other special steel for long span bridge construction. As a result of the investigations made in 1903 by Gustav Lindenthal, the eye bars of the Queensboro cantilever bridge were made of nickel steel. Following this, it was natural to employ this material for the stiffening trusses of the Manhattan bridge, completed in 1909, and in the 668-ft. truss spans of the municipal bridge at St. Louis. extensive use was made of 3¼ per cent nickel steel in the rebuilt Quebec bridge. This material was used in the trusses of the suspended span and in certain parts of the cantilever arms, with entire success. The same experience attended the use of nickel steel in the 591-ft. arch span of the Detroit Superior bridge at Cleveland, built in 1915.

One of the most interesting developments in the use of alloy steels in recent years has been the employment of a natural alloy of nickel-chromium steel, containing from 1 to 1½ per cent of nickel and from 0.2 to 0.75 per cent of chromium with small sulphur and phosphorus content, and manganese, as desired. The ore from which this steel is made comes from Mayari on the Island of Cuba, and hence the name. The ultimate strength of the material ranges from 85,000 to 100,000 lb. per sq. in., and the elastic limit is at least 50,000 lb. per sq. in. On account of the greater variation in the elastic limit than occurs in a synthetically manufactured steel, working stresses used to be more conservatively chosen than for other alloy steels. Because of its natural origin, this material is, under certain circumstances, able to compete favorably with the steels manufactured according to current processes. Mayari steel was first used for a large bridge in the Harahan cantilever at Memphis, Tennessee.

Interesting possibilities were disclosed in the use of silicon steel in the 720-ft. truss span of the Chicago, Burlington and Quincey Railroad bridge over the Ohio River at Metropolis, Ill., built in 1917. This material was a carbon steel with silicon, carbon and manganese above the percentages used in ordinary bridge steel. It was found to work out cheaper than Mayari or nickel steels in this structure. Eyebars were of nickel steel, but built up tension members and compression members were of silicon steel. This material made possible the use of a basic working stress of 25,000 lb. per sq. in. in tension and 30,000 lb. per sq. in. in compression, adequately reduced.

British Railways Reduce Rates

The reduction of railroad rates, so urgently demanded as a step toward industrial readjustment, took effect on January 1, 1922. The reductions apply to England and Wales, but not to Scotland.

The cost of all coal for export will be reduced about 8 pence per ton, industrial coal 11 pence per ton; altogether, about 75 per cent of the coal mined in the United Kingdom will be covered by the new rates. There will be a 15 per cent reduction in the transport cost of iron ore, limestone, pig iron, and semifinished steel. The rate for finished steel products is unaffected, remaining 100 per cent above the 1914 basis, plus 6 pence per ton flat additional. This phase of the revised rate plan is not favorably received by most traders.

The first of the nine sections into which the table is divided deals with the maintenance and renewal of permanent way and rolling stock. The figures therein are based on the expenditure in 1913, plus 200 per cent due to increase in prices. The charge in 1913 was £25,000,000; the estimate for 1920-21 was £75,000,000. The second head deals with locomotive running expenses, based on estimates furnished by the large companies and allowing for increased cost of coal. These are taken as £57,000,000. If a reduction based on the decreased cost of coal by 37 per cent is allowed, the sum will be approximately £36,000,000, yielding a reduction of £21,000,000 sterling.

It is the opinion that the reductions in rates will not only benefit the particular industries whose commodities are affected but that, as a result, trade in general will be stimulated. The rates of wages today are adjusted by a sliding scale based on the official figures of the cost of living, which on November, 1921, was at 203, as against 100 in July, 1914.

Railway Decontrol

F. J. C. Poole, manager of the Great Western railway of England writes interestingly on "Railway Decontrol," stating that what will happen in the immediate future is, a question which not only directly concerns every employe of the railroads, but it, in a large measure, dependent upon the individual exertion of each one of them. Henceforth, the receipts of the undertaking must be made to exceed its expenses by a margin sufficient to pay a reasonable dividend to those who have found the money to provide the property and plant by which the industry is carried on. To-day railways are confronted with a difficult outlook. Trade has been injured by causes with which everyone is familiar.

On the other hand, railway transport has more formidable competitors than hitherto. These competitors, moreover, are favored by having a road provided for them largely at public expense, and in many cases the vehicles represent purchases of Government motor trucks at bargain prices, while the railways have to bear the handicap of high prices of materials and labor. These conditions have to be faced, and it is the manifest duty of every employe to use every means in his power to increase the company's business, to promote efficiency and to effect all possible economy. The railway urgently needs more traffic, and Mr. Poole urges every employe to give full, immediate, and courteous attention to every inquiry made by the public, and to spare no effort to ensure efficiency and to give satisfaction in every kind of service.

Proposed Reduction in Freight Rates

The Government has been advised that the railroads have agreed to make a reduction in freight rates on export coal to seaboard points, the cut approximately one dollar per ton. Railroad rate cuts together with the proposal of the coal operators that they are willing to sell their coal at production costs in order to recover export coal markets that have been captured by the British may be followed by reductions in other directions.

Avoidable Waste in the Operation of Locomotives and Cars*

By WILLIAM ELMER, Division Superintendent Pennsylvania Railroad

Taking an average of the performance of the freight locomotives of the country it has been found that they make an average of 59.3 miles per day, or 1,800 miles per month, and that they earn about $6.25 per mile. How can we excuse an average mileage for all the freight locomotives in this country of less than 60 miles per day? The locomotive spends its entire time either in the hands of the Transportation Department moving trains or ready to move trains, or in the hands of the Motive Power Department being repaired and prepared. Roughly we may say that the engine is in the hands of each of these departments about half the time. Of course there is avoidable waste in each.

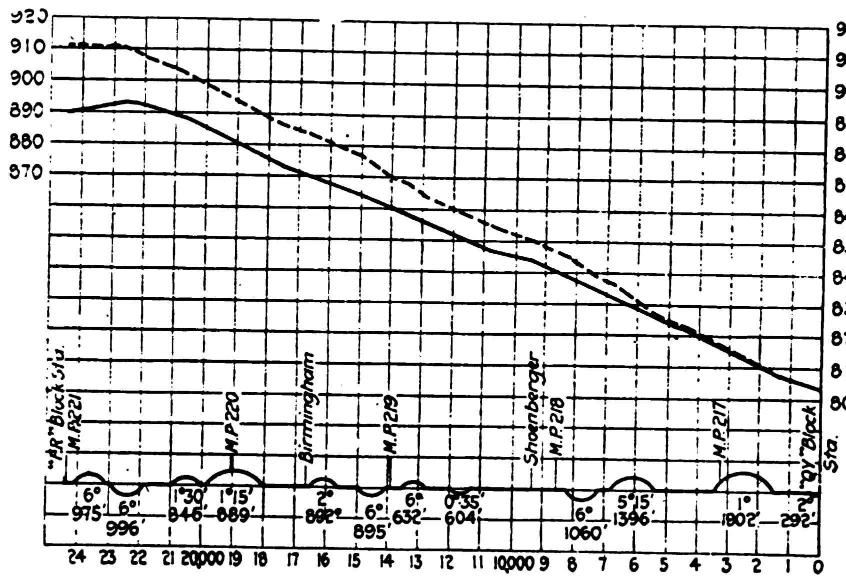
Taking up first the Transportation Department, there are two broad inquiries which may be made:—(*a*) Are the engines properly loaded? (*b*) Are they properly used?

A track chart of the road is necessary, giving the distances from the starting point to the beginning and ending of each curve and tangent, with the degree of curve, and elevations of points where the grade changes. With these data a true profile may be plotted, showing the elevations above sea level and the actual grades; but this profile will not be fully representative of the resistances encountered by moving trains until it has been transformed into an equivalent compensated profile by superimposing the curve resistances on top of the grade resistances for each direction of traffic. We can imagine a level railroad so full of sharp curves that a very considerable resistance would be experienced by a moving train. Many experiments have been tried in an effort to find how much resistance various curves offer to a moving car, and we will take one pound per ton of 2,000 lbs. per degree of curve. The resistance due to grade is fortunately an exact mathematical quantity—20 lbs. per ton for each 1 per cent of grade. Therefore each degree of curve offers the same resistances as a 0.05 per cent grade. A six-degree curve had the same resistance as a 0.3 per cent ascending grade. A grade which is climbing upward at the rate of 26.4 feet per mile or 0.5 per cent and has in it a six-degree curve, or 955 foot radius, will therefore have superimposed on the true grade of 0.5 per cent the equivalent resistance of a 0.3 per cent grade due to the six-degree curve; or a total equivalent grade of 0.8 per cent. Of course to a train coming down this hill the equivalent grade would be the difference between these values, or 0.2 per cent.

The result of such an adjustment is shown in the accompanying engraving. In this the solid line indicates the profile of the road as it is laid out. At the bottom is the usual diagrammatic representation of the alinement. The adjusted profile is shown by the dotted line. In this the original grade has been preserved for the tangent portions of the line, while the grade has been increased for the curved portions. The resultant is a steeper grade than the profile would show. In fact, while the actual difference in elevation between stations 0 and 24 is 86.77 feet, the curves have added an equivalent of 21.467 feet more, or a total equivalent rise of 108.237 feet.

some more complicated formula becomes necessary in the calculation of the tractive power required for moving trains. Besides the resistances due to curves and grades, trains are affected by journal and flange friction, wind, rolling resistance, temperature, etc.

It is a well-known fact that trains cannot be loaded on tonnage alone. One hundred empty cars weighing 20 tons each would be a 2,000-ton train, and might overload an engine to the stalling point, whereas the same engine on the same grade would handle twenty-five 80-ton cars with no trouble. The number of axles is the important factor, and in order that a long empty train may have the same resistance as a short loaded train it is necessary to use a factor for each car known as the adjustment factor and this factor



PORTION OF A RAILROAD BETWEEN BLOCK STATIONS Q Y AND F R

will vary with the different physical conditions met with on different divisions. This involves the use of the adjusted tonnage rating now in general use, with various modifications on different roads.

Having determined the equivalent grade, it will be necessary to decide whether it can be operated as a momentum grade or not. If the length of the grade or other physical conditions on the approach prevent attaining any considerable speed, the dead pull of the locomotive will have to be depended on to get the train over. The tractive power of a locomotive is readily calculated. When a locomotive is moving, some of its tractive-power effort is used to overcome friction of the engine and tender, and on a grade some more is needed to lift its weight against gravity, and at speeds of more than six or eight miles per hour the boiler becomes a factor in its inability to furnish enough steam to follow the pistons with full pressure under long cut-off conditions, so that

With this means of adjustment at hand the next step is to develop tractive power curve for the different engines, showing the speed that they should be able to maintain over that grade. Such a curve is shown in the diagram of the tractive power-speed and train resistance curves shown herewith. And this can be followed by the laying out of a schedule of the schedule between various towers, or stations, with a proper allowance for delays and analysis of road conditions, as well as of the adjusted profile and tonnage rating.

*Abstract of a paper presented at the December, 1921, meeting of the American Society of Mechanical Engineers.

Now comes the crux of the whole matter. After the tonnage has been established, what are the results on the road? Do the trains lose so much time that they cannot get over the road without excessive overtime? If the dispatching and terminal and road supervision are all that they should be and a record has been made for a sufficient period from which may be drawn reliable conclusions, we can determine whether the overtime is excessive—in which event the tonnage should be decreased—or if the majority of the trains get over the road within the overtime limit, then the tonnage should be increased. And in order that the results of a day's work may be immediately available they should be plotted in the form of a diagram.

So far as the Motive Power Department is concerned it is important to have reliable reports which present promptly to the responsible operating officers on the succeeding day if possible all the pertinent facts concerning the performance of the locomotives available. Then in order that the locomotives may be used to the best advantage the facilities at the engine terminals should be ample to promptly inspect and repair all arriving locomotives.

The avoidable waste in the operation of cars may be considered under three heads:

a. The utilization of cars in the hands of agents, shippers and consignees.

b. The handling and displacement of cars in yards and on the road.

c. The inspection and repair of cars by the maintenance of equipment department.

The committee of engineers appointed by Secretary Hoover some months ago to investigate waste in industry made a most amazing report. They undoubtedly gave this question careful study and the report that they made brought out the fact that the production of this country could be immediately increased about 50 per cent by the full utilization of existing facilities.

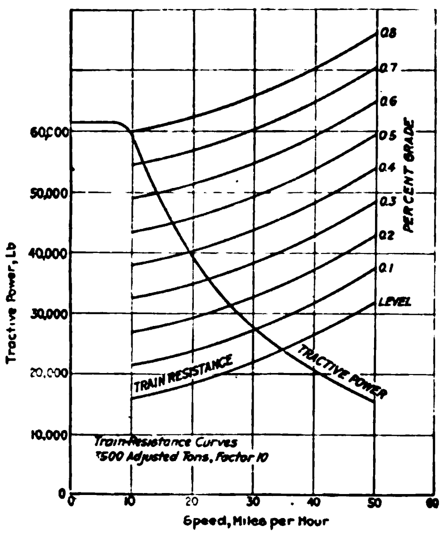
So far as the railroads are concerned one great means that suggests itself is that the maximum loading be secured for the car in the minimum time.

It is a fact not generally recognized that car loading affects the cost of railroad operation very seriously, not only because the paying load may be a small percentage of the gross train load, but also because lightly loaded cars require more tractive effort per ton than heavily loaded cars, e. g., the average weight of a car is from 15 to 20 tons, while the average weight of all commodities is averaging approximately 27 tons. The load of the car itself must be hauled with every movement of the contents and requires as much tractive effort on the part of the locomotive per ton to move this weight as it does for the contents, therefore the importance of keeping the percentage of lading to total weight as high as possible is self-evident. Cases are on record where an increase of car loading has more than liquidated a car shortage.

Next to fully loading the cars comes the prompt release of cars under load as a large factor in the efficiency of a car.

After the cars have been loaded and waybills furnished by the agent to transport freight from point of origin to destination, it becomes the duty of the train master to arrange for movement and delivery with the least possible delay consistent with economical operation. This necessarily involves good organization and effective supervision to accomplish proper movement through yards and over the road.

When a train from the receiving yard has been distributed on the various tracks of a classification yard, the original train has lost its identity and a variety of conditions may arise at this stage of the operation that seriously influence the time consumed by cars enroute to their destination, which may necessarily be repeated from one to many times between the originating point and destination of cars, depending on the distance and the territory over which they are moving. The time required to assemble sufficient tonnage for a train in the classification yard is very largely dependent on the steady or intermittent arrival of trains in the receiving yard; also on the hauling capacity of road locomotives used on trains dispatched in the same direction, which may be 35 or 50 cars from one yard and 100 to 115 cars from another yard for the same class of locomotive, depending on the ruling grade of the division over which trains are being hauled.



TRACTIVE POWER-SPEED AND TRAIN-RESISTANCE CURVES

(Engine: Mikado, 27 × 30 in.; wheels, 62 in.; steam pressure, 205 lb.; superheat, 100 deg. fahr.; heating surface, 5193 sq. ft.; evaporation, 9 lb. per sq. ft. of heating surface per hour.)

In this connection another primary cause of delay in assembling trains in the classification yard is to be found in the usual number of classifications imposed upon certain yards for the convenience of connecting divisions to meet their requirements for various reasons, but primarily due to inadequate track and switching facilities. So-called "prior classifications" are also a source of yard delay at the point where they are assembled, but the time thus consumed is presumably offset by saving in time at the next yard or terminal point where such trains are kept intact and delivered to the division in advance thereof without reclassifying, which means an actual saving in the aggregate time consumed from shipping point to destination, also in operating expenses. Therefore a considerable portion of yard delay is beyond control, owing to prevailing conditions that cannot be eliminated. However, there is ample opportunity for minimizing yard and road delays to train movement by employing the best operating methods, maintaining sound organization and efficient supervision.

When trains are hauled over the road certain defects develop, and by the time they reach the terminal of a run a certain portion of the cars, say 3 to 5 per cent, must go to the shop for repairs. These repairs may be light, medium or heavy. As repairing means delay, it should be the aim of the operating officials not only to see that all cars are repaired, but to have the cars repaired promptly and returned to service in the most expeditious manner.

CONCLUSION

The great secret of the entire operation, therefore, is coöperation and teamwork, and these can be checked by suitable reports.

The statistics which reach the superintendent's desk, giving hourly, daily, weekly and monthly information, are many and varied, and originate from numerous sources, but the reports scanned by the author with most interest each day are those which tell where each of the heavy road freight and passenger engines were the day before and what they were doing. There is a maxim, "Take care of the shillings and the pounds will take care of themselves." It seems to apply particularly to the railroads. Take care of the engines and the dividends will take care of themselves. Of course this could not be literally true, but there is so much involved in this "taking care of the engines," embracing as it does the time and inferentially the money spent in locomotive repairs, the quality of back-shop and enginehouse work performed, the proper tonnage rating, and suitable loading of engines in order to obtain the most economical road speed, the reduction of delays getting into and out of yards, the inspection and repair of car equipment, the efficiency of water stations, coal-, sand- and ash-handling plants, the organization and operation of wreck forces, the handling of local freight and work trains; in fact, almost each and every one of the thousand and one matters that go to make up a successful operation of a division. If any one of the features named above is not functioning properly, as well as others too numerous to mention, the effect will be seen in the slowing down of the road speed or a lowering of the average mileage per serviceable locomotive or a falling off in the loading efficiency. All these must be at their highest possible levels of practical performance, and when they are a glance of the eye at the daily barometer ought to tell it, and when they are not, a few minutes' inspection of the data ought to tell why and point the remedy. The supervisors must have tracks fit for speed and service; the signal engineer must have communicating systems and signal apparatus in good working order; the road foreman must have engines properly rated and sufficient crews and supervision; the train master must have his yard and road forces properly instructed and disciplined; the division operator must have his train dispatchers and signalmen alert and intelligent; and the master mechanic must produce the power in ample quantity and fit for service. If the division superintendent can be assured that everything is being done that can be done to have every available engine in service that can be put in service, and that every engine dispatched is being loaded to the maximum number of cars it can economically haul, then he is assured of an economical performance and an avoidance of waste in the operation of locomotives and cars.

Bids for Electrification of Brazilian Railway

The long-expected notice for sealed bids for the electrification of the Central of Brazil Railway was finally published in the Diario Official for November 27, 1921. The notice calls for proposals on the electrification of stretches of the line, the operation of traction and transport material, the construction of sub-stations, and various other improvements on this important Brazilian railway. It is quite probable, however, that a new "edital" will be issued, as strong objections have been made to some of the terms of the present one.

The proposals will be received on March 30, 1922, at 1 p. m. A bond of 200 contos is exacted to guarantee the signature of the contract. After that day and the day following a judgment of the fitness of the competitors, a day will be set for the opening of the proposals, following which a selection will be made.

Only those competitors will be considered as fit who can prove, in addition to sufficient capacity, that they have furnished and mounted large installations of electric traction, including installations for maneuvers in large railway yards. In order to guarantee the execution of the contract, the bond will be raised to 500 contos of reis.

The works relating to the suburbs of Rio de Janeiro are to be concluded within a period of two years and the other works within a period of three years, both counting from the date of registry and approved by the Tribunal de Contas.

There will be three or four substations, the first being between Mangueira and S. Francisco, the second close to Deodoro, and the third or fourth between Deodoro and Belem.

Thirty locomotives will be furnished, 10 for freight and 20 for passenger trains. For the suburbs, 66 electric cars (carros motores) will be acquired, composed of 60 first-class cars and 6 second class; 100 second-class box cars will also be purchased. For the SS and SD trains, there will be 32 electric cars (carros motores) and 48 box cars (carros reboque).

Electrification of Railways No Panacea

The *Canadian Engineer* states that it is typical of the attitude of many persons towards the electrification of railways who have not carefully investigated the subject that with electric energy available in large quantity and reasonable price, the electrification of railways should be merely a matter of course. The experience of railway engineers and operating officials indicates that the matter is not at all so simple as it appears.

The principal reason that branch lines, lines about railway terminals and favorably situated main lines have not been generally electrified is that the original capital outlay is very large. For example, on the Chicago, Milwaukee and St. Paul which has a larger electrified mileage than any other railway in America, totaling in all 647 route miles, the cost of electrification was in the neighborhood of $28,000 per mile. This did not include the building of power houses or the development of power, as the necessary energy was purchased from a private power development company. It is the general experience that the costly improvements necessitated by electrification can only pay on lines where there is intense traffic, or where there are especially heavy grades and curves, or excessively low temperature handicapping the operation of steam locomotives, or congestion and complication such as occurs in terminals. An indication of the care with which electrification needs to be carried out in order to be commercially practicable, is seen in the fixing of the electrified zones on the C. M. & St. P. Railway. Originally, 440 miles were electrified in 1914-16, and in 1918, 209 miles were added, separated by a considerable distance where traffic conditions were more favorable and where steam operation was deemed to be more economical although the grades and curves were comparatively heavy and electric current was as cheap as on the electrified sections. In level country the peculiar conditions that favor electrification on mountain divisions do not exist, and only in case there is intense traffic such as on the New York, New Haven and Hartford, where for 73 miles the line runs through a thickly populated district is it practicable to electrify.

Such investigations as have been suggested by the Ontario county council for railways with relatively light traffic, do not appear to promise much. If, however, the lines were treated not as steam railways operating by special electric locomotives, but as electric railways with a different class of rolling stock for passenger and light-freight traffic, more favorable results might be expected.

The Railroad's Rate Proposal

In order that more widespread relief can be realized by the agricultural industry from a reduction on freight rates, the Interstate Commerce Commission has been asked by the Association of Railway Executives to grant the following:

"1.—A reduction for an experimental period of six months, of 10 per cent in carload rates on wheat, corn, oats, other grain, flour and meal, hay, straw and alfalfa, manufactured tobacco, cotton, cottonseed and products, except cottonseed oil and cottonseed meal, citrus fruits, other fresh fruits, potatoes, other fresh vegetables, dried fruits and vegetables, horses and mules, cattle and calves, sheep and goats, hogs, poultry, eggs, butter and cheese and wool, any reduction in such rates made since September 1, 1920, to constitute a part of this 10 per cent, it being understood that such reduction of 10 per cent shall not apply to traffic moving wholly within New England, and that if the reduction of wages and labor expenses referred to in paragraph 2 hereof is put into effect prior to the expiration of the said experimental period, this limitation of six months shall not apply to the said reduction in rates. It should be noted that the loss of revenue resulting from this reduction would all come out of the net revenues of the carriers.

"2.—The necessary steps under the law, including, in case of failure to agree in conference, an application to the United States Railroad Labor Board to be filed as promptly as possible, for a reduction in the wages of employes, with the understanding that, concurrently with such reduction in wages, the benefit of the reduction thus obtained shall, in a manner approved by the Interstate Commerce Commission, be passed on to the public in the reduction of existing railroad rates, except in so far as such reduction in rates shall

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The Dawn of a Better Day

Many of the railroad repair shops are having their forces enlarged and some that were closed altogether are reopened. This is the surest sign of returning activity and a certain indication that the worst is past. All that is needed now is that the railroad men will take up their work in earnest. With the eight-hour law established on a reasonable basis that will not likely be disturbed except under the stress of emergencies, there need be no fear of the drudgery of overwork. Agreements that are found to be disagreeable can be amended. Honest toil can never be said to be in any sense humiliating. There is just as much honor in cleaning out an ash pan as there is in setting the valves of a locomotive, if the work is done well and expeditiously. We have been a long time associated with railroad men and we never knew one who died from overwork, even under the ten-hour law. We are willing to admit that ten hours of strenuous work brings on a sense of weariness that leaves little time for recreation or social intercourse or mental improvement.

We have noted, however, that many men have shortened their lives and failed way they spent or, rather, misspent their leisure hours. In spite of long hours of ill-requited toil many seemed to find means to maintain their absurd and costly vanities. Others fell into evil habits, and consequently fell by the wayside. Others looked for trouble and found it. Others had their minds, such as they were, elsewhere, and never anchored anywhere, and while we would not preach the gospel of sitting still under disagreeable conditions, we are assured that there is a crown for us all somewhere if we could only realize it and cultivate contentment.

The only real aristocracies are those of character and intellect. Even among the workingmen themselves there are among them the highest types of our common manhood, not always the best paid—but the most thoughtful—men who by the exercise of self-denial own their homes, men who have not only found the road to the saving-bank but who keep on walking on it and while they may sometimes be sneered at, they are secretly envied even by the thoughtless and improvident. The railroad men are by the very necessities of their occupation generally distinguished for their sobriety and reliability, yet there is even among them room for improvement.

Not only so but the educational facilities are now mightily enlarged. Especially to the young the advantages as compared with those of the last century are very great. Under the improved system of apprenticeship generally in vogue, and the almost universal establishment of night schools, there is seldom a reason why a good education cannot be secured by almost everybody, and while the great bulk of the world's work will likely remain of a manual kind, education does not of itself breed honest discontent, but teaches us humility because all the things that we can ever learn will remain infinitely small compared to the things that we shall never know.

We may add that these reflections are not intended to allude particularly to manual workers alone. On the contrary, as is well known, the largest number of the higher officials, especially in the mechanical department of railroads, have reached their positions by the exercise of the moral and intellectual attributes that we have briefly alluded to. If their troubles are not so apparent to the naked eye, those who have been there know that their multiplex duties cannot be set aside by the eight hour law or any other law. Their responsibilities haunt them at all hours. Instead of encouragement, evil-minded accusations and falsehoods unfounded are hinted at them. The old order that "if you see a head, hit it"—seems to apply to them in an eminent degree.

As it is we believe that we see the dawn of a better day, the advent of a New and though they are not always kept, there never was a more fitting time than the present when they should be kept. Let us buckle on our armor, acquit ourselves like men, and be strong in all that becomes those who realize that the slacker can never be other than an outcast.

The Feed-Water Heater

It is generally conceded that the development of feed-water heating for locomotives marks perhaps one of the most promising subjects for increased fuel economies, and the matter is being followed with marked attention at the present time. It is well to recall that feed-water heating is perhaps the oldest form of fuel economy sought after by the pioneer engineers, and it is interesting to note that a patent was granted to Richard Trevethick and Andrew Vivian in 1802, and the following allusion to feed-water heading is made: "Heats feed-water by conducting the escaping steam into a cistern under a false bottom perforated with small holes. A small portion is driven by a pump into the boiler at each revolution of the wheels."

There appears to be little doubt that, had it not been for the introduction of the injector about 1859, a feed-water heater would now be quite an ordinary standard locomotive fitting. Coming, however, as it did at a time when the feed-pumps in use were generally of the type driven from some part of the locomotive, with the consequent inability to supply the boiler when standing, except by means of the expedient of greasing the rails, and causing the engine to slip—or the crude "donkey pump" that was most wasteful in its steam consumption, an easy field for the injector was afforded. This latter, being a light compact instrument, further enabled a constant feed at all times to be available and the delivery of hot water to the boiler assured. Modern developments, both in reliability and mechanical perfection generally, have left the injector still the most commonly used means for feeding locomotive boilers all over the world.

Feed-water heaters are available today which have stood the "time" test—the final test in all locomotive apparatus—and which supply hot feed to the boiler at temperatures higher than could be delivered by the injector, but which have been obtained by utilizing otherwise lost heat units. Consequently an economy in fuel is certain to follow, it having been abundantly proved that for certain temperature gains, definite fuel economies result.

It is considered by many that in the immediate future no locomotive will be considered fully equipped unless provided with a feed-water heater, making use of otherwise waste heat units and delivering hot feed to the boiler with a positive economy in fuel and incidentally in boiler

Co-operation Needed Among Railroad Men

In closing a highly interesting address delivered at the annual dinner of the New York Railroad Club last month, ex-Governor B. W. Hooper, vice-chairman of the Railroad Labor Board, said that "reverting to the recent strike episode there was a section of public opinion, outside of railroad circles, that wanted a strike. At least they thought they wanted it. Their argument was that, if the railroad employees wanted to strike they should not be hindered, that it was a good time for a strike, and that the railroad organizations could be crushed and union labor, in general, given a setback. There were several weak spots in this argument. In the first place, there is no such thing as a good time for a railroad strike.

"While this may have been an opportune time to fight labor union, the price of the fight would have staggered the Nation. This country has never experienced a general railroad strike, and but few men have any adequate conception of the ruin and misery it would bring to the people, not only the poor, but the well to do.

"For the last few months, tens of thousands of men have been straining their credit and husbanding their resources in an effort to pass through this period of post war depression without bankruptcy. They have stood on the brink of a precipice and looked ruin in the face. A general railroad strike would have pushed them over the edge and plunged them into the abyss. They were not able to stand anything more.

"Then another thought occurs to me, would it have been wise to crush the railroad unions, even if it could have been done? What would have taken their place? Is any man so blind to all the aspects of modern industry as to believe that the time will ever return when railroad labor is not organized?

"If the brotherhoods had been crushed, rest assured that organizations of some character would have sprung up in their stead, and their successors, in all probability, would not have been animated by motives half so conservative and patriotic as those which control the brotherhoods.

"The right of labor to organize is based on sound principles, recognized by Congress and sanctioned by the courts of the land.

"The problem in this country today is not how to stamp out and destroy organized labor, but how to deal with its just demands fairly and humanely, and how to curb its unjust demands and control such of its activities as threaten the public welfare.

"In my judgment, the survival of this republic depends upon the wisdom with which this question is handled.

"Friendly as I am to theory and principle of organized labor, I am profoundly awed when I contemplate its possibilities for evil. If organized labor is to be permitted to throttle individuality, destroy initiative, exact inefficiency, dominate management, limit production, ignore the rights of the public, and set up a class government, then, indeed is this country headed toward Bolshevism and death.

"All of these things are the possible, but not the inevitable results of organized labor. They are merely the abuses of a thing inherently good.

"On the other hand, if organized labor confines its efforts to the legitimate advancement of the cause of the workingman, by the procurement of a just and reasonable wage, the establishment of desirable working rules and conditions, the maintenance of an increasingly good standard of living, and the preservation of the political and civil rights of labor, then will organized labor not only serve its own interests, but it will constitute one of the bulwarks of the American republic.

"In the regulation of railroad labor there are certain principles involved which do not apply to labor in general. The people of the United States must have efficient and uninterrupted railway traffic. The employees must share with the carriers the execution of this public trust. When a man enters the employ of a railroad and every day that he is so engaged, he should understand that in a high sense he is serving the public. He should understand that whatever rights men may have to strike and tie up a strictly private business, they have no such right, morally at least, to tie up the railroads and destroy the property, business, health, comfort and lives of innocent men, women and children.

"This does not mean involuntary servitude. It would not mean that the railway employe would be compelled to work for a railroad. It would simply mean that he would have no right to conspire with his fellow employes to destroy, by concerted action, the transportation of the country for the purpose of enforcing his demands against the carrier. If this is not now the law it ought to be and it will be.

"In consideration of such a legal regulation, it would be the duty of the public to make sure that an absolutely impartial tribunal was provided for the adjudication of all matters of dispute between the carriers and the employes, and this tribunal should place an exalted estimate upon the supreme importance of an honorable and patriotic discharge of this official duty.

"The public should realize that a living wage means something more to an American citizen than a bare existence, and that highly skilled men into whose care the lives of millions are constantly entrusted are entitled to a wage commensurate with their skill, hazard and responsibility.

"The employes would be expected to recognize the fact there is a limit to the ability of a carrier to pay wages, and that there is no mysterious and miraculous fountain of inexhaustible gold flowing into the coffers of a railroad. Every cent of its revenues must come from the pockets of the people. It is not to the interest of either the employe or the public that wages should be made so high as to overburden the carrier. It is obvious, however, that the ability of the carrier to pay cannot be treated as a controlling consideration in fixing wages, for this might result in some instances in requiring the employe to work for little or nothing."

Railroads Show an Increase in Profits in October

Reports filed by 199 railroads for the month of October to the Interstate Commerce Commission show a net operating income of $105,186,283, or 5.4 per cent on their valuation. This is the largest net profit since the increase of rates, the next largest being that of August, 1921, when about 5 per cent was reported. The threatened strike in October affected the traffic in the latter part of that month, and doubtless the effect reached into November, but it will be necessary to await the official reports. While the approach towards the 6 per cent aimed at by the Transportation Act is favorable, it must be borne in mind that the equipment continues to be greatly in need of new installations and repairs. The outlook, however, is hopeful, and already a better spirit is observable among both executives and employees, and the dawn of a better day is upon us.

Rustless Iron

The rustless iron is, of course, produced by alloys, but it is not as costly as might be supposed, and at any rate the longer life given to the metal makes it in fact a great economy. It can be used in hundreds of ways in which the small quantity of the metal used will make the increase in cost so infinitesimal as not even to be noticeable. Also it can be used for many purposes where steel is now used, and the result will be an actual saving in cost at the outset.

Because the new metal is softer and more malleable than steel, the iron can be forged, pressed or drop stamped, and hence utilized for a multitude of articles, parts and fittings which are now made of ordinary iron and various other metals that are subject to oxidation and erosion. Many other discoveries of recent years have been more sensational in their appeal to the general public, the metallurgists admit, but they declare that nothing has been more revolutionary in an established industry than this development of an iron that is almost wholly immune from rust and erosion.

Snap Shots — By the Wanderer

I suppose that, in time, we will so recover from the disease of Government operation of the railroads that we will be sound and healthy again, but the convalescence is slow and is accompanied by a nervousness more or less pronounced according to the individual manifesting the symptoms. It is hardly believable that the initiative could have been so completely knocked out of men as it has been. I have friends who for years have been in the habit of taking certain matters into their own hands and acting according to the dictates of their best judgment, and with never a thought of referring to a man higher up. That their judgment was true and their actions approved is attested by their long incumbency in the positions which they occupy. But suddenly they were told not to think, that the powers above would do that sort of thing for them, and all that they need do was to follow rules and instructions and all that. They did not take kindly to it at first, and some failed to recognize the paternal character of the hand that was leading them. Some had been walking alone for so long that they spurned the hand and got out. Others remained, obeyed orders, did as they were told and became atrophied in so far as their initiative was concerned. And now that they have been turned loose again with a comparatively free hand, they do not know what to do with their freedom, and hesitate to do very simple things because they really don't know whether they are the heads or tails of the organization.

Wendell Phillips once said that "the way to teach men the use of freedom is freedom." It certainly looks as though the converse was also true, that the way to destroy freedom of thinking, freedom of action, initiative, is to subject the man to a few months of bureaucratic control in which all of the thinking is done by men who do not know how to think or what they are trying to think about.

Various surmises have been made as to what would have happened when the Adamson law was enacted if a rider had been attached to it making it unlawful for shopmen to work more than eight hours in a day. Those of us who can lay claim to the possessing of any information at all, know very well that all the talk about an eight-hour day at that time was merely dust thrown into the eyes of the public to befog the real issue, which was overtime payments, and that the national agreement was merely a successful effort to draw the noose of work classification closer and tighter. If the public could only know what that eight-hour day and national agreements have cost, they would look upon the Brandeis saving of a million a day as a mere bagatelle besides this

But now, it seems there is to be, if not a halt, at least a halting in this paying for things not done. A change has come over the spirit of their dreams and the eight-hour day as per Adamson & Co. is no more. To be sure eight hours still remain the nominal day's work, but the elimination of overtime for the ninth and tenth hours by the Labor Board, has made it practically a ten hour day so far as pay is concerned. Under the old regime "of execrable memory," the men rather counted the ninth and tenth hour, and for very good reasons, and it is highly probable that their popularity will only be decreased in direct proportion to the amount of overtime and that it will be very far from being a vanishing quantity. Calamities are apt to come upon us with a rush, while blessing like mercy "droppeth like the gentle rain from heaven." So it may take time to fully recover from the flood in which we were so nearly drowned, but it does look as though our heads were approaching the surface.

There are probably a good many men living today who have a very clear and unpleasant recollection of the days when it was a popular idea or better fallacy among employers that a warm shop in the winter tended to produce effeminacy and laziness among the men, while a cold shop which merely served to keep off the wintry blasts without effecting any mitigation of the outside temperature, would keep them active and make them work harder. They were oblivious to the fact that most of the exertion stimulated by the cold was manifested in the swinging of arms and the stamping of feet, and not in the production of useful work that had a market value.

This idea passed with the generation that held it; but, like other old errors, it has persisted in some quarters even into this day. The place where it manifests the greatest vigor is in the freight car repair yard. So much of this work can be done out-of-doors as well as under shelter that the economy of shelter is not fully appreciated. That the men would rather work outside than in, during the pleasant days of spring and fall there is no gainsaying. Well, so would you or I or anyone, whether our work is at the desk, the moulding floor or the lathe. But this part of occasional disability does not lead us to set our desk or lathe in an open field or change the location of our moulding floor; because in days of storm or cold we could not work at all and the product of our efforts would be ruined To be sure the cars or their parts are not ruined by storm and cold, but if you have ever watched a gang of car repairers during a thunderstorm, a snowstorm or

to give awards for the quantity or quality of the work done.

It involves a good deal of an investment that of housing repair tracks, so it does to house anything. But the question is whether the saving would not warrant the investment.

It is a safe guess that comfortable quarters would double the output of the repair gangs for at least one hundred days out of the year for almost any point in the United States. In the North, there is the cold of winter and, in the South, the heat of summer. In a yard having a daily payroll of three hundred dollars, this would mean a saving of fifteen thousand dollars a year; and, this, capitalized at 6 per cent, means $250,000. Well, a pretty decent protecting shed could be built for $250,000. It is possible, too, that such an investment might serve to increase the feeling of good will of the men towards the employing company, but that is difficult to estimate, to say nothing of capitalizing.

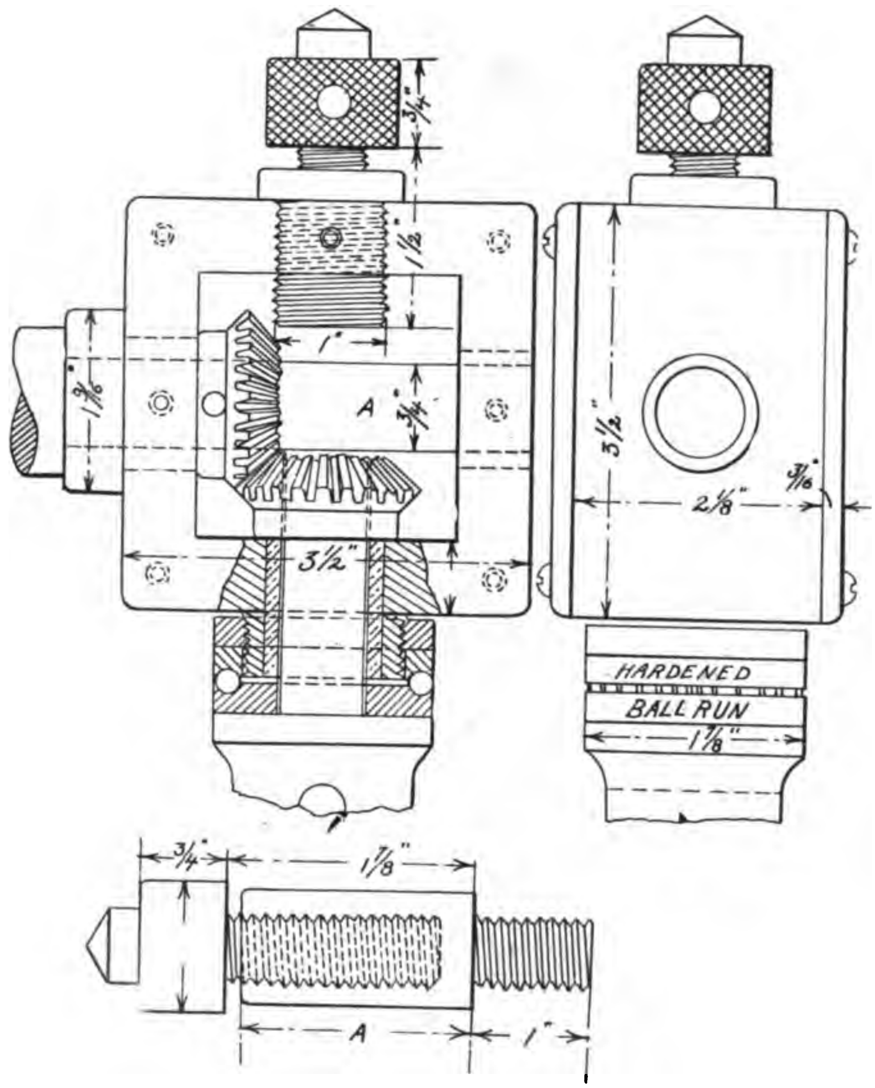
Of course the Pullman Company must provide a ladder by means of which the lame, the halt and the blind can climb into their upper berths. But, as a casual traveler whose casualness runs into considerable frequency, I have been an interested observer for many years in noticing the helplessness of the great majority of my kind, in the matter of handling themselves in and out of an upper. I have seen young soldiers who certainly must have had some athletic training sit helplessly on the edge of an upper berth, waiting for the ladder. It does seem that these men ought to have been taught how to scale a wall or make a human ladder and, if they have, they certainly ought to be able to reach across the aisle, grasp the opposite curtain rail and drop to the floor. It is such an easy thing to swing up into an upper berth and drop back to the floor, and can be done so much more quickly than the porter can bring the ladder that it passes comprehension why so many young men are helpless in the matter. At any rate they don't do it. Possibly it is because they have never seen anyone do it, and it has not entered their heads that it can be done.

But as a phenomenon it is a curious manifestation that, in these days of vaunted athletic training, when men and women alike are supposed to go in for sport, if it is only manifested in the watching of a baseball bulletin board, that it has not developed the body to a sufficient extent to enable its owner to get in and out of the upper berth of a sleeping car without the assistance of the porter and his ladder. Are they unable to do it? Are they lazy? Or have they simply

Details of the Construction of a Right Angle Drill

The engraving of the right-angle drill is presented in order to serve as a guide to those who may wish to make a similar tool. There is nothing new in the idea of using a right-angle drill in contracted quarters where there is no room for the drill, motor and feed screw between the work and the backing.

The frame is a forging 2⅛ ins. wide



RIGHT ANGLE DRILL

and ⅝ in. thick. It is square with an outside dimension of 3½ ins. with a hole 2¼ ins. square through the center. The main shaft *A* runs through the frame from side to side and has a bearing on each side in bushings that are pressed into place. It carries a cut miter gear of 1½ ins. in diameter of 12 pitch and having 18 teeth.

A boss is forged to the outside of the frame at right angles to the main shaft. This boss is 9/16 in. long and is threaded on the outside with 12 threads reception of a brass bushing that serves as a bearing for the drill spindle shaft. The outer end of this shaft carries a socket bored to a No. 3 standard Morse taper and the inner end carries the driven miter gear. The upper end of the enlarged socket portion carries a hardened steel race for a ball bearing. The upper race is screwed to the outside of the boss on the frame already referred to, and is held in place by the check nut screwed on above it. Balls 3/16 in. in diameter are used.

Opposite to the drill spindle the frame is threaded to receive an internally threaded bushing into which the feed screw is screwed. This bushing gives a bearing 1 1/16 ins. long for the feed screw, which will make it possible to drill a hole to a depth of from ⅝ in. to ¾ in. As this is so much less than the depth which would usually be required provi- the machine by the use of an extension socket.

This socket consists of an internally threaded body to receive the feed screw and an externally threaded stud which will screw into the bushing that is screwed into the frame. With this arrangement it is possible to drill holes of any depth.

Ease of running is insured by the use of two bearings for the driving shaft and of ball bearings to take the thrust of the drill spindle.

Revived Activity in the New Haven Shops

Two thousand locomotive repair mechanics of the New York, New Haven & Hartford Railroad, who were laid off during the latter part of December, have been called back to work, and it is expected that the employees of the car repair shop will return to work before the end of January.

Shortly after the men were laid off it was announced that on January 16 a wage reduction would be put into effect. The men objected. It is now said that an agreement has been reached whereby the men who are recalled will return at their old wage. Wage conferences will be held later.

New Locomotives for the Jersey Central

Important additions to the motive power of the Central Railroad of New Jersey is announced beginning the year with the construction of twenty-five Mikado, 2-8-2, type locomtives weighing 337,000 lbs., cylinders 27 ins. by 32 ins. The locomotives will be equipped with all the recent improvements, and are being built by the American Locomotive Company. Meanwhile extensive work on rolling stock and other repairs are proceeding rapidly at the railway company's shops at Elizabeth, N. J.

German Locomotives for Russia

An article in the *Berliner Tageblatt*, dealing with the increasing activity in Russo-German trade, states that the Soviet Government recently ordered 700 railway engines, which German manufacturers have undertaken to deliver in six to seven months. The first cargo of six engines is already at Hamburg awaiting transport to Russia. The Soviet Government has also placed orders in Germany for chemicals, agricultural machinery and rails to the value of a milliard and a half marks. The first deliveries of goods in payment from Russia have already arrived in Germany and it is expected that if the order is filled according to contract, larger orders will be made in the future, some of which may go to other

Notes on Foreign Railways

Consolidation of Transandean Railways

The Chilean and Argentine sections of the Transandean Railway, from Los Andes on the western slope of the Cordilleras, by way of Caracoles on the Chilean frontier, to Mendoza on the eastern or Argentine side, will be consolidated under a single management. This project, presented to the Argentine Government by a delegation from Chile in 1919, was approved on the part of Argentina and has recently been sanctioned by the Chilean Government.

The free interchange of traffic between the two nations, heretofore impeded by protective tariffs, will be encouraged and fostered by the establishment of new and liberal tariff regulations which will permit the natural flow of international trade between the territories served by the lines. All material used for construction, as well as rolling stock and equipment imported into Chile, will be exempt from custom duties. The rates on traffic wil be fixed by agreement between the Chilean and Argentine Governments.

The Outlook in Russia

Among other signs of a better day for the bewildered Russians is a report that from factories purchased in Rumania the construction of 2,000 locomotives is begun, and that according to a new economic treaty the Italian government will undertake the work of rehabilitating the railways in southern Russia. Italian engineers and other skilled workmen will be sent to Odessa with 100 locomotives and other railroad equipment.

Electrification in Hungary

With a view to eliminate the importation of coal from other countries the Hungarian State Railway Administration has decided to proceed with the electrification of 870 miles of railways. It is expected that the work at present projected will be completed within four years, and in the event of the experiments being as successful as expected, the necessary changes on the other railroads will be as rapidly proceeded with as possible.

The African Railway Gauge

In view of the difficulty now confronting the Australian railways in connection with the diversity of gauge, it is to be hoped that steps may be taken to avoid the establishment and extension of similar conditions in East Africa. The question arose in connection with the construction about to be undertaken of the Uasin Gishu Railway in the Kenya Colony. This line will eventually form part of a through route connecting Mombasa and Nairobi with Uganda, the Sudan and the Congo, and is a main line extension of the Uganda Railway, of which the present section from Nakuru to Kisimu on the Victoria Nyanza will become a branch. It is thus contended that it should be built on the meter gauge of the Uganda Railway, though efforts have been made on the ground of economy of construction to adopt the narrow 2-foot gauge. The former width, it is understood, has been definitely adopted, and it is to be regretted that the Uganda Railway itself differs from the 3-foot 6-inch gauge which prevails on the main lines of the South African Union. The initial saving on the smaller gauge is soon offset by the increased cost of transfer to connecting lines. A definite policy in regard to pending and future construction should certainly be established, not only as regards the British possessions, but with the neighboring French, Belgian, Italian and Portuguese systems which are concerned in the working of through railways.

Car Shortage in Germany

A shortage of rolling stock at the present time is seriously handicapping German industry and trade. The shortage of freight cars alone is estimated at about 90,000, which is nearly three times the number actually in use. On October 1, 1921, the number of available freight cars was estimated at 32,000, of which more than 40 per cent were in need of repair. Freight rates were increased by 30 per cent on November 1, and again by 50 per cent on December 1. In addition to this practical doubling of freight rates in such a short period of time, a 30 per cent increase of passenger rates was put into effect on December 1. The present unsettled state of German railroad affairs has led to a sharp conflict between industrialists and labor unions over the continuation of Government operation of the roads; industrial interests are reported as having made the turning over of railroads to private ownership one of the conditions to their coming to the assistance of the Government in the payment of the impending reparation obligations is under discussion.

Railway Construction Proposed in Norway

Proposed railway construction in Norway submitted by the railway directors is estimated at a cost of 1,300,000,000 crowns. The allotment to northern Norway under this proposal includes seven new railway lines, in addition to several extensions of already existing lines, which will provide employment for upward of 10,000 men for the next few years.

British Railway Speed Records

The fastest run in Great Britain at the present time is accomplished by the Caledonia Company of Scotland, the 32½ miles between Forfar and Perth being covered in 34 minutes, an average of 57.4 miles per hour. The Great Western takes second place with a run of 43 minutes for the 41 miles separating High Wycombe from Banbury, a speed of 57.2 miles per hour. This road also holds the record for the fastest non-stop runs in the Kingdom. London to Bath (106 miles) is accomplished in 113 minutes, equal to a speed of 56.8 miles per hour; and the 199 miles between London and the Devonshire holiday resort of Torquay is covered in 230 minutes, or 52.1 miles per hour. Between London and Liverpool the London and North Western American and Irish boat trains accomplish the run of 192 miles in 223 minutes, an average speed of 51.7 miles per hour. Prior to the war, the fastest train in the United Kingdom was one between Darlington and York on the North Eastern Railway, covering the 44 miles in 43 minutes, a speed of nearly 62 miles per hour.

Powerful Diesel-Motor Locomotive

Perhaps the most important development in southern Sweden has been the completion of the largest Diesel-motor locomotive in the world—the fourteenth car of this type built in a Swedish factory. It is now in operation between Helsingborg and Hesselholm. The locomotive is driven by a 250-horsepower, electric-type, four-cylinder Diesel engine making 500 revolutions per minute, and can draw four heavily loaded Pullmans at 60 miles per hour. Only one man is required to operate it; and in a trial run of 590 kilometers the fuel cost was less than 20 cents per mile, demonstrating the economical possibilities of this type of car.

Satisfactory tests of a new type of steam turbine have been completed, and the engine is said to be so superior in design and construction and economical in operation as to warrant the statement that it will rapidly replace those now in use.

Renewed Railway Activity in Great Britain

The railways of Great Britain have displayed renewed enterprise since the abolition of Government control in August. In spite of the unfavorable conditions prevailing at that time, the companies immediately began to frame development plans and make arrangements for the introduction of cheap fares and other popular facilities. Cheap Saturday to Monday tickets available by ordinary trains were issued the first week-end following the return to corporate control, and excursion trains were introduced shortly afterwards. These have proved to be very popular, but there is no immediate prospect of a reduction of the excessive high rates in vogue on other days of the week.

Railroad Casualties

The following table, reported by the Interstate Commerce Commission, for the year ending December 31, 1920, relates to the operation of the railroads under the jurisdiction of the Commission:

Year	Killed	Injured	Tons carried one mile
1920	6,958	168,308	411,151,320,758
1919	6,978	149,053	375,884,209,204
1918	9,286	174,575	408,011,453,000
1917	10,087	194,805	390,040,446,000
1916	10,001	196,722	365,034,029,000
1915	8,621	162,040	277,232,653,000
1914	10,302	192,662	288,746,432,000
1913	10,964	200,308	300,558,334,000
1912	10,585	169,538	261,416,643,000
1911	10,396	150,159	250,440,118,000
1910	9,682	119,507	250,418,0[illegible]6,000
1900	7,856	50,320	141,596,551,161
1898	6.859	40.882	114,077,576,305

Traffic Jam Coming

Elisha Lee, vice-president of the Pennsylvania, Eastern Region, says that "Traffic on our American railroads, measured in ton-miles and passenger-miles, doubles about once in a decade, or possibly a little longer. This rate of increase has been maintained for at least two generations with surprising regularity, despite the various cycles of booms, panics and depressions through which the country has passed meanwhile.

"The events of the war, of course, pushed our traffic figures up to levels some years ahead of the normal growth, and we are now having a corresponding reaction, but get this fact firmly in your minds, because it is most important:

"The next time our country has a real revival in business we shall, in all probability, be confronted with the most severe congestion of railroad traffic, and the greatest inadequacy of railroad facilities, ever experienced in our history."

Loan to Berne Railways

Electrification of Berne railway lines, which are owned by private transportation companies, is to be aided through a Government loan plan, according to a despatch from the American Legation at Berne, based on information published in *Journal de Genève* of November 30, 1921.

The Department of Railroads, with the approval of the Federal Council, will submit to the Federal Chambers immediately a request for a loan of 11,000,000 francs to be used for this electrification, which is in line with similar development now being undertaken by the Swiss railroads.

Fatigue of Metals

Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois, entitled "An Investigation of the Fatigue of Metals," is a progress report of the first part of this investigation, having for its object the determination whether or not there exists any clearly defined relation between static properties and ability to resist repeated stresses. It having been decided not to enter the field series of tests of materials well scattered over the field of ferrous metals was made, and in most cases two or more distinct heat treatments for each metal were studied.

The results of these tests, and the conclusions to be drawn therefrom are given in Bulletin No. 124, copies of which may be had without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

More Railroads Being Abandoned Than Built

Records compiled by the Interstate Commerce Commission indicate that more miles of railroads are being abandoned in the United States than are being built. The Commission during the year, ending October 31, 1921, authorized 405 miles of new construction and 702 miles of abandonment. Among the largest of new construction work were 90 miles added to Idaho Central Railroad; 61 miles to the tracks of the Jackson & Eastern Railway; 43 miles to the Union Pacific Railroad; 25 miles to the Interstate Railroad; 44 miles to the Wichita Falls & Southern Railroad, and 25 miles to the Utah Railway.

Among the largest track mileage abandoned were 99 miles of the Duluth & Northern Minnesota Railway; 95 miles of the Hawkinsville & Florida Southern Railway; 74 miles of the Alabama & Mississippi Railroad; 53 miles of the Ocean Shore Railroad; 52 miles of the Delta Southern Railway, and 36 miles of the Spokane & British Columbia Railway.

Method of Coal Storage by the Standard Oil Company

As a reserve to ensure a regular supply sufficient to take care of a daily consumption of 3,000 to 4,000 tons, the Standard Oil Co. is storing 3,400 cars of coal at its gigantic refining works at Whiting, Indiana. Of this amount (says the "Colliery Guardian"), 100,000 tons is submerged under water in a pit especially constructed for the purpose, while the balance is piled above the water level and along the sides. In the coal heaped up above the water level in the pit itself, capillary attraction draws up sufficient moisture to prevent burning and to ensure against rapid deterioration. The pit is 1,000 ft. long and 200 ft. wide. The bottom, 23 ft. below the surface of the water, is covered with a flooring of concrete 12 in. thick. A double row of piling lines the edges of the pit, and supports a concrete cap 3 ft. 9 in. thick, and sufficiently wide to carry a standard gauge railway track. Immediately behind the inner portion of this double row of piling, a strong wall of sheet piling has been driven, forming a sand tight lining for the sides of the pit. As a precaution against side stresses a row of piles has been sunk flush from the double row supporting the concrete cap, and fastened to the latter by means of 1½ in. iron rods.

On each side of the pit are placed a set of four railway tracks at sufficient distance apart to enable the cranes to swing from the cars to the pit and ground storage piles with complete freedom. Paralleling these and supported on piling trestles running the long way of the pit, are four more tracks from which hopper bottom and side dumping cars may be unloaded directly with out any further handling. Each of these 12 tracks is 1,000 ft. long, and is capable of holding about 25 cars at a time. The total length of all of the trackage, in and adjoining the pit, is a trifle over two miles.

The company has experienced some difficulty from the piling trestles in the center of the pit, which have shown a tendency to get out of alignment when the coal has been lowered to a point where it no longer serves as a support. In order to overcome this difficulty, steel tie rods are being bolted between the trestles themselves and to the sides so that the whole central track section will be effectively anchored to the side walls.

From its cost figures the company is able to compute accurately the cost per ton of moving the coal in and out of storage. The cost of unloading from the cars with the labor charge included is 7.5c. per ton, while that of reclaiming which is done entirely by the crane is 7.3c. per ton.

In ordinary winter weather there is enough seepage of warm water from the underground drains of the oil refineries to keep the water in the pit from freezing. When the plant is operating at full capacity the consumption of steam coal is 65 to 85 cars per day.

Mr. Willard on Railroad Economies

Mr. Willard, president of the Baltimore and Ohio Railroad insists that the economies that are possible in regard to rail-operation have been greatly overestimated. It is inconceivable that railroad managers are neglecting to seek economies in any and every direction when they are so hard pressed between the forces that tend to keep up the operating cost on the one hand and those who seek to bring down rates and charges on the other.

Opinion of the Railway Executives on Reductions

Cuts in freight rates without similar cuts in the operating expenses and costs will seriously jeopardize the stability of the transportation system of the country and exhaust the financial resources that the railroads now have the Interstate Commerce Commission was told by railroad representatives at the resumption of the inquiry into the reasonableness of existing

Items of Personal Interest

J. B. Merritt has been appointed road foreman of engines on the Santa Fe, with office at Raton, N. M.

H. D. Brown has been appointed engineer of tests of the Chicago & North Western, with offices at Chicago, Ill.

James Womble has been appointed acting master mechanic of the Midland Valley, with office at Muskogee, Okla.

H. W. Salmon, Jr., acting fuel agent on the Missouri Pacific, has been promoted to fuel agent with headquarters at St. Louis, Mo.

S. J. DeGraeff has been appointed storekeeper of the Southern Pacific of Mexico, with headquarters at Empalme, Sonora, Mexico.

Edward E. Bashford has been elected executive vice-president of the National Railways of Mexico, with headquarters in New York City.

A. Singleton has been appointed purchasing agent and general storekeeper of the Hocking Valley, with headquarters at Columbus, Ohio.

E. W. Lostrom has been appointed road foreman of engines of the Northern Pacific, with headquarters at Duluth, Minn., suceeding J. A. Marshall.

D. C. McAlister has been appointed general air brake inspector of the Northern Pacific, with office at St. Paul, succeeding E. L. Kendrick, resigned.

I. S. Fairchild has been appointed storekeeper of the New Orleans terminal division of the Illinois Central, with headquarters at New Orleans, La.

G. E. Hagerty has been appointed car foreman of the Santa Fe, with office at Gallup, N. M., succeeding F. E. Knadler, transferred to San Bernardino, Calif.

Q. G. Feick, formerly road foreman of engines on the St. Louis-San Francisco, has been appointed district foreman of the Oregon Short Line, with headquarters at Wampa, Idaho.

Harry W. Jones, master mechanic of the Sunbury, Williamsport, Northumberland and Renovo shops of the Pennsylvania, has been appointed to a similar position in the Altoona shops.

J. E. Osmer has resigned his position as superintendent of motive power and car department of the Ann Arbor, which he has held for nearly 10 years, with headquarters at Owossa, Mich.

J. B. Young has been appointed acting master mechanic of the Central of New Jersey, with headquarters at Ashley, Pa., succeeding A. B. Enbody, granted leave of absence on account of illness.

J. C. Rae, general foreman of the Ann Arbor, with headquarters at Owosso, mechanic, with the same headquarters, succeeding J. E. Osmer, resigned.

W. N. Foster has been appointed master mechanic of the Iowa division of the Chicago, Milwaukee & St. Paul, with headquarters at Marion, Iowa, succeeding E. L. Notley, assigned to other duties.

J. A. Marshall has been appointed acting master mechanic of the Lake Superior division of the Northern Pacific, with headquarters at Duluth, Minn., succeeding J. E. Goodman, granted leave of absence.

F. D. Buckley has been appointed roundhouse foreman of the Chicago, Rock Island & Pacific, with office at Eldon, Mo., succeeding J. H. Bassett, promoted to roundhouse foreman at Kansas City, Kan.

W. C. Eddington has been appointed foreman of the erecting shops of the Atchison, Topeka & Santa Fe at Temple, Tex., succeeding L. V. Blucher, promoted to roundhouse foreman at Gatesville, Tex.

J. H. Moore, signal supervisor of the Rochester division of the Buffalo, Rochester & Pittsburgh, has had his jurisdiction extended to include the Buffalo division, with headquarters at East Salamanca, N. Y.

E. A. Mayhew, plant engineer of the Ohio Body & Blower Corporation, of Cleveland, Ohio, has been appointed assistant mechanical engineer of the Great Northern, with headquarters at St. Paul, Minn.

Elbert H. Gary, of the United States Steel Corporation, and Grafton Greenough, of the Baldwin Locomotive Works, have been elected directors of the Mexican Chamber of Commerce of the United States.

Andrew Fletcher, president of the American Locomotive Company, has been elected a director of the American Car & Foundry Company, to fill the vacancy caused by the resignation of Walter G. Oakman.

Roy Skidmore, erecting foreman of the Kansas City Southern, with office at Pittsburg, Kan., has been promoted to shop superintendent with the same headquarters, succeeding Charles E. Oakes, deceased.

J. J. Herlihy has been appointed division master mechanic of the Baltimore & Ohio, with headquarters at the Washington, Ind., shops, succeeding Charles N. Newman, promoted shop superintendent at Pittsburgh, Pa.

George M. Davidson, chemist and engineer of tests of the Chicago & North Western, with headquarters at Chicago, has been appointed industrial engineer, with the same headquarters, and W. D. Brown succeeds Mr. Davidson as engineer

G. W. Hanegan, storekeeper of the Central and Western divisions of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has been promoted to general storekeeper with the same headquarters.

A. L. Prentice, division storekeeper of the New York Central, with headquarters at Elkhart, Ind., has been promoted to assistant general storekeeper, with headquarters at Collinwood, Ohio, and C. F. Heiderich succeeds Mr. Prentice.

J. Neph, storekeeper of the San Juan division of the Southern Pacific, with headquarters at Bakersfield, Cal., has been transferred to the Los Angeles division, with headquarters at Los Angeles, succeeding J. H. Collins, deceased.

W. R. Harrison, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Chanute, Kan., has been transferred to Argentine, Kan., succeeding E. E. Machovec, promoted to acting mechanical superintendent as announced last month.

J. F. McAuley has been appointed division storekeeper of the Portland division of the Southern Pacific, with headquarters at Portland, Ore., succeeding H. J. Smith, who has been appointed chief clerk to the general storekeeper at San Francisco, Cal.

B. W. Griffith, district storekeeper of the New York Central, Lines West, with headquarters at Collinwood, Ohio, has been appointed general storekeeper, with the same headquarters, and F. J. McMahon succeeds Mr. Griffith as storekeeper at Collinwood.

L. C. Gunter has been elected president of the Knoxville & Carolina, with headquarters at Knoxville, Tenn. S. B. Luttrel was elected vice-president, and J. A. Wallace, secretary and treasurer. This company has been organized to take over the Knoxville, Sevierville & Eastern.

M. C. Goodspeed has been appointed to represent the American Society of Safety Engineers in the Sectional Committee on the Safety Code for Electrical Power Control. Mr. Goodspeed is electrical engineer for the General Electric Company at Erie, Pa., and member of the American Institute of Electrical Engineers.

Howard Elliott, editor of the *New York Traffic Club Bulletin*, has been appointed editor of the *Union Pacific Magazine*, with offices at Omaha, Neb. Mr. Elliott is a graduate of the University of California, and has had twenty years' experience in railroad service, chiefly in the transportation department. Mr. Elliott has also graduated in law and admitted to the Los Angeles Bar, and is an accomplished writer and a ready and fluent

OBITUARY

Charles S. Salmons

Charles S. Salmons, second grand chief engineer of the Brotherhood of Locomotive Engineers, and editor and manager of the *B. and L. E. Journal* since 1894, died at Cleveland, Ohio, on December 6, 1921. Mr. Salmons served during the Civil War in an Illinois regiment, and has been prominently identified with the Grand Army of the Republic. In the management and editorship of the brotherhood journal he showed fine ability, and it is largely owing to his shrewd business economical activity that the widows' and orphans' fund has been maintained with a degree of reliability that is a high honor to his memory and a credit to the brotherhood by whom his services were thoroughly appreciated. As a writer he was distinguished by a degree of painstaking accuracy not too common among class journals. Of an unobstrusive and quiet disposition he was warmly esteemed among those who knew him best. He had also the fine quality of attracting clever young men around him who have profited by his worthy example.

Orville C. Mann

Orville C. Mann, engineer, inventor and manufacturer of railroad appliances, died at Oak Park, Ill., on December 15, in the sixty-third year of his age. He was born at Bath, N. H., and entered railway service in 1878, and had a wide experience on several of the leading roads in the West, particularly in the mechanical department. In 1901 he engaged in the railroad supply business and met with marked success as a manufacturer of smoke jacks. Latterly he became associated with E. McCann, superintendent of bridges and buildings of the Santa Fe, and took over the interests in a spreader which Mr. McCann had invented.

Clarence E. Rood

Clarence E. Rood, sales manager of the Gould Coupler Company, New York, died on December 11 in New York City. Mr. Rood was for many years a well known manufacturer of car wheels and other railway appliances, and operated the Rood Malleable Iron Company, Lancaster, Pa. In 1910 he entered the service of the Gould Coupler Company as sales representative of the New York district. He was well known and highly esteemed among railroad men.

William J. Armstrong

The death is announced of William J. Armstrong, assistant treasurer of the Gould Coupler Company, New York, with which company he was associated for over

Meeting of the Executive Committee of the Air Brake Association

On December 13th, a meeting of the Executive Committee of the Air Brake Association was held at the Hotel Sherman, Chicago, and it was unanimously voted to hold the regular annual convention of the Association at Washington, D. C., Mty 9, 10, 11 and 12, 1292.

The Hotel Washington was selected for convention headquarters with overflow accommodations in the New Ebbitt Hotel in the adjacent block. All sessions will be held in the large convention hall on the top floor of the Hotel Washington, and all exhibits will be erected on the mezzanine floor in that hotel.

President Streeter and the Executive Committee urge as large an attendance at this convention as possible, hoping thereby to obtain a return to the high efficiency of the educational work of the Association prior to war time interruption. The unusual opportunity for sightseeing afforded by the many points of interest in the National Capital will be welcomed by those of our members who take their vacation at convention time and bring the lady members of their family with them.

Many new men during the war years and since have come into railroad work who need air brake instruction. Also, numerous air brake devices have been developed and remain to be explained to the older men as well as those more recently employed. It therefore behooves all Air Brake Association members to earnestly resume and consistently carry on their educational work to the mutual advantage of the worker and the railroad air brake service. Railroad officials will be asked to help along the important educational work of the Air Brake Association now so badly needed by liberally sending their air brake men to the convention.

Rates at the Washington Hotel, European plan, and where all rooms have baths, are as follows: Single rooms, one person, $5.00 to $7.00; double rooms, double bed, $8.00; double rooms, twin beds, $10.00.

Rates at the New Ebbitt, where all rooms without baths have hot and cold running water, are as follows: Single rooms without bath, $2.50; double rooms without bath, each person, $2.00; double rooms with bath, each person, $3.00.

Eliminating the Unemployed

According to a report made by the Secretary of Commerce, Mr. Hoover, the number of unemployed in the United States decreased from 3,500,000 to 1,500,000, as a result of the efforts of the Conference on Unemployment called by President Harding and there is every likelihood of the good work continuing all over the

Two Railroads Take Out Insurance on Employees

Announcements have been made by the Erie and by the Delaware & Hudson to all its employees that beginning on January 1, 1922, they will be insured under a group life insurance plan. Thirty thousand employees are involved. The benefit will apply to employees who have been two years in service prior to December 31. Any employee permanently disabled before reaching the age of 60 will receive the full face of his policy. The maximum amount is $3,000.

The Delaware & Hudson announcement was that it had taken out group life and permanent disability insurance for all who have been on its payroll six months or more. Large insurance underwriters said other railroads were negotiating similar protection for employees.

The Erie insurance is divided between the Aetna Life Insurance Company and the Metropolitan Life, each carrying insurance on 15,000 men. The total insurance involved is about $40,000,000.

The Delaware & Hudson will insure the men without cost to them for $500, and will permit them to carry as high as $5,000 at a comparatively small cost.

Engineers, conductors and yardmasters are arbitrarily covered in the Erie plan for $3,000 each. Firemen, trainmen and assistant yardmasters are insured for $2,000 each. No insurance on the Erie will be for less than $1,000.

United States Civil Service Examinations

The United States Civil Service Commission announces open competitive examinations for junior engineer in mechanical, electrical, signal, telegraph and telephone service. Vacancies in the Interstate Commerce Commission in Washington, D. C., for duty in connection with the valuation of the property of common carriers will be filled from these examinations and, on account of the needs of the service, applications will be received until further notice. Applicants should at once apply for Form 1312, stating the title of the examination desired to the Civil Service Commission, Washington, D. C., and full particulars will be furnished.

A Notable Record

J. E. Alger, Reading, Mass., retired locomotive engineer after 51 years' continuous service, is a member of a notable family of railway men. Mr. Alger's father entered the service in December, 1846, and retired in 1895, while a younger brother began in 1871, and is still at the throttle. Mr. Alger, retired, entered the service in November, 1868, and retired in September, 1919. The continued united services of the father and two sons there-

Construction and Equipment Notes

New Machine and Boiler Shops at Fort Wayne, Ind.

Contracts have been awarded to the Dwight & Robinson Company, New York, by the Pennsylvania Lines West, for the construction of a two-story machine and boiler shop at Fort Wayne, Ind. The cost is estimated at about $400,000.

Additional Equipment of the Western Maryland

The Western Maryland Railway Company jointly with the Post Development Commission construct additional new railroad piers on which the railroad company will install electric cranes, loading and unloading machinery and other necessary equipment to facilitate the handling of freight traffic in the near future.

Electrification on the Delaware, Lackawanna & Western

Estimates are being prepared by the Westinghouse Electric Company and the General Electric Company for the proposed electrification of about 40 miles of track on the Delaware, Lackawanna & Western Railroad near Scranton, Pa. The cost is roughly estimated as between five and six million.

Power Plant Extensions on the Kansas City Southern

John E. Muhlfeld, consulting engineer, New York City, is supervising extensions to the power plant of the Pittsburg, Kan., shops of the Kansas City Southern. These will include a 500 k. w. generator unit, 3,000 cubic feet air compressor, 350 horsepower boiler and the equipping of new and existing boilers with superheaters, powdered coal preparing and other appliances.

Industrial Revival at West Albany

The New York Central is reported to be making arrangements to lease its extensive car shops at West Albany, N. Y., and have the car repair work done under conditions similar to that already in operation at East Buffalo and Toledo. The machine shops, which were closed for several months, are now in partial operation under the company's supervision, and former skilled mechanical employees and others are being engaged, and normal conditions are expected to be resumed in a few months.

Foreign Orders for the American Locomotive Company

The Northern Railway of Spain has ordered six new locomotives, which will be constructed at the Schenectady plant of the American Locomotive Company. The General Electric Company will furnish the electric appliances on these locomotives.

Electric Plant for the Hagerstown & Frederick Railway

Tentative plans are being considered by the Hagerstown & Frederick Railway Company for the construction of a new electric generating plant at Confluence, Pa., with a capacity of about 40,000 k. w. The cost including generating plant and transmission appliances is estimated at about $1,000,000.

New York and New Jersey Tunnel

An agreement has been reached between the New York and New Jersey Tunnel Company and the Erie Railroad Company whereby the contracts for sinking of the shafts on the west bank of the Hudson will be proceeded with at once. The plans as approved of in the construction of the tubes will involve an expenditure of over $20,000,000.

Electrification Extensions in the South

It is reported from Rome, Ga., that the Tennessee, Alabama & Georgia will form a connection with the Rome & Northern, extending to about sixteen miles. The project proposed will be equipped with electric appliances, and will likely be extended beyond the new branch.

Additional Cars for the Union Pacific

It is officially stated that the Union Pacific is asking bids for 6,000 cars, 500 of which to be of the double sheathed box car type of 50 tons capacity, and 50-ft. steel automobile cars.

Electric Power House for the Santa Fe

Plans are completed for a new steam-operated electric power house by the Atchison, Topeka & Santa Fe, at San Bernardino, Cal., the cost of which will be about $200,000. W. S. Wall, Los Angeles, Cal., mechanical superintendent of coast lines, is in charge of the projected work.

New Coaling Plants for the New Haven

Contracts have been awarded by the New York, New Haven & Hartford Railroad Company to Roberts & Schaeffer Company, Chicago, for two 1,200 tons capacity, three-track automatic electric coaling plants to be installed at East Hartford, Conn., and Providence, R. I. The cost will approach $125,000.

Addition to Rolling Stock on the Reading

Orders have been issued by the Philadelphia & Reading Railroad Company for 30 coaches and 5 combination baggage and smoking cars from the Bethlehem Shipbuilding Corporation, and 15 coaches from the Standard Steel Car Company.

New Machines and Tools for the Rock Island

The Chicago, Rock Island & Pacific Railroad Company has ordered about 70 new machines and a variety of hand tools, the cost of which will approach $1,000,000. These include presses, lathes, shapers, grinders and power hack saws, and will be distributed at various division points.

Rolling Stock for the Seaboard Air Line

It is reported the Seaboard Air Line is making enquiries in regard to purchasing 1,500 fifty-ton capacity box cars, 200 forty-ton flat cars with steel underframes, and 300 steel phosphate cars of fifty tons capacity.

Completion of Kansas City, Mexico & Orient Railroad

Early completion of the gaps in the Kansas City, Mexico & Orient Railroad in Mexico is probable. At the present time, though service over this line—which has its terminals at Kansas City, in the United States, and Topolobampo, Mexico, on the Gulf of California—is limited to the lines in this country. Two unfinished gaps remain in Mexico—one between Fuerte and Sanchez, a distance of 155 miles, the other between Alpine and Falomir, approximately 158 miles.

All-Steel Dining Cars for the Pennsylvania

The management of the Pennsylvania Railroad System will in the near future place orders for the construction of twenty additional all-steel dining cars of the largest size and most modern type and equipment. The new cars will not only make it possible to meet the public demand for increased dining car service but will, immediately upon their completion, permit the retirement of all remaining wooden dining cars in use on the Pennsylvania Railroad. They will, therefore, constitute another important step forward toward all-steel passenger train equipment.

Domestic Exports from the United States to Foreign Countries

Steam Locomotives, November, 1921

Countries	Number	Dollars
Mexico	40	1,756,270
Cuba	2	31,341
Dominican Republic	1	29,000
Brazil	1	23,500
Chile	10	360,000
China	3	300,000
Philippine Islands	4	58,660
Total	61	2,558,771

British Railways Wages Boards and Joint Councils

The central and national wages board, British railways is now in operation and will continue at least until January 1, 1924. All questions relating to rates of pay, hours of duty, etc., in default of agreement are being referred to this Board, which is composed of 16 members, of whom eight represent the railway companies, and eight the employees, appointed as follows: Four by the National Union of Railwaymen, two by the Associated Society of Locomotive Engineers and Firemen, and two by the Railway Clerks' Association. In addition to this Board, which is known as the Central Board, there is a National Wages Board, also composed of 16 members, of whom six represent the railway companies, six the railway employees and four the users of railways, together with an independent chairman nominated by the Minister of Labor. The National Board decides all questions of pay and conditions which are referred to it by the Central Wages Board, when that Board fails to agree. Strikes and lockouts are prohibited before the expiration of one month after the reference of the dispute to the National Board, which Board is required to publish the results of its investigation within 28 days from the date of reference.

NEW PUBLICATIONS

Books, Bulletins, Catalogues, Etc.

THE PRINCIPLES AND DESIGN OF FOUNDATION RIGGING. Published by the Air Brake Association. F. M. Nellis, Secretary, 165 Broadway, New York.

The pamphlet of 121 pages and containing 74 illustrations is probably the most thorough and systematic treatise on the subject with which it deals that has thus far been published. It is elementary and complete, two features that are not usually embodied in the same book; but as might be expected, the progress from the elementary to the complex is so rapid that the untrained mind or the man who is not more or less familiar with the subject may have some difficulty in following the progress of the explanations.

It opens with a clear and explicit description of the theory of friction and the reasons for the resistance caused by it, varying under different conditions, and the meaning of the coefficient of friction. Then follows a direct application of these principles to the brakeshoe of a railroad car and an explanation of why the clasp brake is more efficient than the single shoe brake. And always to the fundamental feature that the ultimate reason why the application of brakeshoes to the wheels of a car can stop it is the pull of the rails against those same wheels.

Then follow 27 pages on leverages and methods of calculation of lever arms and pressures in which many rules and formulæ are given, which no one would remember and without a statement as to the real fundamental principle underlying all leverages, all levers and all transmission of power. The trained engineer does not need the book, and the untrained man would probably be confused by the wealth of explanation that is offered him.

The next portion of the book deals directly with the subject that gives its name to the pamphlet, the foundation rigging, and here we have carefully worked out explanations for the various features that enter into and have controlled the design of the foundation brake rigging of the modern car. There are many things in the details of this part of the design that need to be explained to the novice; such, for example, as the location of the brakeshoes below the center line of the wheel, the method of attaching the hand brake and other things that have nothing to do with the calculation of leverage, but which are vital to the proper functioning of the brake. And these details are fully and clearly explained, so that the veriest tryo could see the reason why for all these things as they are. And these explanations are accompanied by such ample illustrations that they should be readily understood by anyone. And the tables of calculations and proportioning of the members of the foundation rigging are full and complete.

The concluding pages of the book are devoted to an explanation of the laws of retardation and acceleration and to showing that they are identical. At the start a broad general statement is made that should be driven home to and borne in mind by every one. It is that: "*Any* change of motion may result for *any* object with the application of a net force of *any* magnitude provided the force has sufficient time in which to effect the change."

In the explanation which follows, the whole is based on the laws of gravitation, as it should be, but the formulæ given are so many and so involved that it is doubtful if the average man will take the trouble to unravel them. Formulæ without a knowledge of the principles upon which they are based are the most elusive items of human knowledge, and it is always well to avoid the bare dogmatic statement of them if possible. So, too, it seems that the discussion of the distinction between mass and weight is useless. As far as the average man is concerned he has nothing to do with mass. Weight is the only thing that concerns him, and to introduce it is apt to surround the subject with the confusion of mystery which is not necessary. It is, therefore, respectfully suggested that the whole principle of acceleration and retardation can be stripped of confusing formulæ and made an exceedingly simple proposition.

But these criticisms aside, the fact remains that, taken as a whole, the pamphlet is a most valuable contribution to the literature of the brake.

LUBRICATION OF LOCOMOTIVES. By E. L. Ahrons. Published by the Locomotive Publishing Company, London, England. 192 pages, with numerous illustrations.

Portions of the valuable matter contained in this book originally appeared in *The Locomotive Magazine*, but Mr. Ahrons, the accomplished engineering author has thoroughly revised the work and added much that is entirely new, so that it may be said that there is no part of the modern high-powered locomotive that is not reached and its need of proper lubrication thoroughly considered. Not only so but the various kinds and qualities of lubricants are described and analyzed in regard to their special adaptability to the requirements of the various parts of the complex machine. The book is the result of genuine study by a master in technique gifted with a graceful and luminous art of expression.

THE CENTENARY VOLUME of Charles Griffin and Company, London, England. With Foreword by Lord Moulton.

J. B. Lippincott Co., of Philadelphia, announces the publication in London of a volume relating to the centenary of the publishing house of Charles Griffin and Company. It is fitting and proper that this should be done, and it is gratifying to note that the work has fallen into capable hands. The volume which extends to 290 pages is a model of the printer's art, and records the monumental work of the eminent publishing house during its century of existence. As is well known it was the first to recognize that in the science of engineering a new field of enterprise was open. The genius of Macquom Rankine, then Professor of Engineering, Glasgow University, was called to the service of the company, and to him and his successors the engineering world owes a debt that never can be repaid. Their text books have beneficially affected the vast industries of mankind.

THE FIRING OF LOCOMOTIVES, by F. Cosgrove. A Complete, Comprehensive Course of Instruction on the Principles of Locomotive Firing. Technical Book Publishing Company, District Office, Scranton, Pa.

The special merit of Mr. Cosgrove's work lies in his method of education, and his wide knowledge of human nature, particularly as exemplified in the mental characteristics of the average fireman, whose methods of preparing for an examination are usually marked by a lamof haste akin to a champion foot-ball player who has spent his leisure hours in the open field and suddenly turns to the necessary cramming for what are briefly called "Exams." The athlete may kick a goal but he seldom kicks fifty per cent in languages or the higher mathematics. Mr. Cosgrove's work is divided into twelve parts of 32 pages each, and by studying one page a day, one instruction paper a month, a man in twelve months will be able to reach as near the head of the list as will make him a marked man for life. We will stand by this opinion with all the unction that we possess. The lack of space prevents us from giving an analysis of each of the twelve parts, including seven instruction papers, and a coal-table chart. These treat not only on the characteristics of coals found in locomotive service, their burning qualities, the principles and processes of burning, smoke, and how to burn a smoky coal smokelessly. Not only these essentials, but the keener knowledge of knowing when trouble arises whether it should be charged to the fireman or the equipment may be learned from the proper study of this work with a degree of assurance that is beyond controversy.

Discussing the Contract System

Frank P. Walsh, attorney for the railroad unions, made an able presentation of his views on the contract system before the United States Labor Board in Chicago last month. Mr. Walsh claimed that the evidence showed that the system was a fraud to dodge provisions of the Transportation Act. George Kaunauer, vice-president and general manager of the Indiana Harbor Belt Railway, claimed that efficiency and economy were the only motives behind adoption of the contract system of car repair work established on that road, and claimed the right to "farm out" work to contractors not under the jurisdiction of the road.

Rust

Iron will not rust in perfectly dry air. A piece of iron had been kept in dry air for about nine years, and it had been found there was no sign of rust. Iron did not rust in perfectly air-free water, and it was known that metal had been kept for several months in steam without the slightest trace of rust forming.

Sulphur in the Coal Bed

Bulletin No. 125, by H. F. Yancey and Thomas Fraser, just issued by the Engineering Experiment Station, deals with the manner of occurrence and the distribution of the various forms of sulphur in the coal bed. The experimental work was undertaken as a part of the United States Bureau of Mines plan of research on coal preparation, and the application of the information secured to the problem of producing cleaner coal was the principal objective. The solution of this problem must of necessity rest to a considerable extent upon an intelligent knowledge and appreciation of the physical and the chemical forms in which sulphur occurs in a particular coal, and how it is distributed through the coal in the bed. Copies of this Bulletin No. 125 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

The Vacuum Automatic Brake

This is a practical text book intended for the guidance of railway men whose work may include the fitting up or operating the vacuum automatic brake apparatus, and has already reached a second edition, and may be said to contain the latest word on the subject. The separate types of brake cylinder, with the latest improved attachments, are fully described and illustrated. Varieties on design are shown, embracing the latest accessories, such as "accelerators," "load" valves, together with vanader power brake and automatic vacuum brake or electrified section. Testing for leakage and alarm signal apparatus are also added.

Westinghouse Electric Publishes New Catalogue

Safety Switches and Panel Boards is the subject of Catalogue 12-A, dated 1921-1922, which is now being distributed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This catalogue is profusely illustrated with views of installations of safety switches in the shop, in the office and in the home. It is specifically shown why Krantz safety switches are safe, and how they can be operated by anyone. Dimensions and list prices of these switches are given in detail. Some of the subjects that are discussed are the railway type safety panel boards, the safety car lighting panels, the auto-lock control panels, the dead-front and dead-rear safety switchboards, the live-front knife switches and many other devices.

Lubrication

The Texas Company's technical publication, *Lubrication,* sustains its high character as an eminent authority in the uses and abuses of oils. Different oils for different uses are only mastered by a chosen few, and the company's experts have reduced or rather raised this attribute to a science. As an illustration, steam cylinder oil is supposed by some to be suitable for air compressors. This is a gross error. A lighter oil with a viscosity of about 180° cleans out the lines and lubricates the air tools also.

Leaflet on Arc Welding

Arc welding for repair and reclamation, general applications of arc welding, and arc welding for manufacturing processes are well described and illustrated in Leaflet 1825, just published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. A story is told of how costs are reduced by the use of arc welding.

Railway and Locomotive Engineering
A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV | 114 Liberty Street, New York, February, 1922 | No. 2

The Edwards Railway Motor Car

It is a good many years since the first attempts were made to apply the internal combustion engine to the propulsion of railway cars, and numerous designs have been worked out and put into practical operation. The great success that has attended the use of this type of engine in its application to road vehicles has turned the attention of a number of designers towards the adaptation of the ordinary automobile truck engine to the railway motor car.

Among the latest and most successful of these adaptations is that of the Edwards Railway Motor Car Co. of Sanford, North Carolina. The work was undertaken in 1915 by a number of owners of short line railways whose passenger business was being taken away by competing motor busses and jitneys.

They, then, turned their attention to highway motor trucks, and a deal of experimentation was carried on in order to develop the car that is now offered for railroad consideration. In this work it was found that it was not sufficient to put a body and a set of flanged wheels on a motor truck in order to obtain a satisfactory railway car; because though the standard construction, and, strange as it may seem, it will not stand up to the requirements. One, reason is that the final drive on the rear pair of wheels does not give sufficient traction to meet the requirements; and, finally, it was found that a converted truck was practically helpless even in a mild snowstorm or whenever there was ice or frost upon the rails.

The car, as developed under these auspices is carried on two four-wheeled trucks, that at the rear being used for driving purposes and is fitted with wheels 24 inches in diameter, whereas those at the front are only 20 inches in diameter. Power is transmitted to these wheels by chains, as it was found that they stood up under the service better than the direct gear drive as they served to cushion the shocks of the wheels on the rails and prevent them from being transmitted to the machinery. As to the durability of this method of driving, cars in service have run 25,000 miles with one set of chains and sprockets at a cost of about one-quarter of a cent per mile.

The motor used is a 4-cylinder machine adapted to heavy duty, having cylinders 4½ inches in diameter and 6½ inch stroke and capable of developing the car for speeds as high as 45 miles an hour. Where exceptional grades, such as those of 4 per cent are encountered, it is possible to gear the car for speeds as high as 30 miles per hour. The clutches are arranged so as to be able to obtain four speeds in each direction, and they are the same for both forward and backward motions.

Two types of passenger cars have thus far been developed, one having 4½-inch by 6½-inch engines; as stated, which weighs 12,000 pounds; the other has 3¾-inch by 5¼-inch cylinders and weighs 9,000 pounds, and can be built with a seating capacity of from 25 to 43 people.

EDWARDS RAILWAY MOTOR CAR IN OPERATION ON THE ATLANTIC & WESTERN RAILROAD

As to cost of maintenance, one of these smaller cars was put into service on the Atlantic & Western Railroad in September, 1917, and at the end of a run of 120,000 miles the entire maintenance cost for labor and material was $1,603.40, making an average maintenance cost of 1.33 cents per mile. At the end of this period the car was in such a condition that it was estimated to have an additional life of about 180,000 miles, which will put the depreciation charge against the equipment at about 2¼ cents per mile.

which two round trips were made daily over a run of about 25 miles. The total cost of this operation for twelve months, covering a run of 35,760 miles, was estimated at $15,405.90 or 43.08 cents per train mile. This estimate included the actual wages paid to the train crew, consisting of engineer, fireman, conductor and brakeman, cost of fuel, locomotive and coach maintenance, oil, waste and water and a depreciation of the engine and coach which was placed at 4 cents per mile.

After the introduction of the motor car the steam service was reduced to a run every other day.

The cost of operating the motor car under these conditions, for one year, was $3,580.48. As the car ran 43,800 miles the cost per car mile was 8.18 cents per mile. This included the wages of the motorman who constituted the whole crew, the cost of fuel, oil and other supplies, the cost of maintenance and an estimated depreciation of 2¼ cents per mile.

With the advent of frequent and dependable rail service the competition of bus lines and jitneys ceased to be worthy of notice, and passenger revenues correspondingly increased.

In the days when the steam train was laid off, the train crews worked in the shop on the maintenance of equipment.

Mr. Willard on Fuel Economy

"It has been said that the railroads have too many supervisors. I have had letters calling my attention to the fact that we had too many supervisors and suggesting that some of them should be taken off. But it has seemed to us that the railroad was justified in spending $50,000 a year for an organization of men selected from among its own employees to instruct enginemen and firemen how to save coal, when it is possible in our opinion to save at least 500,000 tons of coal a year, which at $3.00 per ton would amount to one and one half million dollars on the Baltimore and Ohio Railroad."

Underwood Challenges McAdoo

Frederick D. Underwood, president of the Erie Railroad Company, seriously questions Mr. McAdoo, the former Director General of Railways, as to his ability to pass as an expert on the qualifications of railroad men. Mr. McAdoo had testified before the Interstate Commerce Commission that he had threatened to discharge several railroad presidents because of the inefficiency of the roads.

Mr. Underwood claims that "ordinarily about 17 per cent of the railroads' traffic is for export purposes. During the war this was increased to 50 per cent. Naturally, there was congestion at eastern terminals, and avoirdupois was needed to move it. The railroads had to remedy

United States Labor Board Issues Additional Rules Affecting Clerks and Station Agents

On January 22, new railroad rules, affecting about 300,000 clerks and station agents, were issued by the Labor Board, and went into effect on February 1. A saving of $50,000,000 is expected from two provisions on the new code—one sanctioning intermittent, or "split trick" service, and the other stipulating that time and one-half shall be paid only after the ninth hour of work.

While concurring in the decision as a whole, A. O. Wharton, one of the labor group members, appended a statement asserting that time and one-half should be allowed after the eighth hour.

The decision expressly recognizes the principle of the eight-hour day, but provides that the ninth hour shall be paid for at the pro rata or regular rate.

The rule authorizing "split tricks" will not only save the railroads much money, it is said, but it will also enable them to employ many agents at small stations that have been closed. It provides that employees may be required to work eight hours at any time during a spread of twelve hours.

In three recent decisions affecting different classes of employes the Labor Board has established three different standards for overtime pay. The shop crafts were granted time and one-half for overtime after eight hours, but the maintenance of way employes' decisions, while recognizing the eight-hour day, provided for time and one-half pay only after the tenth hour.

W. L. McMenimen, labor member, and Ben W. Hooper and G. W. W. Hanger, public group members, submitted a detailed answer to the dissenting opinions, undertaking to justify the decision.

"Punitive payment," reads the dissenting opinion, "has but one justification—namely, preventing the working of unreasonable hours. Therefore, it is our judgment that the imposing of rules requiring punitive payment for any service rendered by employes covered by this decision within the ten-hour period is unjust, unfair, and unreasonable and burdens the carrier with an uneconomical condition."

The rule authorizing "split tricks" not only will save the railroads great sums, but it will also result in the reopening of many small stations. And, in consequence of this, many agents who have been unemployed will find jobs.

Under the national agreements the roads were required to pay time and one-half for all time beyond a spread of eight hours. Now the eight hours still constitute the day, but, where the work is by nature intermittent, it may be spread over a period of twelve hours.

During Labor Board hearings on the duced testimony intending to show cost of maintaining small stations under the national agreement was prohibitive.

This evidence, for instance, showed the sole duties of an agent might be to meet the "9 o'clock train" in the morning and the evening train at 8 o'clock, perhaps. Because the spread extended over nine hours he must be paid time and one-half for three hours' overtime. Much of the day, according to testimony, the rural station agent worked on the side, at farm labor or odd jobs.

When this condition caused the closing of smaller stations there were innumerable complaints from the rural stations. The new rules, it is expected, will silence these.

The Future of the Railroads.

Walter D. Hines, formerly Director General during the period of Federal control of the railroads, stated before the Senate Interstate Commerce Committee that adequate railroad service in this country in the future is dependent upon greatly enlarging the railroad facilities of the country, and this will demand enormous quantities of capital.

In view of the fact that the war has necessitated the postponement of many sorely needed railroad additions and betterments, it is thought that the annual expenditures for capital purposes ought to be considerably in excess of a billion dollars per year for many years to come.

New Record Output of Canadian Steel

Production of steel ingots and castings in Canada during November, according to the Dominion Bureau of Statistics, showed a decided improvement, the output rising from a high record of 72,204 long tons in October to a total of 75,039 long tons. Of the November output, 73,806 tons was made by the producers for their own use, mostly in the manufacture of steel rails. A small amount was produced for direct sale, the total under this item being 1,233 long tons, practically all of which was in the form of steel castings.

New Haven Trains on Time

An increase of 14 per cent in the number of trains run on time during the year 1921, as compared with 1920, is revealed by figures made public by the transportation department of the New York, New Haven & Hartford Railroad Company. The total number of trains run by the New Haven during 1921 was 505,853, of which 461,204, or 91.1 per cent, were on time. The percentage for 1920 was 77.1.

Many of the other railroads are making an equally excellent record, and all are

Annual Report of the Chief Inspector, Bureau of Locomotive Inspection

The annual report furnished by the Bureau of Locomotive Inspection for its tenth fiscal year, ending June 30, 1921, is in many respects the most noteworthy hitherto presented. The data contained in the report include a résumé of all accidents resulting in the serious injury or death to one or more persons, caused by the failure of some part or appurtenance of the locomotive or tender, together with the casualties resulting therefrom. Also all defects of the locomotive and tender constituting violations of the law and rules found and reported by the Federal inspectors. Comparisons with previous years are also shown, of which the following are the most noteworthy:

Number of locomotives inspected, number found defective, percentage inspected found defective, number ordered out of service, and total defects found by years.

	1921	1920	1919	1918	1917
Number of locomotives inspected	60,812	49,471	59,772	41,611	47,542
Number found defective	30,207	25,529	34,557	22,196	25,909
Percentage found defective	50	52	58	53	54.5
Number ordered out of service	3,914	3,774	4,443	2,125	3,294
Total defects found	104,848	95,066	135,300	78,277	84,883

Number of accidents, number killed, and number injured as a result of failure of parts and appurtenances of the entire locomotive and tender, by yours.

	1921	1920	1919	1918	1917
Number of accidents	735	843	565	641	616
Decrease from previous year (per cent)	12.8	[1] 49.2	11.8	[1] 4.1	....
Number killed	64	66	57	46	62
Decrease from previous year (per cent)	3	[1] 15.8	[1] 23.9	25.8	....
Number injured	800	916	647	756	721
Decrease from previous year (per cent)	12.6	[1] 41.6	14.4	[1] 4.8	....

[1] Increase.

The comparative table below for the fiscal years ended June 30, 1912, 1915, 1920, and 1921, shows the number of accidents, number of killed, and number of injured as a result of the failure of some part of appurtenance of the boiler only:

	1921	1920	1915	1912
Number of accidents	342	439	424	856
Number killed	51	48	13	91
Number injured	379	503	467	1,005

Derailments due to defects in or failure of some part of the locomotive or tender and the number of persons killed and injured as a result of such derailments for the fiscal years ended June 30, 1917-1921, inclusive.

	1921	1920	1919	1918	1917
Number of derailments[1]	8	7	7	2	4
Number killed	....	7	6	....	1
Number injured	30	18	7	2	21

[1] Only derailments reported by carriers as being caused by defect in or failure of parts of the locomotive or tender were investigated or counted in this tabulation.

During the first six months of the fiscal year 1921, accidents and casualties occurred at an alarming rate and exceeded those of any like period during the five preceding years. However, during the last six months a marked reduction is recorded, the number of accidents and casualties during the year were considerably in excess of those occurring during the year 1919, and as referred to in the last annual report, a large number of accidents resulting in serious injury were caused by the failure of what are frequently termed unimportant parts. For instance, during the year 85 accidents were caused by the failure of some of the grate-shaking apparatus, 82 by squirt hose, and 65 by some part of the reversing gear, all of which could have been avoided by reasonable care.

There were no authentic records from which comparisons could be made of such accidents prior to the enactment of this law. A comparison, however, of the fiscal year 1915, the year in which the boiler inspection law was amended, and 1921, the present year, is of importance, and shows the far reaching effect of proper inspection and repair, as required by the law and the rules and regulations established thereunder.

Comparing 1912, the first year of the boiler inspection law, covering parts and appurtenances of the boiler only, with the year 1915, the fourth year of the law, there is shown to be a reduction of 50 per cent in the number of accidents, 85.7 per cent in the number killed, and 53.5 per cent in the number injured.

Comparing 1912, the first year of the boiler inspection law, with the year 1921, covering parts and appurtenances of the boiler only, there is shown to be a reduction of 60 per cent in the number of accidents, 44 per cent in the number killed, and 62 per cent in the number injured.

Comparing 1915, the fourth year of the existence of the law, with the year 1921, there is shown a decrease of 19 per cent

Fig. 1. Shows a crown-sheet failure, due to low water, which resulted in the injury of one person. The crown sheet was overheated its entire length and pulled away from 313 radial stays of the oil-burning type, which stays have hammered heads and are tapered on the fire box end 1½ inches in 12 inches. All fire-box seams were riveted. The crown sheet pocketed to a depth of 16½ inches. The tops of both the flue sheet and door sheet for a distance of 36 inches were bent downward to an angle of 45°.

in the number of accidents, an increase of 292 per cent in the number killed, and a decrease of 17 per cent in the number injured, due to the failure of some part or appurtenance of the boiler only. Barrel explosions have been entirely eliminated, and while the so-called crown-sheet failures have materially decreased, the great increase in fatalities indicates that the severity of these failures has increased tremendously.

During the year there were a number of accidents investigated in which fire-box seams formed by the autogenous welding process were involved, where, through the failure of these seams, it is believed the result of the accident was much more serious than would otherwise have been. Autogenous welding can be used on many parts of the locomotive and tender and on parts of the stayed surfaces of the boiler with safety and economy, but inasmuch as our accident investigations show that approximately 80 per cent of the autogenously welded seams fail, where they are involved in the accidents, we believe that such methods should be avoided in fire-box crown-sheet seams where overheating and failure are liable to occur, or on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which fully meets with the requirements of the law and rules, at

Fig. 2. Shows a crown-sheet failure, due to low water, which caused the serious injury of three persons. The autogenously welded seam between the crown sheet and combustion chamber failed. The line of demarcation showed that the water at the time of the accident was approximately 2 inches below the highest part of the crown sheet.

The top connection to the water glass was so arranged that it formed a pocket or trap for the accumulation of condensation, which affected the proper registration of the water. The gauge-cock drip was found stopped up, which materially altered the sound of the gauge cocks when being tried and rendered their indications misleading.

least until some means has been developed through which the quality and tenacity of the weld may be established in advance of its failure. This should apply on all parts of the locomotive and tender where, through failure, an accident and an injury might result.

Boiler explosions have been the most prolific source of serious and fatal injuries. There have always been more or less differing opinions among railway officials and employees and others as to the cause of boiler explosions. This being true, much thought has been given to this particular subject, and it is believed that a better understanding as to the cause of an explosion would tend to eliminate or reduce accidents from this source. Therefore, it may not be amiss to recite here well-established facts.

The primary cause of a boiler explosion is because some part of the vessel is too weak to withstand the pressure to which it is subjected, and the cause of this weakness is sometimes hard to determine. The violence which follows boiler explosions is accounted for by well-known established physical laws.

All matter, whether solid, liquid, or gaseous, consists of molecules of atoms, which are in a constant state of vibration, and the result of this vibration is heat. The intensity of the heat evolved depends upon the degree of agitation to which the molecules are subjected.

The process of the generation of steam from water is simply an increase of the natural vibration of the molecules of the water caused by the application of heat until they lose all attraction for each other and become repulsive, and unless confined fly off into space, but, being confined, they continually strike against the sides of the vessel in which they are confined, thus causing the pressure which steam exerts when under confinement.

The generation of steam by the addition of heat is accomplished in two steps; heat added to water first increases the activity of the molecules and is indicated by a rise in temperature. Heat which warms the water and causes the rise in temperature is called "sensible heat." When sufficient heat is added to water, its temperature continues to rise until about 212° is reached, the temperature of the boiling water under atmospheric pressure at sea level. The temperature at boiling water varies directly with the pressure to which it is subjected; the greater the pressure the higher the temperature. Under 200 lbs. pressure the boiling temperature is 388°, while under a nearly perfect vacuum water boils or becomes in ebullition and gives off a vapor at 32°, at which temperature ice begins to form under atmospheric pressure.

A British thermal unit is the quantity of heat required to raise the temperature of one pound of water 1°; therefore it takes 180 units to raise one pound of water from 32° Fahrenheit to 212°. Water does not flash into steam as soon as the temperature reaches 212°, but, on the contrary, 970 additional heat units are used in forcing the molecules apart against their mutual attraction or cohesion, which additional heat is known as "latent heat."

It will be seen from this that every pound of steam in the boiler at atmospheric pressure contains 1,150 heat units. As steam is generated and the boiler pressure increases, the heat energy in the steam also increases until each pound of steam under 200 lbs. pressure holds within itself 1,199 units of heat, and the temperature of the water in the boiler is increased to 388°.

When shell sheets rupture or crown-sheets fail and the boiler pressure is suddenly reduced to atmosphere, a tremendous amount of heat energy stored in the water is instantly released and causes a large part of the water to suddenly flash into steam while the volume of the steam expands many times. The capacity of the boiler is then wholly inadequate to accommodate the increased volume of steam so suddenly generated, nor will the rupture permit it to escape fast enough to avoid a tremendous reaction. As a result of this reaction, we have the appalling explosions which are from time to time so forcibly brought to our attention.

The force of a boiler explosion is in proportion to the size and suddenness of the initial rupture and the temperature and volume of the water in the boiler at the time of the rupture. The average modern boiler has a capacity of approximately 500 cubic feet of water below the crown sheet and has a steam space of about 150 cubic feet. If such a boiler with 200 pounds' pressure ruptures from any cause, so as to suddenly reduce the pressure to that of the atmosphere, the released energy will amount to approximately 700,000,000 foot-pounds and if the explosion took place in two seconds approximately 690,000 horse-power would be developed.

This gives some idea of the force which accompanies many boiler failures, with their serious and fatal results, and supplies the reason for the violence which in many cases is sufficient to hurl the entire boiler several hundred feet or tear it into fragments, scattering them in every direction.

As previously stated, explosions result because some part of the vessel is too weak to withstand the pressure to which it is subjected. This weakness may be caused by:

1. Abnormal steam pressure.
2. Weakness in design or construction.
3. Improper workmanship.
4. Corrosion or wasting away of material.
5. Broken or defective stays.
6. Overheated crown or fire-box sheets.

A remedy for the first three causes is provided for in the law and rules by requiring that the working pressure be fixed, after careful consideration of each individual boiler by competent authorities, and by fixing a substantial factor of safety for all parts of the boiler to provide against hidden defects of material and construction.

To protect against failure due to corrosion or other defects caused by wear and usage, the law requires that regular inspections, both interior and exterior, be made and that all boilers be subjected to a hydrostatic test at regular intervals and a sworn report filed showing the conditions found and repairs made.

Failure of crown or fire-box sheets, due to overheating, may be the result of scale or grease on the fire-box sheets or from low water.

The fire-box sheets and tubes are in contact with the fire, and would become heated to that temperature if it were not for the pressure of water in the boiler. A previously explained, the temperature of the water in the boiler depends on the boiler pressure, but rarely reaches a temperature greater than 400° Fahrenheit; therefore, while the plates are in contact with the water on one side they cannot greatly exceed this temperature, although the temperature in the firebox may exceed 2,500°, which is about the facing point of firebox steel.

The heat in the firebox is conducted through the plate to the water in the boiler, where it is absorbed, the sheets thus being prevented from heating to the temperature of the fire and burning gases. If, however, the transmission of the heat to the water is obstructed by scale or grease, or if the water fails to absorb the heat, due to being foamy, the plates will retain the heat, and may become red hot; or if the sheets are unprotected by water from any cause, they become overheated. Metal loses strength when heated, and if heated to a high temperature has comparatively little strength to resist the pressure within the boiler, when as a result the sheets are forced off of the stays and failure occurs. It is a well-recognized fact that scale or grease may be the direct cause of an explosion. Scale may indirectly cause an explosion by restricting or closing the openings in the water-indicating appliances, thereby causing a false level of water to be registered, deceiving the enginemen.

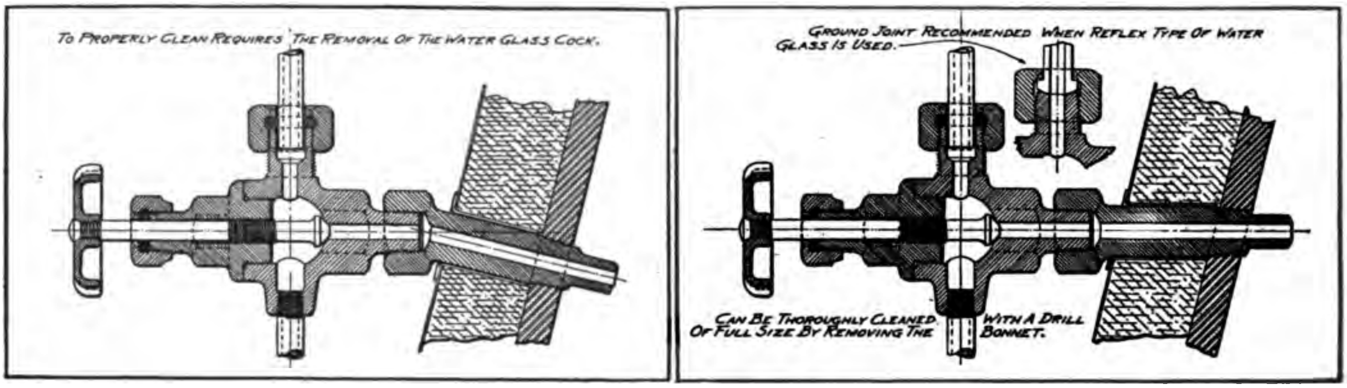


FIG. 3. SHOWS DETAILS OF GAUGE COCKS

One of the most perplexing problems which has presented itself while operating the modern locomotive is that of securing a correct indication of the height of water over the crown sheet under all conditions of service.

In the last annual report was included a report covering tests made to determine the action of water in the boiler on the water-indicating appliances with respect to their correct registration. These tests established that gauge cocks screwed directly in the boiler do not correctly indicate the general water level while steam is rapidly escaping from the boiler, and in order to secure a proper appliance it was recommended that a water column to which three gauge cocks and one water glass were attached be applied. Locomotives constructed since that report was rendered have had water columns applied. On old locomotives the application has not progressed rapidly, probably due to the difficulty in obtaining necessary appropriations, The necessity for such appliances, however, is practically unquestioned, and some roads are proceeding with the application in a very satisfactory way. It is hoped that in the near future this important appliance will be applied on all locomotives, so that enginemen may have accurate knowledge of the general water level in the boiler under all conditions of service.

Transcribed reports showing defects found on all locomotives ordered out of service and those found approaching violations of the law and rules were furnished the chief operating officers of the carriers monthly, so that they might be fully informed of the condition of their locomotives as disclosed by our inspectors.

During the year 209 applications were filed for extension of time for the removal of flues, as provided in rule 10. Investigation showed that in 25 of these cases the condition of the locomotives was such that no extension could properly be granted; 22 were in such condition that the full extension requested could not be granted, but an extension for a shorter period within the limits of safety was allowed; 25 extensions were granted after defects disclosed by our investigation had been repaired; 38 applications were withdrawn for various reasons; and the remaining 99 were granted for the full period requested.

As provided in rule 54, there were filed 2,791 specification cards and 9,785 alteration reports These have been carefully checked to determine whether the boilers represented were so constructed as to safely withstand the pressure to which they were being subjected and that the stresses given in the specifications and alteration reports had been correctly calculated.

On July 1, 1920, the rules became effective requiring each locomotive used in road service between sunset and sunrise to be equipped with a headlight which will enable the enginemen to see in a clear atmosphere a dark object as large as a man 800 feet ahead of the locomotive and that front and one on the rear that will enable the enginemen to see 300 feet ahead of the locomotive. These requirements have been given close attention and have been fully complied with so far as it has been brought to our attention. The lighting equipment with which locomotives are now equipped seems to be meeting with the universal approval of officials and employees required to operate and maintain them.

During the year the inspectors of this bureau, at the direction of the commission, spent 962 days on special work, in connection with the transportation act of 1920 and the interstate commerce act, other than the duties required by the locomotive inspection law.

The law provides that whenever any district inspector shall in the performance of his duty find any locomotive or apparatus pertaining thereto not conforming to the requirements of the law or the rules and regulations established and approved he shall notify the carrier in writing that the locomotive is not in serviceable condition, and thereafter shall not be used until in serviceable condition. *Provided,* that a carrier, when notified by an inspector in writing that the locomotive is not in serviceable condition because of defects set out and described on said notice, may appeal to the chief inspector to have the locomotive reexamined. The carrier, being dissatisfied with the decision of the chief inspector, may appeal to the Interstate Commerce Commission.

Under the provision of the law not a single formal appeal has been taken from the decision of any inspector during the fiscal year. This demonstrates that wisdom and good judgment have been exercised by our inspectors in the performance of their duties.

In the last annual report certain recommendations were made for the betterment of the service in accordance with section 7 of the act as amended. During the year experience has further demonstrated the wisdom of these recommendations; therefore they are respectfully renewed and the reasons therefore given.

First. That the act of February 17, 1911, be amended so as to provide for adcommission as the needs of the service develop. The act of February 17, 1911, provides that 50 inspectors be appointed, whose duties shall be to make such personal inspections from time to time of locomotive boilers under their care as might be necessary to fully carry out the provisions of the act, so the locomotives might be employed in moving traffic without unnecessary peril to life or limb. At the time this law was enacted there were approximately 63,000 locomotives coming under its jurisdiction.

This act has since been amended, extending the authority of the chief inspector and his two assistants, together with all of the inspectors, to cover the entire locomotives and tenders and all of their appurtenances. The number of locomotives has increased to more than 70,000. With the extended duties of the inspectors and the increase in the number of locomotives, it is impossible for the number of inspectors now provided to adequately accomplish the purpose for which the law was established.

New duties and responsibilities have been imposed upon the commission by the transportation act of 1920, and the act to regulate commerce has been extended, and no doubt in the future, as in the immediate past, this bureau will be called on from time to time to make investigations necessary to carry out the requirements.

To be in position to effectually carry out the duties imposed, it is necessary to have an efficient corps of competent and well-trained inspectors who can be called upon when occasion requires. In order to obtain and retain on the service such inspectors, their salaries should be increased to be commensurate with the duties performed and the responsibilities imposed. The absence of inspectors from their accustomed duties or the lack of a sufficient number is reflected by the increased number of accidents and casualties and the deficiency of motive power. It is therefore respectfully recommended that the act of February 17, 1911, be amended so as to provide for additional inspectors to be appointed by the commission as the needs of the service develop, and that adequate salaries may be paid that will obtain and retain in the service a full corps of well-trained, efficient inspectors, and that the amounts directly appropriated to carry out the provisions of the act of February 17, 1911, as amended, be increased to meet the requirements.

Second. That all locomotives not using oil for fuel have a mechanically operated fire door so constructed that it may be operated by pressure of the foot on a pedal or other suitable device located on the floor of the cab or tender at a proper distance from the fire door, so that it may be conveniently operated by the person firing the locomotive.

This recommendation is based on the failures of such character as to permit the steam and water contained in the boiler at the time of the accident to be discharged into the fire box, many times being directed toward the fire door.

The old swing-type door, which is largely used at present, is almost invariably blown open in case of such accidents and permits the discharging of steam and boiling water, with the contents of the fire box, to be blown into the cab of the locomotive, seriously and most frequently scalding and burning the persons therein. Such accidents frequently occur while coal is being put into the fire box, and with the fire door necessarily open, under such circumstances it is impossible for it to be closed.

Fig. 4. Shows a picture of a damaged injector steam ram bonnet, which blew out, resulting in the instant death of one employee. This bonnet had been seriously damaged by the use of hammer and set or chisel used in tightening. The threads were damaged to such an extent that the bonnet could be inserted in the injector to within two full threads of its final seat without being screwed in. Such methods for removing and applying nuts of the spanner-wrench type create an unsafe condition, as well as an expensive one, by damaging such parts.

The automatic fire door would remain closed if closed when the accidents occur. If open, it would automatically close the moment the operator's foot was removed from the operating device, thus preventing the direct discharge of the scalding water and fire into the cab of the locomotive with such serious results.

The automatic fire door is not a new and untried device, as there are thousands of them in service, and they are required by law in some States. The automatic fire door is also of great value in prevention of serious cracks and leaks in fire-box sheets by limiting the time the fire doors are open when placing coal on the fire, thus reducing the amount of cold air admitted and consequent expansion and contraction and the setting up of great strains. Their use is also very valuable in the conservation of fuel, which is at the present time a most important item.

Third. That all locomotives be provided with a bell so arranged and maintained that it may be operated from the engineer's cab by hand and by power. The reason for this recommendation has been thoroughly discussed on previous occasions, and its necessity seems so apparent that it hardly requires further comment. We believe, however, that this is an appliance which is vital to the safety of the employes and general public at highways and other public places traversed by the railroads. The operation of modern motive power demands the full attention of the enginemen, and it is frequently the case while passing over road crossings and through congested territories that the operators are so occupied with their other important duties that it is impossible for them to ring a bell by hand in order to give warning of approaching danger.

Fourth. That cabs of all locomotives not equipped with front door or windows of such size as to permit of easy exit have a suitable stirrup or other step and a horizontal handhold on each side approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it; handholds and steps or stirrups to be securely fastened with bolts or rivets; the distance between the step and handhold to be not less than 60 inches nor more than 72 inches.

This recommendation is based on the result of investigation of accidents of a character which make it impossible for enginemen to remain in the cab and which compel them to make exit through the cab window to the ground or running board. While locomotives are operating at a high speed, to be compelled to jump from the cab window is exceedingly dangerous and invariably results in serious, if not fatal injury.

The front doors or windows on modern locomotives are so small that they will not permit the enginemen to pass out through them, thus making it necessary to climb over the roof of the cab or out through the side window when necessary to go from the cab to running board in front while in motion.

Such attachments can be applied at a nominal expense and practically without delay to the locomotive and would add greatly to the safety of the employees. Accidents resulting in fatal injury which have been investigated by this bureau show that injury and death would have been avoided had these appliances been in use.

A great number of locomotives have been equipped with the appurtenances above recommended, although, like many other appliances in use, they are not maintained

Fifth. That all locomotives where there is a difference between the readings of the gauge cocks and water glass of 2 or more inches under any condition of service be equipped with a suitable water column, to which shall be attached three gauge cocks and one water glass, with not less than 6 inches, preferably 8 inches, clear reading, and one water glass with not less than 6 inches, preferably 8 inches clear reading on the left side at back head of the boiler.

Water glasses should be so located, constructed, and maintained that they will register the approximate general water level in the boiler under all conditions of service and show within one inch a corresponding level, and so maintained that the engineer and firemen may have under all conditions of service a clear view of the water in the glass from their respective and proper positions in the cab.

Gauge cocks should be located within easy reach of the engineer from his proper position in the cab, while operating the locomotive, extension handles to be applied if necessary to accomplish this. All gauge cocks to be supplied with suitable nipples that will directly discharge into a properly constructed and located drain or dripper that will convey the discharged water to near the cab deck or floor, nipples to be not less than one-half inch nor more than one inch above the dripper or drain and kept in correct alignment.

Gauge cocks and water glasses are now universally used for gauging the water level in the boiler, and since the two appliances show a corresponding level under operating conditions it is clear that one or the other is incorrect and therefore misleading. Investigations have clearly established that gauge cocks when screwed directly into the boiler do not correctly register the proper water level over the crown sheet. It is very important that at least two appliances attached separately and maintained that they will register the approximate general water level in the boiler under all conditions of service and show within one inch a corresponding level, and so maintained that the engineer and fireman may have under all conditions of service a clear view of the water in the glass from their respective and proper positions in the cab.

Should any other appliance than the water column or water glass be invented which will safely and correctly indicate the water level in the boiler, due consideration will be given. The requirements herein recommended should be complied with the first time the locomotive is shopped for classified repairs, as established by the United States Railroad Administration.

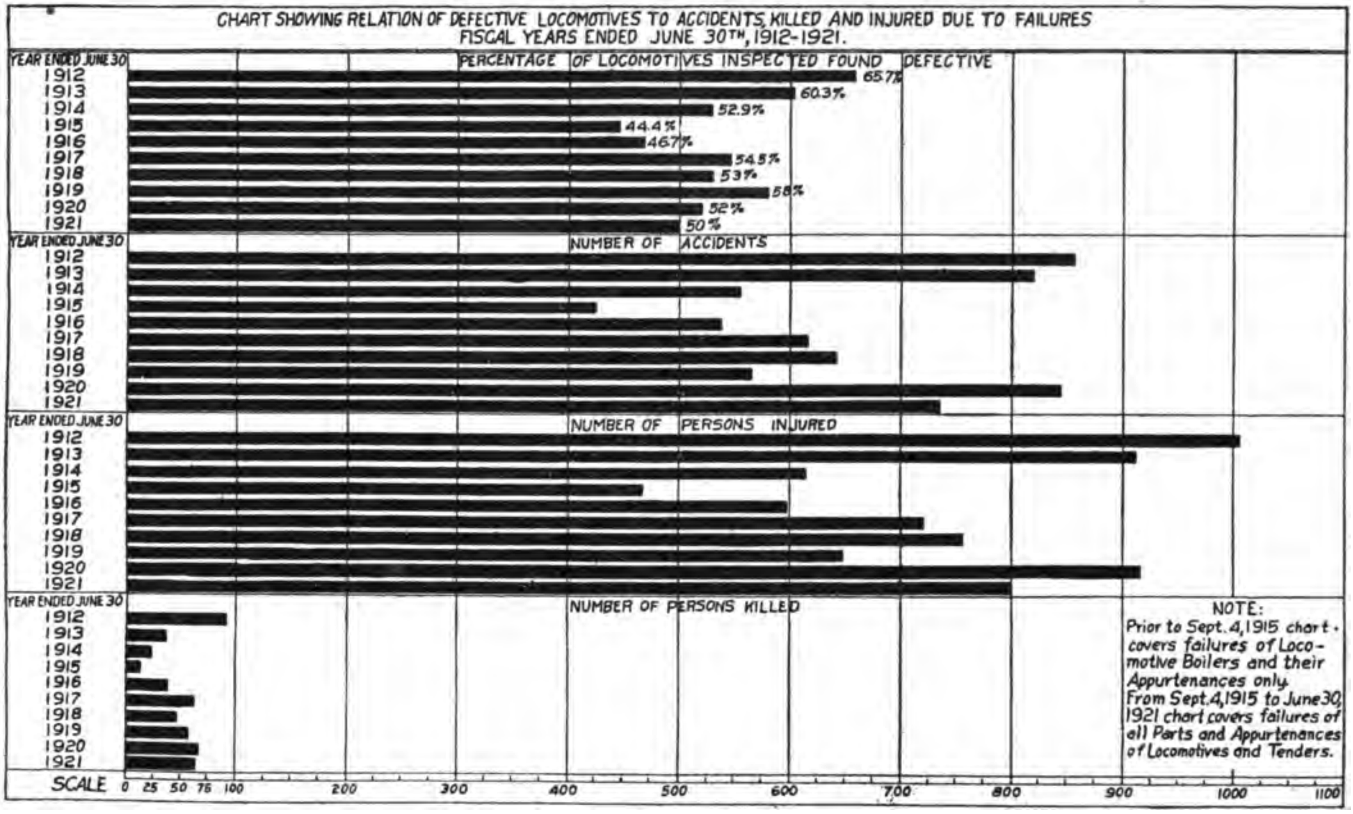


FIG. 5. CHART SHOWING RELATION OF DEFECTIVE LOCOMOTIVES TO ACCIDENTS TO PERSONS

Loyalty of Employees Recommended

Gen. W. W. Atterbury, vice-president, in charge of operation, Pennsylvania Railroad, in the course of an address recently delivered, claimed that one of the greatest problems confronting the railroads today is to restore the old feeling of loyalty on the part of their employees, which was in government control. The increased cost of running the railroad during the war was not the most serious damage that government control inflicted upon us. The most serious injury was the demoralization of railroad personnel, and the inroads that were made upon the domain of management.

Ever since the termination of government control, the railroads have struggled to free themselves from the "National Agreements" which resulted inevitably from the policy pursued by the railroad administration.

Why do you find railroads leasing their repair shops to private individuals and to outside corporations to operate? With many thousands of skilled mechanics out of work: with enough cars and locomotives in need of repair to keep these men steadily employed, why does a railroad company hand over such essential work as equipment repairs, to a private corporation? For the simple reason that that is the only escape from costly, restrictive rules and working conditions, that have been continued in effect by government mandate. With fair, though not arbitrary, working conditions, these shops can handle repairs at a lower figure than the railroads can do the work in their own shops.

I cite this as an example, to illustrate one of the phases of the problem of "workmanship" in railroad service that must be met. These conditions have been kept in effect largely through the failure of gov-

Report on Investigation of Autogenous Welding

Prepared for the Master Boiler Makers' Association

Among the reports prepared by special committees of the Master Boiler Makers' Association, and which, it is expected, will be amplified for the convention to be held this year as reported elsewhere in our pages, a report on the above subject prepared by Thomas F. Powers, Chicago & Northwestern Railroad, chairman, together with John Harthill, John F. Raps, H. J. Wandberg, C. E. Elkins and W. J. Murphy, is of interest to all engaged in autogenous welding as showing particularly the necessity of using the best materials and methods of welding in order that a higher degree of efficiency may be acquired and maintained.

The report explains briefly that "the purpose of this special committee was to investigate autegenous welding by personal observation owing to conflicting reports by different members on the floor of the convention. At first, we were under the impression that we should join our investigation with the committee of the American Welding Society and the Boiler Code Committee of the American Society of Mechanical Engineers. After due consideration, it was our conclusion that the object of the three committees was along different lines and your committee decided to ascertain, by actual investigation, the results obtained from autogenous welding.

Your committee has visited at least one shop on more than 25 railroads and as many as eight shops and roundhouses were visited on some of the railroads.

We found that autogenous welding for firebox repairs is used by every railroad visited and in most cases successfully. We do not believe that it is necessary to go into detail as to what is being done on the various roads by autogenous welding, other than to say that we found complete firebox with no rivets above the mud ring, patches, collar patches around fire holes, corner patches, one-half and full side sheets, one-half flue sheets and one-half door sheets, cracks, checks out of staybolt holes and crown sheets and combustion chamber sheets welded in.

We think it is sufficient to say your committee is satisfied from their investigation that, as a general proposition, autogenous welding of fireboxes is successful. Our investigation has satisfied us that most of the railroads are improving their autogenous welding year by year; that welders are getting to understand the process better; that more care is used in the selection of welders; that foremen are very much alive to the fact that it is necessary to properly educate welders and that a welder, to be successful, must be educated to make welds that will stand up under service, can be made, and are being made that will hold as well as the original sheet even when subject to the most severe strains and tests.

It is our opinion that inexperienced operators, poor welding material and improperly prepared work have been principal causes of failures in autogenous welding. It is now a recognized fact that welders can not be made within a few weeks. It takes months of experience before an operator becomes proficient enough to be trusted with autogenous welding in locomotive fireboxes, and it is our belief that if we are to avoid failures in autogenous welding, we must keep the inexperienced welder out of the fireboxes.

We quote below part of a letter written by H. H. Service, supervisor of welding equipment on the Santa Fe Railroad, and we believe that if this practice is adopted, it will overcome some of the failures:

"It is my opinion and belief that we should first prove that the welding in fireboxes is done efficiently and is stronger than the riveted seam. To illustrate to you the work which we are following on the Santa Fe, we are asking all our welders, both oxy-acetylene and electric, to make a field test once each month and he is given his efficiency later after the specimens have been tested. When his efficiency or tensile strength is below 70 per cent his attention is called to this fact and he is asked to do better. Another feature we are watching closely is, that when the firebox is removed for a renewal, we endeavor to test all parts of the old welded seams wherever we can secure test specimens."

Proper Materials Essential to Good Welding

From our observations and discussions with various boiler foremen, we have agreed that it is necessary that work be properly prepared; that openings be neither too large nor too small, and above all that they be kept free from dirt. To secure good welding, firebox sheets must be clean. It is a mistake to use one grade of welding iron for all purposes. Jobs have been done with fence wire, nails, scrap metal from sheet shearing and what not, and it is no wonder that so many varieties of success and failures are found. When firebox material is specified for a firebox, tank steel should not be used, and if it is necessary to make up firebox steel to certain specifications, it is also necessary that any of the material used in the repairs that go into this firebox should be just as good as the original firebox material, and it is our opinion that all welding wire should be made to specifications. thing by autogenous welding with any kind of an operator, or any kind of welding material, or without the proper kind of supervision, is entirely wrong. Autogenous welding is not a divine healer. Unless good judgment is used in its application and as long as loose attention is given to its use, there will be conflicting opinions as to its success.

Welding Flues to Back Flue Sheet

It appears that there is considerable difference of opinion relative to the success or failure of welding flues to the back flue sheet. Many roads feel that they can get greater mileage by welding their flues, while other roads are not so successful. The success of welding of flues, whether done at the time of application or after the locomotive has been in service for some time, in our opinion, depends on several conditions which must be taken into account. Some of these are: feed water conditions, the kind of coal used, use of injector, whether the firebox is with or without combustion chamber and whether or not water is treated. Some railroads claim to have increased their mileage as high as 50 per cent with welded flues with a big reduction in engine failures from flues leaking; while other roads, especially in bad water districts, are unable to get as much mileage from welded flues as when they are not welded, and have a great deal of trouble with cracked bridges in the back flue sheets. It is sufficient to say that the welding of flues is something that will have to be worked out according to local conditions. We are satisfied that there are roads which are running flues welded to the back flue sheets successfully. We are also satisfied that there are other railroads, due to water and other conditions, which are unable to run welded flues successfully.

In conclusion, it might be well to state that your committee has personally inspected welding under various conditions, both in the roundhouses and shops, and we are satisfied that autogenous welding in all its varieties is a success. Were it not so, it would soon be discouraged and discontinued. The fact that it is being used and its use extended by most of the railroads in this country is evidence that it is a good form of repair. It is economical and quick, and is as essential in the shops and roundhouses today as air and pneumatic tools. As stated above, there have been and will be failures just as there is good and bad riveting, calking, etc., and we are of the opinion that each railroad or section of railroad will work out its own method of repairs based upon conditions and experience in the particular work

Extensive Order of New Locomotives for the Northern Pacific Railway Company

The American Locomotive Company filled an order a short time ago, for seventy-one engines. The order consisted of 20 Pacific type locomotives, 25 Mikados, 20 eight-wheeled switchers and 6 Mallets.

All of the engines were built at the Brooks works of the company at Dunkirk, New York. An interesting feature of the manufacturing of the machines is the use of welding at the boiler seams. In the case of the fire-box of the Pacific locomotives, the crown and side sheets of the fire-box were made of one piece so that no welding or riveting was necessary. The combustion chamber was also of one piece, and was butt welded along the bottom center line and also to the crown sheet of the fire-box. The longitudinal seams of the shell were welded for 18 inches at the front and back, with the exception of the seams over the combustion chamber, which were welded at the front end only.

PACIFIC TYPE 4-6-2 LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY COMPANY. AMERICAN LOCOMOTIVE COMPANY, BUILDERS

MIKADO TYPE 2-8-2 LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY COMPANY. AMERICAN LOCOMOTIVE COMPANY, BUILDERS

In the construction of the fire-box, flexible stays were somewhat sparingly used. There were two vertical rows at the front and back and five horizontal rows at the top. In addition to these there was a slight spreading out into a sort of foot at the bottom of the and three extra bolts at the top to fill in the corner formed where the vertical and horizontal rows met.

Two combustion tubes 2 inches in diameter were expanded in on each side of the fire-box just below the brick arch and a little ahead of the center of the fire-box. Immediately above the arch, and following its slope there were three rows of hollow stay-bolts. These, when considered as three sloping rows, were staggered as they, of course, occupied regular stay-bolt positions. In the combustion chamber, flexible stay-bolts were used for the three front rows and the two top ones, but none were used at the bottom. The combustion chamber had a length of 39 inches. The fire-door was made with the O'Connor expansion ring, with an inside ring riveted to the back sheet and back head.

A detail that will at once attract attention on looking at the engine is the location of the reversing gear. This is usually placed at the side of the boiler in a line with the reach rod. In this case it is dropped down and put in an inclined position near the bottom of the fire-box.

The general dimensions of the Pacific engines are as follows:

Tractive effort 41,900 lbs. with a fac- Cylinder diameter, 26 in.; piston stroke, 28 in.; wheel base driving, 14 ft.; wheel base total, 37 ft. 7 in.; weight in working order, 314,000 lbs.; weight on drivers, 181,000 lbs.; weight on trailer truck, 64,000 lbs.; weight on front truck, 69,000 lbs.; weight on engine and tender, 512,600 lbs.; steam pressure, 190 lbs.; fire-box length, 120⅛ in.; fire-box width, 84¼ in.; heating surface tubes, 2,002 sq. ft.; heating surface flues, 1,082 sq. ft.; heating surface fire-box, 300 sq. ft.; heating surface arch tubes, 35 sq. ft.; heating surface total, 3,419 sq. ft.; superheater surface, 928 sq. ft.; grate area, 70.3 sq. ft.; tubes length, 18 ft.; tubes diameter, 2¼ in.; tubes number, 190; superheater flues diameter, 5½ in.; superheater flues number, 42; driving wheels diameter, 73 in.; tank capacity water, 10,000 gals.; tank capacity coal, 14 tons; cast steel is used for all engine wheel centers, the driving boxes and the tender frame.

The following specialties were applied to the Pacific locomotives: Hancock non-lifting injectors; Mellin reverse gear with oil piston; coal pusher on tender; Smith adjustable hub plates on trailing truck wheels; Pyle National back-up lamp; Adams & Westlake marker lamps equipped with tungsten with Viloco duplex sander valve; Franklin Railway Supply Co.'s No. 8 butterfly fire-door; American Arch Co.'s brick arch in five sections, supported on four 3½ in. tubes; three 3½ in. Consolidated safety valve with the encased pops. Hancock line checks and strainers; Hancock 2½ in. double vertical check valve with double stop valve; balanced throttle valve top opening with drifting valve in dome; Barco automatic smoke box blower fittings; Commonwealth Steel Co.'s cradle at rear of frames; Hunt-Spiller gun iron cylinder and valve chamber bushings; cylinder cocks operated by Hancock pneumatic operating cylinders; King type U. S. metallic packing on piston rods and valve stem; Wilbert grease lubricators on piston rods; Smith adjustable hub liners on all driving wheels; driving axles—hammered open-hearth, oil heat treated steel—hollow bored; Elvin grease cellars; Detroit lubricators; Brunker force feed air piping attachment connected to oil supply pipes between sight feed and air cylinder of compressor; Adreon-Campbell graphite lubricators; Hancock guide oil cups; Ohio Injector Company's Chicago flange lubricators on front drivers.

All of the engines were designed for operation on a 2.3 per cent grade and to pass 16° curves with the exception of the switching engines which will pass curves of 19°.

The Mikados have a tractive effort of 57,100 lbs., with the same factor of adhesion (4.32) as the Pacifics. They have the following principal dimensions: Cylinder diameter, 28 in.; piston stroke, 30 in.; wheel base driving, 16 ft. 6 in.; wheel base total, 35 ft. 3 in.; weight in working order, 337,000 lbs.; weight on drivers, 247,000 lbs.; weight on trailer truck, 59,500 lbs.; weight on front truck, 30,500 lbs.; weight on engine and tender, 551,000 lbs.; steam pressure, 180 lbs.; fire-box length, 120⅛ in.; fire-box width, 84¼ in.; heating surface tubes, 2,234 sq. ft.; heating surface flues, 1,030 sq. ft.; heating surface fire-box, 288 sq. ft.; heating surface arch tubes, 35 sq. ft.; heating surface total, 3,587 sq. ft.; superheater surface, 874 sq. ft.; tubes length, 18 ft.; tubes diameter, 2¼ in.; tubes number, 212; superheater flues diameter, 5½ in.; superheater flues number, 40; grate area, 70.30 sq. ft.; driving wheels diameter, 63 in.; tank capacity, water, 10,000 gals.; tank capacity, coal, 16 tons.

Cast steel is used as in the Pacific engines with the exception of the tender frame which is of rolled channels.

These engines and the mallets are fitted with the Duplex type D stokers, and the Franklin grate shakers, the Chicago flange lubricators on the front drivers and Miner friction draft gears; the Davis solid truss brake beams.

The Mallet locomotives are of the 2-8-8-2 type and have a tractive effort when working simple of 105,100 lbs., with a factor of adhesion of 3.99. When working compound the tractive effort is 87,600 lbs. with a factor of adhesion of 4.78, thus running very close to the possible maximum of 5.

The principal dimensions are as follows:

Cylinder diameter low pressure, 26 in.; cylinder diameter high pressure, 40 in.; piston stroke, 30 in.; wheel base driving, 15 ft.; wheel base total, 55 ft. 2 in.; wheel base engine and tender, 83 ft. 6¼ in.; weight in working order, 483,000 lbs.; weight on drivers, 419,500 lbs.; weight on trailer truck, 28,000 lbs.; weight on front truck, 35,500 lbs.; weight of engine and tender, 696,000 lbs.; steam pressure, 200 lbs.; fire-box length, 126⅛ in.; fire-box width, 96¼ in.; heating surface tubes, 3,575 sq. ft.; heating surface flues, 1,548 sq. ft.; heating surface fire-box, 332 sq. ft.; heating surface arch tubes, 41.6 sq. ft.; heating surface total, 5,496.6 sq. ft.; superheater surface, 1,305 sq. ft.; tubes length, 24 ft.; tubes diameter, 2¼ in.; tubes number, 254; superheater flues diameter, 5½ in.; superheater flues number, 45; grate area, 84.3 sq. ft.; driving wheels diameter 57 in.; tank capacity, water, 10,000 gals.; tank capacity, coal, 16 tons.

Cast steel is used in these engines as in the Mikado and the specialties are the same.

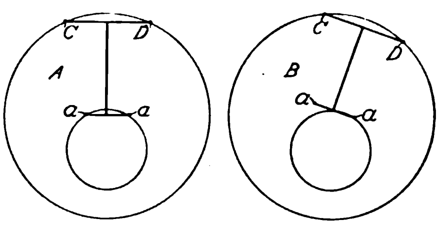
MALLET TYPE 2-8-8-2 LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY COMPANY.
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

Shop Devices for Locating Keyways in Eccentrics, Cutting Off Packing Rings, and Hollow Milling Cutter for Cylinder Cock Valves

The keyway is usually cut in the eccentric of a Stephenson valve gear on the side of the greatest throw. In order that the eccentric may be properly placed upon the axle, it is of the first importance that the keyway should be accurately located. The device here illustrated makes the locating of the keyway a very simple matter.

It consists of a Tee with two pins *C* and *D* set in the head at equal distances on each side of the center of the blade, and so disposed that a line connecting their centers shall be at right angles to the

blade itself had best be made of the width of the keyway to be cut, for convenience



DEVICE FOR LAYING OUT KEYWAYS

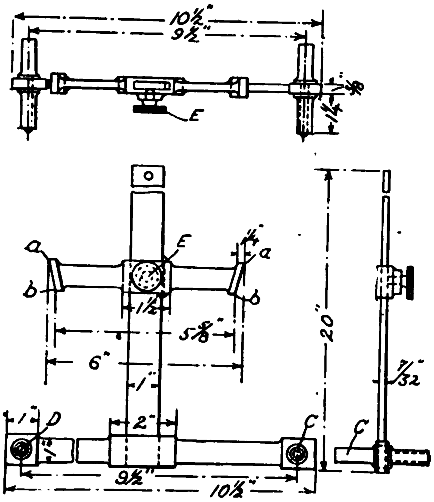
in laying out the keyway. The blade and

Sliding on the blade end capable of being fastened to it by the thumb screw *E*, is a crossbar whose ends are also at equal distances on either side of the center, and so disposed that straight lines connecting the toes *aa* or heels *bb* shall stand at right angles to the center line of the blade.

The principle of operation is this:

The center line of the keyway must be on the line connecting the centers of the outside of the eccentric and the axle fit.

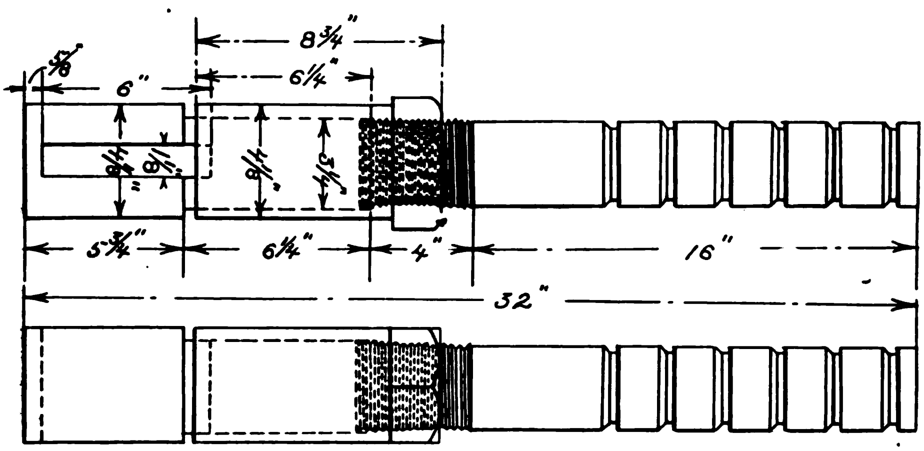
It is evident that if the pins *C* and *D* are brought to bear against the outside of will always pass through the center of the outside of the eccentric. It is also evident that if the toes *aa* of the crossbar are brought into contact with the inside face of the axle seat, the center line of the blade will pass through the center of the



DEVICE FOR LAYING OUT KEYWAYS ON ECCENTRICS

wheel fit. As there is only one line that can be a common diameter of the outside of the eccentric and the axle fit, it is evident that if the pins *C* and *D* are in contact with the outside of the eccentric and the points *aa*, or *bb*, are in contact with the axle seat, then the center line of the blade must pass through both centers and where it crosses the axle fit will be the location of the keyway.

This is shown diagrammatically in the sketches *A* and *B*. In *A* the pins *C* and *D* are in contact with the outside of the eccentric and the points *aa* are in contact with the axle seat, and the blade of the Tee passes through both centers of the



GANG TOOL FOR CUTTING OFF PACKING RINGS

keyway. But if the device is turned into position *B*, with the pins *C* and *D* still in contact with the outer surface of the eccentric it will be seen to be impossible to so adjust the crossbar that both points *aa* or *bb* will be in contact with the axle seat.

HOLLOW MILL FOR CYLINDER COCK VALVES

This is a very simple and easily applied hollow milling cutter that has been designed for milling the outside of cylinder cock valves. The shank of the holder is turned to a taper to fit the spindle of the lathe in which it is to be used and the body is turned to an outside diameter of 1⅛ in. with a keyway cut across the end, for driving purposes.

The cutter itself is turned to an outside diameter of 2 in. and bored to an inside diameter of 1¼ in. The ring thus formed is cut with the teeth for milling at each end as indicated by the dotted lines in the side elevation.

There are 16 teeth, and they are cut to following dimensions as indicated by the several letters:

Outside diameter of the cutting edge D = 1 17/32 in.

Inside diameter of the cutting edge C = 1¼ in.

Depth of cutting edge F = ¼ in.

Depth of flute B = 7/64 in.

Diameter of bottom of flute 1¾ in.

The work is held by the holder and the cutter in a clinch on the carriage and forced against the work, which is thus finished with a single setting.

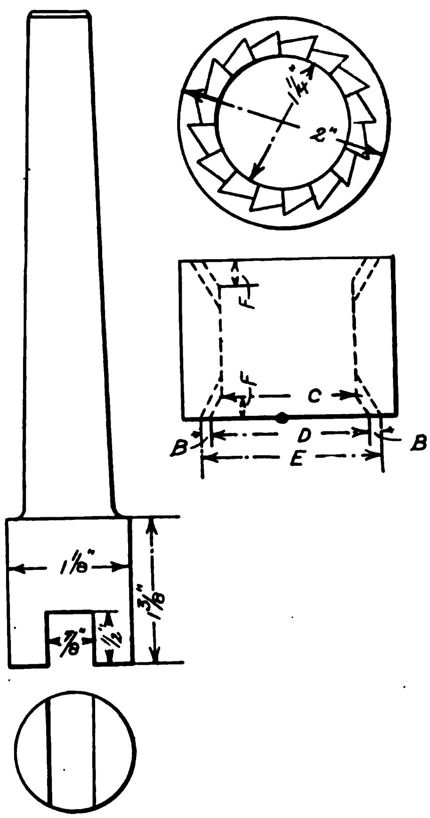
GANG TOOL FOR CUTTING OFF PACKING RINGS

This device is a holder for the tools used in cutting off piston packing rings from the cast iron shell that has been turned and bored to the proper outside and inside dimensions.

The main body of the holder is turned with a shank suited to fit the machine in which it is to be used. This shank has a maximum outside diameter of 3 in. which extends for 16 in. from the end. Then there is 4 in. of screw thread 3¼ in. in diameter to which a hexagon nut is fitted. Beyond the thread the body is turned to a diameter of 3¼ in. for 6¼ in. when it is enlarged to 4⅛ in. for a length of 5¾ in., making a total length of 32 in. for the holder over all.

In the enlarged end a rectangular slot *A* is cut. This is 1⅛ in. wide and 6 in. long and comes to within 5/8 in. from the end of the holder. At the end it is beveled 1/32 in. to fit the bevel of the cutting tools.

These tools are made 3/16 in. wide at the top and ⅛ in. at the bottom and about 5½ in. long. The bevel, it will be seen, corresponds to that at the bottom of the



HOLLOW MILL FOR CYLINDER COCK VALVES

slot *A*, so that when the end too is in place is stands square with the holder.

The slot *A* is filled with tools set at the proper intervals apart for cutting the rings to the desired width. The fillers have the same bevel on the sides as the tools but are, of course, set upside down so that each tool is held square with the holder.

When the tools and separators have been put in place so as to fill or nearly fill the slot *A*, the whole is clamped firmly in place by a sleeve that is made to slip easily over the 3¼ in. diameter portion of the holder. This sleeve is turned to an outside diameter of 4⅛ in., and is forced down against the nest of the cutting tools and separators by the nut working on the thread.

The shank is held in a boring machine and the tools fed against the work that is held in a chuck on the table.

These handy shop devices are already in operation and as will be noted are not difficult of construction, and will pay for their cost in a very short time, as each has the quality of performing the work required in their operations that has been found to be accurately reliable.

Snap Shots—By the Wanderer

It is curious to see the quirks and turns that the mind resorts to when it doesn't quite like to come out into the open and declare itself. Lay its cards on the table, as it were. It is that fear of a lack of sympathy on the part of the public, coupled to the consciousness that certain actions do not contribute to the public comfort that usually imposes silence upon railroad officers as to the reasons for the steps that they may be forced to take. This secretive or protective silence has sometimes acted like a boomerang in the past and has contributed in no small amount to the hostility manifested towards the railroads by individuals, politicians and the public. The come-out-into-the-open policy has been advocated in season and out for a number of years and has been gaining ground. But it has been left to one road to introduce a practice that its patrons and employes denounce up hill and down dale, and, at the same time try to convince a public that knows better, that the new practice will conduce to its comfort and convenience. The practice was probably introduced as a matter of economy; for the road is in sore straights.

It needs the sympathy and good will of the public to the last degree. So the question arises as to whether it would not have been better and really more profitable even in the matter of dollars and cents, to have come out frankly and said: "We are obliged to economize in every possible way, and this practice, while it may cause some inconvenience to our patrons, is a matter of dire necessity with us, as it will enable us to save some fifty or more thousand dollars a month." The public would then know and possibly sympathize.

Instead, it is not told the reason for the change, but is surfeited with declarations that it is a convenience and a time saver which people don't believe. I am wondering if this is really the wiser course.

I have taken occasion to comment upon that most commendable notice that the Pullman Company have posted in its sleeping cars, requesting passengers not to use the common rooms in the morning for lounging or smoking until the passengers have completed their toilet. It took some time to stop the spitting habit but it has been pretty nearly done away with; thanks, possibly, to the assistance contributed by penalties and boards of health. So it cannot be expected that the morning loafer will be eliminated in a day. He still persists and is quite the nuisance that he ever was. How would it do to post bigger notices and more of them so that he who loafs may read? Indeed, be compelled to read, and know that his fellow passengers, on whom he is inflicting himself, can read

In the preface of a suppositious book which the hero of a recent novel is engaged in writing, he says: "This England is yours. It belongs to you. Many enemies have desired to take it, but they have never taken it because it is yours and has been kept for you by the English people." Something of the sort is being preached now by the earnest thinkers of the country regarding America. And plea after plea is being made to each individual to stand by and do his uttermost for the upbuilding and rebuilding of what was so badly shattered by the war.

Men were not, as a rule, overworked in 1914 and yet, in six years, their man-hour efficiency in railroad shops fell away 40 per cent. Was it the easily acquired higher wages? Did they come, like the gambler's winnings, so easily, that incentive to effort was destroyed? Or was it because the individual worker was advised by his leader and monitor to "do as little as possible and get all that he could for it. In short, skimp his work. Is it likely to win and hold friends for the leaders to say that the great struggle now will be to keep what was won during the war? That doesn't sound like the echo of the slogan: "A fair day's work for a fair day's pay." And just so long as men are being encouraged to shirk, and demands are made that they be paid for work that they do not do, there will be a brake upon our advancement to better times and more work.

We are condemning many of the practices of our forefathers, some of which contributed to our convenience and at no great risk to safety. It does not take a very old man to remember when the slip car was used. Sometimes it was a matter of daily practice. The old link-and-pin coupler lent itself admirably to this method of dropping a car. The hand-brake was set on the next to the rear car; the rear car ran in on its slack; the brakeman leaned down from the platform and pulled a pin and the slip car was left to the tender mercies of the grade, the wind and the station agent's son who was aboard to take charge. There was no jar, no shock, and I never heard of any trouble. To be sure, the car weighed only about 15 tons. But the brakes were not as effective as they are today and there does not appear to be any good reason why a slip car could not be handled safely even at high speeds and with heavy cars. So say the advocates of slip cars, and I cannot controvert their arguments. But it would be a bold railroad officer that would put a slip car on a fast express of today. It is very easy to give advice and say what ought to be or could be done, when there is no responsibility attached. It was very easy for the mice to vote to put a bell on the cat. But to assume the responsibility for the doing of it, was quite another matter.

The popularity of the dining car is only equaled by the unpopularity of its prices. We all agree that even at the highway robbery prices that we pay, we are more or less the objects of charity in that we do not pay for our food what it costs to give it to us. I have already acknowledged that I have no remedy at hand for the situation, but even a remedyless man may make a suggestion.

Standing in line is monotonous, nervous work, whether it be at a ticket office or on the bread line.

The old omnibus and tramway lines of Paris were not allowed to load their vehicles beyond their seating capacity. Crowds might gather at any stopping place, but the laws of loading were inexorably applied. There was never any pushing or jostling or elbowing to get aboard a vehicle. Before its arrival the passenger was handed a ticket containing a number, and he simply waited until that number was called, and then his place was held and ready for him.

It does seem as though some such method of numbering and consecutive admission to the dining cars could be worked out, and the queue at each end done away with.

As it is, the man who does not jump and run before the first announcement that "dinner is now being served in the dining car," is doomed to a long standing in line.

It is amusing to those who are easily amused to read notices to the effect that passengers are forbidden to go or ride upon the platforms of cars, and then have another thrust upon them saying that meals can be obtained by going to the dining car. In short, disobedience of the regulation is recommended to those who are hungry, and hunger knows no law. This is a minor matter, to be sure, but there are other places where it is simply necessary to wink at violations because conformity is next to impossible. For instance: in the matter of brake applications. There are a number of 4 and some 6 per cent railroad grades in this country. And yet we have it on very good authority that the air brake will not control a train on a 4 per cent grade. What is the railroad man faced by this fact to do? Stay indefinitely at the top of the grade; let his train run away, while descending and be stopped on the level, or use the hand-brakes? He will probably choose the hand-brake method, and yet he is expressly forbidden to do so by the law. But law or no law, if the road is to be operated the hand-brakes, through the medium of a goodly club, will be applied. Or, how about that 85 per cent of brakes with 100 per cent operative, if every car in the train is fitted with air brakes. What does operative mean? It cannot mean "effective," for the prescribed tests for the head of the grade are not of such a character that the effectiveness of the brake can be judged. So if, when an application of the brakes is made, the push rod of the brake cylinder comes out, that brake is operative, yet it may be such a weakling that it has no capacity for doing any work. So, the genial cynic asks, of what use is an operative brake if it is not effective? Probably, when the law was enacted, its framers intended "operative" to be synonymous with "effective," but they didn't say so and so we have possibilities of most beautiful runaways with every freight train that negotiates a grade. And more frequently than the records show, this possibility is realized. All of which goes to show that it is difficult to so frame a rule or a law that it can and ought to be observed. If it can't, why frame it at all? Or if it ought not to be, at certain times and occasions, why not insert these exceptions in the law, just as the exceptions as to who, outside of the service, can wear an army or navy uniform, is inserted in the law that forbids you and me and our friends from doing it. But the vague suspicion arises that "operative" was inserted with the express intention of leaving a loophole for the use of a brake that was not as good as it might seem to be. A sort of skimmed milk masquerading as cream.

Oxy-Acetylene Welding

A committee of three welding experts, including D. A. Lucas, chairman; H. J. Wandberg and Thomas Lewis, reported at the recent meeting of the Welding Association that they were "satisfied that welding done by the oxy-acetylene process can be successfully and substantially done and give perfect satisfaction and service, with great help and saving in repairing and in maintenance and construction of steam boilers.

Care should be taken to see that a competent man is assigned to the welding; a man that is known to understand the nature of welding, and has been tried and tested out before he is put on a job of welding; that is, to stand a constant pressure as in a boiler weld.

It came to our observation that a foreman boiler maker who was responsible for a number of welding operators doing firebox or boiler welding and a lot of miscellaneous welding of different parts, picked his welders put in a firebox to do welding that had not been tried and tested out on several pieces, made of boiler iron, and then tested or pulled to determine the quality of the weld.

If the tests justified putting this welder on firebox or boiler welding, he was started out under the direction of an older and experienced welder who stayed with him through the job.

We find that successful welding has been done on all stayed portions of the boiler. It is not necessary to enter into details here as this subject has been before the Association several times and all are acquainted with different kinds of welding.

We feel justified in recommending oxy-acetylene welding as one of the best known methods of repairing and building boilers.

Interpretation of Existing Standards for Freight Car Trucks

The committee on car construction has sent out the following notice under the date of January 25, 1922, from the office of the secretary of the Mechanical Division of the American Railway Association.

According to the votes by the members of the American Railway Association, all of the fundamentals in the recommendations made by the committee on car construction at the June, 1920 convention, are now standard.

As it is very desirable that all new construction shall be uniform and in accord with these fundamentals, it is intended that new designs for truck side frames and bolsters, in fact for the complete truck, be made, but in order to provide the best that can be obtained some time will elapse. Until such designs have been prepared, and adopted as standard, it is recommended that for new construction and for replacements the truck side frames be made to conform with A. R. A. Sheet "B," as limiting dimensions, that the tension and compression members be U-section, and that the dimensions relating to trucks, which are given below, be adhered to:

	Inches
Height from rail to center of brake shoe	13
Height from rail to bottom of truck springs	10¾
Height from rail to brake beam hanger fulcrum	24⅞
Height from rail to top of springs—empty car	18¾
Height from rail to center plate bearing surface	26¼
Height from rail to top of truck side bearings	27⅜
Distance from center to center of side bearings	50

The use of either the U. S. R. A. or A. R. A. standard bolsters is recommended, provided that such modifications in the shape are introduced that the truck heights as given in the foregoing are maintained. This involves making the vertical distance between center plate bearing surface and bolster spring bearing surface 8 in. The bolster sections should remain as before, or if slightly modified to provide sufficient clearance between bottom of bolster and spring plank, the section moduli should remain as before.

Important Associations Join

The American Railway Association, Engineering Division, and the Association of Steel Manufacturers, have become member bodies of the American Engineering Standard Committee. The American Railway Association, which speaks for practically all the steam railways of the country, has four great technical branches, each having its own secretary, the Engineering and the Mechanical Divisions, and the Signal and the Telephone & Telegraph Sections. The Engineering Division, which is intimately connected with the American Railway Engineering Association, the two organizations having the same officers, covers broadly the civil engineering activities of the railways. The standardization work in which the two associations are engaged, and which they have accomplished, is very extensive, both in scope and in amount. Mr. E. A. Frink of the Seaboard Air Line Railway, who is chairman of the standardization committees of the two associations, represents the American Railway Association (Engineering Division) upon the American Engineering Standards Committee.

These two new member-bodies bring the total number of national organizations represented upon the American Engineering Standards Committee up to twenty-eight, and of representatives to fifty-two.

Mr. Hoover on Railroad Rates

It it not possible to help the railways by increasing their rates, and the best hope of reducing rates is to increase the movement of goods. Rates are too high and need readjustment in their relation to each other and the prices of goods, but the time to correct these matters is not now. Normal rates cannot be made under abnormal conditions. The specific thing to do, Mr. Hoover says, is for the Government to endorse the railways' securities issued for productive uses, and to take care that the railways shall be allowed to earn the money to repay the securities without loss to the endorser.

Governor Allen's Opinion of the Labor Board

"The Labor Board is a capable group of men doing their level best, but their accomplishments are limited because the Labor Board shows all the drawbacks of arbitration with few of its benefits. They have not the power or authority to make their positions worth while. Our court in Kansas is a typical judicial court, and when there is a dispute that they cannot settle amicably it is taken there."

Boilermakers' Supply Men's Association

The annual convention of the Boilermakers' Supply Men's Association will be held in Chicago on May 23-26, at the Hotel Sherman. Mr. G. R. Boyce, Secy., states that many firms are making preparations for a display of material.

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The Return of the Conventions

It is a matter of congratulation that the American Railway Association has seen fit or found it possible to withdraw the ban of indefinite postponement set up against the conventions of the Mechanical Section, in accordance with which there were no meetings last year. That the renewal of the conventions is welcomed by the supply men is evidenced by the applications for space that are coming in to the secretary of their association. That the renewal will be welcomed by the railroad men goes without saying, for he must be a silent recluse indeed who can go to one of those great meetings and not come away greatly benefited by what he has seen and heard and said. And the saying is not the least of it. For many a man goes there with his head puzzled by uncertainties as to what he should do, and by telling others of what he is doing so classifies his ideas on the subject in hand that he feels as though he had had a course of training.

It is sometimes impossible to take advantage of even a good thing because of financial disability, and that is the reason assigned for the abandonment of the conventions last year. It is now tions were founded, and during the whole of their existence up to 1914, there was not a break in the continuity of their annual conventions. During this period there was a constant and healthy growth in their membership and in the character of their proceedings, until the latter formed a library of mechanical literature that was unsurpassed by any other in the world.

Then came the great war, and first by crippling the personnel and then by crippling the finances it has been found to be necessary to abandon these conventions, the first one to be omitted being that which would have immediately followed the declaration of war in 1917. These interruptions have probably been more serious than we can realize. It is like any other interruption to continuity of thought. It breaks into organized and progressive work in a way that takes time to recover from.

But now that the war is over and we are getting settled into the harness of reconstruction and rehabilitation, we can hope to look forward to a long series of years of uninterrupted work by this association whose predecessors have done so much for the benefit of the railroads, the country and the world.

The Railroads Past and Present

The appearance of Walker D. Hines, former director general of railways before the Interstate Commerce Commission, and his absurd claim that the railroads had been substantially overmaintained during the period of governmental control is, fortunately, not taken seriously by the American people. They know better. In a period of great public stress it was not to be expected. At the same time much real good came out of the experience. It was at once clearly demonstrated that the railroads previous to the war period had been "cribbed, cabined and confined" by an excess of repressive legislation. Law making after the war has taken a new departure, and while there is still much room for improvement, it does not matter so much where the railroads stood in the past or stand in the present as it does in the direction in which they are now moving. While it must be admitted that there was a serious attempt at what was called standardizing the locomotives, and some regulation effected in regard to the multiplicity of competing lines, initiative was paralyzed by the centralization of all authority, statistics show labor became to a considerable extent demoralized, partly by the sudden calling into action of large numbers of the most active and experienced men, while those in authority who remained at their posts were largely shorn of their supervising powers. Added to this, the fact that while the cost of living was rising by leaps and bounds the Government was provokingly slow in increasing the wages of labor, which, as is well of other occupations for many years. These and other causes created a degree of ill-will on the part of the working element, which is easy to understand, but not so easy to eradicate.

All the good that came of Mr. Hines' period of control should not be credited to him, nor, perhaps, much of the evil either. He simply drifted with the tide of events. Confusion was to be expected, and it is to the credit of the railroad men themselves that they got along as well as they did. After all great wars there has followed a painful period of investigations and recriminations coming like a flood tide. Even if the whole truth were known little good would come of it. To act nobly in the living present is better, and let the dead past bury its dead.

The question of rates and wages we are likely to have always with us, and in this regard it is interesting to observe the action of the English railway boards in the adoption of an elastic scale of wages adjusting itself month by month, according to the fluctuations in the cost of living, so that the workmen do not know what they are going to get until the pay day arrives. This plan may work out there, the country is small and its very compactness makes the plan workable. It would not do here. In our vast territory prices of commodities are not equable, and there are conditions where the law of averages would work real hardships. A kindlier feeling between employer and employe will, no doubt, come by and by. The Government should see to it that the railroads are placed in a position where the suggested amount of earnings are possible of attainment, and men of Mr. Hines' kind should be allowed to remain in quiescence.

As might have been expected, the Association of Railway Executives has prepared a statement in reply to the testimony of Mr. Hines, where it is pointed out that the material point at issue is what was the condition of the railroads at the end of Federal control as compared to their condition at the beginning of Federal control? From this statement we quote the following:

"The relative condition of locomotives, freight cars and roadbed at the beginning and end of Federal control is not a matter of opinion, but of record.

"At the beginning of Federal control 17.5 per cent of the locomotives of the railroads were in bad order. After 26 months of Government operation 25.6 per cent of the locomotives were in bad order.

"At the beginning of Federal control there were in use by the carriers about 2,253,000 freight cars, of which 5.1 per cent, or 128,780 cars, were reported in bad order. At the end of Federal control the railroads had 2,307,000 cars, of which 6.7 per cent, or 153,727 cars, were in bad order.

"Cross-tie renewals in 1918 and 1919 (the period of Federal control) were 25,-

(1915-16-17), a number of ties sufficient to lay nearly 9,000 miles of track.

"Rail renewals during the two years of Federal control were 440,230 tons below the average of the test period.

"The amount of ballast used during the period of Federal control was 1,818,100 cubic yards less than the average used in the period of private control."

If Mr. Hines can find any error in these figures doubtless opportunities will be given him to do so, and we will be pleased to record the same. In our opinion it would be going too far to claim that Mr. Hines lies deliberately, but we are convinced that he lies under a mistake.

Intensive Snow-Fighting in the Northwest

The reports from the Northwest show that the railroads have been assailed by the earliest heavy snow in years, and the annual winter battle with this element in the Cascade and Rocky Mountain regions have assumed serious proportions. To combat the drifts and frozen fills, hundreds of standard stanch rotary ploughs are kept continually at work during storms. In the Bitter Root Range, in western Idaho, snow drifts to a depth of the largest rotaries. In such cases workers drill deep holes into the drifts, removing the snow in huge cakes.

Besides the rotary type of snow-fighter, the Jull steam excavator, having a large corkscrew projecting from the center of the head-end, is used on all roads. This machine can break up the hardest packed drifts and throws snow forty to sixty feet from the right of way.

It is a thrilling sight when five to seven monster moguls begin to drive a rotary Jull snow-digger into an immense frozen bank. Shrieking, steaming, hissing, puffing and panting, the big locomotives work away until the last foot of track opens. Sometimes a rotary will clear the road over a division in the mountains only to turn out and fight back through a new storm. It is a hard fight, but nearly every winter the railroads win.

In the Cascade Mountain division of the Northern Pacific last winter a large-sized steam shovel was utilized to clear a badly filled stretch of track. The Milwaukee made a new departure when it used small quantities of TNT in some huge snowslides on its tracks near Easton. The explosive blew out parts of trees, rocks and earth, mixed with the frozen snow.

All the dangerous curves and cuts in the Western mountains have been proprotected by snowsheds, but during severe storms the sheds fill with snow that is more difficult to remove than any on the open mountainsides.

January and February are the snowy months in the Northwest. The depth often reaches ten to thirty feet on the summit passes. The heavy snowfall of last

Government Watching Suspected Strike

The Government is reported to be formulating plans for dealing with a joint strike of coal miners and railroad workers on April 1, which is said to be proposed by leaders of the mine unions. The attorney general seems satisfied that the Government had legal authority to handle the situation at the proper time. The exact legal procedure has not been indicated, but there is reason to believe that efforts will be made to enjoin the miners and tie up their strike funds. It will be recalled that this course was adopted by the previous Administration, and a decision was given by the court that a great coal strike was inimical to the public welfare. The specific dates for a conference of representatives of the railroad unions with the miners to form an alliance will not be decided upon until replies are received from invitations dispatched to union heads.

Disposing of Railroad Ties

In these days of high-priced coal, complaints are occasionally made that old ties are being burned by the Pennsylvania, and that the great bulk of the ties might be used for firewood. We presume that similar complaints reach the officials of other roads. The Pennsylvania has officially announced that every effort has been made to dispose of the ties for any good purpose that may be suggested. Offers at 10 cents per tie will be accepted, and at this price the ties will be collected near highways or other suitable points for removal. Offers do not seem to materialize. Railroads are not charitable institutions. Neither, apparently, are the complainants. One might as well complain that there is much available fruit lost in Brazilian forests. We read of the ravens feeding Elijah, but the railroad companies wait in vain for any philanthropic movement calculated to distribute worn-out ties as firewood to warm the poor along the railroad lines. If our experience is of any value, we venture to state that the poor that we observed along railroad lines seemed to be more expert in illegally obtaining coal from railroad cars than they were in saving old ties.

Regional Districts Proposed

A resolution adopted at a recent meet of the Association of Railway Executives, and which before becoming effective must have the approval of the four brotherhoods, bids fair to become effective. It declares that the aim of the executives is an effort to compose and adjust all points now at issue, no restrictions to be imposed upon the consideration of any and all questions of wages and rules governing working conditions. If the proposition is given effect, conference committees representing the carriers and the train-service employes—engineers, firemen, conductors, and train- by this method, which generally obtained prior to Government operation. Should they fail, the points on which they can not agree will, as now, come before the Railroad Labor Board.

There will be at least three regional districts—eastern, southeastern, and western, as defined by the Interstate Commerce Commission—and there may be subdivisions of these.

Water Power in Place of Coal

A. Langlois, an eminent Canadian engineering authority states the Canadian Dominion has an immense wealth in store, providing, however, that a sound policy of exploitation is designed, in order to make use first, of such water powers which may be developed most advantageously. Canada possesses enough reserve of water power to meet all demands for a great number of years to come, if we compare the amount of power available, some 18,000,000 h.p. at the minimum flow, of which hardly 10 per cent are yet utilized. If the cost of a hydro-electric installation is expensive, the source is inexhaustible through use and with proper development and conservation the yield will never fail.

Badges of Proficiency

A Western railroad is to award badges to the enginemen showing the greatest degree of efficiency in operating their locomotives. In the old days bonuses were awarded for the saving of coal and oil, but we live in an advanced age, and consequently we hold our minds in a solution of doubt until we see how it works. In our wanderings we have seen princelings and lords in ordinary garments, and they generally looked contemptible, but when be-badged, like a dollar store window, the effect was dazzling, and he felt a quivering of the knees, inherited, no doubt, from a long line of down-trodden ancestors. Of course it need hardly be pointed out that a dress parade is essential to show off these glittering marks of distinction.

Lux In Tenebris

The Railroad Trainman pauses a moment to state that there isn't anything to be gained by either the railroads or their employes in belittling each other, and whether they appreciate it or not, in the public mind the railroads and their employes represent the same thing, and the sooner the railroads and their employes can reach a basis of common understanding that will let both of them decide what, in fairness, belongs to them, and then stand for it as an honest proposition, the better it will be for both of them.

Briefly in other, and even wiser words, we should learn to practice to do unto others as we would that others should

Mikado Locomotive for the Greenbrier & Eastern Railroad and Eight-Wheel Type Locomotive for the Dayton-Goose Creek Railroad

Built by the Baldwin Locomotive Works

The Greenbrier & Eastern Railroad, a short coal carrying line recently built in West Virginia, has received its first locomotive from The Baldwin Locomotive Works. This is a Mikado type engine, carrying approximately 181,000 pounds on drivers developing a tractive force of 45,750 pounds. It is designed for operation on curves of 25 degrees and grades as steep as 5.3 per cent. The wheel arrangement is well suited to service where frequent backing is required; while it allows the use of a boiler having ample capacity for sustained heavy hauling, without overloading the drivers.

MIKADO TYPE 2-8-2 LOCOMOTIVE FOR THE GREENBRIER & EASTERN RAILROAD. BALDWIN LOCOMOTIVE WORKS, BUILDERS

The boiler has a straight top, and it contains an arch and a 40-element superheater. A power-operated firedoor is applied, and provision is made for the future application of a stoker, should this be found desirable.

Machinery details include piston valves 12 in. in diameter, and a simple design of Walschaerts motion controlled by the Ragonnet power reverse gear. The driving hubs are fitted with bronze wearing plates. Flange lubricators are applied to the front and back drivers, and rail washing pipes are applied for use when running in either direction. The rear truck is of the well-known Hodges type.

The 4-4-0 type locomotive for the Dayton-Goose Creek Railway is of interest as representing a type formerly built in large numbers, for which there is now only occasional demand. This railway serves the Goose Creek oil fields of Texas, and operates about 25 miles of line. The grades are generally light, and the track is laid with 60-pound rails. An American type locomotive, designed and equipped in accordance with modern practice and having wheel loads suited to the track conditions, is well qualified to meet the traffic requirements of a line like this one.

EIGHT-WHEEL TYPE 4-4-0 LOCOMOTIVE FOR THE DAYTON-GOOSE CREEK RAILWAY. BALDWIN LOCOMOTIVE WORKS, BUILDERS

This locomotive weighs 89,000 pounds, and has 15-in. by 24-in. cylinders and a boiler pressure of 180 pounds. Locomotives of this same weight and type were commonly used in heavy passenger service 17 or 18 in. in diameter and carried a steam pressure of 130 to 140 pounds. This combination resulted in approximately the same tractive force and ratio of adhesion as are found in the Dayton-Goose Creek locomotive.

The new locomotive uses superheated steam, which is controlled by 8-in. piston valves operated by Walschaerts gear, and set with a lead of 3/16 in. The boiler contains a superheater of 13 elements, and is equipped with the Baldwin standard arrangement for burning oil. The general form of the boiler is similar to that formerly used, in which the firebox was placed between the frames and driving axles. In this case, however, the firebox is entirely above the frames, thus rendering the staybolts more readily accessible. The smoke box has an extension of moderate length, and contains a low double exhaust nozzle and petticoat pipe.

This locomotive has comparatively heavy frames and spring rigging. The driving boxes are of cast steel, while the hub liners. Flange oilers are applied to the leading drivers. The tender is of the Vanderbilt type, with capacity for 4,000 gallons of water and 2,000 gallons of oil. The frame is built up of plates and angles, and the bumpers are of cast steel.

The locomotives described are interesting illustrations of motive power specially designed to meet the requirements of short line railways. Further particulars are given in the tables of dimensions.

Built for the Greenbrier & Eastern Railroad

Gauge	4 ft. 8½ in.
Cylinders	23 in x 28 in.
Valves	Piston, 12 in. diam.
Boiler	
Type	Straight
Diameter	80 in.
Working pressure	185 lbs.
Fuel	Soft coal
Firebox	
Material	Steel
Staying	Radial
Length	108⅛ in.
Width	84 in.
Depth, front	79½ in.
Depth, back	58¼ in.
Tubes	
Diameter	5⅜ in., 2 in.
Number	40, 238
Length	18 ft. 0 in., 18 ft. 0 in.
Heating Surface	
Firebox	186 sq. ft.
Tubes	3241 " "
Firebrick tubes	25 " "
Total	3452 " "
Superheater	895 " "
Grate area	63 " "
Driving Wheels	
Diameter	51 in.
Journal, main	10 in. x 12 in.
Journals, others	9 in. x 12 in.
Engine Truck Wheels	
Diameter, front	28 in.
Journals	6 in. x 10 in.
Diameter, back	36 in.
Journals	8 in. x 14 in.
Wheel Base	
Driving	14 ft. 6 in.
Rigid	14 ft. 6 in.
Total engine	31 ft. 9 in.
Total engine and tender	62 ft. 10½ in.
Weight	
In Working Order	
On driving wheels	180,970 lbs.
On truck, front	20,100 "
On truck, back	36,150 "
Total engine	237,220 "
Total engine and tender	359,800 "
Tender	
Wheels, number	8
Wheels, diameter	30 in.
Journals	5 in. x 9 in.
Tank capacity	6,000 U. S. gals.
Fuel	10 tons

Tractive force	45,750 lbs.

Built for the Dayton-Goose Creek Railroad

Gauge	4 ft. 8½ in.
Cylinders	15 in. x 24 in.
Valves	Piston, 8 in. diam.
Boiler	
Type	Wagon top
Diameter	48 in.
Working pressure	180 lbs.
Fuel	Oil
Firebox	
Material	Steel
Staying	Radial
Length	64 15/16 in.
Width	31¼ in.
Depth, front	55½ in.
Depth, back	54½ in.
Tubes	
Diameter	5⅜ in., 2 in.
Number	13, 77
Length	10 ft. 6 in., 10 ft. 6 in.
Heating Surface	
Firebox	87 sq. ft.
Tubes	611 " "
Total	698 " "
Superheater	157 " "
Grate area	15.5 " "
Driving Wheels	
Diameter	60 in.
Journals	7 in. x 28 in.
Engine Truck Wheels	
Diameter	28 in.
Journals	4½ in. x 7½ in.
Wheel Base	
Driving	8 ft. 0 in.
Rigid	8 ft. 0 in.
Total engine	21 ft. 9 in.
Total engine and tender	46 ft. 5¾ in.
Weight	
In Working Order	
On driving wheels	54,500 lbs.
On truck	34,500 "
Total engine	89,000 "
Total engine and tender	182,000 "
Tender	
Wheels, number	8
Wheels, diameter	28 in.
Journals	4¼ in. x 8 in.
Tank capacity, water	4,000 U. S. gals.
Tank capacity, oil	2,000 U. S. gals.

Tractive force	13,770 lbs.
Service	Passenger
Brake equip.:	Air, with one 9½ in. pump.

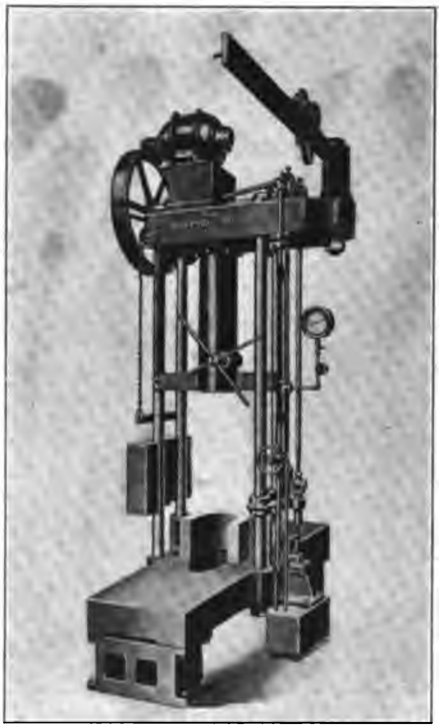
An Improved Press for Railroad Shop Operations

The Watson-Stillman Co., New York, has brought out a press which is herewith illustrated, designed for the many operations of forcing, pressing and bending, that are found in railroad and other large machine shops. Not only is it a rapid and convenient means of pressing in and out locomotive driving box brasses, pressing on and off gears, discs, etc., but on account of its wide bed it is adaptable to

cylinder type, having the ram movement from the top downward.

The pump is only required for the actual pressure application, the hand wheel as shown providing a means of bringing the ram quickly to and from the work, obviating the necessity of waiting for the pump to move the ram through the idle part of the stroke. The bottom platen is amply strong for bending, with bending blocks on its ends under the full capacity of the press.

Upon referring to illustration it will be seen that there is a "U" piece hinged to one of the columns of the press so that it may be easily swung into the center of the press or to one side. The jib crane is furnished with a trolley so that a chain hoist may be attached for easily handling



IMPROVED PRESS FOR RAILROAD SHOP OPERATIONS

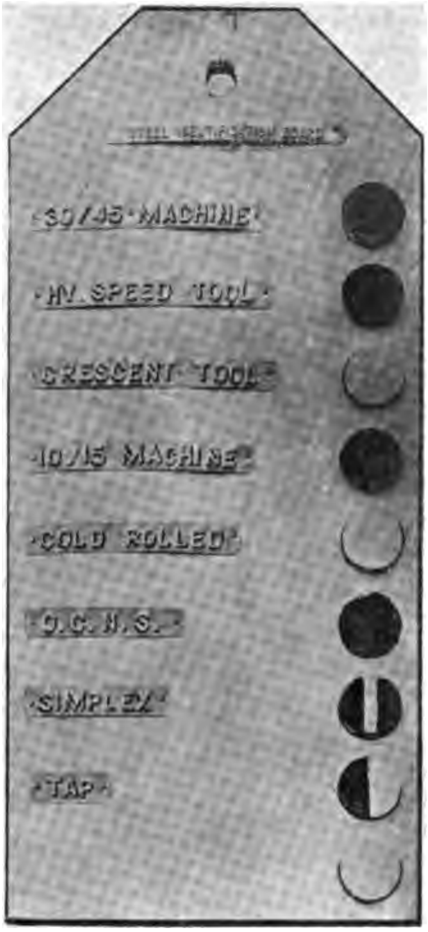
the work into and out of the press. There is provided a hole in the bottom platen for receiving the shafts and pressing on gears, etc. The press illustrated shows a motor driven pump. The drive can be either by belt through tight and loose pulleys or by direct attached constant speed motor for direct or alternating current.

As shown a gauge is provided which indicates the pressure on the ram in pounds per square inch and the total pressure in tons. The pump is a 2 plunger type and the entire control of the press is through a single screw stem valve.

The material used for the bottom platen, top platen, cylinder and crane bracket, may be made of open hearth steel castings; the ram and rods of machinery steel, and the cylinder is copper lined. The press as illustrated is built in a capacity of 75 tons with a ram movement

A New Idea in Steel Identification and Storage

It often happens that, due to an absence of standard equipment on the market of lack or a standard way of doing things, manufacturers are forced to create new methods or devise new equipment that will exactly fit into their particular system of



IDENTIFICATION BOARD WITH COLORED DISCS.

operation. With the result that the new idea evolved and executed as generally an improvement over everything of a similar nature that has preceded it.

Such a condition caused the firm of Gould & Eberhardt to devise the following method of marking their steel bars for identification and also designing and constructing suitable steel storage racks to conform with the highly developed manufacturing system employed in their new plant at Newark, New Jersey.

Several new ideas in steel marking, together with a novel design in storage racks is the result of their efforts to solve their own factory problems.

In the manufacture of shapers and automatic gear cutting machinery, they naturally use many different kinds and sizes of steel bars—round, square, hexagon, and rectangular in shape, so this convenient system of storing and marking the

possibility of an error in finding the required piece.

Plain colors and combinations of colors play an important part in the scheme of marking the steel, each color having a direct significance with regard to the metallurgical contents or the particular make of steel. The identification colors are painted on the ends of the bars as they are received in the shipping department.

To assist the Raw Material Clerk in selecting the proper steel, a very noticeable identification board is hung above each rack. On this rack are listed all the different kinds of steels the company uses, with a two inch diameter disk, painted in the corresponding color, opposite each name. The board has a white background which shows the various colors to great advantage.

The various steels with their corresponding colors as listed on the board are:

30/45 Machine	Red
Hy Speed Tool	Blue
Crescent	Yellow
10/15 Machine	Green
Cold Rolled	White
O. C. N. S.	Halves of Green and Red
Simplex	Green with White Stripe
Tap	Halves of Green and White

A very good conception of the appearance of the identification board together with the general arrangement and rugged construction of the steel racks can be gleaned from the illustration.

Each rack is built up of five duplicate sections, spaced four feet apart and properly braced to form a very rigid rack sixteen feet long. The entire rack being bolted together with ½ inch bolts.

The individual section has a base consisting of a heavy eight inch I beam eight feet long, with six heavy 2 x 2 inch angles, seven feet high, equally spaced and forming uprights to divide the section into five tiers. These tiers are turned subdivided by one-half inch rods which extend from top to bottom thereby making ten tiers available in each rack.

Cross pieces or shelves on which the steel bars lay are heavy 2 x 2 inch angles, spaced about twenty inches above each other at the bottom and diminishing in this distance until at the top, where the very small rods are stored, the distance between is about six inches. The top piece of each section is composed of a heavy 2 x 3 inch angle, making a very rigid top brace to complete the frame of the section, and also permitting the storage of extra large diameter short bars on top of the rack.

The five cross sections are spaced and held together to form the completed frame work of the rack by 2 x 2 inch heavy angle stringers extending the full length of the rack at the top and bottom of each side.

Extra longitudinal bracing is provided by ¼ x 2½ flat bars crossed between and bolted to the top and bottom of the sections.

An extra angle on each side at the top and extending the length of the rack prevents pieces from rolling off, while further precaution is taken by having timbers with half round notches cut in them extending along the front on the top of the rack, permitting short round pieces to be laid in place.

Naturally, the most convenient way to place the steel in the rack would be to have all the steel of the same kind in one tier

MATERIAL RACK WITH IDENTIFICATION COLORS PAINTED ON THE ENDS OF THE STEEL BARS with the largest and heaviest pieces on the bottom shelf and the varying sizes in regular order, according to their dimensions, with the smallest at the top. This order has been reversed wherever possible, in some cases the square, hexagon, or rectangular shaped bars, which are generally smaller in size, being placed on the bottom shelves and the very heavy bars on the very top so that they may be easily handled with the travelling crane which travels above these racks.

In order to facilitate the placing and location of the various kinds and sizes of steels into their proper places, each rack is given a section number, besides each tier in the rack is lettered and each shelf is numbered, making it a very simple matter to give instructions for the proper location of each bar as it is received, besides assisting to keep stock and taking inventory.

Much thought has been given to the general design of the rack and also the system of storage employed, both perhaps embodying all the desirable features that Gould & Eberhardt have found to be correct during their eighty-eight years of manufacturing experience.

It need hardly be pointed out that without this improved method of marking material, much time is frequently lost in handling and transferring, which by the establishment of a method of marking is totally avoided.

Improving Steel Making

An improvement of the acid Bessemer steel process which aims to reduce the cost of making steel and to decrease the possibility of low quality steel in the process has been recently invented by a member of the department of mining and metallurgy at the University of Wisconsin.

The purpose of the invention is to use basic material for the lining of the Bessemer converter instead of the acid lining now used in order to prevent corrosion of the interior of the converter and to reduce the amount of air pressure and engine power now required. With the basic lining, composed of lime, magnesite, dolomite, oxid of iron, or the like the inventor believes it will be possible to use lower pressure and cut down the time of blowing about 30 per cent.

To prevent corrosion of the converter bottom the inventor proposes a number of different kinds of linings for various acid Bessemer converts and details the particular parts of the converter that require such a basic lining, while the remainder of the converter has an acid lining to resist corrosion by the acid slag. The invention is applicable to the bottom-blown type, side-blown type and other kinds of Bessemer converters operating on the principle of making

The Proper Care of Air Tools

In a paper presented before the Pittsburgh Railroad Club, by Mr. H. S. Covey, secretary of the Cleveland Pneumatic Tool Co., in which he called attention to some of the details that should receive especial attention in the installation and care of pneumatic tools. Chief among these items was the caution to avoid low pressure and wet air. The combination of the two is capable of putting a hammer entirely out of commission and if it runs at all the blow is feeble and rivets driven by it will not be tight but will have to be cut out.

The four indispensable details needed to secure a proper operation of a pneumatic hammer are dry air, plenty of it, uniform pressure and proper lubrication.

In order to secure dry air, the tank or reservoir should be set vertically and provided with a driven cock near the bottom.

The large shop pipe should enter the tank at a point about 12 in. from the bottom.

The air, as delivered to the tank, is usually quite hot; and, because of its high temperature it rises to the top. As it cools and is drawn off it falls towards the bottom and is drawn off into the shop pipe. As the air cools there is a condensation of the water held in suspension. This water is thus separated from the air and falls to the bottom of the tank whence it can be drawn off.

The securing of a proper volume of air for the shop tools is largely a matter of the size of the mains by which it is led off from the tank. There should be given a gradual rise so that any water that may condense in them will drain back towards the tank and not towards the tools. Further all branch lines should be tapped into the top of the main trunk line so as to obtain dry air, because if there is any water in the mains it is at the bottom and should be flowing back towards the tank.

Another matter that is apt to cause trouble is the oil with which the air is likely to be saturated, and which is picked up in the compressor. Unless special precautions are taken to prevent it, a considerable portion of this oil will pass on through to the shop mains and branches and to the shop pipes, where the hose lines, leading to the tools, are attached.

It is well known that oil has a very detrimental effect on rubber and will cause it to disintegrate, and the detached particles will clog the tools. It is well, therefore, to avoid the use of rubber hose for air tools and to use, in its stead, a hose having a composition inner tube upon which the oil has no serious effect. This will not, however, wholly neutralize the trouble.

It is better to separate the oil as far as at a nominal cost. One that works very well may be made of a piece of 5-in. pipe, 3 ft. long, with a cap at each end. It should be set vertically and is attached to the branch lines which feed the drop and hose lines. The branch pipe should enter the separator at the top through one side of the cap and be run down on the inside to a point about 3 in. from the bottom at which point the air is discharged. There should be a series of baffle plates put in the pipe through which the air rises to the top and by which it is filtered. The filtration leaves a deposit of oil clinging to the baffle plates.

The outlet is placed near the top on the side of the cap opposite to that at which it entered and the air will flow from it freed from the oil and water.

The separator is drained of its accumulated oil and water through a cock in the bottom cap. Occasionally it will be necessary to remove the baffle plates and clean them with a stream of compressed air, which will quickly remove any adhering oil.

The close fit with which air tools are made necessitate that they should be frequently lubricated. The oil used should be of good quality and one that will not gum. A heavy black machine oil should never be used as it will be apt to clog the numerous parts of the machine that must be kept open.

Here again, the presence of water plays an important role. If the air is charged with water the lubricant will be washed away and the tool will soon lose it efficiency and fail to work, while the delicate parts and polished surfaces will be rusted.

In order to keep a hammer in good condition, it should have a bath of coal oil every night which will soak up the worn out oil of the day, and, then, each morning it should be attached to the air hose and be blown out. After which it should be freshly oiled and put into service. If treated in this way it will act like a new tool.

In concluding Mr. Covey said that if dry air, in sufficient volume at adequate pressure be furnished, plus suitable lubrication, he predicted that air tool troubles that infest the day "will fold their tents like Arabs and gently steal away."

The Passing of the Compounds

The compound locomotives are going out of use not only in the United States but latterly in Canada, and are being replaced by the modern unit equipped with superheater, brick arches, piston valves, and other refinements in locomotive practice. It has been repeatedly proved that the rebuilt locomotives, by their greater power and superior econ-

Construction and Equipment Notes

Extending Roundhouses on the Erie

In addition to a contract awarded for a new one-story, 23 stall, brick and steel roundhouse, with machine shop and boilerhouse, by the Erie Railroad Company, to be erected at Pavonia Ave., Jersey City, at a cost of $75,000, there is also an enlargement to be made of the roundhouse at Marion, Ohio, which has now 35 stalls, and a larger turntable added.

Improvements on the Missouri, Kansas & Texas

Extensive contracts for improvements on equipment and structures on the Missouri, Kansas & Texas Railway, have been awarded by the Company, including the construction of a water treating plant at its Parsons, Kans., terminal, and a new freight terminal at Denison, Tex. The work is under the supervision of F. Ringer, chief engineer, and the estimated cost, including 57 miles of new track, approaches $3,000,000.

Large Addition to Rolling Stock of the Chicago, Burlington & Quincy

The Board of Directors of the Chicago, Burlington & Quincy has, it is reported, authorized the purchase of 7,300 freight cars. Among others are 3,000 composite coal cars, 2,500 box cars, 1,300 refrigerator cars and 500 stock cars. The order is said to be the largest ever made by the company.

New Locomotives for the Seaboard Air Line

The Seaboard Air Line has ordered 10 mountain type locomotives from the American Locomotive Company. These locomotives will have 27 by 28-ins. cylinders, and a total weight in working order of 315,000 pounds. An additional order of 15 Mikado type locomotives has also been made to the same company. The cylinders of these engines will be 27 by 30-ins. The total weight of the locomotives in working order is estimated at 284,000 pounds. All will be equipped with superheaters and other modern appliances.

Extensive Betterments for the Santa Fe

The Wall Street Journal announces that estimates of this year's requirements of the Atchison, Topeka & Santa Fe Railway in new equipment, additions and betterments, including that of terminal companies, will require an outlay of nearly one billion dollars. Of this at least $10,000,000 will be expended in new equipment, and considerably more in extensions. It is expected, that the purchases of materials and supplies will be proceeded with as rapidly as possible.

New Freight Cars for the Union Pacific

Orders for 4,500 cars have been placed by the Union Pacific Railroad Company among the leading car manufacturers. Among others the American Car & Foundry Company will furnish 1,000; the Mt. Vernon Car & Manufacturing Company, 1,000; the General American Tank Company, 1,000, and 500 with the Standard Steel Car Company. The cost will approach $10,000,000, and the various orders are expected to be filled by July this year.

Car Repairs for the Chesapeake & Ohio

Contracts have been given out by the Chesapeake & Ohio Railroad Company for the repair of 300 composite cars to the American Car & Foundry Company, 500 steel cars to the Illinois Car & Manufacturing Company, and 200 composite cars to the Ralston Steel Car Company.

New Railroad Shops in Prospect

Plans are reputed as completed by a number of railroad companies for additional repair shops. Among others the Lehigh Valley will erect new car and locomotive shops at Jersey City, N. J., costing about $150,000. The Pennsylvania has arranged for a new boiler shop at Fort Wayne, Ind. The Santa Fe has completed plans for a new machine shop 65 ft. by 10 ft. at San Bernardino, Calif. The Buffalo, Rochester & Pittsburgh will erect a new car repair plant near Pittsburgh, Pa. The Missouri-Pacific has already awarded contracts for car repair sheds 46 ft. by 50 ft., at St. Louis, Mo., and will also build shops at Nevada, Mo.

The New Haven Introduces a Gasoline Car

A gasoline driven car, the first of its kind that has been put in operation on the New York, New Haven & Hartford Railroad, and known as No. 9000, has been placed in operation on the Derby division between Ansonia and New Haven, where the runs are short and the traffic not heavy. It is a combination of railroad car and automobile. In its initial trial trip it ran at a speed of thirty-five miles an hour.

The car is twenty-eight feet long and a trifle over nine feet wide, and seats thirty-five people. Four feet of its length are reserved for baggage. The motor is the same as that used in a Mack truck, and can develop sixty horsepower. The total weight of the car when fully loaded is estimated at 20,000 pounds. Only two men will be needed to operate it—the driver and a man to act as baggage man and conductor—and it is understood that if it proves a success others of the same type will be put in service on other short runs of the system.

New Bridge Over the Mississippi

A new steel bridge, 1,200 ft. in length, crossing the Mississippi river at Minneapolis, Minn., is being planned for the Northern Pacific Railway. The work will involve the removal of the tracks from the University of Minnesota campus, and relaying outside. The cost is estimated at about $2,000,000.

Rolling Stock of the New York, Ontario & Western

The Standard Steel Company has received orders for 20, 79 ft. coaches; 4 combination smoking and baggage cars; 3 60 ft. baggage cars and 3 60 ft. combination baggage and mail cars, from the New York, Ontario & Western, to be completed at an early date. The coaches and cars will all be of steel construction, and equipped with Commonwealth trucks.

Repairing Metal Car Roofs

Among other economies recently coming into practice is the repairing of antride metal car roofs. This might have been learned many years ago from the roof men engaged in repairing the roofs of ordinary frame buildings, that such roofs, usually of tin, have a tendency to wear more rapidly toward the edges is well known. All that is necessary is to remove the worn portions, attach new material, and apply paint material in the usual way. In the case of more extensive repairs, the entire car roofs are being stripped and a process of cleaning the material is being adopted and facilities are being established for straightening the sheets, and after thorough repair much economy is effected.

In addition to antride repairs preservatives against the decay of the inner portions of wooden cars are also coming into use. The use of zinc chloride a sodium fluoride. Two brush coats of creosote applied to t..e flooring and entire interior of stock cars, as well as the roof when stripped are being endorsed. It should be borne in mind that earnest economy is real wealth.

Extensive Equipment Orders.

Equipment orders which have been announced this year indicate that not only is business looking up in the supply field but that the railroads are planning to put their properties in shape as soon as possible for increased traffic. The largest order reported is that of the Union Pacific Railroad Company, which announced plans for purchasing $10,000,000 worth of new equipment to be delivered in the next six months. Equipment companies state that the contract ranks among the largest placed by any railroad since the movement to purchase new equipment set in several months ago.

The Union Pacific order calls for 2,000

double-sheathed 40-foot, 50-ton automobile cars, designed for general service, including the hauling of grain in bulk. Contracts for these cars were awarded to the Pullman and General American Car Company and the Standard Steel Car Company. The road also ordered 1,000 box cars each from the Mount Vernon Car and Manufacturing Company and the American Car and Foundry Company.

The Illinois Central Railroad has placed orders for 2,000 gondola cars, as follows: Haskell & Barker Car Company, 700; the Western Steel Car Company, 400; the Standard Steel Car Company, 400; and the American Car and Foundry Company, 500, besides 30,000 tons of 90 lb. rail, 14,000 tons of which are being furnished by the Tennessee Coal & Iron Company, 11,000 tons from the Illinois Steel Company, and 5,000 from the Inland Steel Company.

The Seaboard Air Line greeted the new year with an order for 1,500 to 2,000 cars. Orders for additional freight cars are expected to be placed shortly by the Chicago, Burlington & Quincy Railroad Company, which is talking about 7,000 cars. The Great Northern is also planning to buy about 3,500 cars. The Long Island Railroad recently placed orders for 50 passenger cars; the Philadelphia & Reading, 50 in addition to orders already placed; the Chicago, Burlington & Quincy, 127, and the Union Pacific, 63.

Considerable significance is attached to the large Union Pacific order. This company has the reputation in rail circles of being a good buyer of cars and locomotives and is said to place its orders at most opportune times. Certain executives, therefore, state that other companies will probably study their budgets to see if the present is a propitious time for equipment purchases.

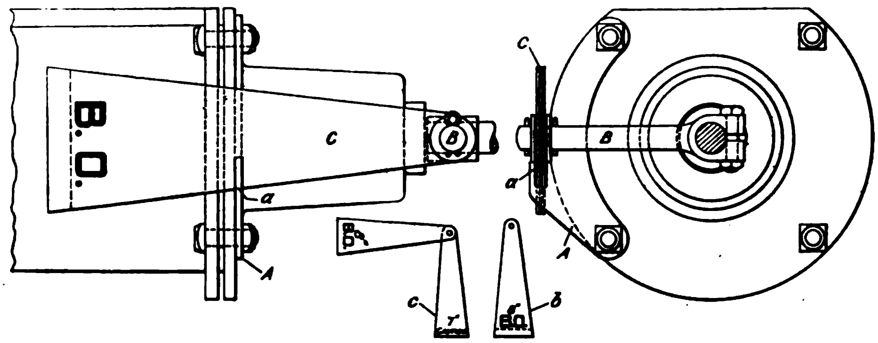
The following railway construction plans indicate that many carriers want to put their roads in perfect running condition: A contract awarded by the Illinois Central Railroad to the Ellington-Miller Company of Chicago for a car repair shed at McComb, Miss., at an estimated cost of $140,000; plans of the Illinois Terminal to extend its line from Formosa to O'Fallon, Ill., a distance of fourteen miles, at a cost of $641,964; a contract awarded by the Missouri, Kansas & Texas Railroad to the Graver Corporation, Chicago, for a ground-operated water-treating plant at Parsons, Kan.; plans of the Chicago, Milwaukee & Gary to construct an extension between Aurora and Joliet, Ill., a distance of approximately twenty-nine miles, at an estimated cost of $2,700,000, and the awarding of a contract by the Chicago Union Station to the Lamson Company of Boston for conveyors, chutes and other mechanical handling equipment for the $4,000,000 railway mail terminal of the Chicago Union Station project, which has

Brake Piston Travel Indicator

It is generally acknowledged that the regulation of the travel of the airbrake piston is a most important matter, and that adjusters are either expensive or apt to be unreliable. In order to enable inspectors to tell at a glance as to the condition of the travel an indicator has been designed by B. Haskell of Franklin, Pa.

This indicator does not show the exact amount of piston travel but only as to whether it is approaching or has exceeded the 8-inch standard.

It consists of a carrier *A* bolted to the non-pressure head of the cylinder. This is made of a thin plate and conforms to the curve of the head except that it has



DETAILS OF BRAKE PISTON TRAVEL INDICATOR.

a projecting lug or rest *a* projecting from the side.

Clamped to the push rod is a pin *B*, which extends out to and beyond the outer edge of the rest *a*.

This pin carries one or more small semaphore-shaped blades *C*, which normally lie upon the rest *a*, as shown in the engravings, and are in a horizontal position. The one marked *B. O.* (indicating "bad order"), is of such a length that, when the push rod has been moved out 8 in. it will drop down into a vertical position, as shown by the small semaphore at *b*. When two or more semaphores are used one is of such length that it will drop to a vertical position, as at *c*, when the push rod has moved out 7 in. This will indicate to the inspector that the travel is approaching 8 in. and may reach it before the train arrives at the end of its run. The "bad order," semaphore meanwhile remains in the horizontal position.

The device is simple in construction, easily applied and will serve to indicate to the inspector at a glance as to whether the brakes on a car need or are likely to need attention in the matter of piston travel, a point that should be a time saver wherever inspection is made and should be especially valuable at the heads of grades, where it is desirable that train delays should be reduced to a minimum in order that the needs of economical transportation should be fully main-

Pitfalls in Railway Working

At the very outset of the day's work there is the possibility of overlooking some mechanical defect when examining the engine. This possibility can, however, be greatly minimized by cultivating the habit of making a systematic inspection, starting at the step on the left side of engine and passing around and under the engine back to the starting point. This should be done always in exactly the same manner, so that no part will be missed, special attention being paid to gland nuts, slide bar studs, big end and eccentric bolts and set screws, quadrant block pins, split pins in brake gear, cowcatcher and ash arrester. The next thing to consider is that any shortage of coal, water, sand or tool equipment may lead to serious trouble on the road.

The absence of a pinch bar or drag chain may cause serious delay to traffic in the event of a breakage of draw gear or valve gear.

Having seen to all these details (and each detail is important), the next chance of going wrong lies in taking the engine funnel first from shed, when it should go tender first. Or some trains the usual procedure in this respect may be varied for special reasons, and failure to obtain a circular or observe a notice may lead to this result.

In station yards the possibility of collision calls for continual watchfulness. Even on the road when a fixed signal purports to indicate that the line is clear, the driver must still be on the alert in case the line is not clear. Nevertheless, the fixed signals must occupy first place in the mind of the driver, and everything else must be subordinated to their *strict observance.*

The recently published report of the official enquiry into the causes of the disaster which occurred on the Philadelphia & Reading last year emphasizes the fact that signals should not be disregarded unless the proof that they are out of order is beyond the possibility of a doubt on the part of all who may be in any way

Railroads and Rolling Stock in Russia

At the December meeting of the Canadian Railway Club held in Montreal, E. A. MacMillan, superintendent of the Atlantic City and Shore railroad, delivered an address on his experience in Russia during two years of his partly enforced residence in that unhappy country. Mr. MacMillan had a variety of experiences from "moving accidents by flood and field," to being "in prison oft." On the subject of railroads and their equipment, their introduction and past and present condition were graphically contrasted, Mr. MacMillan stating that "among the early improvements decided upon in the construction of the Russian railways was the adoption of the five-foot gauge which permits of heavier equipment, both for passengers and freight. Sleeping cars can obviously be made more comfortable. The freight cars at first were the small single truck type of ten tons capacity, without air-brakes and linked up by the nasty little hair-pin couplers, the same as those used on the English system. The adoption of this type of car was obviously a mistake in a country that has so much bulk freight as grain, coal, lumber and oil. Latterly, however, the freight rolling stock has been made much heavier and now there are to be seen a great many of what the Russians call "American box cars." These are even heavier and of a greater capacity than those in use on this continent.

The first class equipment was not exceeded by anything in America or Europe for comfort or luxury. There were four classes of passengers besides the coolies, who were really freight. The locomotives were Russian, German, French, Belgian, Swedish, English and American. Their own engines were very good, and their mechanics could do very fine work, although unaided by all the modern shop equipment that is used on our own roads. In fact it was generally conceded that in operation they had very little to learn from the various missions that were organized to assist them. The one outstanding feature that I noticed was the lack of wrecking equipment. I saw dozens of very serious wrecks, but did not see a modern wrecking crane in the whole of Russia. Dozens of locomotives and hundreds of cars are still in the ditch from wrecks that occurred months and even years ago. I remember one occasion in which a locomotive broke through a culvert. They simply raised the grade and put in a few carloads of ballast so that the track could be built over the prostrate engine. Probably their instinct for revolutions and reversals of conditions prompted them to decide that turn about was fair play, and that it was time the track had the upper hand over the locomotive. No doubt they intend to come along and rescue much of the rolling stock that is now hors de combat, but that probably will not be until the government changes for the better.

We visited several railway shops but saw no real attempt to get the work out. They were lucky to do the necessary maintenance on the engines they were using. Between three depots I counted eighty-five dead engines on the side tracks. Many of them were Baldwins or American locomotives, almost new and probably requiring only some trifling repair. In their incessant cry for charity it is always locomotives that the Soviet Government asks for. It is estimated from figures supplied by the Soviet Government that there are about fifteen thousand bad-order locomotives in Russia. This amounts to a decrease of about seventy-five per cent in their effective power. They also admit that the serviceable rolling stock has decreased by about seventy per cent. In addition they say that over one thousand locomotives are idle from lack of fuel. In this connection I should add that they burn wood almost exclusively in their engines, now that they have neglected their coal mines. It is also indicative of the energy of the government that in the winter of 1919 it was necessary to destroy ten thousand wooden houses in Petrograd in order to supply fuel for the rest of the city—and this in a country that is one of the wealthiest in coal and standing timber.

In connection with the loss in rolling stock it should be noted that thousands of box cars are used all along the line as *dwellings* by the countless refugees. Thousands of families have lived thus for years and it is a very common thing to see many yard tracks full of cars in which windows have been cut and which have the family laundry stretched out between masts erected from the car roofs. Despite this diminution of seventy per cent in serviceable freight cars, there are still available infinitely more than the industry of the country requires. In the Volga region it was a common sight to see grass growing on the tracks at the entrance to grain elevators. This was because no grain was being shipped, because no grain was being grown by the peasants who knew that the government would claim it as nationalized property because that was the law: "Because I made it so," said Lenin. It is very obvious that a country that does not mine any coal or manufacture any commodities or encourage any enterprise, also does not have much use for box cars. It is a case where cause and effect are very difficult to disentangle. The first thing one notices upon entering the outskirts of Moscow is that every available side track is full of derelict rolling stock. Also, no one could fail to notice the very many factory chimneys, none of which were smoking and not likely to do so for some time.

Railway Bridges in South Africa

Seventeen railway bridges are to be constructed in British South Africa at a cost of about $1,000,000. Of these five will be required for the Vaal River, consisting of 150-foot steel spans. A branch railway will also be built through the diamond mining district of Griqualand, connecting Angra Tequena with Delagoa Bay, thereby shortening the route to Europe by about 100 miles.

New Short-Line Railway in Panama

Work has been begun on the construction of a narrow-gauge railway in Panama, to connect the Santa Rosa sugar mill with the sugar-growing districts. The equipment is expected to include the purchase of *2* locomotives and 20 cars of 5-ton capacity.

Railway Construction in Italy

It is reported that a railway will be built between Adria and Ariano, in the Province of Rovigo, construction to begin as soon as necessary financial arrangements have been completed. The distance between the two points is about 15 kilometers, but the railway will have to cross the Po River near its estuary, which is particularly broad.

Activity in British Railway Material

Sufficient orders for railway equipment seem to keep the leading manufacturers of railway supplies fairly busy in Great Britain. Some are specializing on railway car springs, ties and wheels, couplings, and journal boxes. Considerable orders for such material have been received for the colonial railways of India and foreign markets. One factory is on double time with a full force of 700 men in each shift building locomotives and bodies for foreign markets.

Rail Strike in Germany Ended

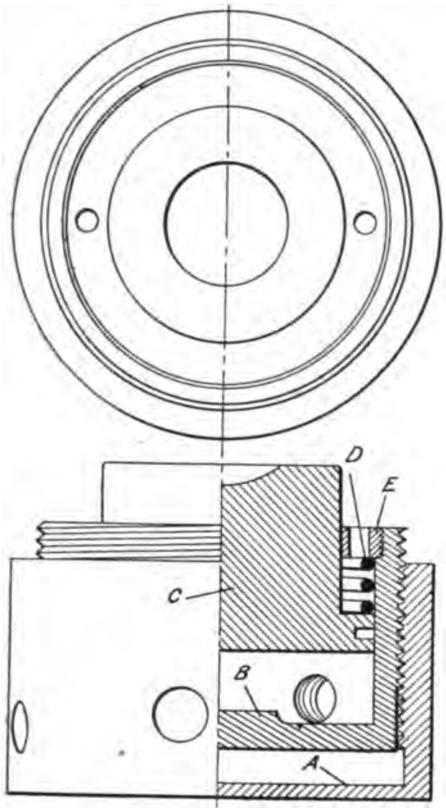
On February 5, it was reported that the general strike of the railway men throughout Germany seems to have come to an end. Representatives of the Railway Union have given assurances for arranging a settlement of the strike and in consequence the leading labor organizations have issued an appeal to the strikers to resume work.

The decision of the Railway Union representatives came after a protracted conference attended by Andreas Hermes, Minister of Food and Acting Minister of Finance, and officials of the General Federation of Labor Unions and of independent organizations. At this conference the Government gave the striking railroad men and the organizations pleading for them assurance that the disputed wage schedule and the reclassification of workers would be adjudicated immediately; the strike began on February [illegible]

Pneumatic Holder-On, Tire Heater, and Countersink Ratchet for Patch Bolts

A compact pneumatic holder-on has been designed at the Meadville shops that is quickly adjusted to the work and can be as quickly withdrawn.

The base *A* is a cup made of machinery steel with an inside thread cut to 8 to the



DETAILS OF THE PNEUMATIC HOLDER-ON.

inch. The shell is pierced with six holes, *a*, each 9/16 in. in diameter and laid out on a spiral curve with the distance between the centers of adjacent holes, .146 in. as measured along the axis of the cylinder, the reason for which will be presently explained.

The cylinder *B* screws into the shell or base *A*, it is made of machinery steel and is bored out to a diameter of 3⅛ in. to take the plunger *C*. At one side at the bottom it is bored out and tapped with a ½-in. hole *b*, that is threaded 14 to the inch to take the air hose. It is screwed into the base *A* until the hole *b* comes fair with one of the holes *a*. It will be seen, upon examination that these holes permit of an adjustment through a range of ⅞ in. The thread has a pitch of .125 in. Then if the cylinder is given 1 1/6 turns it will move .146 in. along the axis of the shell, which is the same as the range of the holes *a*.

The plunger *C* is of tool steel with a

the inside of the cylinder, and with a groove for the packing.

This flange also affords a bearing for the spring *D*, which has its other bearing against the ring *E* that is screwed into the cylinder, and is provided with two spanner wrench holes 7/32 in. in diameter for the purpose.

The air hose is slipped through one of the holes *a* and screwed into the hole *b*. Then when air is admitted beneath the plunger *C*, the latter is forced out against the work, compressing the spring *D*, which forces the plunger back and away from the work as soon as the air is exhausted.

The air is admitted and exhausted by the use of three-inch cock in the air pipe.

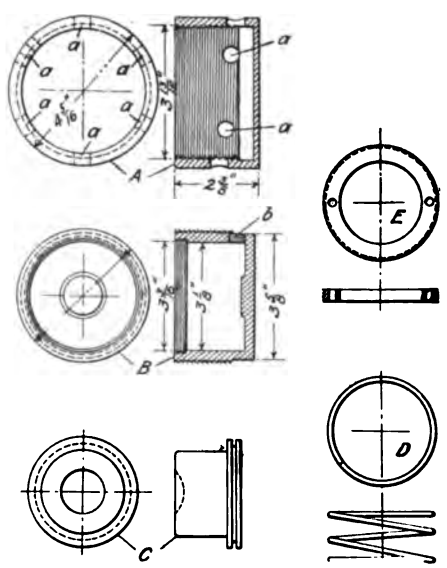
Tire Heater

The use of oil for heating tires in order to shrink them upon their centers has been a common practice for many years, and a number of arrangements have been designed for the work. The one here illustrated is very simple in construction, works well, rapidly and economically and may be worth copying by those having trouble with the apparatus now in use.

The source of fuel supply is a tank 12 in. in diameter and 33 in. long, having a gauge glass attached to one side. Air under pressure is admitted to the top and the oil delivery is through a ½-in. pipe leading out from the bottom.

The air line has a Tee, as shown, with a globe valve between the Tee and the tank and in the side pipe.

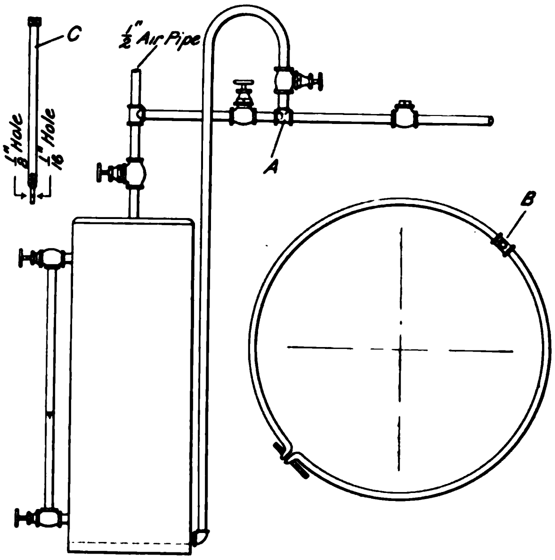
The oil and air pipes come together in the Tee *A*. The globe valve, in the oil line, just above the Tee *A* has the hole in the seat reduced to ⅛ in., while the pipe entering the Tee is reduced in its



inside diameter to form a nozzle 1/32 in. in diameter, from which the oil drops down into the path of the air jet.

The air pipe as it enters the Tee *A* is reduced to form a nozzle ¼ in. in diameter, from which the issuing air mingles with the oil dropping from the oil nozzle and passes through a ½-in. check valve and thence on through the ⅜-in. pipe to the ring which it enters at *B*.

The connection at *B* is made by means of the pipe *C*. This is a ⅜-in. pipe with a reducing bushing at one end to screw into



TIRE HEATER AS USED ON ERIE RAILROAD.

the ¾-in. Tee *B*. Where this pipe connects with the main delivery pipe leading off from the check valve it is plugged with a hollow plug that is pierced with a ⅛-in. and a 1/16-in. hole. These holes and the check valve effectually prevent any blowing back or explosive effect reaching the tank.

The ring is made of ¾-in. pipe bent to a diameter 1¼ in. larger than that of the tire to be heated and perforated on its inside diameter with 1/16-in. holes drilled 3 in. apart.

The best results are obtained with this heater when benzine is used for a fuel with an air pressure of 80 lbs. per sq. in.

The full pressure is turned into the tank, and then the air valve leading to the ring is opened slightly and air is blown into it. The oil valve should then be opened, allowing sufficient oil to mix with the air, so that, when it is ignited, it will burn with a clear blue flame. The air and oil valves can, then, be gradually opened. If the flame is yellow or red it indicates a waste of benzine and a loss of heat. The of doors and uses about one gallon of benzine or gas naphtha to heat a tire 3 in. thick and requires about 10 minutes to do the heating.

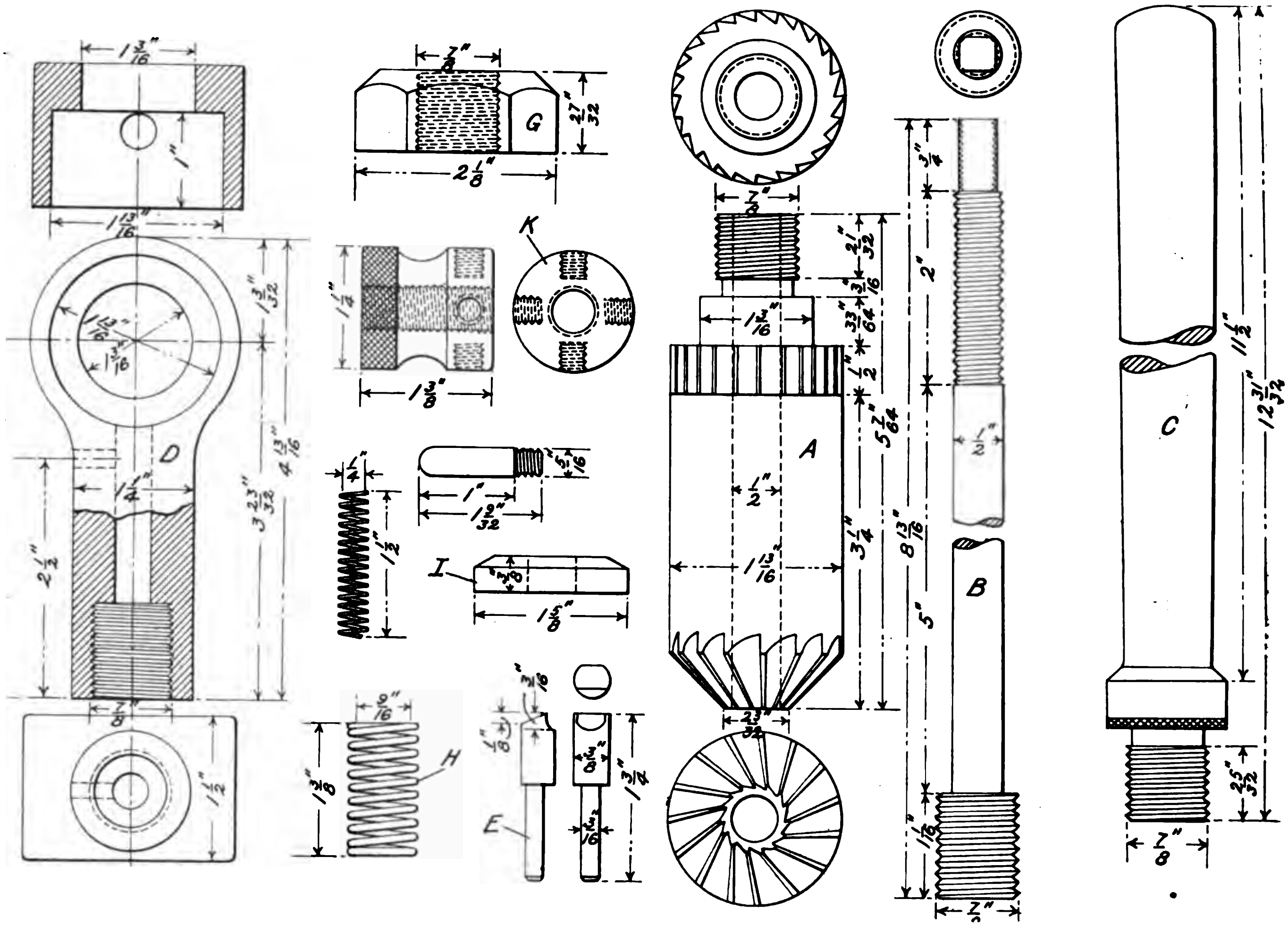
thread is cut to 13 to the inch and runs down 2¾ in. from the end.

The handle *C* and the ratchet holder *D* are of the ordinary form, with a pawl *E* and spring *F* for working in the ratchet.

The nut *G* is screwed to the upper end of the body *A* and with a bearing against the top of the same serves to hold the pawl and ratchet in line.

Bearing against the top of the body and inside the threads of the nut is the spring *H*, which by being compressed by the nut *K* through the washers *I*, serves to put a pressure on the body sufficient to force the cutting edges of the fluted end against the plate to be countersunk, the thrust being carried by the stem *B*, which is screwed into the plate.

This stem *B* is first screwed into the plate by means of a wrench on its squared end. Then the body and handle with the attached parts are slipped down over it. Then the spring *H*, with the washer *I*, is slipped in place and the whole tightened and held tight as the work progresses by the running down of the nut *K* in the stem *B*. To facilitate a rapid adjustment of the nut *K* against the spring the former is knurled, as shown on one of its circumferences.



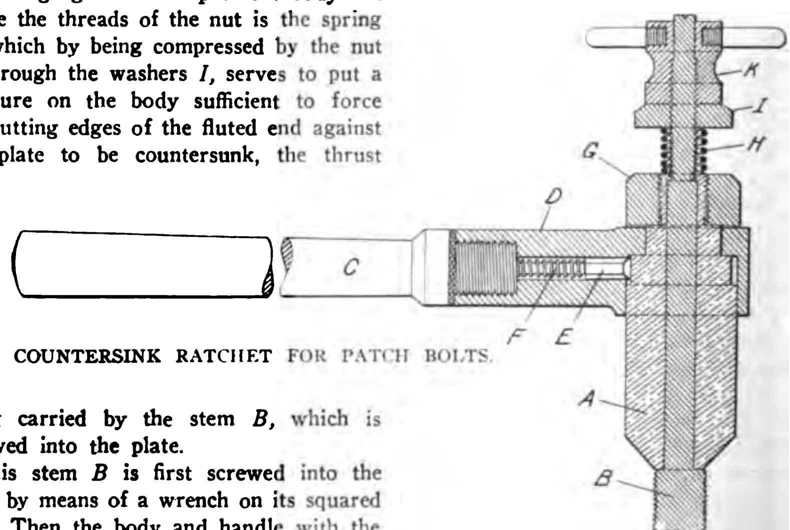
DETAILS OF COUNTERSINK RATCHET FOR PATCH BOLTS AS USED ON THE ERIE RAILROAD.

Device for Reaming Countersink for Patch Bolt

This is a ratchet device for reaming the countersink for a patch bolt.

The reamer *A* is made of tool steel 1 13/16 in. in diameter and 5 7/64 in. long over all. Its lower end is beveled at an angle of 54° and is cut with 15 flutes, whose maximum depth at the outside is ⅛ in. The ratchet, which is above the main body, is made up of 24 teeth with a depth of 3/32 in., and they have a face of ⅛ in. Above this there is a bearing for the pawl handle and at the upper end there is a ⅞-in. screw for the holding nut. An axial hole ½ in. in diameter runs through it from end to end.

Within this hole the stem *B* is placed. This stem is enlarged and threaded at one end to take the thread that has been tapped in the plate. At the other end it is squared to take a wrench but with the diagonal of the square left to the full ½-in. diameter so that the thread cut at that end appears on the corners. This



COUNTERSINK RATCHET FOR PATCH BOLTS.

Notes on Foreign Railways

Electric Equipment for Australia

The Victorian Government is about to issue a loan of £2,000,000, it is understood, for the purpose of obtaining funds to finance the Morwell electricity scheme. The total cost of this project for producing electric power from brown coal, or lignite, at Morwell, Victoria, and transmitting it about 90 miles to Melbourne, is estimated at £15,000,000. Much of the equipment for this scheme has already been ordered in America.

Electrification of Central Railway of Brazil

A complete translation of the announcement and call for tenders for the electrification of certain lines of the Central do Brazil Railway, the supply of traction and transport material, and material for construction of substations has been forwarded to the Bureau by Consul General Gaulin, of Rio de Janeiro.

The specifications will be loaned to firms interested through the Bureau's district offices. Inquiries should be sent to the Electrical Equipment Division, Bureau of Foreign and Domestic Commerce, Washington, D. C., referring to file No. 877.

Transportation Supplies for Argentine

Locomotives, cranes, cargo towers, electric motors and other equipment will begin to be ordered for Argentine in March. No delivery is specified, but payment will be made of 80 per cent on presentation of conditional receipt for the material, balance when delivery is formally accepted.

A list of the material, together with specifications and forms for submitting bids, have been sent to the Bureau. Firms interested may obtain this information from the Electrical Equipment Division, Bureau of Foreign and Domestic Commerce, Washington, D. C., by referring to Miscellaneous Exhibit No. 233.

Proposed South African Railway

The Union Government is considering the possibility of building a railroad through Swaziland to Kosi Bay, and thorough surveys will be made for the railway line and for a harbor on Kosi Bay, according to information from Consul Lewis W, Gayle at Durban. On the completion of the surveys the Government will know exactly what its commitment may be and whether political and economic conditions will allow construction to begin.

Swedish Railroads

Sweden has approximately 9,500 miles of railroads, of which 6,400 miles are owned and operated by private companies, while the remaining 3,100 miles, comprising the more important trunk lines, are State owned and operated. As compared with other European countries, Sweden, therefore, has the greatest railroad mileage per inhabitant. The per capita railroad trackage is approximately 16 miles per 10,000 inhabitants, as compared with 8 and 12 for Germany and France, respectively. The scarcity of coal, intensified by war restrictions, as well as the presence of an abundance of water power, has given impetus to the movement for the electrification of all Swedish railways. The high cost of coal and wages and other operating expenses has caused enormous increases in passenger and freight rates, so that at present, despite recent slight decreases, rates are still somewhat higher than those charged in the United States.

Another Internal-Combustion Locomotive

A combined internal-combustion locomotive that is now operating on the Minneapolis, St. Paul, Rochester & Dubuque Railway. On this line, which is an electrically-operated one, a limited parlor car train is run over a distance of 107 miles with four stops in 3 hours and 25 minutes. The locomotive has two 8-cylinder 175-b.h.p. internal-combustion engines, which are direct coupled to two 600-volts compound-wound electric generators, the engines being started by compressed air taken from a large receiver used for the brakes. It is stated that the engines can rotate at normal speeds and deliver their power irrespective of the speed of the locomotive, a factor of great importance when adverse conditions are not requiring sudden demands.

Loss of Finnish Railways Rolling Stock

During the World War and the insurrection in Finland 58 locomotives, about 440 passenger cars, and 5,000 freight cars, the property of the Finnish Railways, and aggregating in value at least 1,000,000,000 Finnish marks, were taken as war booty from the Russians. In May of this year the Finnish Railway Administration addressed an inquiry to all the Border States regarding this property, as to the extent of the Finnish rolling stock within their respective territories and whether the same could be returned.

Replies to this inquiry have been received from Esthonia, Latvia, and Lithuania, while Poland and the Ukraine have not answered as yet. The States replying advised that, inasmuch as the rolling stock was taken as war booty from the Russians, it cannot be returned. All Finnish rolling stock in Soviet Russia was ceded to the latter country by the peace treaty signed at Dorpat in 1920. Under the circumstances, the value of all this rolling stock is a total loss to Finland.

New Short-Line Railroad in Mexico

Contracts have been awarded to a firm in El Paso, Tex., for the construction of a new railroad, 47 miles in length, called the Ferrocarril de Chihuahua y Oriente, to run from Sierra Los Lomentos and Edupcion mine to the Mexican Central Railroad at Candelaria, 65 miles south of Juarez. The contract calls for the completion of the roadbed and bridges within 150 days, it being understood that the railroad company will lay the steel. It is planned to have the road in operation by August, 1922, or sooner.

The line will be of standard gauge and will carry passengers and freight. The main traffic, however, will consist of lead and silver ores from the Erupcion mines, which in magnitude of ore deposits are likened to the famous ore deposits of the Santa Eulalia district near Chihuahua, Mexico.

Electrification of Swiss Federal Railways

Fifty-seven million francs have been credited in the Swiss budget of 1922 for electrification of the Federal railways. It is hoped that the electrification of the Bellinzona-Lugano-Chiasso, the Erstfeld-Lucerne, and the Goldau-Zug lines will shortly be completed. The Amsteg power station, of 80,000 horsepower, will be ready to furnish energy about April, 1922, and the Lucerne-Zug-Zurich line will probably be electrified by the end of the year. Together with the St. Gothard, the Sion-Lausanne line is to be electrified, and will be opened in the summer of 1923. The current will be supplied by the 60,000-horsepower Barberine station, which by that time will have been completed.

Locomotive Repairs in Italy

While there are at least a dozen new railroad repairs in operation in Italy since the war, they are utterly unable to overtake the work on the dilapidated locomotives and other equipment. Germany and Austria, although greatly crippled themselves, have already undertaken extensive repairs for the Italian railroads, and it is reported that the work is being done in these countries at a much lower rate than can be done in Italy. Doubtless the food prices which are at dizzy heights in Italy have much to do with the situation. The cost of living is said to be six times higher than in pre-war times.

Electrification Work in Serbia

The Serbian Parliament is discussing the question of electrifying a portion of the Serbian railways. The portion immediately under discussion extends to 530 miles. Hydro-electric stations are already planned and the scheme seems in a fair way to be proceeded with, as a British loan has been secured.

Items of Personal Interest

W. A. Rocksberry has been appointed boiler foreman of the Chicago, Rock Island & Pacific at Eldorado, Ark.

E. Gardner Thorpe has been appointed general storekeeper of the Long Island, succeeding Eugene Wright, promoted.

J. H. Valentine has been appointed chief dispatcher of the Chicago, Milwaukee & St. Paul, with headquarters at Savanna, Ill.

George Walker has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe, with office at Prescott, Ariz.

J. N. Snider has been appointed coal traffic manager of the New York Central, lines east, at New York City, succeeding G. N. Snyder, resigned.

Charles W. Irvin has been appointed assistant boiler maker foreman on the Chicago, Rock Island & Pacific, with offices at El Dorado, Ark.

C. H. Creager and S. A. Rogers have been appointed road foremen of engines of the Baltimore & Ohio, with headquarters at Washington, Ind.

Charles M. Muchnie, vice-president of the American Locomotive Company, sailed from New York on the *Paris* last month on a brief trip to Europe.

J. P. Kavanaugh has been appointed general storekeeper of the Chesapeake & Ohio, general eastern division, with office at Clifton Forge, Va.

G. W. Bichlmeir, purchasing agent of the Union Pacific has been promoted to general purchasing agent, with headquarters at Omaha, Nebr.

Frederick A. Isaacson has been appointed assistant mechanical engineer of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan.

Henry Dersch has been appointed traveling engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding W. H. Dempsey, transferred.

W. A. Worely has been appointed roundhouse foreman on the Arkansas-Louisiana division of the Chicago, Rock Island & Pacific, with office at Winfield, La., succeeding J. H. Kelley.

E. R. Printon has been appointed general storekeeper of the Chesapeake & Ohio of Indiana, and of the Cincinnati division of the Chesapeake & Ohio, with headquarters at Covington, Ky.

Henry D. Jouett, terminal engineer, Grand Central Terminal improvements, has been promoted to chief engineer of the Cleveland Union Terminals, with headquarters at Cleveland, Ohio.

W. A. Webb, vice president in charge of operation of the Missouri, Kansas & Texas, has been appointed general manager of the Cambria & Indiana, with offices at Philadelphia and Colver, Pa.

C. H. Norton, master mechanic of the Erie, with headquarters at Hornell, N. Y., has been placed in charge of the mechanical department of the Susquehanna and Tioga divisions of the same road.

D. G. Durnell, master mechanic of the Pennsylvania, Southwestern Region, with offices at Cincinnati, Ohio, has been transferred to Lancaster, Ohio, succeeding R. J. Sponseller, acting master mechanic.

G. W. Hanegan, storekeeper of the central and western divisions of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has been promoted to general storekeeper with the same headquarters.

C. B. Tobey, assistant general storekeeper of the Lehigh Valley, with headquarters at Packerton, Pa., has been promoted to general storekeeper, with the same headquarters, succeeding C. C. Huntington.

C. T. Ripley, general mechanical inspector of the Atchison, Topeka & Santa Fe, with headquarters at Chicago, has been promoted to the newly created office of chief mechanical engineer, with the same headquarters.

W. S. Smith, assistant mechanical superintendent of the Missouri Pacific, with headquarters at St. Louis, Mo., has been promoted to mechanical superintendent, with the same headquarters, succeeding J. E. O'Brien, resigned.

Leroy Holt, assistant purchasing agent of the Tennessee Coal, Iron & Railroad Company and the Chickasaw Shipbuilding Company, Birmingham, Ala., has been appointed purchasing agent, succeeding George Gray, resigned.

W. C. Garraghty, formerly motive power inspector on South West district, Baltimore and Ohio at Cincinnati, has been appointed air brake instructor, Eastern Lines Baltimore and Ohio, with headquarters at Baltimore, Md.

Joseph J. Bennett, assistant purchasing agent of the Illinois Central, has been appointed purchasing agent, with offices at Chicago, Ill., succeeding W. A. Summerhayes, who has been placed in charge of the tie and lumber department.

William Nelson, mechanical engineer of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn., has been appointed assistant superintendent of motive power of the Kansas City Southern, with headquarters at Pittsburg, Kans.

Webster E. Harmison, master mechanic of the Erie, with offices at Kent, Ohio, will also have jurisdiction over the car department at that point, succeeding W. W. Warner, who has resigned to accept the position of manager of the Youngstown Equipment Company.

H. D. James, manager of the Control Engineering Department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been elected president of the Engineers' Society of Western Pennsylvania. Other officers, who were also elected at the annual meeting of the society are Frederick Crabtree, vice-president, and J. C. Hobbs and C. D. Terry, directors.

T. H. Hays has been appointed manager of the Indianapolis, Ind., office of the Westinghouse Electric & Manufacturing Company, and A. E. Hitchener, assistant to the manager of the Industrial Department will have general charge of the sections formerly under the supervision of W. H. Patterson, who will handle Westinghouse direct traction elevator equipment in the Middle West.

R. H. Dewson, well known air brake expert, has retired as district engineer of the Westinghouse Air Brake Company, in the Eastern territory, and will henceforth serve the company in a consulting or advisory capacity. Mr. Dewson has shown marked ability during his many years as resident engineer for the Eastern district, embracing New England, New York, New Jersey, Eastern Pennsylvania and Baltimore, with headquarters in New York. Mr. Dewson had expressed a desire to be relieved of all duties in order that he might have a much-needed rest, but the Company was loath to accept his resignation and induced him to accept the less arduous position. He now resides at Quincy, Mass., where he plans to spend part of his time while enjoying the greater leisure which his new position will afford.

Joseph C. McCune, has been appointed district engineer of the Eastern territory of the Westinghouse Air Brake Company, with headquarters in New York, succeeding R. H. Dewson. Mr. McCune received his early training under the late W. V. Turner, and has occupied positions of importance in the Westinghouse organization for a number of years. Mr. McCune enjoys a wide acquaintance in railroad circles, and is well known as a frequent contributor of articles on air brakes in the technical press. Mr. McCune joined the Westinghouse Air Brake Company after graduation from Cornell University. He served through the war as an officer of engineers, acting as an instructor in the Third Officers' Training Camp at Camp Lee, Va., and later saw service in France as a member of the Expeditionary Forces. He will maintain his present headquarters in New York.

Obituary

Donald H. Amsbury

Donald H. Amsbury, manager of the Dearborn Chemical Company, died at Pittsburgh, Pa., on January 25, after a brief illness from pneumonia. He was highly esteemed by all who had the honor of his acquaintance, and as chairman of the entertainment committee of the Pittsburgh Railway Club, he was a general favorite, particularly among the railway supply men.

Lawrence B. McCabe

Lawrence B. McCabe, a well-known railroad bridge and tunnel engineer, died at his home in Baltimore, Md. He was a graduate of Lehigh University, and engaged with his brother on general railroad construction work, among others, the Baltimore Belt Line, portions of the first New York subway. He was in his 75th year.

Fusion of Two Leading British Railroads

The fusion of the two greatest English railroads is announced, the Midland and the London & Northwestern. Each has a capital approaching one billion dollars, and together they own 14,122 miles of track and 8,000 locomotives.

The amalgamation is a result of the Government grouping of railways for administrative purposes and is simply anticipating making a closer union which would be enforced later.

The administration will be concentrated at Euston Station, London, and great economies will be brought about.

Asbestos in Arizona

An asbestos claim has been located in Apache County, Arizona, according to an authoritative investigation by the U. S. Bureau of Mines. The deposit, seemingly extensive in its reach, has been traced for more than 20 miles. Vein exposures are so pronounced that the passerby, in the absence of miner's tools, can pick from the wayside a ton or more of the crude product, broken down from the prominent veins.

Considering the shortage of crude asbestos in this country, it is regrettable that the Government forbids the mining of asbestos deposits on unallotted Indian lands, where this discovery has been made. The Office of Indian Affairs has recommended to Congress the lifting of the ban which now prohibits the development of unallotted Indian lands for the purpose of mining asbestos, coal, oil and gas, and it is confidently expected that official permission

Washington Branch Discontinued

The Pressed Steel Car Company and Western Steel Car & Foundry Company have discontinued their Washington office February 1st. Mr. L. O. Cameron, who has been a representative of these companies in the Southern territory for many years, has severed his connections with these companies, but will continue his office in the Munsey Building to handle other accounts.

Railway Master Blacksmiths' Convention

The International Railroad Master Blacksmith's Association, has completed arrangements to hold the next annual convention at the Hotel Sherman, Chicago, Ill., on August 15, 16 and 17, 1922. Secretary William J. Mayer, will issue programme with full particulars at an early date.

Master Boiler Makers' Association.

The Executive Committee of the Master Boiler Makers' Association has announced that the thirteenth annual convention of the association will be held at the Hotel Sherman, Chicago, Ill., May 23-26, 1922. Members desiring reservations for accommodations should apply directly to the Hotel Sherman. The convention, which was to have been held at St. Louis, Mo., in 1921, and at which a number of valuable reports on special subjects was to be presented, was cancelled owing to business conditions, but the reports have been published in book form and are being distributed to members in good standing by the secretary, Harry D. Vought, Room 315, 26 Cortlandt street, New York City.

Pressed Steel Mfg. Co. Obtains a Judgment

An injunction and order for accounting has been granted by the United States Court of the Eastern District of Illinois against the Mt. Vernon Car Manufacturing Company, Mt. Vernon, Ill., sustaining the claims of the Pressed Steel Manufacturing Company, Chicago, Ill., sustaining the validity of all of the claims at issue. The patents in dispute covered the corrugated steel plate end for freight cars, which were infringed upon by the defendant company in equipping 1,000 box cars which were furnished to the Baltimore & Ohio, with the improvement, and as which the order for accounting has been granted.

Civil Service Examinations

The United States Civil Service Commission announces an open competitive examination for Inspector of Locomotives on March 8 and 9, 1922; and also for the positions of Inspector of Safety Appliances and Inspector of Hours of Labor on March 22 and 23, 1922. The salaries are

ters in the discharge of official duties. Applicants, in the case of Locomotive Inspectors, should apply for Form 1892, stating the title of the examination desired to the Civil Service Commission, Washington, D. C. In the case of the other inspectorships referred to, application should be made for Form 1933, giving title of examination desired, when details of subjects and ratings will be furnished by the Commission.

Research Graduate Assistantships.

The Engineering Experiment Station, University of Illinois, Urbana, Ill., announces that sixteen Graduate Assistantships, for each of which there is annual stipend of $600, and freedom from all fees except the matriculation and diploma fees, are now to open to applicants, the appointments being made in the spring, and they become effective in September. In addition to other studies, railway engineering, mechanical engineering, civil and electrical engineering, and theoretical and applied mechanics are included. Full information may be obtained by addressing the Director of the Engineering Station, Urbana, Ill.

American Society for Testing Materials.

The twenty-fifth annual meeting of the American Society for Testing Materials will be held from June 26 to July 1, 1922, at Atlantic City, N. J., with headquarters at the Chalfonte-Haddon Hall Hotel. Particulars may be had on application to J. K. Rittenhouse, assistant treasurer, 1315 Spruce street, Philadelphia, Pa.

NEW PUBLICATIONS

Books, Bulletins, Catalogues, etc.

Machine Drawing

D. Van Nostrand Company, New York, has published a new text-book by Carl L. Svensen, on the Machine Drawing for advanced students, who may be particularly interested in the relation of machine drawing to engineering. It embraces a large collection of examples in problems relating to machine details of many kinds. Draft room practice and a complete treatment of working drawings is present with a degree of thoroughness that shows how carefully the author has covered the subject. The work extends to 214 pages in cloth binding.

Employment

The latest reports from the Department of Labor and other sources indicate that the numbers of workers employed remained practically constant during the last three months. During the past month there were increases in the number employed in railway equipment shops, machinery and iron and steel plants. The Steel Corporation has recently been turning out galvanized sheets at 75 per cent

Railroad Traffic in 1921

Total loadings of freight cars in the year 1921 were nearly 6,000,000 less than in 1920, a decrease of 13 per cent. The principal decreases were in loadings of coal, forest products, ore and miscellaneous groups. Shipments of grain and grain products and of merchandise in less than car load lots, were larger in 1921 than in 1920. Detailed figures are shown in the following table, which is compiled from the weekly reports of the American Railway Association.

(Thousands of cars loaded)

	1921	1920
Grain and grain products..	2,326	1,800
Live stock	1,530	1,586
Coal	8,151	10,281
Coke	327	659
Forest products	2,533	3,105
Ore	917	2,423
Merchandise, cars not full	11,045	9,143
Miscellaneous	13,085	16,788
Coal	8,151	10,281
Total	39,913	45,864

Accident Bulletin, No. 80.

The statistics given in Accident Bulletin, No. 80, covers reportable accidents that occurred during the three months ending June 30, 1921, and in the important matter regarding casualties to persons it is gratifying to observe that the safety movement continues to show a marked decrease in the matter of casualties. The report for the three months referred to shows that it is fair to assume that the record is about as low as it has been since 1898, while the traffic record as shown in the estimated number of ton miles was about three and a half times less than that recorded in 1920. It may be questioned whether the safety first movement or the Workingmen's Compensation Act has had the most pronounced effect in bringing about the humane result. Coincidentally it is an assurance that the good work will go on and the record for the entire year will not only be the lowest in the present century but for many years previous. It is also noteworthy that in the record of locomotive-boiler accidents while there are six reported during the three months there are no injuries to employes or other persons reported. Copies of the Bulletin, which extends to twenty-one pages, may be had from the Government Printing Office, Washington, D. C., at five cents per copy.

A. S. M. E. News.

The rapid growth in the membership of the American Society of Mechanical Engineers has rendered it necessary that the Society Affairs Section of *Mechanical Engineering* should be separated from the regular monthly issues of that periodical, and the A. S. M. E. News has made its twice a month it will increase the effectiveness of the society's work, particularly in the prompt publication of news of importance to the members, thereby avoiding the delay necessary in the preparation of important special papers on technical subjects which has been, and will continue to be, the chief feature of *Mechanical Engineering*. The new publication is printed in few pages and in news style and will be published on the second and twenty-seventh of each month. It is carefully edited and finely printed. Among other excellent features, the Employment Service Section, with brief notices of Positions available and Men available, is admirable.

Babbitting Motor Bearings

Babbitting motor bearings is described in detail in Circular Reprint No. 104, published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The publication is a discussion of the production of babbitt metal by J. S. Dean, of the Railway Motor Engineering Department, Westinghouse Electric Company, and it contains a number of photographs of equipment used in the manufacture of babbitt metals as well as the results of various tests of samples of alloys.

Torchweld Instruction Manual

The Torchweld Equipment Company, Fulton and Carpenter Streets, Chicago, have issued a new instruction manual governing the use of their equipment, together with general instructions on oxy-acetylene welding. The book contains 74 pages and is written from the standpoint and language of the welder. Users of Torchwell apparatus may obtain copies by addressing the company at the above address.

Tank Car Specifications

Section 7-C of the Specifications for Class I and II Tank Cars, and the last paragraphs of Section 7 (d) of the Specifications for Class III and IV Tank Cars as revised 1920, effective November 1, 1920, provide that no nipples, valves, or other attachments shall project below the bottom outlet cap except while car is being unloaded.

At the request of certain owners of tank cars, the effective date of this requirement of the Tank Car Specifications is extended to April 1, 1922.

Gas Masks for Train Crews in Tunnels.

The United States Bureau of Mines, Washington, D. C., reports that the investigation of gas masks for the use of train crews in railroad tunnels has been completed. Results of the tests will soon be published by the Bureau of Mines in a technical paper, entitled "Tests of Gas from Locomotive Smoke in Railroad Tunnels, with Analyses of Tunnel Atmospheres," by A. C. Fieldner, S. H. Katz, and S. P. Kinney. A small mask was devised that fits conveniently into a coat pocket, and in actual service with locomotive engineers and firemen was found to last two to six months before distasteful gas penetrated.

Identification Tags

It is reported that while some employers are preparing badges for good service, others are preparing a tag system for identifying workers in case of accident. Boards of Safety are taking the matter into consideration. It is noted that tags are easily lost, while seafaring men avoid such losses by becoming tattooed men.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV | 114 Liberty Street, New York, March, 1922 | No. 3

New Mountain Type and Santa Fe Type Locomotives for the Manila Railroad

The Manila railroad on the island of Luzon, the largest island in the Philippine group of islands, is having important additions to its locomotive equipment and rolling stock. Much of its original equipment has become almost unfit for service, and in need of repair. The situation, however, is being much improved by the addition of the new Mountain, 4-8-2, type locomotives for passenger service and ten Santa Fe, 2-10-2, type locomotives for freight service, built by the American Locomotive Company at the Brooks Works. In designing the locomotives the constructing engineers arranged to have as many as possible of the detail parts of the two types of locomotives the same in order to facilitate maintenance and reduce the number of extra parts which would have to be carried by a road situated at so remote a distance from the point of manufacture. That the designers succeeded to a high degree is evidenced from the fact that the interchangeable parts include the boiler complete with attachments, cylinders complete, except in height, valve motion parts with exception of eccentric cranks; trailing truck; cab; tenders; cocks and valves; fittings and brake cylinders. The following parts are also interchangeable except for the modifications required because of the use of lateral motion driving boxes on the forward axle of the 2-10-2 type locomotive; rods, crank pins, driving axles and driving boxes, driving box saddles, shoes and wedges, equalizing arrangement details and spring hangers.

Both types of locomotives have 20 in. by 28 in. cylinders, 11 in. piston valves with 5½ in. valve travel, and an extended wagon top boiler carrying 180 lbs. steam pressure. The inside diameter of the first ring of the boiler is 63 in.; the firebox is $84\frac{5}{16}$ in. long by 60¼ in. wide with 130 2-in. tubes and 22 5⅜-in. flues, 18 ft. 6 in. in length. The heating surface is 176 sq. ft. for the firebox, combustion chamber and arch tubes, and 1,823 sq. ft. for the tubes and flues. The superheater surface is 493 sq. ft. and the grate area 35.2 sq. ft.

The Santa Fe, 2-10-2 type locomotives are capable of exerting a traction force of 35,700 lbs., with 48 in. drivers, and weigh 188,000 lbs.; 148,500 lbs. of which are on the drivers, 15,500 lbs. on the front truck and 24,000 lbs. on the trailing truck. The engine wheel-base is 18 ft. 4 in., and rigid wheel-base 13 ft. 6 in.

The Mountain, 4-8-2 type locomotives, which are capable of exerting a tractive force of 28,600 lbs., have 60 in. drivers, and weigh 183,000 lbs., 119,000 lbs. being on the drivers, 34,000 lbs. on the front truck, and 30,000 on the trailing truck. The engine wheel-base is 34 ft. 7 in., and driving wheel-base 15 ft. 9 in. The tenders have a capacity of six tons of coal and 5,000 gallons of water.

The road on which these locomotives run includes 1.5 per cent grade and curves of 492 feet. The track gauge is of the 3 ft. 6 in. type which is the standard on the railroads in the Philippine Islands and also in Japan and other eastern as well as in many southern railroads.

Among other accessories the locomotives are provided with screw type couplings having the hook, screw, cleves, links and screw crosshead made of chromo-vanadium steel. The bumper and rails on the front end of the locomotive and rear end of the tender have been designed, however, to allow for a future appliance of the M. C. B. couplers. The brake equipment was furnished by the Vacuum Brake Company of England, and in addition to the ejector and apparatus for controlling the train brakes, the locomotives are equipped with

MOUNTAIN 4-8-2 TYPE LOCOMOTIVE FOR THE MANILA RAILROAD. AMERICAN LOCOMOTIVE COMPANY, BUILDERS.

steam driven brakes, while independent hand brakes are used on the tender.

The equipment throughout is strictly modern and includes Locomotive Superheater Company's superheater pyrometers, security brick arches, Worthington feedwater pumps and heaters, Alco 7 in. type E-3 steam power reverse gear, Pyle-National electric headlights and Barco flexible connections in the vacuum brake piping between the engine and tender.

It will thus be seen that the new locomotives are well equipped and, it may be added, that these are not the first locomotives on this road from the United States, as the American Locomotive Company delivered ten locomotives to the road in 1913. The old locomotives have made records of 140,000 miles between shoppings, which is an excellent record as any record in excess of 80,000 miles is considered as being above the average on American railroads. It will be remembered also that the H. K. Porter Company furnished 10 locomotives to the same road last year, and an additional 10 locomotives are being furnished at the present time, so that the new equipment bids fair to meet the requirements of the service for some time. The development of the railroads in the Philippine Islands has not been as rapid as might have been expected. The Manila railroad which serves the island of Luzon is 665 miles in length, and has a north and south line with branches, with headquarters in Manila. Including the new locomotives now being placed in service, the equipment consists of 145 locomotive, 240 passenger cars and 1,675 freight cars. The Philippine railroads, which serve the islands of Panay and Cebu extend to 295 miles of line authorized and 133 open. On this line, which is an American enterprise, there are at present 15 locomotives, 50 passenger cars and 198 freight cars.

It might have been expected that there would have been a more rapid development of railroad extension in the islands, rich as they are in natural products, and with a population of over ten millions. The passenger traffic is not large and such as it is is largely confined to the third class. Excellent first class coaches are provided but are not largely patronized. There are no large cities along the railroads, the population being widely scattered in small towns or villages. The climatic conditions are such that the wants of the natives are few and elementary, although they are beginning to show a wider taste, especially among the rising generation. The imports which are largely from the United States show a gradual increase, and are principally distributed by the Manila railroads. These include wheat, flour, cotton goods, chemicals, automobiles, fish, paper, silk, iron and steel. The demand for domestic utensils, and even mirrors and toilet articles, are rapidly increasing. One would have imagined that the long period of Spanish occupation would have left its traces of elegant ornamentation among them, but the lack of communication was such that Manila and vicinity was about as far as the Spanish grandees projected their civilization, if it might be so classified in the matter of personal adornment.

SANTE FE 2-10-2 TYPE LOCOMOTIVE FOR THE MANILA RAILROAD. AMERICAN LOCOMOTIVE COMPANY, BUILDERS.

The exports are chiefly cocoanut oil, copra, hemp, maguey, sugar centrifugal, raw sugar, tobacco leaf and cigars. The latest returns for the cost of imports amount to nearly one hundred and forty millions, while the exports show a little in excess of that amount, so that the balance of trade is nearly equal. There is considerable inter-island passenger traffic, the principal being by boat at Hondagua. The total area is 115,026 square miles, of which nearly one-third comprises the island of Luzon, while Mindanao, the next in size, is nearly as large as Luzon. There are 7,083 islands extending 1,152 statute miles from north to south, and 682 miles from east to west.

Prevention of Freight Loss and Damage

In these days, when the necessity of economizing is paramount, it is surprising how many leaks may be discovered by the keen observer who has the mental capacity to understand where steps may be taken to remedy the defects. At a recent meeting of the Canadian Railway Club, held in Montreal, Joseph Marshall, special representative Freight Claim Prevention, American Railway Association, presented a series of startling facts and figures in relation to the amount of loss accruing to the railways on account of loss and damage, coming to the notice of the claim departments of the various railroads. In 1920 the final figures in the United States and Canada amounted in value to nearly 126 millions. It would more than pay the cost of supervision of maintenance of ways and structures and maintenance of equipment. It would almost pay the bill for rails as far as Canada is concerned. Plain robberies are about 20 per cent of the total claim payments. The next largest item is unlocated damage. A large portion of this damage is occasioned by the rough handling of cars. Opinions differ as to what constitutes rough handling. Among others, J. A. Pilcher, mechanical engineer of the Norfolk & Western, claimed that cars equipped with spring draft gears should not be brought together at a speed greater than two miles per hour at time of impact. Mr. Pilcher chose spring draft gears on the theory that we must bring the force of our handling down to meet the strength of the weakest link, and then he suggested we cannot continually make heavier cars to meet heavier handling, and that railway men must learn to ease up and not hit cars hard just because they look as if they could stand it. Repeated drops of water will wear away granite.

There is a marked distinction between switching at two miles per hour and coupling at two miles per hour—two different things. If an engine foreman can switch fast and not damage the scenery—he is a good man. If he can so line up the work that every member of the crew understands what the other fellow is trying to do, and between them they have their speed down to two miles per hour when the cars come together, he is a good prevention man. It is worth study in every yard, as shown by the claim account and the car repair bill.

The next largest item is Defective or Unfit Equipment, to which we can add wrecks. Besides rough handling causes damage to freight, damage to equipment, resulting in leaky roofs and sides of cars, besides impairing the running gear or brake equipment and places the car either on the rip track or in line for replacement.

Intercourse and exchange of experiences and opinions among the train men should be encouraged. Appended are some of the subjects for discussion which might be varied to suit the conditions in each yard:

Restrictions as to commodities that will be sent over humps.

Restricting the number of cars that will be handled in one cut; some restrict to 15 cars, others 20 cars.

Discussing signalling methods to avoid misunderstanding and to learn the best method for each particular yard. The man on the engine knows the number and weight of cars, but he does not always know how far he is going.

Shall the engineer take signals from the engine foreman only?

What does a man going from one yard to another know about the interpretations applied to the terms used by switchmen? When it is used, is the wash-out signal a quick stop, or a slow sign?

What is behind the failure of couplings to make—plenty of room for discussion here.

What is the best brake equipment for switch engines, straight air or automatic?

To what extent are trains classified to reduce switching en route?

Do enginemen know the effect of releasing brakes on long trains when running at low speed? Many fruitful angles to the brake question and a wide field for discussion.

Brake pipe leakage causing trouble with air brakes—much of this results from pulling air hose apart with the engine. Every trainman ought to uncouple the hose and and not simply allow the engine to pull the coupling apart. A "Live" committee in any terminal will soon put a stop to that practice.

Stopping trains by applying air at rear end, either by opening conductor valve, angle cock, or tail hose is another practice that would be discouraged.

How much time should be allowed for the inspection of train after being made up? Is enough time being allowed in any particular yard? It is said stretching trains entering or leaving terminals is a great help to car inspectors and enables them to test the air in the least possible length of time.

The question of the proper place in trains for old and weak equipment is a "live" subject which should be kept in the minds of yard men at all times.

Reporting bad brakes and hand brakes, and long brake chains, for proper corrective measures will help the rough handling account.

Yard in testing plants connected with freight houses where practicable will be of help. With this goes the work of triple valve cleaning, lubricating, ring adjusting and the like.

There is also the important matter of getting the men to visit the air brake instruction car, where such a car is used.

A good plan, where it can be worked, is to choose certain engineers who are willing to apply their minds to the subject, to study train handling and make a report of their observations and circulate this to employes. The same can be done with respect to other employes writing from their standpoint, such as conductors, yard foremen, car foremen, etc.

Claim prevention calls for education and co-operation. We must educate ourselves and the other fellow. There are conflicting opinions as to what constitutes education for the purpose of preventing claims, but we can call it education in good service—it is nothing more.

What we do to prevent rough handling will, of course, reduce the number of derailments and reduce the money—after an accident does occur the big thing is to salvage as much freight as possible. To this end, wreck outfits should be equipped with tarpaulins and cooperage supplies to take care of any situation, and as the Car Department usually looks after picking up wrecks, the wreck master should be a member of some committee, at least he should be kept posted on claim prevention matters so he will be interested—so he will never fail to open a car which is lying on its side—get his men inside and re-arrange the freight in such a manner as to cause the least damage when car is righted. He should know exactly what the car contains before taking hold of it with the big hook. It may burst open. If the freight inside the car is arranged for such a contingency, or shifted in position for the proper righting of car, a lot of money can be saved.

The Safety Department of a railroad can consider freight claim prevention along with its safety work. We do not suggest here that the work can be mixed, but simply want to show how they are interested because we, as railroad men, ought not to allow a bad practice or condition to go unnoticed, particularly when we can reinforce our argument from two standpoints.

Here are some examples:

A defective running board or apron over which freight is trucked might go off under a truck; if so, personal injury is possible, plus damage to freight.

Leaking tank cars cause loss of oil and danger of fire, explosion and personal injury.

Dragging arch bars, or brake beams, can be talked from both standpoints; so can overloading of coal on tender or coal cars; so can holes in freight platforms. Also bad brakes and methods of signalling in yards.

These are just a few to show the wide range of overlap in the work of men who may be looking after safety first as well as those who may have sole charge of doing things to prevent freight claims.

All work to eliminate rough handling in transit and defective equipment combines safety first with safety to freight.

The Car Department can do much to prevent the use of cars unfit for the class of freight to be loaded. Equipment may be scarce, but a good system of carding cars, showing class of freight they are fit to carry, and a proper interest by yard men, will always produce the few good cars to be found in every yard to load the few high-grade commodities loaded from that place every day.

In theory, when a merchandise house is set for the day, every car is one fit to carry merchandise. Any cars found unfit must be used as they stand set out, or fixed up. We know it doesn't pay to break up a house setting, so the tendency is to use the car. This car, if used, will be loaded to some freight house at some other place, perhaps a small place where the house foreman must make his own empties. In any event, wherever it goes, it likely will be unloaded at a point where it at once becomes another merchandising car, and this may go on for weeks and months until finally the car gets out of the merchandise channel and is set for the loading of mill products or other commodities.

Perhaps they can replace bad hasps or locks, as a car in that condition is a standing invitation to be robbed each time it is loaded. Perhaps this can be done on all cars which reach the rip track for any purpose.

Card leaky roofs so they will not be used for high-grade commodities.

The Purchase and Storage Department can help when buying new equipment by following the Mechanical Division's recommendation and help get money-saving devices into effect.

Many further details could be added, but which could be developed from any discussion of the points here mentioned. It will be conceded that all railroad men should work together locally and nationally in the effort now being made to reduce transportation expenses, and every branch in transportation service should get busy with all the means at their command to produce the best service possible at the least cost.

Device for Milling Eccentric Keyways in Axles of Locomotives After the Axles are Pressed Into the Wheels

Details of Construction and Application

This is a device for milling the eccentric keyways in the driving axles of locomotives after they have been pressed into the wheels.

The general scheme of the arrangement is that a base *A* is clamped to the axle so that its center line coincides with the center line of the keyway that is to be cut.

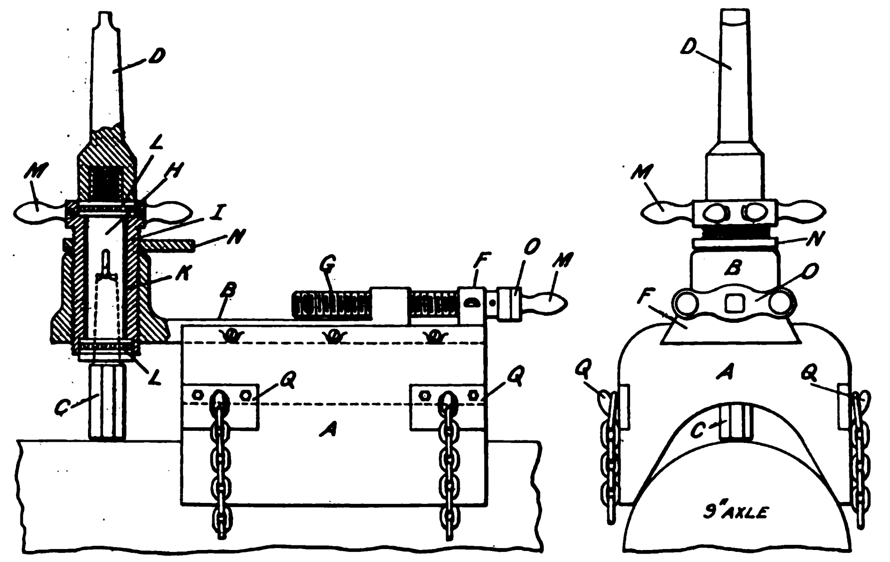
The base carries a slide *B*, which may be moved to and fro along the line of the keyway, and which carries the milling cutter *C* by which the work of cutting is done. The cutter is given a vertical feed by which, being an end as well as a side milling cutter, it can be fed into the work, and when it has been driven down to the depth of the keyway, to be cut, it can be locked in that position and then fed horizontally until the full length of the keyway has been cut.

The driving of the cutter can be done by an air motor or flexible shaft, or any other convenient means; provision being made for the attachment of the motor to the Morse taper of the shank of the driving socket *D*.

The base *A* is a U-shaped steel casting 12 in. long, and very rigid in design. The inside faces of the legs are finished along the lines indicated at *a a*. These faces are equally distant from the center line of the base. The top of the base is finished as a guide for the slide, with dovetailed sides, whose center line is 9/64 in. out of center with the center line of the base. The distance across from bottom to bottom of the dovetail is 5-9/32 in. and the dovetails, themselves, stand at an angle of 60° with the horizontal bottom of the guide.

The slide *B* may be best made of a steel casting of the general shape shown in the engraving, and is planed to fit in the dovetail of the base. The total width of the slide is 5 in. which leaves 5/32 in. to be taken up by the gib *E*. This gib is ¼ in. thick and as its sides are at an angle of 60° with the edges, the distance across the edges is about .01 more than 5/32 in. that is to be taken up between the slide and the dovetail faces of the base. Or about enough to give an easy sliding clearance. One face of the gib is counterbored at three places for the points of 5/16 in. set screws, for which the base is drilled and tapped at the points *b b b*.

The base is also provided with two pockets ⅛ in. deep on each side for the reception of the hook plates by which the base is clamped to the axle. Each of these hook plates is fitted in place and held by two ⅜ in. tap bolts. These serve merely to hold the plates in place, the whole stress produced by the clamping chains being taken by the shoulders against which they rest.



MACHINE FOR MILLING ECCENTRIC KEYWAYS IN AXLES.

A bearing block *F* is also fitted into the dovetail of the guide of the base. This furnishes a bearing 1 in. in diameter and 1 in. long for the feed screw *G*. This bearing block is held to the base by two 5/16 in. machine screws, for which suitable holes are drilled and countersunk as shown. This bearing block has the full width of the dovetailed guide and fits snugly in between them, and takes the whole thrust of the feed screw.

The slide *B* has a total length of 14⅜ in. The distance of the center of the boss *d* in which the milling cutter runs from the back end of the slide is 12¼ in. The nut *e* for the feed screw is 1½ in. long and the length of the thread of the feed screw is 7½ in. So that allowing for the thickness of the collar on the feed screw, the center of the milling cutter stands 1½ in. beyond the end of the base when drawn home. The normal feed is 6 in. which will bring the end of the feed screw flush with the nut, and leave the slide with a footing of 4½ in. on the base. The feed screw and rim *D* on the slide are cut to 8 threads to the inch and 1 in. in diameter.

The thrust of the feed screw is taken by two collars, one made solid with it and the other pinned to it. The screw is turned by a crank *O* into which two handles *M* are screwed, and which has a square hole to fit over the end of the screw.

The milling cutter *C* is of the ordinary type and is made with a No. 3 Morse taper shank and is 6-11/16 in. long over all and 1 in. in diameter.

The shank fits into the sleeve *H*, which is turned to go into the brass bushing *K* with a driving fit. The sleeve is made of tool steel and has the keyway *S* for driving out the milling cutter.

The sleeve with its brass bushing revolves in the vertical feed screw *I*. This screw is threaded on the outside with 10 threads to the inch to mate those cut in the inside of the boss *d* of the slide *B*. Both it and the boss are cut with keyways to match those in the sleeve and bushing for the driving out of the keys.

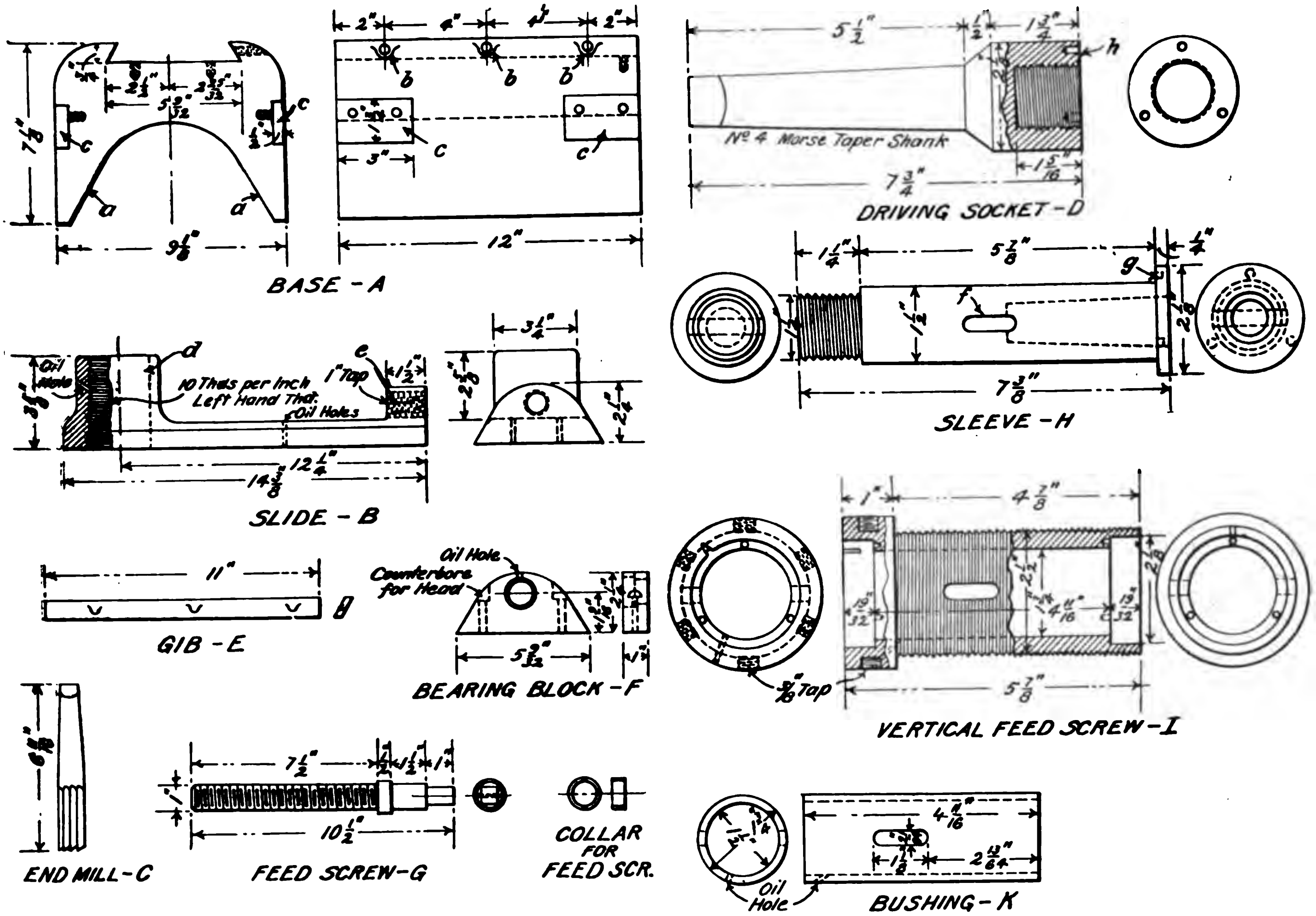
The vertical feed screw is provided at each end with a recess for the reception of the raceways *L* for the ball bearings on which the revolving parts turn and which take the thrust of the milling cutter. These are put in with an oil tight fit. These raceways *L* are of the shape shown in the engraving and are held in place by three dowell pins ⅛ in. in diameter as indicated. One race fits into the recess shown at each end of the vertical feed screw, and their mates fit one against the top of the flange at *g* at the bottom of the sleeve *H*, and the other against the bottom of the driving socket *D* on the face *h*. In both cases balls of 3/16 in. diameter are used.

The top end of the sleeve *H* screws into the bottom of the driving socket *D* which carries the raceway, that mates with the one at the top end of the vertical feed screw *I*.

Six of the handles *M* are screwed into

the swelling at the top of the vertical feed screw, so that the latter can be turned and the revolving parts raised and lowered.

two screws are run up through the clamp and tightened against the bottom of the axle, thus drawing the chains taut and



DETAILS OF MACHINE FOR MILLING ECCENTRIC KEYWAYS IN AXLES.

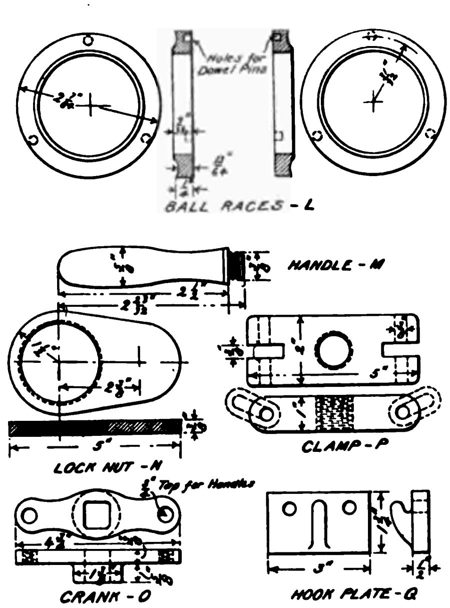
It will be seen that as the feed screw is run down the upward pressure against the bottom of the milling cutter, pushes it up against the lower ball bearing which thus takes the thrust.

When the cutter has been fed into the metal to the full depth described the locknut *N*, which is screwed to the outside of the vertical feed screw, is run down and jammed against the top of the boss of the slide *B*, thus locking the feed screw in place and so holding the cutter down to its work. Then by turning the feed screw *G* the cutter is moved horizontally cutting the keyway to the length and depth desired.

The assembled drawing shows the device mounted upon a 9 in. axle. It is clamped to it by means of the chains as shown which are attached to ⅜ in. pins passing through the ends of the clamp *P*. This is simply a strap of 2 in. steel, slotted at the ends to receive a link of the chain, and drilled and threaded at the center for a 1 in. tightening screw.

The base is set on the axle in line with the center of the keyway to be cut. The clamps are set up against the bottom of the axle and the chains hooked over the fastening the base to the axle in readiness for work.

As a labor saving device its merits have been already fully appreciated by competent authorities in such work.



DETAILS OF MACHINE FOR MILLING

Pressed Steel Car Company

The report submitted by President F. N. Hoffstot, of the Pressed Steel Car Company, although showing a falling off in dividends from the year is full of hope for the future. In 1920, the total amount paid as dividends was $1,875,000, and in 1921, $1,125,000. Mr. Hoffstott states in the interesting report that the company's business is so indissolubly linked with the business of the railroads that anything that affects them affects us. Before the war the railroads were about adjusted to new conditions resulting from the supervision of their business by the Interstate Commerce Commission and would have replaced their depleted equipment had it not been necessary to bend their energies first to help meet the extraordinary demands from abroad and then after the United States entered the war, to support our war program. Then quickly followed government control of the railroads, resulting ultimately, by the granting of increased wages, in the entire overturning of the rules for employment, established as a result of many years of experience. Since the armistice, one by one the pegs supporting this government protection have been removed, but unfortunately this action was not uniform or intelligent. Mr. Hoffstot is looking hopefully for marked

Australia and Its Railways

At the regular monthly meeting of the New York Railroad Club, held at the United Engineering Society's Building, New York, on February 17th, 1922, F. M. Whyte presented a paper on "Australia and Its Railways." The use of lantern slides illustrating the leading features of the paper added interest to the subject. Mr. Whyte's paper had the merit of comprehensiveness, furnishing as it did a complete historical, geographical and political synopsis of the development of the country since the creation of the earlier colonies in 1786 to the proclamation of the Commonwealth in 1901 as a united dominion within the British Empire. The population approaches 6 millions, exclusive of aborigines. The percentage of foreign born to native born is about the same as that of the United States,—one-seventh foreign—the Australian foreign element being largely British. The following are estimates of the value of products for one year including six months each of 1919-1920, the latest available:

Agriculture	$343,000,000.00,	about 21%
Pastoral	518,000,000.00,	about 31%
Dairy and poultry.	184,000,000.00,	about 11%
Forest and fish...	47,000,000.00,	about 3%
Mining	94,000,000.00,	about 6%
Manufacturing ..	465,000,000.00,	about 28%
Total.....	$1,651,000,000.00	100%

During the year 1919-1920 the value of the imports from the United States was, at normal exchange, $114,000,000, or 24% of the total; and the value of the exports to the United States was $53,000,000, or 7.4% of the total.

When railroad building was started in Australia it was the desire and the intention of the officials in the colonial office that the railroads should be of one gauge; but deviation from this having been once started, it was quite natural to extend the deviation and Queensland and Western Australia on the continent, as apart from Tasmania, built to the 3 ft. 6 in. gauge. About one-half the mileage in South Australia is 3 ft. 6 in. also. Practically the total mileage in Victoria is 5 ft. 3 in. as is also about one-half the mileage in South Australia. Practically the entire mileage in New South Wales is 4 ft. 8½ in.

The object of each colony was to develop its own resources, irrespective of the other colonies and at present each state considers it to be of most importance to follow the practice of the respective colony. These state jealousies appear again between smaller political sub-divisions and result in the development of particular seaports at the expense of other, in some instances, as good, or better, ports. Thus we find human nature there to be quite the same as it is here. At present home rule is the style and, in Australia, there are various sections agitating for home rule so that they may take up the questions of their local developments in the way they think best, and, possibly, have local ports and direct their railroads to them.

Sheep and cattle raising and grain growing require, under present conditions, extensive areas and large railway mileage per unit of population and on a population basis, Australia has about 2½ times the mileage of the United States. The amount of transportation necessary to serve such activities is not great. Such conditions indicate the desirability of large mileage at low cost and the error has been made frequently of thinking that a narrow gauge line, say 3 ft. 6 in. can be built at a much lower cost per mile than can a, say, 4 ft. 8½ in. line. In a fairly level country the difference in cost is not great and in the past, at least, has been over-estimated. The important difference is in the additional cost of the longer cross ties. In a rugged country the relative costs may be quite different. In any event, it is apparent that about one-half the total of 27,300 miles of track on the continent of Australia was built to 3 ft. 6 in. gauge with the idea of getting the greatest mileage at lower cost.

At various times after 1901, the railway officers of the various states were asked to recommend what should be done and to estimate the cost of carrying out their recommendations; but for various reasons it was decided in 1920 to appoint a commission, the members of which should be in no way interested in the railways; the questions submitted to this commission related to the gauge which should be adopted as standard, the estimated cost of connecting the state capitals with that gauge, the cost of converting all lines not of that gauge to the gauge recommended, how the work should be executed and controlled and whether any break-of-gauge device or third-rail arrangement should be used.

It was considered that either the 5 ft. 3 in. or the 4 ft. 8½ in. gauge, each of which make up about 25 per cent of the mileage on the Australian continent, was broad enough for present and for future requirements; that no gauge broader than 5 ft. 3 in. offered any advantage which would justify the expense of installing it; that the 3 ft. 6 in. gauge, about 50 per cent of the total mileage, was sufficiently objectionable to justify the cost of widening to the 4 ft. 8½ in. gauge; and that any advantage which the 5 ft. 3 in. might have over the 4 ft. 8½ in. gauge would not justify the greater cost of installing it. The 5 ft. 3 in. gauge does have some advantages over the 4 ft. 8½ in. but these are largely theoretical and in so far as these relate to possible wider and higher loading are concerned, they are not, under present conditions, available in Australia because the clearances on the narrower gauge are greater than those on the broader.

Referring, now, to these two gauges as the broad and the standard gauge, respectively, there may be enumerated the particular items of cost which favored the standard gauge and these were: (a) The axles, all kinds; a very large percentage of the broad gauge axles can be manipulated to make them suitable for the standard gauge, whereas, the reverse is possible only to a very limited extent. (b) The cross ties in the broad gauge lines are long enough for the standard gauge and are not too long; many of the ties in the standard gauge lines are not long enough for the broad gauge. (c) A large percentage of the cross ties in the 3 ft. 6 in. lines are long enough for the standard gauge and especially so if, say, four longer ties per rail length are added and the present wheel loads are not exceeded. And (d) the rolling stock of the 3 ft. 6 in. lines should not be changed to the standard gauge; the lines should be converted in sections giving opportunity to wear out present rolling stock on outlying, unconverted sections, the converted sections to be equipped with new standard gauge rolling stock as replacement.

In regard to locomotives no more of those with inside cylinders have been built in recent years and the old ones of that description are being dismantled rapidly. The outside valve motions are also being used. The fireboxes are generally narrow, being placed between the frames or the wheels; the inner sheets are of copper as are the staybolts and the tubes. Some Garrett type locomotives are in service on the 3 ft. 6 in. lines but are confined now to freight service. Some unfortunate experiences were had with the steam joints of these locomotives which rather turned the railroad officials against the articulated locomotive. A large part of the population of one state is set against them because of delays to some picnic trains to which the articulated locomotives had been assigned. The calculated maximum tractive effort of their locomotives is small as compared with ours, being from 20,000 to 36,000 lbs. The possible tractive effort is limited by the strength of the draft rigging; an exception to this is the Trans-Australian which is equipped throughout with M. C. B. standard couplers. The inwardly opening fire door, hinged at the top, is used to a considerable extent. The use of brick arches and of superheaters may be considered standard practice. The stack may be mentioned here merely because their designation of it, chimney, seems quite as odd to us as our designation of it does to them.

The fuel procured for the locomotives is a very good quality of bituminous coal, the Newcastle coal is widely known as a good steaming coal. This is New South Wales coal and it is used also in Victoria and South Australia. Queensland and Western Australia each has ample supplies from local mines. Tasmania gets coal elsewhere to mix with its locally mined coal. In Victoria there is a large deposit of "brown coal," containing from 45 to 50 per cent of moisture and which burns, much as does anthracite, without a flame. Experiments, not extensive, to use this in locomotive boilers have not been successful although it is to be used in a very large steam-electric development in process of construction by the state. The coal vein is opened from the surface. South Australia has some lignite coal which is not being used. Professor David of Sydney University has found in the coal mines of Western Australia impression of fern leaves similar to those he found in the Antartic coal.

Passenger cars, generally, are like the British design, although a considerable number used in long distance, as distinguished from suburban service, have passageway throughout the train, the passage way in each car at the side, and the compartments opening from it. In the compartments of the day coaches, a sitting-up car, there are two rows of seats facing each other and the depth of these seats and the softness of the cushions in them is simply a revelation to a person accustomed to American practice. In the sleeping cars each compartment provides a lower and upper berth placed crosswise of the car; in some cars, two lowers and two uppers are provided, but these are being changed. The state is building some sleeping cars for second-class service in which there are three berths in a tier; this is on 3 ft. 6 in. gauge. The doors giving passage to and from the station platforms are in the side walls of the car bodies and not from the car platform; many of these side doors are on hinges and swing outwardly the lower end being, of course, above the station platform. Many of the suburban cars have sliding side doors, one for each compartment; during suitable weather conditions these doors remain open and, frequently, passengers stand in the open doorway while the train is in motion. The obvious happens at times and generally after dark and, now and then, a corpse is found in the morning along the roadside. It is a pronounced surprise to a person who is accustomed to railroad operation in America to see these side doors open, no bar or other obstruction across the opening, and passengers standing, or sitting, in the doorway.

The atmospheric conditions in a considerable part of Australia for several months of the year justify, in the opinion of the average American, some artificial heating arrangement in the passenger cars, but there is none. When leaving a terminal the passenger may be furnished with a can of hot water, possibly containing a chemical, and wrapping himself and the can in a rug, he may get a certain degree of comfort; but upon rising in the morning after an all-night trip, he will not get much comfort from his water can. Nor is he in very good humor for a breakfast in a cold dining car. On the other hand, the Australian complains that when we entertain him in our cars during the winter we roast him.

Motor cars having internal combustion engines have been tried and are being tried on lines of light traffic and are meeting with such success as similar efforts in America. Such cars seem to be favored for service on outlying sections where traffic is not only light but where fluctuations in demand are not wide. If equipment, which is surplus a large part of the time, must be kept in reserve for usual, though infrequent, demands, it is certain that interest, insurance and depreciation on such equipment, in the form of steam operated facilities or in some other form, must be added to the costs to obtain the total cost. It was found in some instances in Australia that the cost of providing this reserve equipment and providing spare units or parts necessary for insuring regular operation, defeated the objects desired. This confusion in the kinds of equipment may be a good deal like that resulting from different gauges of track. A large percentage of the suburban passenger traffic at Melbourne is handled in electrical driven, multiple-unit trains and all of it will be so handled in the near future.

Working Hours on the German Railways

The new regulations in regard to working hours on the railways in Germany do not affect the eight-hour law which has been in operation for many years, but the new regulation is so worded that the eight hours may be interrupted by not only the meal period, but also by other causes that may arise. In this way the way is paved so that only two shifts may be employed for 24 hours instead of three. This regulation will be particularly applicable to many engaged not only on running repairs that may come in intermittent periods during the 24 hours, but those who may be engaged as station agents or freight handlers whose work is usually of a fragmentary kind as far as the actual working time is concerned. It may in brief be calculated so closely that beyond the 8 or 10 hours specified for rest, the remainder of the twenty-four may be broken into as often as the supervising authorities see fit. It would be premature to pronounce upon the regulations until they have been tested during an experimental period, but it may be added that a regulation of this kind is already in operation on the northern railways of Scotland where trains are few, and the station agents and others are not complaining.

Austrian Railway Electrification

The Austrian Government, despite all difficulties, is actively engaged on the electrification of her principal railways necessitated by the scarcity of coal. Work is proceeding on the Alberg line, for which two power stations will be utilized.

One of these is the Ruetz power station, which is already in use for the part of the line known as the Mittenwaldbahn (from Innsbrück to Reutte via Garmitz and Partenkirchen). It is on the Tyrolese side, and will have to be enlarged and extended. The other is the Spullersee power station, which is now being constructed, on the Vorarlberg side of the line. The Spullersee power station is a high pressure station, with a water storage lake, the Spuller Lake, from which it takes its name. The fall of water utilized is about 875 yards. The Spullersee power station will be in the Kloster Valley, and when completed will have six sets of engines of 8,000 h.p. each, altogether 48,000 h.p., to produce monophase, alternating current of 15,000-volt, at $16^2/_3$ periods. At present only three engines are erected. The power stations will be connected together by 55,000-volt overhead lines.

Benefit of One Set of Standards

The benefit to be derived from having only one set of standards is so great that the producers should be willing to comply with more severe requirements that are uniform, in preference to less severe requirements different for each consumer or group of consumers. On the other hand, consumers should be willing to accept less severe requirements, thereby obtaining the benefit derived from economy in manufacture, rather than insisting on more severe requirements with accompanying added cost. An ideal specification is one which can readily be met by a producer who is competent and willing. When a specification is so severe that it condemns much good material, it results in economic waste. The creation of uniform national standards means economy for the producer, the consumer, and the country as a whole, and hence activities which will accomplish this desired result should be encouraged by the Government to the maximum extent.

Expert Report on Locomotive Boiler Welding—Details of Approved Methods of Selecting Material and Perfecting Repairs

Among the subjects which will be discussed at the annual convention of the Master Boiler Makers' Association, and which will be held at the Hotel Sherman, Chicago, Ill., on May 23-26 inclusive, will be that of "Locomotive Boiler Welding." Advance copies of the report prepared by H. H. Service, supervisor of welding, Atchison, Topeka & Santa Fe Railway, Kans., chairman; I. J. Pool and R. W. Clark, is before us and it is expected to create considerable discussion, and whatever may be the variety of opinions which the report will call forth, it is greatly to the credit of the committee that they have thoroughly investigated the subject in the light of practical experience, and we are pleased to have the opportunity of publishing the report in our pages in order that many of our readers who may be interested in locomotive boiler welding may have a chance to familiarize themselves with the interesting details which the report contains in a reasonable period of time before the convention is held. The report is as follows:

The responsibility of good welding depend largely upon the skill and experience of the operator.

Welding electrodes that have the approved chemical contents or elements which will give the best tensile strength which conditions may require should be adopted for boiler repairs. Another important point is that welding electrodes which are to be used on firebox welding should have even flowing qualities; that is, the globules of metal should flow from the point of the electrodes to the work in a steady stream, so they will not interfere with the skill of the operator or the functions of the electric arc. The efficiency of the operator should be fully determined before he is allowed to perform any welding in locomotive fireboxes, by having him weld specimens at least once each month. The welded specimens should be forwarded to the engineer of tests who will test them for tensile strength. The efficiency of the welded specimen should be at least 75 per cent of the firebox steel used, before the operator is allowed to do any firebox welding.

It is important that good judgment should be exercised in assigning operators to autogenous welding in fireboxes.

Another important feature is that no piece of work should be welded unless it is properly prepared. That is, all seams should be beveled as in Fig. 1, and should be thoroughly cleaned, free from grease, rust, scale and other foreign substances. It is very essential that the weld be made on bright, clean metal and that this condition be preserved throughout the entire welding operation. The use of a roughing tool as shown in Figs. 2 and 3, or a sandblast machine, may be used for cleaning purposes. All seams should be carefully fitted and beveled to 45 degrees, not allowing more than ¼ inch or less than 3/16 inch space at the bottom of the V as shown in Fig. 1, as determined by the use of a gage.

If the opening at the bottom of the V closes to less than 3/16 inch, the welder should stop and have it chipped to the standard opening. Under no condition should the plate be burned with the cutting torch to enlarge the opening, unless it is going to be chipped afterward.

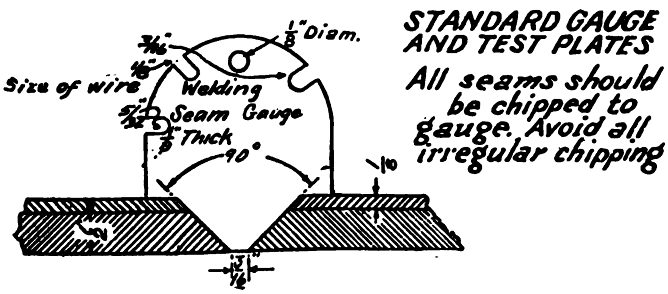


FIG. 1. BEVEL FOR WELDING OF SHEET.

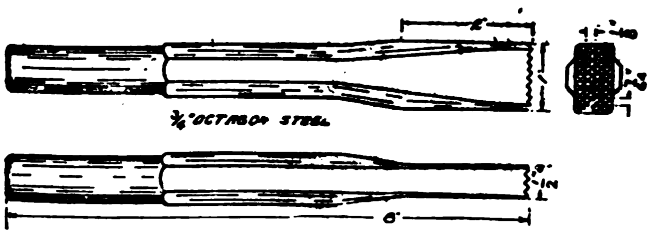


FIG. 2. SCALE REMOVING TOOL.

Welding of Complete Fireboxes

All sheets should be beveled on the rivet line from the fire side, Fig. 4, and plates should be fitted into the mud ring, held together with strongbacks or clamps about 12 inches in order to hold the plates in perfect line. The sheet should then be tack welded between each of the clamps, the tacks being from two to three inches wide. After this operation has been performed, the clamps should be removed and the intermediate spaces welded. Do not remove the firebox from the ring until after the welding has been completed. All seams should be reinforced 20 per cent of the thickness of the firebox sheet on the fire side and when it is possible to do so, seams should be reinforced on the water side approximately 10 per cent, especially on the

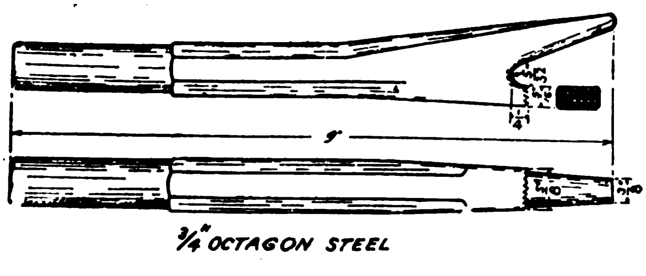


FIG. 3. BEAD SCALE REMOVER.

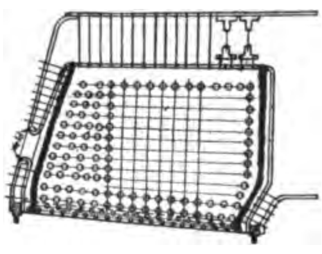


FIG. 4. HOW THE FIREBOX IS WELDED.

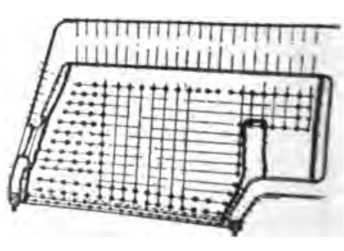


FIG. 5. FIREBOX AND COMBUSTION CHAMBER WELDED.

portions approaching the crown sheet and the crown sheet under all conditions.

All welding should be started at the bottom of each intermediate space and finished at the top of the seam. For all firebox work current values from 100 to 125 amperes will give the best results when properly handled by the operator using a 5/32-inch diameter electrode. The cost of welding firebox

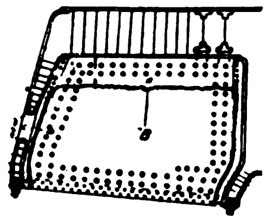


FIG. 6. THE KNUCKLE PATCH IN THE FIREBOX.

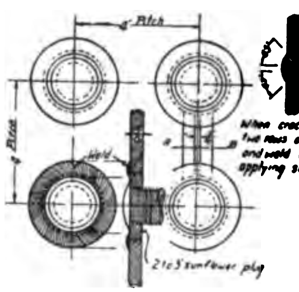


FIG. 7. HOW CRACKS AT STAYBOLT HOLES ARE WELDED.

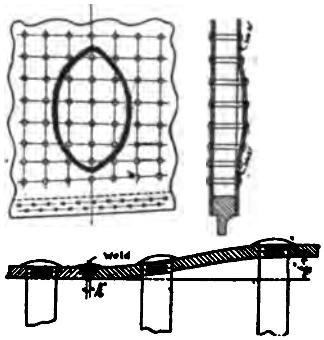


FIG. 8. PATCHING AROUND DEFECTIVE STAYBOLTS.

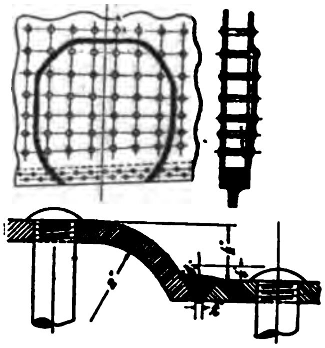


FIG. 9. PATCH IN SIDE SHEET.

seams per lineal foot is 90 cents for labor, material and current.

Preparing Half Side and Door Sheet for Welding

The sheet should be bolted to the mud ring after it has been properly beveled and fitted in place. Staybolts may be applied, except the rows adjacent to the seam which is to be welded. All horizontal seams should be held in place with strut bolts and tack welded every 12 or 14 inches. Then weld intermediate spaces alternating from the center space to the spaces at either end. Vertical seams should be tack welded similar to horizontal seams.

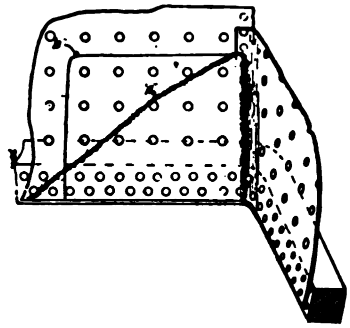


FIG. 10. CORNER PATCH IN SIDE SHEETS.

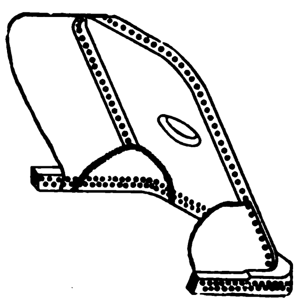


FIG. 11. PATCH AT JUNCTION OF SIDE AND DOOR SHEET.

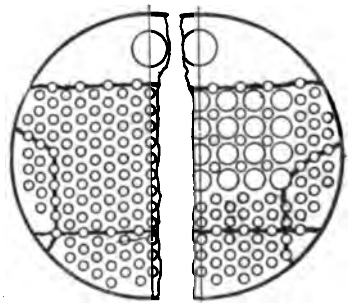


FIG. 12. PATCHES WELDED IN FRONT AND BACK FLUE SHEETS.

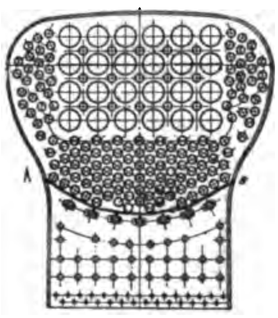


FIG. 13. TOP PORTION OF BACK FLUE SHEET AS ARRANGED NEW FOR SUPERHEATER.

After being tacked, start welding at the bottom space and finish at the top space.

Firebox Sheet Knuckle Patch

Preparation for the firebox knuckle patch, Fig. 6, may be followed as outlined for the welding of half side sheets or door sheets. The use of strut bolts can be applied to hold the patch in line when necessary, while it is being tack welded. All strut bolts should

into position. Under no circumstances should the knuckle patch be less than 12 inches from the crown sheet.

Weld the horizontal seam first, then tack weld the flanged sheet to the wrapper sheet. Remove all strut bolts and weld intermediate spaces, working from the bottom on either side of the patch upward, finishing at the top.

The method indicated in Fig. 7 is to be used to repair cracks at staybolt holes in firebox sheets, where not more than 6 sunflowers are necessary to complete repairs, and not more than 4 sunflowers will be joined together. This system may be used in main shop general repairs, sunflowers not to exceed 3 inches in diameter.

Repairing Small Portions of Side Sheet

When the defective portion does not extend over six staybolts repairs can be made as per instructions given for Fig. 7, which give very efficient results. When the defective portion is larger it is then advisable to use methods as shown in Fig. 8, by removing the defective portion and applying a patch of an elliptical or circular shape. In preparing the patch, sufficient metal should be allowed so that when the patch is dished 3/8 to 1/2 inch in the center, the opening at the same should not be more than 1/4 inch wide at the bottom of the V and not less than 3/16 inch. The patch should be held in place by strut bolts and tack welded on the

of the patch before the opposite side is tack welded, so as to allow the patch to draw in one direction. After this has been completed, allow it to cool before starting on the opposite side. By so doing there will be only one contraction of the patch. All welding should be performed from the bottom upward. Should the defective portion of the side sheet extend down to the mud ring rivets, apply the patch as in Fig. 9, the welding operation being the same as outlined for Fig. 8. Should the defective portion be at a location as shown in Fig. 10, the seam may be applied as indicated by line "A."

Should the plate at the corner of a firebox becomes defective and it is necessary to remove a portion of the side sheet and the door sheet, it is advisable to apply a patch to both sheets as in Fig. 11.

Should it be necessary to make repairs according to Fig. 12, Fig. 13 and Fig. 14, the work should be done by welding from the fire side of the sheets and reinforcing them on the water side.

Method of Welding Patch on Front of Crown Sheet

Should it be necessary to repair the front portion of the crown sheet, prepare for welding as outlined previously. A very important feature about this welded seam is that the front point adjacent to the flue sheet should be finished on the flat side of the firebox at least 12 to 14 inches below the highest point of the crown sheet in order to

Welding of Seams

Should the seams become defective and cause considerable trouble, repairs can be made with the electric arc process as shown in Figs. 15 and 16.

Remove the defective portion of the flange, which is giving trouble, by cutting through the back of the rivet holes, bevel the sheet 45 degrees and tack weld it every 12 inches; then weld the intermediate spaces. The weld should not be any thicker than the flange of the sheet and tapered to a point. Weld the old rivet hole solid as shown in the illustration.

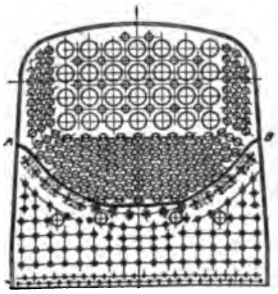


FIG. 14. NEW TOP PORTION WITH WIDE FIREBOX, BACK FLUE SHEET.

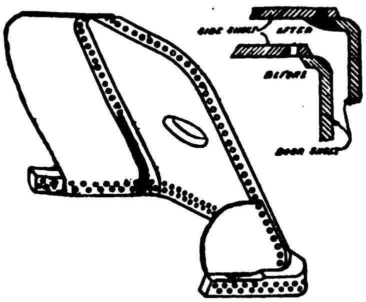


FIG. 15. METHOD OF WELDING DEFECTIVE SEAMS.

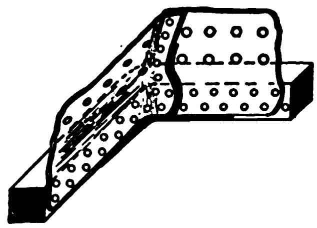


FIG. 16. REPAIR TO A LEAKY MUD RING CORNER.

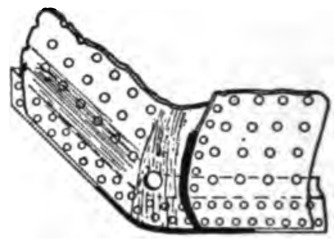


FIG. 16A. ANOTHER SECTION OF THE MUD RING.

Broken Mud Ring

In case mud rings become broken it is advisable to remove a portion of the firebox sheet. Bevel the mud ring from the top, giving at least ¼-inch opening at the bottom of the V, and reinforce it at the bottom of the mud ring after the weld has been completed on the top portion, afterward applying a patch on the portion of the firebox which was removed. The welding current values for welding mud rings are from 125 to 150 amperes, using an electrode 5/32 inch in diameter.

Should the door collar become defective, the defective portion can be removed and a patch applied as in Fig. 17, following the instructions as described for Fig. 8.

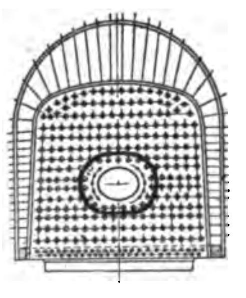


FIG. 17. PATCH WELDED ON DOOR COLLAR.

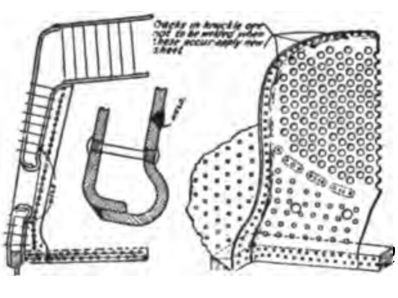


FIG. 18. KNUCKLE CRACKS NOT TO BE WELDED.

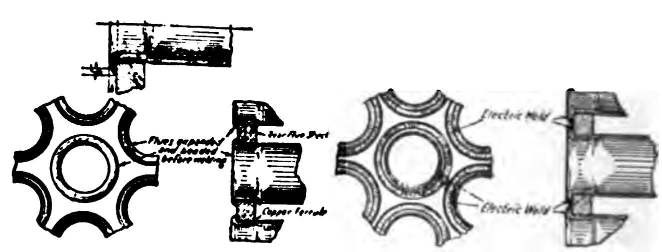


FIG. 19. USE THIS METHOD OF APPLYING FLUES IN LOCOMOTIVE BOILERS BY MEANS OF THE ELECTRIC ARC WELDING PROCESS.

Improper Welding of Firebox Plates

Under no circumstances should welding be allowed directly in the knuckles of firebox sheets as shown on Fig. 18. This ruling should be enforced vigorously.

It is very important when applying copper flue ferrules to the flue sheet that, when set and rolled, they do not project out on the fire side of the sheet, so that when the flue is applied the copper will not project under the flue beads. After the flues have been set in the regular manner very good results may be obtained by welding them after having received the second working. That is, if the locomotive is allowed to work its regular turn until the flues are to be reworked the second time, this allows the flues and flue sheets to get a good setting. By so doing it also allows the grease to be burned off the sheet.

After the flues are worked the second time, the sheets should be thoroughly sand blasted. When welding, the top row of flues should be welded first, the second row next and so on until the entire flue sheet has all the flues welded to it. It is very essential that the welding should be started at the bottom of the flue and worked upward, the weld being finished at the top of the flue to secure satisfactory results. It is in this operation that the flowing quality of the electrode is most important and should be given a great deal of consideration. The heat values on this operation vary widely and the operators should use their best judgment according to conditions.

Care should also be exercised on the part of the operator not to apply an excessive amount of metal. If he should do so, the metal will overheat and crack and cause a great deal of trouble. If it should become necessary to reweld a leaky flue which has been welded previously, all the old metal or weld should be removed and the flue worked tight into the sheet, after which it should be sand blasted and welded as formerly described there is real danger if not thoroughly cleaned.

American Welding Society

The American Welding Society has issued the first number of its *Proceedings.* This publication will deal with activities of the Society and its Research Department. Technical papers, research items and other notes of interest to those engaged in the art of welding will appear. Its make up is attractive, and the matter is interesting and instructive.

Use of the Locomotive Whistle

Superintendent T. Ahern, of the Coast division of the Southern Pacific, in a letter to the engineers, says: "Extensive tests show that a whistle call for a station signal should never be less than five seconds, the long blasts of the crossing signal two and a half seconds, and the short ones one second. Particular care should be exercised to cut off the blasts sharply and not to slur them. It is of the utmost importance in causing sound to travel that these instructions be carried out. After sounding a whistle cut off the steam completely and allow a perceptible time to elapse between the blasts. They then are carried to a distance very much more clearly than if jumbled into one continuous blast. The whistle is an important safety device."

Notes on Domestic Railroads

Rolling Stock for the Chicago, Burlington & Quincy

Large additions to the freight equipment of the Chicago, Burlington & Quincy are being made. These include 1,000 gondolas ordered from the Norton Steel Car & Foundry Company, 1,000 box cars to the Mt. Vernon Car & Manufacturing Company; 500 box cars, 500 gondolas and 400 refrigerator cars to the Pullman Company; 500 box cars and 400 refrigerators to the General American Tank Car Corporation; 500 Composite Gondolas, 500 refrigerators and 500 stock cars to the American Car & Foundry Company and 1,000 gondolas to the Bettendorf Company.

The Rejuvenation of the Seaboard Air Line

S. Davies Warfield, president of the Seaboard line, states that the company will issue $4,600,000 six per cent equipment trust certificates, the proceeds of which will be used to repair and replace worn out equipment, 25 Mikado type locomotives will be furnished by the American Locomotive Company; 2 twin screw, steel, combination passenger and freight steamers are being built at Wilmington, Del., for service between Baltimore and Norfolk, 5,000 freight cars that were returned from Federal control unfit for service will be thoroughly repaired or reconstructed and extensive purchases will be made of shop and other equipment.

Increased Passenger Traffic on the Long Island

Over 20 per cent increase in the passenger traffic on the Long Island in 1921 as compared with 1920 is a gratifying report were it not offset to some extent by a falling off in freight traffic. The company however, adopted an elastic policy of increasing the number of passenger trains and reducing the number engaged in freight traffic. 50 new steel passenger coaches were recently ordered, as the continued rapid increase of the population bids fair to further large increases in passenger traffic. Monthly tickets sold to commuters during 1920 numbered 484,953 and 586,960 were sold in 1921.

Safety on the New York, New Haven & Hartford

Reports of fatal accidents on the New York, New Haven & Hartford show a marked reduction since the establishment of the railroad's bureau of safety some years ago. The record at that time being 326 while the report for last year shows the list of fatalities of 140 being a reduction of 186. The divisions and shop maintain a constant rivalry in all matters relating to increased safety, while representatives of the safety department are constantly active in the good work, and expect still better results in the near future.

Additional Equipment for the St. Louis-San Francisco

Plans for extensive improvements on the St. Louis-San Francisco are completed and include additions to freight and passenger equipment, power plants, machinery and tools. Repair work on locomotives and cars are already employing a largely increased force in the various shops. In common with many other roads, repair work has been considerably delayed, but the outlay estimated at about $8,000,000 gives promise of being the busiest year since the organization of the company. Bids are asked for new shop machinery, derricks, water plants and other equipment.

Alaska Government Railway

The ceremonies that are being determined upon at the opening of the Alaska government railway, which are now nearly completed, have been postponed until June, when it is hoped that President Harding and other government officials will be present and take part in the exercises incident to the official opening of the line. The direct opening to the rich coal fields recently discovered in Alaska is expected to have a beneficial effect on the serious fuel problem that has hindered the development of the Northwest.

Rolling Stock for the Philadelphia & Reading

Contracts have been awarded for the construction of 2,500 steel coal cars of 70-ton capacity, the orders being distributed to the Pressed Steel Car Company, the American Car & Foundry Company, the Midvale Company and the Standard Steel Car Company. Deliveries are expected early in the spring. Orders are also placed with the Bethlehem Corporation for 35 coaches and 15 combination cars, to be built at the Holland & Hollingsworth plant.

Equipment Additions to the Santa Fe

Important additions are being made to the machine shops of the Atchison, Topeka & Santa Fe, at San Bernardino, Cal., and orders were also issued for a large boring mill, axle lathes, a steam hammer and three motor-driven internal and external tool post grinders. A reinforced ice plant, and a 45 by 98 ft. coaling tower, 54 ft. in height is being erected at Riverbank, Cal. The engineering department of the company, located in the Kerckhoff building, Los Angeles, Cal., is in charge of the work.

Thawing Coal on the Pennsylvania

The Pennsylvania System coal terminal, at South Amboy, added a thawing shed to its equipment, and it has been in operation during the recent winter weather when coal sometimes arrived at tidewater frozen in the cars, preventing the operation of the car dumping machines. The thawing shed accomodated twenty cars at a time. When the doors were locked blowers were opened over steam radiators and heated to between 200 and 250 degrees. Ducts are located six feet apart underneath the cars and the heated air striking the bottom of the cars soon heats them sufficiently to thaw the coal. The cars run by gravity from the thawing shed to the dumping machine. The average time consumed in the thawing process is about three hours.

New Shop Tools for the Pere Marquette

The Pere Marquette purpose asking bids on extensive additions to shop machinery and tools, which will include a 600-ton wheel press, three air compressors, electrically driven, motor driven planers, drilling machines, engine and turret lathes, draw cut shapers and grinding machines.

The St. Louis, San Francisco Making Large Improvements

An expenditure approaching $8,000,000 has been authorized by the St. Louis, San Francisco, looking toward the repair and modernizing of cars and locomotives, and the purchasing of new equipment. An appropriation has also been made for laying 186 miles of track, including the addition of a new second main track in connection with the St. Louis and Kansas City terminals. The outlay also embraces orders for the rebuilding of 7,000 freight cars, and improvement of the coaches in branch service, rebuilding of locomotives and steel coal cars, besides the rebuilding of all mail and mail apartment cars and the necessary improvement of all baggage cars.

New Terminal Plant on the Minneapolis, St. Paul & Saulte Ste. Marie

The Minneapolis, St. Paul & Saulte Ste. Marie, has completed plans for the construction and complete equipment of a new terminal plant at Park Fall, Wis. This will include repair and machine shops, a roundhouse, and car sheds with a capacity of 200 cars. The plans involve an outlay of over $500.000, and the work is expected to be rapidly proceeded with in early spring. Meanwhile 2,000 tons of rail and 1,000 tons of tie plates are being added to the track equipment.

Railroad Wages and the Cost of Living

Speaking in the Senate on February 10, Senator La Follette of Wisconsin claimed that railway labor is receiving substantially no more real wages in terms of commodity values for services rendered than it received twenty years ago. Comparing the buying power of the average earnings per year, the Senator, using 37 cents as the purchasing power of the dollar during the first half of 1921 and 38 cents during the second half of the year, as compared with 1900, he claimed that on this basis he gave the purchasing power of all employees as $662 in the first half of 1921 and $599 in the second half, as compared with $507 in 1900. For the engineers and conductors the adjusted figures for 1921 were below those for 1900, but the figures for all other classes showed considerable increases. For the engineers the buying power was $1,057 in the first half of 1921 and $999 in the second half, as compared with $1,161 in 1900. For the firemen it was $778 and $719 as compared with $662. For the conductors it was $972 and $909 as compared with $1,004. For the trainmen it was $751 and $687 as compared with $694. For the machinists it was $815 and $758 as compared with $698. For the trackmen it was $397 and $342 as compared with $311 and for the telegrapher it was $736 and $681 as compared with $644. For all classes except the engineers and conductors the figures for the last half of 1921 also exceeded those for 1913.

This table, the Senator said, presents the actual situation of the railway employees accurately and impressively. "No honest mind can examine these figures without being convinced that the wages of the workers on the railroads cannot be cut, under present conditions, without inflicting a grave injustice upon this splendid body of men."

In another table the buying power of the annual earnings was reduced to percentages. For all employees in the first half of 1921 it was 117 per cent of that for 1900 and for the second half it was 105 per cent. For the second half the percentages were: 86 for engineers, 108 for firemen, 90 for conductors, 113 for trainmen, 108 for machinists, 110 for trackmen and 106 for telegraph operators.

The Association of Railway Executives Compare Present and Past Wage Rates

The Association of Railway Executives issued Bulletin No. 213, on February 23, claiming that even with the wage reduction approximating eleven per cent, made by the Railroad Labor Board, effective July 1, 1921, railroad employees are now receiving, with a few exceptions, over one hundred per cent more pay than they did in 1916, according to tabulations made from reports filed by the carriers with the Interstate Commerce Commission. Electricians, who in 1916 averaged 28.8 cents per hour now average 80.1 cents, an increase of 178 per cent. Prior to the wage reduction of July 1 they averaged 88.1 cents or 8 cents an hour more than their present average. The average hourly rate now for blacksmiths is 79½ cents, 8 cents less than during the first half of 1921 but 102 per cent more than in 1916 when the average was 39.3 cents. The average for carpenters since the wage reduction, has been 68.2 cents compared with 76.2 cents prior to July 1 last. The present rate is 135 per cent greater than it was in 1916 when the average was 29 cents. Painters and upholsterers now average 73.9 cents which, under the Board's order, was a reduction of 8 cents per hour, but which is 139 per cent more than in 1916 when they averaged 30.9 cents. Machinists, who in 1916 averaged 41 cents an hour now receive approximately 80½ cents, which is 8 cents less than was averaged prior to July 1, but 96.3 per cent more than in 1916. The average hourly rate now for boiler makers is 81½ cents compared with 89½ cents, the average during the first six months in 1921. Their present rate is 99.3 per cent greater than it was in 1916 when the average rate was 40.9 cents per hour. The present average rate is obtained by applying to the rates filed by the railroads during the first six months in 1921 the wage reductions made by the Labor Board in decision No. 147 which went into effect on July 1, 1921.

Give the Railroads a Chance

In the course of an address delivered by Elisha Lee, vice-president of the Pennsylvania railroad, before the Traffic Club of Baltimore, last month, he claimed that "among those who controlled our political destinies there were apparently many who thought—perhaps with perfect sincerity, however erroneously—that it was more important to prevent any railroad company from accumulating wealth than it was to insure that the railroad industry as a whole should be solvent, prosperous and progressive.

"The injury has been done. We cannot undo the past, but we can learn from it and set about rectifying our errors in the future. I think the business men of America are a unit now in realizing that railroads must be financially sound and prosperous, and in desiring a national railroad policy which will insure, as quickly as possible, the attainment of the necessary degree of prosperity for the years to come. Meantime, however, it seems inevitable that we shall have to go through a period of difficulty.

"Existing rates may be an inconvenience, but they are not prohibitive, and in all probability their restrictive effect has been considerably exaggerated. On the other hand, there can be no question as to the harm which would result to the country as a whole from any widespread visitation of financial difficulties upon the railroads. That would be a calamity of the first magnitude. So, give the railroads a chance by not pressing too hard in the matter of rates and by letting the orderly readjustments which have been going on take their course."

Extending the Continuous Service Regulation

The new code issued by the Labor Board and becoming effective on March 1, extends the scope of the old national agreement, providing for the payment of pro rata rates for the ninth and tenth hours of continuous service, and time and one-half thereafter, and also for the employees on split tricks whose hours of labor may come within a spread of 12 hours, but where actual working time only will be counted. The application of the new code includes stationary engineers, hoisting engineers, flue blowers and borers, cinder pit men, fire builders and coal passers. This extension was advocated by the firemen and others to whom the measure previously applied.

Locomotive Inspection

The abstract of the report of the Bureau of Locomotive Inspection of which A. G. Pack is chief inspector, has been welcomed by our readers as a fine reflex of the good work in the interest of economy in locomotive operation. The importance of the work of the Bureau has never been so distinctly apparent both in the matter of efficiency as well as in the effect on the casualty list which, in the very nature of things, will never be entirely avoided, but which will be greatly decreased, if the intelligent appeal for more inspectors is heeded, as it appears to be from the announcement also reported in our pages that the staff of inspectors will be largely increased in the near future. It is impossible that the present limited force can overtake their work, and it is absurd to suppose that the work could be done by railroad employees, with the universal pressure in point of saving time in the matter of locomotive repairs, the mechanics, no matter how accomplished they may be, are literally compelled to let needed repairs go. Defects that appear trifling were allowed to go last trip, and the tendency to allow the defects to go again grow imperceptibly into a habit, and disaster of more or less magnitude is inevitable. A supervising authority whose word is law has a salutary effect, and the fact that the pronouncements of the skilled inspectors were not once appealed against during the year reported on, shows that their orders are respected with a degree of respect not too common among governmental officials.

Snap Shots—By the Wanderer

The break-in-two or three or four is the *bete noir* of the freight train crew. A hot box is bad enough but that can be coaxed along into a terminal and forgotten, but the break-in-two or three or four means work, and frequently a lot of it. Chaining up cars, using emergency knuckles and sometimes replacing derailed cars. Never jobs to be courted, but dreaded on a winter's night and in stormy weather. There seems to be three main causes for the trouble, the too rapid starting of long trains; the dynamiting triple and the slipping by of the couplers. These are listed in the inverse order of their apparent frequency.

The too rapid starting of a long train is an engineer's liability. A seventy-five car train may have anywhere from 10 feet and upwards of free slack with five times that amount of total slack, and cautious, careful starting is required if the caboose is not to get an acceleration in the form of a jerk that means more miles per second than most of us realize. With the engine moving slowly and the strain seemingly stretched it is a temptation to "open her out" before that stretching has been fully accomplished, and then—well some drawhead along towards the rear parts company with itself, the emergency can't quite catch up to the engine while it anchors the rear and, presto, we have three trains instead of one. All of which means a little more training for the engineer. I have often argued that the efficiency of lawyers and the administration of justice would be vastly improved if the members of the bar were to to compelled to serve on the jury. So it also seems to me that the efficiency of engineers might be greatly improved if they were compelled to ride in the caboose, taking an occasional header against the front door and were afterwards shown a complete log of what their colleague on the locomotive had been doing with the throttle lever and the engineer's valve while they were obeying the laws of inertia at the rear.

The dynamiting triple! Well the least that can be said about him is that he is a cowardly skulker. He will do all that could be asked of him on the rack and in terminal tests. He will give no evidence of a tendency to kick when he is under observation on parade; and, then, on the first application as the train goes over the top, away he goes with a bang and hides his own individual identity behind the mass of his fellows whom he has dragged into the mischief with him, so that he cannot be picked out with any certainty.

But he and his mates anchor that position of the train in which they happen to be situated and don't send their influence back to the rear in time to anchor that and preventing the cars from rearing up into the air or making a side trip out over the right of way or on to the adjacent tracks. Or, if located at the rear, they stop sudden like a balky horse while the engine and the front continue serenely on their way for a space, to be, in turn, brought to a stop by an emergency application brought about by a broken drawhead and a parting hose.

Then the crew, if they survive, hunt for and try to pick out the culprit and send him to the shop for repairs, when lo, he behaves with all possible seemliness, or perhaps remains undetected on the car to practice his devilishness at the next opportunity, while some innocent bystander has been removed and saddled with his misdemeanors.

Yes, the dynamiting triple is a terror, and I not being an air brake expert, can only comment on this evidence of the "cussedness of inanimate things," and wonder if he will ever be run to earth and brought under control.

Then, there remains the "slipped by" break-in-two. I can't help thinking that this is a purely preventable mishap. I call it a mishap not an accident because it does seem to my uninformed lay mind that it could be prevented. We have a law that requires the center of the drawbar and knuckle to be at a certain definite height above the top of the rails and the deviations from the limits of these requirements are probably few and far between when the car is at rest. But drawbar attachments and knuckles do wear and the amount and tendency of this wear is quite impossible to detect when a train is made up. The inspector walks down the train; air all right, wheels all right, drawbars all right in appearance, go ahead! The engineer inadvertently takes up slack with a jerk. Two couples slip by, the train parts, emergency applies and that may or may not be all. Now when this little thing is responsible for seventy per cent of all break-in-twos, and these may run from a hundred to a hundred and fifty a month on a single division, and the average delay entailed thereby runs from an hour and a half to two hours, to which resultant equipment damage must be added, it looks to an interested outsider like myself as though it offered a fruitful field for the safety-first men to cultivate and get busy in applying a preventative.

Metaphorically speaking, I throw up my hands and acknowledge that to make a car-to-car inspection in the yard, for the purpose of picking out cars whose knuckles will have a tendency to slip by, or to pick them out in a made-up train, goes beyond the limits of a commercial possibility. Beside a coupler that might display a fiendish tendency to separate from one mate might travel with perfect harmony with another just as matrimony. So there you are, or are not, according to the way you look at it.

However, here is a remedy that came to me from a railroad official that, while it may not be a universal panacea, has every appearance of being a good thing.

After a train has been made up, and when the terminal test for brakes has been made, set up enough hand brakes on the rear to hold the train and have the engineer stretch it. Where a pair of couplers show a tendency to tilt one up and the other down they should be separated then and there, because if they are not, they will probably do so later on in their journey, to the regret of all concerned. So why not take out a little insurance policy at the start and, like a wise parent, prevent a union before it is too late. At the best it will not put a stop to all break-in-twos, but it cannot fail to reduce the ruin attributable to this most prolific case. And even if it cut the number down by but two or three, the time required for the inspection would probably be much less than that lost by the delays, and the property saving would be a pure gain.

There was a time when there was a swinging door in the passageway at the end of Pullman cars. It was a good deal of a nuisance to everybody and especially to passengers with hand baggage, and we can make a guess that that was one of the reasons for its removal. But it did one good thing. In cold weather it cut off the incoming blasts of cold air from the outside at station stops. Since its removal nothing has been substituted in its place as a wind shield. Complaints are numerous, but they usually end with that, unless some passenger, more irate or more energetic than his fellows, does the obvious and gets up and closes the door. But this selfishly altruistic, irate passenger is not always there, and so the car remains cold and drafty until the train starts and the porter has finished his exchange of greetings with his fellows.

The opening of the door is evidently unavoidable if passengers are to leave and enter. But why leave it open after it has served this very useful purpose? Why leave it wide open during the whole of a stop? Why not issue orders to the porter to close the door at every stop as soon as it has ceased to be used? Of course, he won't always do it, but the few occasions on which he does will give comfort enough to a few passengers to more than pay for the trouble of issuing the blanket of instructions that are, in the main, disregarded.

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The Transportation Rate Inquiry

The Interstate Commerce Commission has been continuously in session since early in January, 1922, on its investigation to determine whether and to what extent if any, further general reduction in the rates, fares and charges of carriers can lawfully be required by the commission upon any commodities or description of traffic. In the conduct of the investigation the Commission has assigned specific dates for the hearing of testimony upon specific commodities and in addition to the specific commodities the week of January 30 was assigned for the presentation of testimony by the public and shippers on the general aspect of the case, the presentation of direct testimony by the carriers and the cross-examination of carriers' witnesses was completed on January 18. Rebuttal evidence was presented during February and the case is being advanced for oral argument early in March, as it is very important that this comprehensive investigation should be completed and a decision rendered at the earliest practicable date.

It is generally admitted that the Commission is giving every one an opportunity to present evidence on the subject, and a mass of information of real value has been submitted. Whatever decisions may be arrived at, however, the changes, if any, cannot be other than experimental, and likely to further change. All we can hope for is that if in the multitude of council there is wisdom, some good will assuredly come.

Change in Rail Policies

Important changes in the Government policy toward the railroads were made on March 1. The section of the Transportation Act fixing six per cent. as the return on railroad properties, and which railroads are entitled to earn under the regulations of the Interstate Commerce Commission, has expired, and also there expired the period during which the railroads that were controlled by the government during the war were entitled to ask government loans to aid them in continuing operations after their return to private management.

The six per cent return clause, generally called the guarantee provision, is superseded by the transportation act provisions which hereafter required the Interstate Commerce Commission to make rates that will give railroads a "reasonable return on the value of property used in transportation." The commission is expected therefore to define for itself what earnings constitute reasonable return and to make rates accordingly. The subject of the definition of reasonable return has already been taken up formally by the commission for the purpose of securing arguments from railroads and interested parties to proceedings before it in relation to rate regulations.

Applications from railroads desiring the government loans have been pouring into the commission in considerable numbers in the endeavor to get in before the limitation began. Among roads asking for monetary aid were the Chicago, Peoria and St. Louis, which sought $1,000,000 for new equipment and repairs, and the Memphis, Dallas and Gulf, which asked $246,782, half of which is to be used for new equipment, and the balance for improvement to its line. There are also in the files of the commission, it is understood, a number of applications which will be made public after being recorded.

Railroad Expansion Absolutely Necessary

We heartily agree with the Secretary of Commerce, that few people seem to realize the amount of expansion in our transportation machine necessary to keep pace with the growth of the country; and an equal few seem to have any notion of the price that we pay for not having it. Our country is more dependent upon railway transport than any other. All others have comparatively greater coast lines and internal waterways. The experience of the twenty years before the war have shown that we must build an extension of lines, including terminal facilities, additional sidings, etc., every year equal to the construction of a new railway from New York to San Francisco. We must add at least 2,500 locomotives and 120,000 cars, annually, to our equipment. Since we entered the war in 1917 we have constructed at least 10,000 miles of railways less than our increasing population and economic development called for, and we are behind in rolling stock by about 4,000 locomotives and 150,000 cars. The moment that we reach anything like normal business we shall see a repetition of car shortage, followed by an increase in the cost of fuel.

Furthermore, there is nothing that is so irrecoverable a loss to the Nation as idle shops and idle men. To-day we have both. There is nothing that will so quickly start the springs of business and employment as an immediate resumption of construction and equipment of the railways. When business does resume, we shall need all of our capacity for the production of consumable goods. We shall not only find it strangled for lack of transportation but we shall find ourselves plunging into the manufacture of this very railway equipment and construction in competition with consumable goods for materials and labor. Herein lies the basic cause of destructive price inflation and booms, with all their waste and over-expansion. In times of depression we should prepare for the future, and by doing so we can cure the depression itself.

Public Control of the Railroads a Real Injury

The Merchants' Association of New York insist that the public control and operation of public utilities should be avoided when and wherever possible. In relation to the railroads the Association claims that it is natural that the advocates of public control of utilities and the agents of the government in its disastrous attempt to manage the railroads of the country should endeavor to uphold the principle of public control and to show that the experiment made during the war benefited rather than injured the railroad system. Mr. Walker D. Hines, who was Director General of Railroads, for example, has recently testified before a Congressional Committee that when the government took the railroads they were so demoralized that they could not have continued much longer in operation. He added that the roads were in much better condition when they were restored to their owners than they were when the Government took charge of them.

Testing for Valve and Cylinder Blows

It has been found good practice in testing for blows with piston valve for valve and cylinder packing blows, to place the engine on top or bottom quarter and place reverse lever on center, thus covering the ports, having the brake applied. In this position, open the throttle, and if blow is stopped it denotes the trouble is covered; then move reverse lever forward or backward opening admission ports to cylinder, and if the blow now occurs, we know it is defective cylinder packing on that side. The valves can be tested in the same manner, except that the blow will go out the stack in many cases instead of cylinder cocks, and there are times when the blow will not show when ports are covered, but by moving the valve either backward or forward, when the steam strikes admission ring, the blow will develop and we very often find a defective ring or valve bushing hollowed out.

Another method is to place the locomotive on the right, back lower eighth; set the air brake and place reverse lever in a position so that steam will enter left cylinder. If no blow exists, it is reasonable to believe that the left valve and cylinder packing is free from leakage. Then move reverse lever so that ports are covered on the left side and test right side in same manner. If blow now exists we know that the leak is on the right side. To indicate whether the valve or cylinder packing is at fault, take a stick of soft wood, about a foot or 18 inches long and insert it between the teeth, putting the other end against the valve chamber. If steam is passing by the valve chamber to cylinder, it will cause a pulsation, indicating that the blow is in the valve. If no pulsation is found by this method, place the end of the stick against the cylinder, which will determine without a doubt where the blow exists.

A Locomotive Sustains and Receives Damages

It is a good law that works both ways. The locomotive seems to be getting a hearing in the courts. In past years it mattered little what stood on the right of way of the locomotive, the railroads were almost invariably called upon to pay the damages. A recent damage suit in Cleveland took a reverse twist, and the New York Central secured a judgment for damages sustained to one of its locomotives amounting to $336.21. A five ton truck stood on the track. The engineer shut off steam, and applied the emergency brake quicker than chain lightning, but the momentum of the locomotive and train was such that a collision was unavoidable. The truck got the worst of it, but as these motor trucks are rapidly increasing in size it would not be surprising if they continue to increase in bulk they will be able to meet locomotives on even terms in a few years. It was a clear case against the motor man, and it is to be hoped that he will know better not to stop his truck on the middle of a railroad track, as judge and juries are beginning to see that railroad equipment may be, and very often has been, seriously damaged by motor trucks and even by the lighter automobiles. Of the average driver of the latter machine there is more hope of a fool than there is of him. He courts disaster and rushes in where even a thick-witted motor truck driver would think twice.

United States Patent Office Bill Passed

It is particularly gratifying to be able to report the successful passage of the bill both by the Senate and lower House enlarging the staff and increasing the salaries in the United States Patent office, without any restricting amendments. For many years the delays and confusion in the patent office continuel to be a serious injury to manufacturing concerns as well as a discouraging annoyance to inventors. It is a humiliating commentary on the grasping spirit of our legislative bodies that in an important department of the government, the operation of which has always shown a surplus of income over expenses, the surplus should be seized upon and appropriated to other and frequently questionable purposes, with the pernicious results already referred to besides driving out many of the most skilled employees of the department who, naturally, could not be expected to continue their services at salaries which were only moderate many years ago.

Labor Union Chiefs Form Alliance of Miners and Transportation Men

Representatives of seventeen organizations embracing two million union coal miners, railroad workers and longshoremen, have declared for a cooperation of their forces which is intended to more effectually protect the union workers in wage controversies. No specific programme for allied action was outlined. The miners did not ask a sympathetic strike on April 1, the date of the miners' threatened walk-out. An executive committee was appointed to decide on the course of action by the various unions whenever an emergency arose in the wage struggles of any of the allied groups. The plan does not become effective until ratified by the various organizations and was said to require the approval of a convention of delegates. The railroad representatives declined to discuss their meeting, but were said to have favored the proposal from the outset. The whole matter is therefore one depending on future action when it becomes apparent that joint action may be deemed necessary.

The seventeen organizations that are parties to the agreement are the United Mine Workers of America, the Brotherhood of Railway Carmen of America, the Order of Railway Conductors, the International Brotherhood of Stationary Firemen and Oilers, the International Brotherhood of Blacksmiths, Drop Forgers and Helpers, the Switchmen's Union of North America, the International Association of Machinists, the Brotherhood of Railroad Signalmen of America, the International Brotherhood of Electrical Workers of America, the Brotherhood of Locomotive Firemen and Enginemen, the order of Railroad Telegraphers, the Brotherhood of Railroad Trainmen, the Railroad Employes' Department of the American Federation of Labor, the Brotherhood of Locomotive Engineers, the United Brotherhood of Maintenance of Way Employees, the Brotherhood of Railway Clerks and the International Association of Longshoremen.

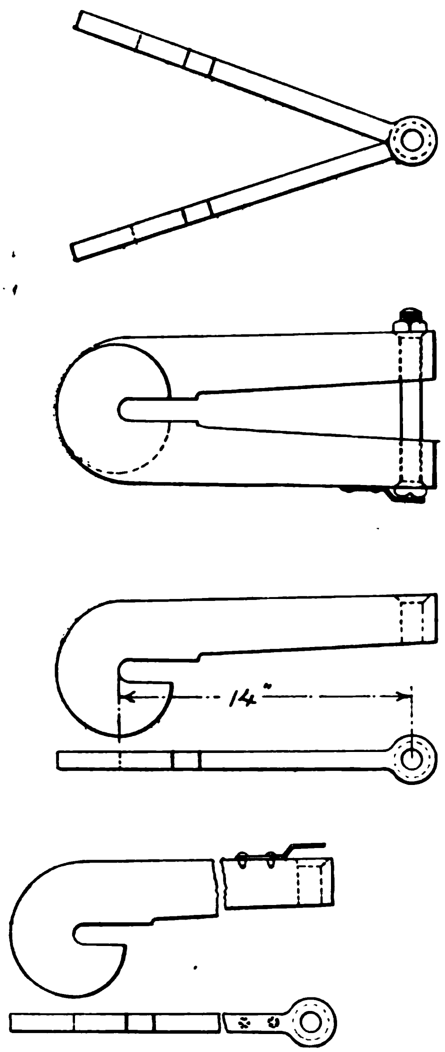
Automatic Train Control

In accordance with the order issued by the Interstate Commerce Commission, representatives of the 49 railroads cited met in Chicago last month to consider what action should be taken in the matter. After considerable discussion it was decided to appoint a committee of nine members which might be added to by any carriers who may think proper. The committee appointed so far and who will report at a future meeting includes C. E. Denney, vice-president and general manager of the New York, Chicago & St. Louis, chairman; T. H. Beacom, vice-president and general manager, Chicago Rock Island & Pacific; W. M. Jeffers, general manager, Union Pacific; A. M. Burt, assistant to operating vice-president, Northern Pacific; E. B. Katte, chief engineer electric traction, New York Central; C. H. Morrison, signal engineer, New York, New Haven & Hartford; W. J. Eck, signal and electrical superintendent, Southern Railway; R. W. Bell, general superintendent motive power, Illinois Central, and C. F. Giles, superintendent machinery, Louisville & Nashville.

Meanwhile the Interstate Commerce Commission has called attention to the fact that parties interested in special devices are endeavoring to create an impression that a particular device has been already selected, and the Commission desires it to be understood that its order does not prescribe, prefer, or indorse any particular device or type to be used by any carrier, the only requirement being that the installation shall pass certain technical specifications and requirements which have been found to be necessary for the successful operation of devices of this character. These are so broad as to afford the desired freest field of opportunity for inventors and for trying out all automatic train control and train stop devices.

Device for Twisting Eccentric Rods and Improved Chuck for Planing Shoes and Wedges

It is frequently necessary to twist eccentric rods through a slight angle in order to adjust them to the engine and



DEVICE FOR TWISTING ECCENTRIC RODS.

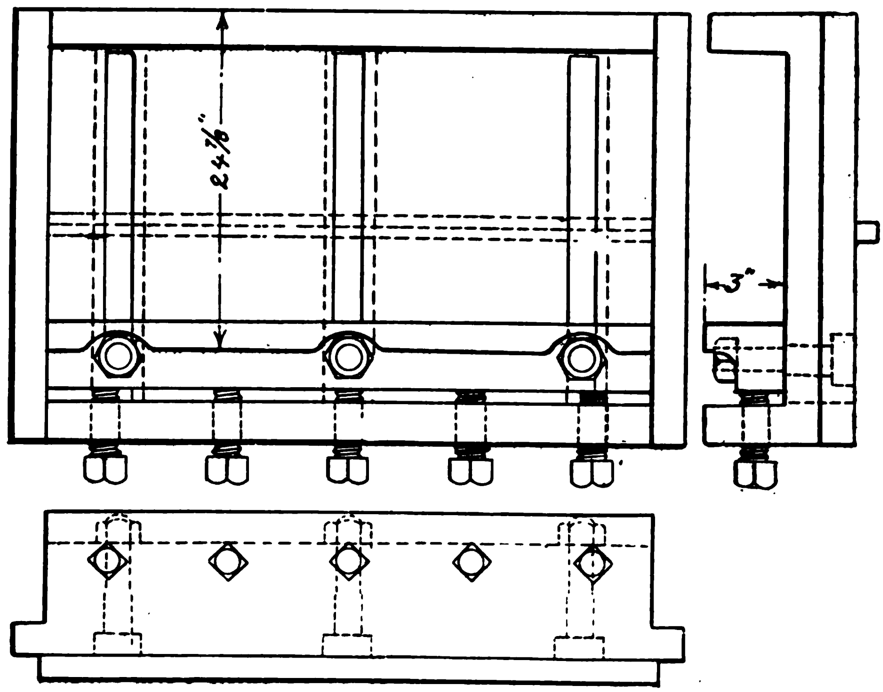
the work can be done as well cold as hot, if the proper appliances to do it are available.

The device shown in the accompanying engraving is for that purpose. It consists of two jaws which are shown in detail in the two sets of illustrations at the bottom of the group. They are fastened together with a pivotted connection so that the two sections can swing apart on an angle as shown in the uppermost illustration which is a plan of the assembly. To use the device, the two sections are separated on an angle so that the distance between their outer ends is equal to that which shall be occupied by the twist. The straight, flat eccentric rod is laid across the angle and in the jaws of the two sections. The connecting bolt is then shortened by running on the nut. This turns one jaw in one direction and the other in the other with the result that the rod will be twisted between the two bearing points by an amount dependent upon the shortening of the pivotal bolt.

A cap is bolted to the section whose arm lies at the bottom to prevent the pivotal and operating bolt from falling out when the nut is removed.

Chuck for Planing Shoes and Wedges

The construction of this chuck is so clearly shown in the engraving that but very little description is necessary. It consists of a cast iron bedplate having a projecting rib on the bottom face for fitting into the T groove in the planer bed, to which the base is fastened by straps and bolts. One side is made solid with the base and on the other there is a sliding face that is guided by transverse grooves and is first adjusted against the work by the set screws and then held down by the clamping bolts as indicated by the dotted lines.



CHUCK FOR PLANING SHOES AND WEDGES.

The chuck is intended to be used in multiple. That is a number of them are placed end to end on the planer bed so as to do the work on several shoes or wedges at the same time.

Safety Statistics

To assist in the work of educating the management, the executive force and the foremen, it is necessary that each factory keep a few simple records: First a list of "Causes of Accidents"; second, a tabulated "Compensation Summary"; and third, an "Accident Summary." The first gives a list of accidents by departments or by factories for the week, classified under these headings: machine accidents, tool accidents, burns, eye accidents, falls, handling materials, miscellaneous. The "Compensation Summary" gives by departments or plants each year or half year, as desired, the cost of compensation, medical expense, etc., per $100 of payroll, and per 1,000 man-hours worked.

The "Accident Summary," usually submitted monthly, gives by department or plant the accident rate and the severity rate. The accident rate is the number of accidents per million hours worked, and the severity rate gives the days lost-time per 1,000 hours worked.

Waste in industry is one of the greatest economic crimes of the day and the waste of manpower through needless accidents the least justifiable. Therefore, it behooves all persons connected with industry, by practice and precept to exert their utmost efforts to eliminate preventable accidents. By so doing they become members of the "Universal Saving Society." The costs are practically nil except their own conscientious endeavors. And the dividends—increased production, saving of lost time wages, the prevention of suffering, and the elimination of anguish on the part of loved ones—are well worth the effort. Not only so, but it would appear that the safety committees that have been established on the railroads and elsewhere are getting more expert in the good work which was so nobly begun.

Notes on Foreign Railways

Invitation to British Railway Men to Go to France and Learn Something

French engineering firms engaged in the manufacture of railway equipment join in inviting young British railway men to come into their factories during the summer vacation and work for nothing. This looks friendly as far as educational advantages are concerned, but not kindly as far as the complete lack of remuneration goes, unless the invitation is reciprocal and the French invited to go to Britain under similar conditions. We were not aware that there were any particular periods of vacation among British railway men, and as far as they are particularly concerned, young and old, if all that is said be true, too many of them are having enforced vacations already. Not only so, but during the summer months both nationalities are particularly clever in looking after the welfare of American tourists, with tangible results.

Strike Deferred on the Irish Railways

The general order lengthening the hours of labor on the Irish railways, and against which a strike was threatened but has been deferred. The Minister of Labor in the new Irish cabinet has induced the railway men to stay at their work and some kind of compromise is expected in the near future. The dark days through which the Irish people have passed and are still passing have evidently taught them the lessen that "it is better to bear the ills we have than fly to others that we know not of."

French Getting Tired of the State Owned Railways

A movement is on foot looking toward the leasing of the French railways. As is well known the privately owned railways are more economically, and in some respects, better operated than the State owned railways. The scheme proposes giving a majority of votes to private persons owning shares. One-third of the shares would be retained by the departments and communes served by the State railway, and two-thirds would be subscribed for by the public. In other words the French people are getting tired of the politicians running the railways.

The Railway Gauge Question in Australia

The attempt to come to some conclusion looking towards the standardization of the railway gauge in Australia has again been postponed evidently for the lack of funds. In common with other railways all over the world, the deficits in 1921 were monumental, owing it is reported to the high cost of labor and materials. The Queensland railways have had the heaviest deficits. Mr. Hughes, the prime minister, insists that the government can raise all the money necessary for the purpose, but the great majority of the people seem to be of the opinion that they could get along with less debt and consequently less taxes than they have to attend to at present.

Electrification of Bologna-Monfalcone Railway

The Director General of Italian State Railways announces that the administration is desirous of receiving tenders for the electrification of the Bologna-Venice-Monfalcone railway line, which work is to be intrusted to private enterprise. Bids will be opened on April 30, 1922, at the Direzione Generale Ferrovie dello Stato, Rome, where full details as to the nature of this contract may be consulted.

Harnessing the River Rhone

A report showing an outline of the waterpower in France has just been published. It furnishes particular reference to the River Rhone as the most important source of potential hydroelectric power in France. Developments are proposed of a most extensive kind, the estimates reaching as high as $400,000,000. The financing of the project will be accomplished by a gradual carrying out of the entire scheme extending over a period of years.

Of particular interest to American manufacturers is the opportunity afforded for participation of American capital and for the sale of American-made machinery and supplies. Practical steps have already been taken toward the constitution of a great national Rhone development company, and there is little doubt that force of circumstances will compel the development, in one form or another, of this national resource.

Copies of the above report and of the law authorizing the power development of the River Rhone, together with an outline of the progressive financing scheme for the project, may be obtained from the Electrical Equipment Division of the Bureau of Foreign and Domestic Commerce or from the Bureau's district offices by referring to Exhibit No. 1178.

Railway Electrification in Great Britain

Sir Vincent Raven, speaking before the North-East Coast Institution of Engineers, England, gave examples of savings which electrification would effect on an existing steam railway, 250 miles single track, which it has now been decided to electrify. Apart from obviating considerable track doubling and new lines, these are shown to amount to a reduction in the annual train mileage of through goods trains, of about 25 per cent. for the same total ton mileage. At the same time the average speed of travel would be increased, the total time for the double journey being reduced from about 56 hours to 26. The saving in new wagons due to this acceleration of service was estimated to amount to approximately 42,340-ton wagons, or the equivalent.

Decapod Locomotives in Russia

During recent years the locomotive standards in certain European countries, and notably in Russia, have, however, been added to by the adoption of ten-coupled engines embracing both the 0-10-0 and 2-10-0 types. This development was expedited during the war, when, early in 1915, it became apparent to the Russian Government that the railways needed more locomotives because of the changed conditions of freight traffic and of the new requirements imposed on the railways by the outbreak and continuance of hostilities.

The adoption of certain features of design ordinarily associated with American locomotive practice is accounted for to some extent by the fact that the engines were built in the United States, and that the designing of certain details was, in the first place, left to the builders in order to enable them to deliver the locomotives as quickly as possible. Later, however, after a series of very thorough tests had been made in Russia with the first lot of locomotives, which proved the type itself to be quite satisfactory, changes in the design were effected in order to bring them into conformity with the usual Russian design and the railway standards of that country, those changes being carried under the superintendence of an eminent Russian engineer, who was sent to America for this particular purpose.

Increase of Equipment in Poland

In July, 1919, there were approximately 2,127 locomotives, 4,859 passenger cars, and 41,953 freight cars in operation in Poland. During the following two years the increase had reached to 3,696 locomotives, 8,489 passenger cars, and 8,790 freight cars. This amount of increased equipment had been supplemented by the delivery of 300 locomotives under the terms of the reparation treaty. The amount of motive power and rolling stock undergoing repair had also been greatly reduced during the period referred to, while the amount of track in operation which had been reduced to a little over 3,000 miles early in 1919 is now over three times that amount.

Brake Cylinder Piston Travel and Leakage

Data of Comprehensive Investigation Tabulated

For many years the proceedings of the Air Brake Associations have contained discussions on the effect of variation in brake cylinder piston travel, and it has been frankly acknowledged to be one of the evils attendant upon the use of the air brake. To avoid it numerous devices have been proposed by which there should be an automatic compensation for the wear of the brakeshoes by which the piston travel should be kept constant. Many of them have been very ingenious, some of them quite simple, and a.l more or less effective but none of them has received a general application. The consequence is that cars are roaming the country in all sorts of condition of adjustment and with a range of piston travel in their cylinders that few. even among the best informed, have any idea of. Add to this range of piston travel and equally wide range of piston leakage and we have a situation that, to say the least, is somewhat startling and strikes smashing blows at the slogan of "safety first" and wou'd seem to substitute in its place the cry of a lost cause, "let him save himself who can."

Such a presentation of the case would be hazardous and be met with prompt denials from interested parties if it could not be substantiated by actual figures obtained in the field.

About a year and a half ago Johns-Manville, Inc., made an investigation as to the condition of brake cylinders and their pistons, which, for extent and thoroughness, has probably never been equal ed.

Representatives were sent to seven railroad terminals, located as follows, in the: Middle Atlantic, Southeast, Middle West, Southwest and Western districts of the United States.

At each of these seven terminals, one hundred cars were taken at random and memoranda made of each, as to the date of the inspection, the car number and initial; the last cleaning point; the shop marks on the reservoir; the date of last cleaning; the piston travel; the rate of cylinder leakage per minute from an initial pressure of 50 lbs.; the type of triple valve on the car; the type of brake cylinder whether 8 in. or 10 in. in diameter, and whether this cylinder was combined with the auxiliary reservoir or detached.

Certainly this was a comprehensive investigation and when the territory covered and the number of cars examined are considered it may fairly be assumed to be quite representative of the country as a whole.

The initials on the cars showed that in the number examined there was a representation of every large system in the country and many of the smaller roads. The classes of the cars embraced everything to be found in ordinary traffic. The last date of cleaning showed that the requirements of the regulations were being scrupulously lived up to. The type of triple valves encountered covered about everything that is used in freight traffic, so that the impartiality of the investigation is above reproach.

Of all the items noted, the piston travel and the brake cylinder leakage are the two that are of interest, and are the two, the determination of which was the object of the investigation.

It was found that the piston travel varied from 3½ in. to 12 in., and that the leakage varied from 0 to 50 lbs. per minute with a brake cylinder pressure of 50 lbs. per square inch, meaning that some cylinders would lose all the pressure that they might have in one minute, and that others would lose none, while the great majority would strike hither and yon between the two extremes.

In addition to the data obtained in the field in the original investigation, a calculation has been made of the initial pressure that would be developed in the brake cylinder by various reductions from brake pipe pressure of 70 lbs. and 90 lbs. for

Piston Travel in.	Piston Displacement cu. in.	8 in. Brake Cylinder: 70 Lbs. Brakepipe Pressure: 10 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	70 Lbs. Brakepipe Pressure: 15 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	70 Lbs. Brakepipe Pressure: 20 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure: 15 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure: 20 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure: 25 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.
3.50	175.98	45.23	57.68	57.68	72.24	74.55	74.55
.75	188.50	42.84	57.23	57.23	68.67	73.97	73.97
4.00	201.06	40.62	56.75	56.75	65.46	73.40	73.40
.25	213.65	38.57	56.29	56.29	62.46	72.83	72.83
.50	226.20	36.66	55.84	55.84	59.73	72.28	72.28
.75	238.76	34.89	55.39	55.39	57.15	71.22	71.22
5.00	251.33	33.23	54.96	54.95	54.95	71.16	71.16
.25	263.98	31.67	52.49	54.51	52.49	70.64	70.64
.50	276.46	30.23	50.41	54.08	50.41	70.11	70.11
.75	289.03	28.87	48.43	53.66	48.43	67.99	69.59
6.00	301.59	27.58	46.57	53.24	46.57	65.56	69.07
.25	314.16	26.37	44.84	52.83	44.84	63.21	68.56
.50	326.73	25.23	43.16	52.42	43.16	61.09	68.05
.75	339.29	24.15	41.59	52.01	41.59	59.04	67.89
7.00	351.86	23.12	40.11	51.61	40.11	57.09	67.06
.25	364.43	22.15	38.70	51.22	38.70	55.25	66.58
.50	376.99	21.23	37.37	50.83	37.37	53.50	66.09
.75	389.56	20.35	36.09	50.45	36.09	51.84	65.62
8.00	402.12	19.52	34.89	50.07	34.89	50.25	65.15
.25	414.69	18.72	33.73	48.74	33.73	48.74	63.75
.50	427.25	17.96	32.63	47.29	32.63	47.29	61.96
.75	439.82	17.23	31.58	45.92	31.58	45.92	60.26
9.00	452.39	16.54	30.57	44.59	30.57	44.59	58.62
.25	464.96	15.87	29.60	43.33	29.60	43.33	57.06
.50	477.52	15.22	28.68	42.12	28.68	42.12	55.57
.75	490.09	14.62	27.79	40.96	27.79	40.96	54.13
10.00	502.65	14.04	26.94	39.85	26.94	39.85	52.75
.25	515.22	13.47	26.13	38.78	26.13	38.78	51.43
.50	527.79	12.93	25.34	37.75	25.34	37.75	50.15
.75	540.36	12.41	24.58	36.75	24.58	36.75	48.93
11.00	552.92	11.91	23.85	35.80	23.85	35.80	47.75
.25	565.49	11.42	23.15	34.88	23.15	34.88	46.61
.50	578.05	10.96	22.48	34.00	22.48	34.00	45.52
.75	590.62	10.51	21.82	33.14	21.82	33.14	44.46
12.00	603.19	10.07	21.19	32.31	21.19	32.31	43.44

BRAKE CYLINDER PRESSURE DEVELOPED FOR VARIOUS PISTON TRAVELS IN 8 INCH BRAKE CYLINDER.

both 8 in. and 10 in. diameter of cylinders. For the 8 in. cylinders a clearance space of 125 cu. in. was assumed, and for the 10 in. cylinder, a clearance of 150 cu. in. The calculations cover a range of piston travel from 3½ to 12 in., varying by ¼ in.

Air brake men will grasp the significance of this table at a glance, but there are some peculiarities about the figures that may need some explanation to those who are not actively engaged in air brake work.

Piston Travel in.	Piston Displacement cu. in.	10 in. Brake Cylinder: 70 Lbs. Brakepipe Pressure, 10 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	70 Lbs. Brakepipe Pressure, 15 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	70 Lbs. Brakepipe Pressure, 20 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure, 15 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure, 20 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.	90 Lbs. Brakepipe Pressure, 25 Lbs. Reduc. Cylinder Pressure Lbs. per sq. in.
3.50	274.89	46.98	58.04	58.04	75.02	75.02	75.02
.75	294.53	44.25	57.54	57.54	71.24	74.41	74.41
4.00	314.16	41.75	57.04	57.04	67.61	73.80	73.80
.25	333.80	39.46	56.56	56.56	64.27	73.19	73.19
.50	353.43	37.35	56.07	56.07	61.19	72.60	72.60
.75	373.07	35.40	55.59	55.59	58.34	72.02	72.02
5.00	392.70	33.58	55.13	55.13	55.70	72.43	72.43
.25	412.34	31.90	53.24	54.66	53.24	70.87	70.87
.50	431.97	30.33	50.95	54.21	50.95	70.31	70.31
.75	451.61	28.84	48.80	53.76	48.80	68.75	69.75
6.00	471.24	27.48	46.79	53.31	46.79	66.11	69.20
.25	490.88	26.19	44.91	52.88	44.91	63.64	68.66
.50	510.51	24.97	43.14	52.44	43.14	61.31	68.12
.75	530.15	23.83	41.47	52.01	41.47	59.11	67.59
7.00	549.78	22.75	39.89	51.59	39.89	57.04	67.08
.25	569.42	21.73	38.41	51.17	38.41	55.09	66.56
.50	589.05	20.76	36.99	50.76	36.99	53.23	66.05
.75	608.69	19.84	35.65	50.25	35.65	51.47	65.55
8.00	628.32	18.98	34.39	49.81	34.39	49.80	65.05
.25	647.96	18.14	33.18	48.22	33.18	48.22	63.25
.50	667.59	17.35	32.03	46.71	32.03	46.71	61.38
.75	687.23	16.60	30.92	45.25	30.92	45.25	59.60
9.00	706.86	15.88	29.89	43.88	29.89	43.88	57.90
.25	726.50	15.20	28.89	42.58	28.89	42.58	56.27
.50	746.13	14.54	27.93	41.32	27.93	41.32	54.71
.75	765.77	13.91	27.02	40.12	27.02	40.12	53.22
10.00	785.40	13.31	26.14	38.97	26.14	38.97	51.80
.25	805.04	12.74	25.30	37.87	25.30	37.87	50.43
.50	824.67	12.19	24.49	36.81	24.49	36.81	49.12
.75	844.31	11.55	23.72	35.79	23.72	35.79	47.86
11.00	863.94	11.14	22.98	34.81	22.98	34.81	46.65
.25	883.58	10.65	22.26	33.87	22.26	33.87	45.48
.50	903.21	10.18	21.57	32.97	21.57	32.97	44.36
.75	922.85	9.72	20.91	32.10	20.91	32.10	43.28
12.00	942.48	9.29	20.27	31.26	20.27	31.26	42.24

BRAKE CYLINDER PRESSURE DEVELOPED FOR VARIOUS PISTON TRAVELS IN 10-INCH BRAKE CYLINDER.

It is the feature of the triple valve that, when a brake-pipe reduction has been made for the purpose of making an application the compressed air flows from the auxiliary reservoir into the brake cylinder until it (the pressure in the auxiliary reservoir) has equalized with that of the brake pipe. But if it should so happen that the space in the brake cylinder is not large enough to receive the air that would naturally flow into it from the auxiliary reservoir, the pressures in the auxiliary reservoir and the brake cylinder equalize at a point above that of the brake-pipe, dependent upon the size of the brake cylinder space. Also a given amount of air on a brake-pipe reduction that can find accommodation in the brake cylinder will develop the same brake cylinder pressure whether the reduction is made from a brakepipe and auxiliary reservoir pressure of 70 lbs. or 90 lbs. For example, as the 10 lbs. can flow into the cylinder even for the short piston travel of 3½ in., the pressure developed will be the same for both a 70-lb. and a 90-lb. brake pipe pressure.

But on a 15-lb. reduction from 70 lbs. brake pipe pressure with a 10 in. cylinder the brakepipe pressure falls at once to 55 lbs., but the auxiliary reservoir and brakepipe pressures will equalize above that point for all piston travels of 5 in. or less. Hence it follows, that, when the piston travel meets this condition it makes no difference whether a reduction of 15 lbs. or 20 lbs. is made, the brake cylinder pressure remains the same. With a travel of more than 5 in. the 15 lbs. from the reservoir builds up its own pressure in the brake cylinder while, for a 20-lb. reduction, the auxiliary reservoir and brake cylinder pressures continue to equalize until the piston travel has reached 8 in., when the auxiliary reservoir, brakepipe and brake cylinder are equalized at about 50 lbs.

Likewise with a 90-lb. brakepipe pressure. The pressures developed for 20-lb. and 25-lb. reduction are the same for piston travels of 5½ in. or less, while the auxiliary reservoir and brake cylinder equalize for all travels of 8 in. or less.

These are the factors that make for the varying brake cylinder pressures that are so harassing in train operation. Take the extremes of 3½ in. and 12 in. travel for the 8 in. cylinder for example. The pressures developed are 45.23 lbs. and 10.07 lbs. per square inch respectively for a 10-lb. brakepipe reduction, while for the 10-in. cylinder the difference is even greater. As the reductions increase the differences decrease, but they are, at the best, almost two to one.

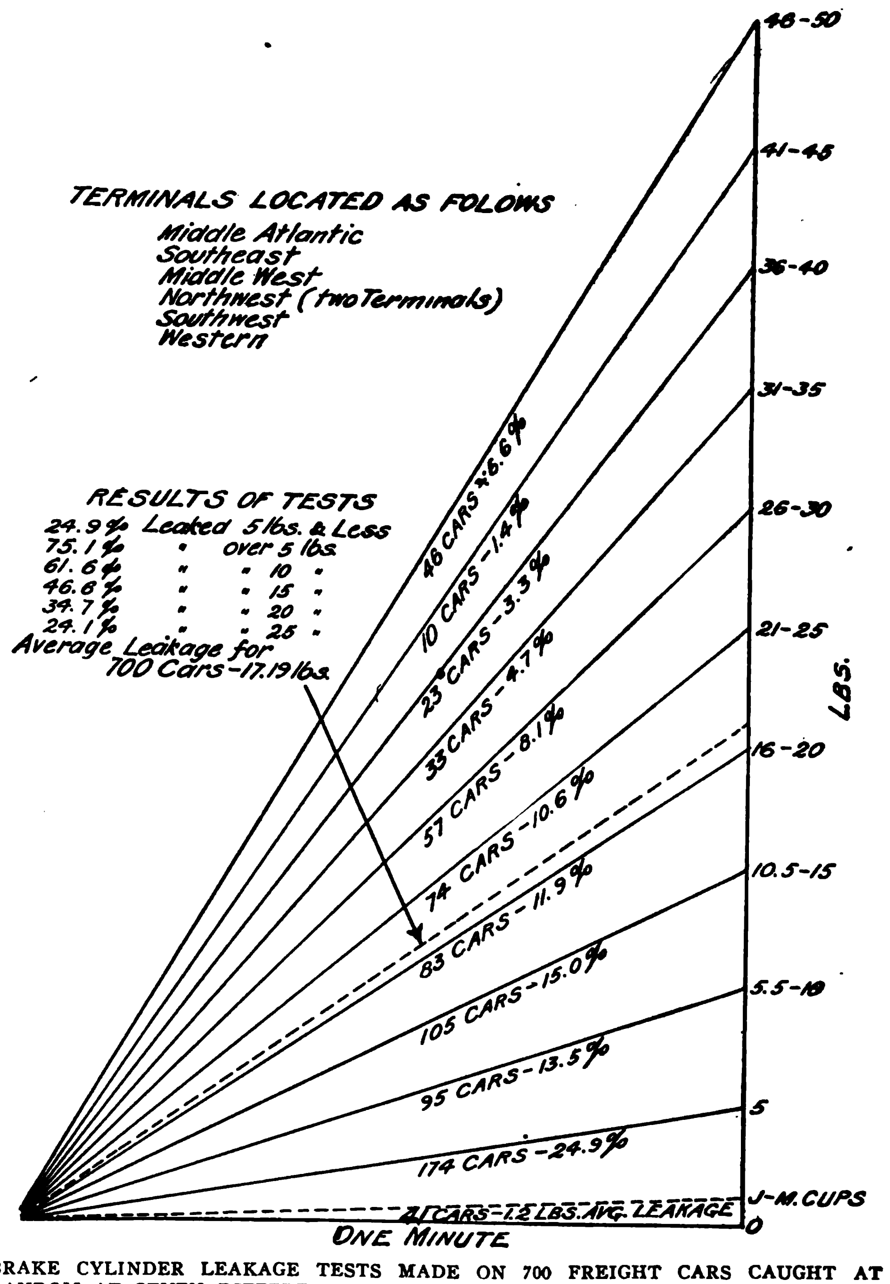
This is enough to cause annoyance but the trouble dces not end there. We have still the varying leakages to contend with and this knows no law.

In order to show as to just what this may lead to and what it means in brake cylinder pressures the details of the results of the investigation at one of the terminals is given in full.

Piston Travel Ins.	Brake Cylinder Leakage Per Min. from 50 Lbs. in Lbs.	Diam. Cyl. Ins.	Initial Pressure Lbs. Per Sq. In.	Pressure at end of 1 Min. Lbs. Per Sq. In.
9	2	10	15.88	14.94
7¾	11	8	20.35	14.39
8⅛	3	8	18 33	16.80
8¾	7	8	17.23	13.78
6½	1½	8	25.23	24.32
9½	16	8	15.22	7.82
6⅛	1	10	26.83	26.19
6¾	27	10	23.83	7.75
8¼	2½	8	18.72	17.43
5½	1	10	30.33	29.64
6⅛	1½	10	26.83	25.87
9½	1	8	15.22	14.76
7	4	8	23.12	20.78
11¾	19	10	9.72	2.55
6¾	14	10	23.83	15.49
6⅝	1	10	24.38	23.78
7½	1½	8	21.23	20.40
8¼	38	8	18.72	0.00
9¼	19	8	15.87	6.89
10	22	8	14.04	4.27

Piston Travel Ins.	Brake Cylinder Leakage Per Min. from 50 Lbs. in Lbs.	Diam. Cyl. Ins.	Initial Pressure Lbs. Per Sq. In.	Pressure at end of 1 Min. Lbs. Per Sq. In.
8¼	1	8	18.72	18.20
8	2½	8	19.52	18.20
6½	24	8	25.23	10.42
6	36	8	27.58	4.05
6⅜	16	10	25.56	15.60
6	19	10	27.48	15.09
4½	16	10	37.35	24.48
8½	3½	10	17.35	15.62
5¾	50	8	28.87	0.00
7¾	15	10	19.84	11.83
8½	1	8	17.96	17.46
6½	7	10	24.97	20.68
12	23	10	9.29	.76
8⅛	5	8	19.11	16.50
7	0	10	22.75	22.78
5¼	16	10	31.90	20.38
5¼	22	8	31.67	15.90
6	17	10	27.48	16.40
8¼	6	8	18.72	15.62
8¾	14	8	17.23	10.32
9½	2	8	15.22	14.30
7¼	12	10	21.73	14.98
6	50	8	27.58	0.00
9	22	8	16.54	5.92
12	17	8	10.07	3.56
7	22	10	22.75	10.03
8¾	5½	8	17.23	14.52
8⅝	20	10	16.96	7.17
11	4	8	11.91	10.26
8¼	45	8	18.72	0.00
9¼	1	8	15.87	15.40
5½	15	10	30.33	19.89
8½	0	10	17.35	17.35
8¾	6	8	17.23	14.27
7½	2	8	21.23	20.12
4½	32	10	37.35	11.61
8	7	8	19.52	15.82
7¾	1	8	20.35	19.81
7⅜	5	10	21.23	18.46
6¾	4	8	24.15	21.75
8	32	8	19.52	2.60
7	11	10	22.75	16.38
6	30	8	27.58	7.98
5⅛	9	8	32.42	25.87
7¼	12	10	21.73	14.98
6	3	8	27.58	25.62
7¾	1	10	19.84	19.31
6	21	8	27.58	13.86
7	0	10	22.75	22.75
5¾	4	10	28.84	26.15
6¼	2½	8	26.37	24.79
7½	2	10	20.76	19.74
6	27	8	27.58	9.94
6¼	3	8	26.37	24.47
4½	30	8	36.66	12.84
7¾	24	8	20.35	7.35
9½	50	10	14.54	0.00
6½	32	8	25.23	5.48
8	4	10	18.98	16.90
6¼	5	10	26.19	23.03
6	43	10	27.48	0.00
7¾	35	10	19.84	1.16
4⅛	25	10	40.60	19.24
4½	5	8	36.66	32.69
8	21	8	19.52	8.41
6	14	8	27.58	18.43
7¼	38	8	22.15	.49
5¾	22	10	28.84	14.04
4½	50	8	36.66	0.00
6	1½	8	27.58	26.60
9¾	1½	10	13.91	13.25
8	4	10	18.98	16.90
5⅜	13	8	30.92	21.76
4½	15	10	37.35	25.30
8⅞	3	10	16.21	14.78
5¾	42	10	28.84	.58
5¾	0	8	28.87	28.87
7¾	15	8	20.35	12.23
7¾	12	10	19.84	13.43
5½	11	10	30.33	22.68

with a 10-lb. brake pipe reduction and the pressure remaining in the cylinder at the end of one minute under a leakage proportional to that obtained with a 50-lb. initial pressure. The calculation of the leakage for each case was based on the hypothesis that the leakage is proportional to the absolute initial pressure. This will make the leakage a trifle high, but by a difference from the actual that is negligible. In order to emphasize this condition, a diagram has been prepared showing the variations. In this diagram the unshaded upper portion added to the shaded lower portion represents the initial pressure as developed with a 10-lb. brake pipe reduction. The lower shaded portion represents the pressure remaining in the cylinder at the end of one minute.



BRAKE CYLINDER LEAKAGE TESTS MADE ON 700 FREIGHT CARS CAUGHT AT RANDOM AT SEVEN DIFFERENT TERMINALS IN U. S. A., 1920 (100 CARS TESTED AT EACH TERMINAL)

In addition to the data gathered in the field, and bearing directly on the matter in hand, there have been added two columns showing the initial pressure that would have been developed in the brake cylinder

This condition is even worse than the first. On some cars there is no pressure remaining; on others there has been no diminution of pressure, and the last condition of those cars is worse than the first. This means, cycling, recharging, shocks and the making of excessive stresses between cars with possible break-in-twos.

The report deals in detail with the investigations at the several terminals with the following general results, showing the number of cars falling within the limits of the piston travel and leakage per minute from 50 lbs. as specified.

TABLE No. 1

Piston travel 3½- 4 in.	3
Piston travel 4¼- 5 in.	9
Piston travel 5¼- 6 in.	35
Piston travel 6¼- 7 in.	28
Piston travel 7¼- 8 in.	11
Piston travel 8¼- 9 in.	6
Piston travel 9¼-10 in.	4
Piston travel 10¼-11 in.	3
Piston travel 11¼-12 in.	1
Leakage 5 lbs. or less	24
Leakage 5.5-10 lbs.	16
Leakage 10.5-15 lbs.	11
Leakage 16-20 lbs.	16
Leakage 21-25 lbs.	6
Leakage 26-30 lbs.	13
Leakage 31-35 lbs.	3
Leakage 36-40 lbs.	3
Leakage 41-45 lbs.	1
Leakage 46-50 lbs.	7

TABLE No. 2

Piston travel 3½- 4 in.	2
Piston travel 4¼- 5 in.	17
Piston travel 5¼- 6 in.	21
Piston travel 6¼- 7 in.	27
Piston travel 7¼- 8 in.	17
Piston travel 8¼- 9 in.	12
Piston travel 9¼-10 in.	4
Leakage 5 lbs. or less	21
Leakage 5.5-10 lbs.	19
Leakage 10.5-15 lbs.	15
Leakage 16-20 lbs.	11
Leakage 21-25 lbs.	14
Leakage 26-30 lbs.	4
Leakage 31-35 lbs.	4
Leakage 36-40 lbs.	3
Leakage 41-45 lbs.	0
Leakage 46-50 lbs.	9

TABLE No. 3

Piston travel 4¼- 5 in.	7
Piston travel 5¼- 6 in.	23
Piston travel 6¼- 7 in.	19
Piston travel 7¼- 8 in.	21
Piston travel 8¼- 9 in.	18
Piston travel 9¼-10 in.	8
Piston travel 10¼-11 in.	0
Piston travel 11¼-12 in.	4
Leakage 5 lbs. or less	41
Leakage 5.5-10 lbs.	6
Leakage 10.5-15 lbs.	14
Leakage 16-20 lbs.	10
Leakage 21-25 lbs.	11
Leakage 26-30 lbs.	4
Leakage 31-35 lbs.	4
Leakage 36-40 lbs.	3
Leakage 41-45 lbs.	3
Leakage 46-50 lbs.	4

TABLE No. 4

Piston travel 3½- 4 in.	0
Piston travel 4¼- 5 in.	8
Piston travel 5¼- 6 in.	17
Piston travel 6¼- 7 in.	23
Piston travel 7¼- 8 in.	23
Piston travel 8¼- 9 in.	13
Piston travel 9¼-10 in.	6
Piston travel 10¼-11 in.	7
Piston travel 11¼-12 in.	3
	100
Leakage 5 lbs. or less	21
Leakage 5.5-10 lbs.	15
Leakage 10.5-15 lbs.	18
Leakage 16-20 lbs.	11
Leakage 21-25 lbs.	12
Leakage 26-30 lbs.	5
Leakage 31-35 lbs.	6
Leakage 36-40 lbs.	4
Leakage 41-45 lbs.	2
Leakage 46-50 lbs.	6

TABLE No. 5

Piston travel 3½- 4 in.	2
Piston travel 4¼- 5 in.	9
Piston travel 5¼- 6 in.	17
Piston travel 6¼- 7 in.	28
Piston travel 7¼- 8 in.	18
Piston travel 8¼- 9 in.	14
Piston travel 9¼-10 in.	8
Piston travel 10¼-11 in.	3
Piston travel 11¼-12 in.	1
Leakage 5 lbs. or less	25
Leakage 5.5-10 lbs.	10
Leakage 10.5-15 lbs.	16
Leakage 16-20 lbs.	13
Leakage 21-25 lbs.	11
Leakage 26-30 lbs.	11
Leakage 31-35 lbs.	6
Leakage 36-40 lbs.	3
Leakage 41-45 lbs.	1
Leakage 46-50 lbs.	4

TABLE No. 6

Piston travel 3½- 4 in.	2
Piston travel 4¼- 5 in.	12
Piston travel 5¼- 6 in.	18
Piston travel 6¼- 7 in.	14
Piston travel 7¼- 8 in.	20
Piston travel 8¼- 9 in.	8
Piston travel 9¼-10 in.	8
Piston travel 10¼-11 in.	8
Piston travel 11¼-12 in.	10
Leakage 5 lbs. or less	19
Leakage 5.5-10 lbs.	22
Leakage 10.5-15 lbs.	10
Leakage 16-20 lbs.	8
Leakage 21-25 lbs.	8
Leakage 26-30 lbs.	7
Leakage 31-35 lbs.	6
Leakage 36-40 lbs.	3
Leakage 41-45 lbs.	2
Leakage 46-50 lbs.	15

TABLE No. 7

Piston travel 3½- 4 in.	1
Piston travel 4¼- 5 in.	8
Piston travel 5¼- 6 in.	22
Piston travel 6¼- 7 in.	40
Piston travel 7¼- 8 in.	19
Piston travel 8¼- 9 in.	5
Piston travel 9¼-10 in.	3
Piston travel 10¼-11 in.	2
	100
Leakage 5 lbs. or less	23
Leakage 5.5-10 lbs.	7
Leakage 10.5-15 lbs.	21
Leakage 16-20 lbs.	14
Leakage 21-25 lbs.	12
Leakage 26-30 lbs.	13
Leakage 31-35 lbs.	4
Leakage 36-40 lbs.	4
Leakage 41-45 lbs.	1
Leakage 46-50 lbs.	1

SUMMARY OF ALL LEAKAGE TABLES

Leakage 5 lbs. or less	174—24.9%
Leakage 5.5-10 lb.	95—13.5%
Leakage 10.5-15 lb.	105—15.0%
Leakage 16.0-20 lb.	83—11.9%
Leakage 21.0-25 lb.	74—10.6%
Leakage 26.0-30 lb.	57— 8.1%
Leakage 31.0-35 lb.	33— 4.7%
Leakage 36.0-40 lb.	23— 3.3%
Leakage 41.0-45 lb.	10— 1.4%
Leakage 46.0-50 lb.	46— 6.6%
	700—100.0%

AVERAGES OF LEAKING AND PISTON TRAVEL

	Piston Travel	Leakage (Per 50#)	Pressure Initial	Pressure After 1 Min.
Table 1	6.62	17.32	25.69	16.26
Table 2	6.61	17.25	25.85	15.19
Table 3	7.20	14.33	22.80	14.73
Table 4	7.45	17.55	22.57	13.14
Table 5	7.19	17.02	23.52	13.68
Table 6	7.71	20.08	21.78	10.97
Table 7	6.75	16.53	24.91	14.38
Average	7.09	17.15	23.87	14.05

AVERAGE LEAKAGE FOR PRESSURE DEVELOPED

Table 1— 9.43#	Table 5— 9.84#
Table 2—10.66#	Table 6—10.81#
Table 3— 8.44#	Table 7—10.00#
Table 4— 9.43#	

AVERAGE LEAKAGES FOR PRESSURE DEVELOPED

Table 1	9.43
Table 2	10.66
Table 3	8.44
Table 4	9.43
Table 5	9.84
Table 6	10.81
Table 7	10.00

SUMMARY OF PISTON TRAVEL

Piston travel 3½- 4 in.	17	2.4%
Piston travel 4¼- 5 in.	86	12.3%
Piston travel 5¼- 6 in.	149	21.3%
Piston travel 6¼- 7 in.	181	25.9%
Piston travel 7¼- 8 in.	126	18.0%
Piston travel 8¼- 9 in.	66	9.4%
Piston travel 9¼-10 in.	33	4.7%
Piston travel 10¼-11 in.	27	3.9%
Piston travel 11¼-12 in.	15	2.1%
	700	100.0%

Diagrams are presented showing the variations in the leakage of the cars taken at one of the terminals represented at No. 4, from which it will be seen that the effects would be more than detrimental to braking efficiency if the cars were to be arranged in a train in the order in which they were caught and numbered in the yard. Leakages jumping from 3½ lbs. to 50 lbs. per minute between two consecutive cars and back to 3½ lbs. again two cars later, would not be conducive to safe grade braking.

A second diagram shows the leakage on the 700 cars as tabulated in the summary. A third diagram gives the averages of the leakages of each group of cars as given in the general summary. For example:

The first group shows that there were 174 cars having a leakage of 5 lbs. per minute or less. The average leakage of these 174 cars was 2.5 lbs. as given in the diagram. Likewise the group of cars in the leakages summary from 5.5 to 10 lbs. per minute, of which there were 95, averaged 7.6 lbs. per minute and so on.

The startling point of all this is that only 24.9 per cent of the cars examined showed a leakage of 5 lbs. per minute or less, and that only 18.0 per cent of the cars had a piston travel falling within the range of from 7¼ in. to 8 in.

The scope of the investigation was so great that it undoubtedly represents the

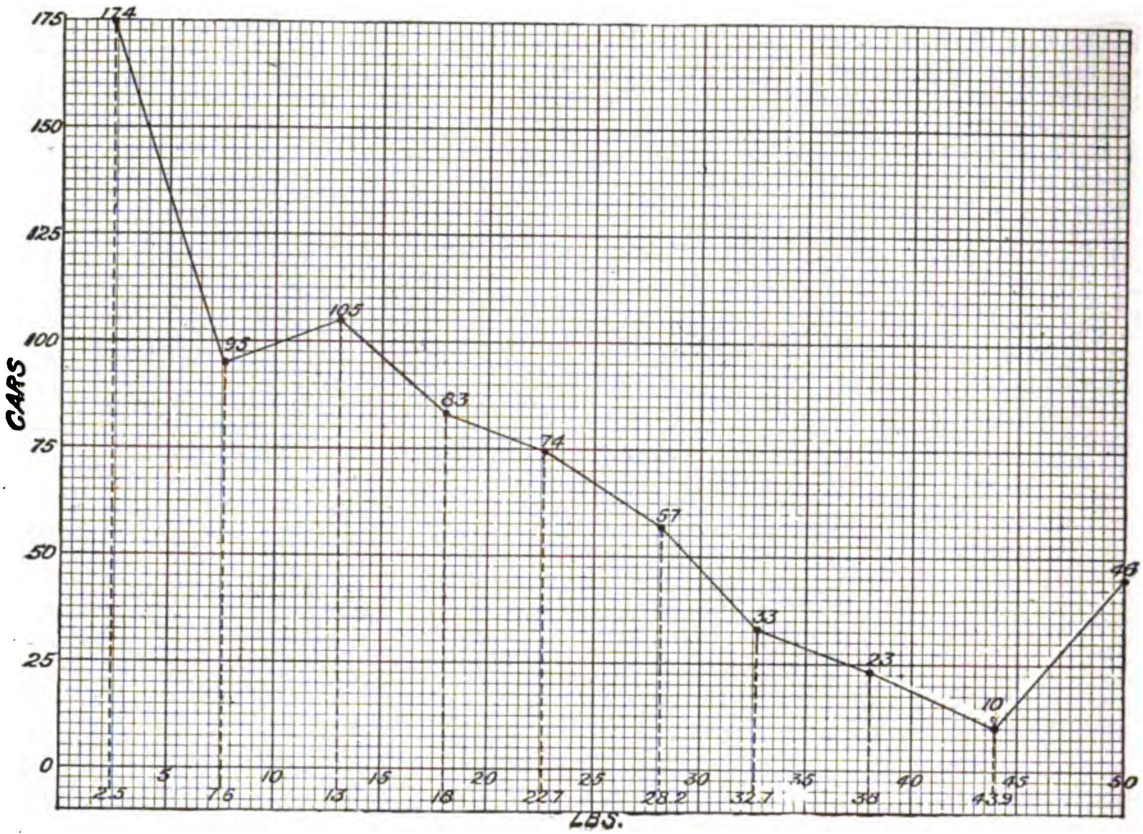


DIAGRAM SHOWING THE AVERAGE LEAKAGE FOR EACH GROUP OF CARS FROM 0 TO 50 LBS. TOTAL NUMBER OF CARS TESTED 700.

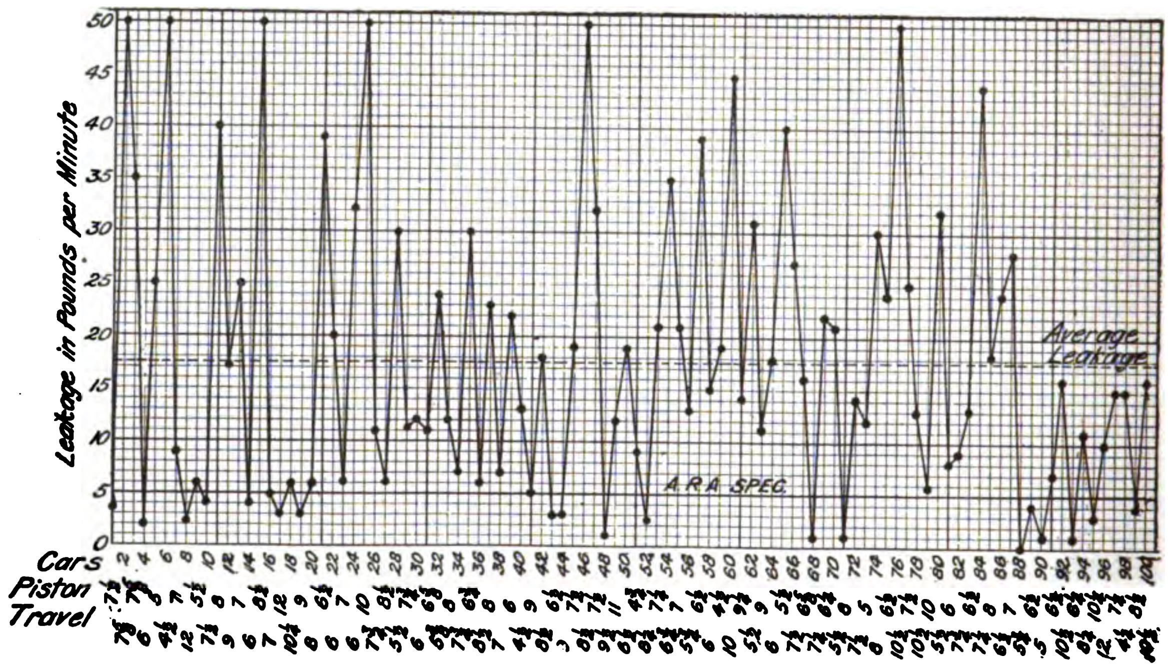


DIAGRAM SHOWING RESULTS OF CYLINDER LEAKAGE TEST ON THE 100 CARS TAKEN AT ONE OF THE TERMINALS.—TABLE NO. 4.

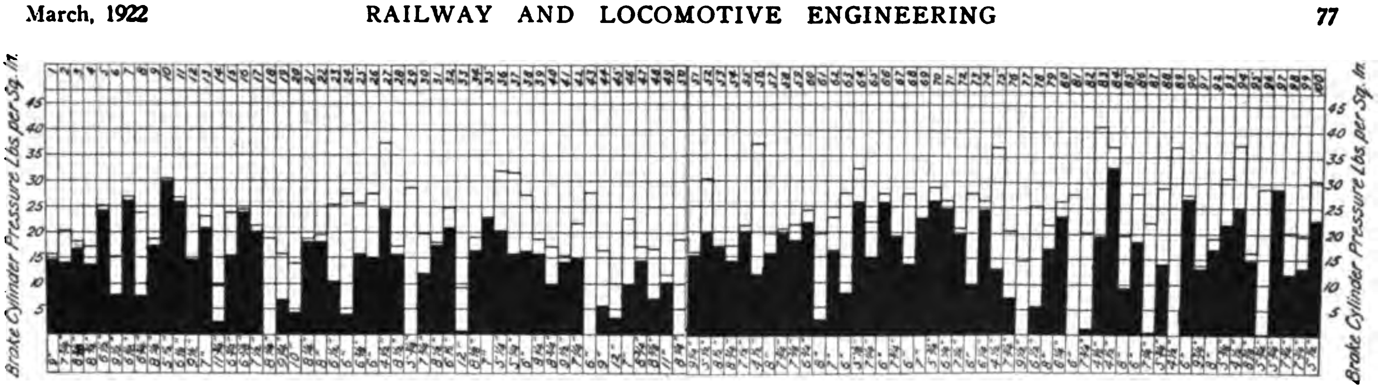


DIAGRAM SHOWING INITIAL PRESSURES RESULTING FROM AT 10 LB. BRAKE PIPE REDUCTION AND PRESSURE REMAINING AT THE END OF ONE MINUTE.

average condition of the air brake equipment throughout the country, and it shows further that that equipment is in a deplorable state of much needed repairs. The condition must, therefore, be accepted as a proven fact and the question arises as to what can be done to improve it by those who are qualified to make improvements.

Comparative Tests of Steel at High Temperatures

At the last meeting of the American Society for Testing Materials, Mr. R. S. MacPheran presented a paper on some Comparative Tests of Steels at High Temperature that were made in the laboratory of the Allis-Chalmers Co. at Milwaukee. Wis. The temperatures to which the steels were raised for testing ran up to about 1300° Fahr, which was up to an approximation to those obtained in internal combustion engines. The points of especial interest, however, are those showing the behavior of steels at temperatures that come within the range of ordinary practice.

The steels tested included open hearth, carbon, nickel, chrome-high-nickel, chrome-vanadium and high manganese steels. The tests were made for tensile strength, limit of elasticity and elongation.

There was one feature in which all of the tests agreed. Starting with a base temperature of 100° Fahr. the tensile strength decreased, as the temperature was increased and then under a further increase of temperature the tensile strength also increased, usually, but not always rising to a strength above that which it possessed at 100°. Then after reaching a maximum there was a rapid fall in tensile strength as the temperature was raised still higher.

The point at which these changes occur varies with the different steels for there is no one temperature at which all steels will show a decided change in physical properties, as this point will vary in steels of different compositions or treatments. The maximum tensile strength, however, for rolled carbon steel, annealed, and forged 3.25 per cent nickel steel, annealed, occur at between 600° and 650° Fahr. And the maximum tensile strength usually occurs at a higher temperature than the minimum ductility.

The final sharp fall in tensile strength, referred to, especially in the case of heat-treated steels, usually occurs when the temperature has been raised to about 800° Fahr.

The effect of nickel in small amounts is slight, but in large percentages it tends to lower the temperature at which tensile strength begins to decline. Steel containing nickel is also the only steel examined where the ductility materially diminishes at the higher temperatures. It may here be noted that the same property was observed in the one set of forged monel metal bars.

The alloy steels containing chromium are less affected by rise in temperature than carbon steels. The curves of the tensile loads, elongation and reduction all run out more nearly straight than in carbon steels and the maximum loads occur at higher temperatures. It is true that the carbon steels were not heat treated and it is possible that quenching and tempering would alter the shape of these curves.

The results so far obtained would indicate that the introduction of metals forming carbides tends to strengthen steels at high temperatures.

New Method of Forging Wheel Centers

A new process for producing disc-center wheels has been developed in England and carried on at Coventry by the Powell, Brett Company. The process consists in turning out wheel centers in the shape of drop forgings by means of special hammers. The wheel centers are produced direct from an ingot by a special process, and the cast condition of the steel under powerful drop hammers is broken down into a proper forged state. The final operation of stamping ceases practically at the critical period of temperature of the steel and the center leaves the dies with the material in what is said to be an ideal state, uniform in shape, perfectly balanced and possessing a ductility and tensile strength leaving little to be desired for this class of steel. The production of wheel centers by this method involves the employment of a very powerful drop hammer of special design.

Pennsylvania's Rail Supply for 1922

Since the New Year the Pennsylvania has placed orders for 80,000 tons of steel rails, although the amount on hand is about 75,000 tons, besides a large supply of used rail in good condition for lighter service on branch lines and other less important tracks. Practically all of the rail ordered for delivery this year will be of the heaviest section, weighing 130 pounds to the yard. The orders are divided as follows: Carnegie Steel Company, 40,000 tons; Bethlehem Steel Company, 18,000 tons; Cambria Steel Company, 18,000 tons and Lackawanna Steel Company, 4,000 tons.

Motive Power and Rolling Stock Statistics

In the matter of a comparison between American railroad equipment and that of other countries, it need hardly be called to mind for instance that American locomotives are generally twice, and in many cases three times, as powerful as those of any other country given, except Canada; and consequently, in respect to hauling power, the figure of 68,592 should be rather 150,000 in comparison with Great Britain, France or Germany. The same thing is true of passenger cars and freight cars, the former probably averaging from 50 to 100 per cent larger than the average passenger car in European countries, and the capacity of the freight cars being three times that of the freight cars of other countries, with the exception of India and Canada. By applying these percentages, United States totals for rolling stock will be brought up to a closer proportion to the total mileage of track.

When Are the Railroads to Begin Buying?

We are often asked the question, "When will the railroads begin buying?" When they have difficulty in taking care of their overhead charges, let alone setting aside anything for surplus, and must contend with high costs and a reduced volume of traffic, they cannot be expected to incur liabilities for the purchase of rolling stock, particularly at a time when a large part of the equipment they own is not in service, nor will they have a volume of traffic to produce increased revenues unless the manufacturers along their lines are operating successfully.

When car business does revive there will be, in addition to the work we have had in former years, considerable "heavy repairs," as large cars built 20 years ago are only now beginning to need substantial repairs, and few railroads are fitted to do this work as economically as car shops.

Indications point to a large demand for passengers cars, as for years few have been bought, and while this is not an important factor with us, it will help. During the year we took a substantial order for China, which we hope to complete early this year.

Full Crew Repeal Discussed Before the New York Legislature

At a meeting of railroad representatives at Albany, N. Y., held on March 2, the Niswell-Martick bill introduced in the legislature with a view of repealing the so-called full crew law, was discussed before a special committee of the legislature. In speaking of the measure, Michael Welsh, assistant superintendent of the New York Central, stationed at Buffalo, stated that in all his years of experience as a railroad man he never knew of one accident that would have been prevented by a full crew.

C. C. Paulding, vice president of the New York Central, was the principal advocate of repeal. He said the full crew law had never prevented accidents, but that the decrease in them had been due to improved mechanical safety devices, new signal systems and greater efficiency of the air brake.

Marcus Dow, general safety agent for the New York Central, said that after the full crew law was placed on the statute books, accidents on railroads continued to show an increase and that the roads took steps to prevent accidents through the education of employes.

P. J. Langdon, air brake superintendent of the Delaware, Lackawanna & Western, said that if a man was placed on every car there would still be accidents. Letters were read from a number of chambers of commerce urging the repeal of the law. The associated industries of the state also went on record as opposed to its continuance.

James P. Holland, president of the New York State Federation of Labor, and John E. Fitzgibbons, legislative representative of several railroad brotherhoods, spoke for the train crews. The latter insisted that statistics showed that the full crew law had saved thousands of lives. William E. Fitzimmons, representing the Brotherhood of Engineers and Firemen, urged that the law be retained.

January Railroad Earnings

Based on the showings of forty-six of the 201 Class 1 railroads of the country for January, the total net operating income for that month is now estimated at $30,000,000 by local officials. On the basis of seasonal distribution of earnings this is equivalent to an annual interest return of approximately 2.6 per cent on property valuation. The net earnings statements which are now being issued daily by the Interstate Commerce Commission, compare most favorably with the record of January, 1921, when the Class 1 carriers as a whole failed by $1,000,000 to cover their operating expenses and other charges. In January of 1920, however, the net operating income of the railroads was $59,639,698, or about twice the estimated total for January this year. Only two large roads reported completely for January, the Pennsylvania system showing an increase and the Southern Pacific a decrease in net as compared with the corresponding month of 1921.

The Railroad Labor Board

The question of abolishing the Labor Board or giving it more power to enforce its decision is a burning one. There are important points on which the public needs light before making up its mind for or against giving the board power to enforce its edicts. The temper of the times is not favorable to domination either by unions or by Government bodies. The board has been industrious, painstaking and well-meaning. It is premature to assume either that it is useless or weak. It seems in need of defense against its friends as well as its critics.

Air Brake Alliance Association

The Air Brake Appliance Association will hold its annual convention coincidentally with the Air Brake Association from May 9 to 12, inclusive, at the Washington Hotel, Washington, D. C. Exhibit spaces measuring five by six feet will be ready by May 8, and it has been suggested that the exhibits be confined to the smaller units instead of the heavier and larger working appliances. For full particulars regarding the convention, and requests for exhibit space communications should be addressed to J. F. Gettrust, secretary-treasurer, 318 West Washington street, care of the Ashton Valve Company, Chicago.

Labor Board Changes Hour Schedules for Signalmen

By order of the United States Labor Board new rules were promulgated re-establishing the ten-hour day at the usual hourly wages and elimination of time and one-half pay for regularly assigned work on Sundays and holidays, applying to railway signalmen, replacing the regulations the national agreement rules made under Federal control. The new rules went into operation on February 16, and affect more than 12,000 workers, and according to figures based on Interstate Commerce Commission statistics, the labor bill of the railroads will be reduced about $300,000 by eliminating the overtime pay provisions of the national agreement. Overtime pay also is eliminated for employes paid a monthly salary by a new formula for determining the monthly rate, based on the standard monthly rate. Some other rules were also changed in regard to any fixed hour for starting work and any specified lunch period.

Investigation of Power Brakes and Appliances for Operating Power Brake Systems

At a session of the Interstate Commerce Commission, held at its office in Washington, D. C., on the 20th day of February, 1922, the following order, No. 13,528, was promulgated:

The Commission having under consideration the matter of the specifications and requirements to be prescribed by it for the installation of power brakes and appliances for operating power brake systems upon locomotives and cars of carriers by railroad subject to the interstate commerce act:

It is ordered, that the Commission, upon its own motion, enter upon a proceeding of inquiry and investigation to determine whether, and to what extent, power brakes and appliances for operating power brake systems, now generally in use upon the locomotives and cars of carriers by railroad subject to the interstate commerce act, are adequate and in accordance with requirements of safety, what improved appliances of devices are available for use, and what improvements in power brakes and appliances may or should be made, to the end that increased safety in train operation may be obtained.

It is further ordered, that a copy of this order be served upon each carrier by railroad subject to the interstate commerce act, and that notice of this proceeding be given to the public by depositing a copy of this order in the office of the Secretary of the Commission at Washington, D. C., on the date as recorded.

Valuable Hints on Coal Storage

In discussing the question of coal storage, H. D. Fisher, in COMBUSTION points out particulars gathered from his personal experience, from which we make the following abstract:

All experience proves that underwater storage is the one real way of laying up coal for long periods but the northern limits where this is practical make it necessary for a great many plants either to store their coal dry, blast it out with dynamite, or wait till spring. In fact, the experience of the Omaha Electric Light and Power Company should be interesting after one or two severe winters unless they intend merely to submerge the foot of the pile and work the coal off the top in winter.

The general idea of spontaneous ignition of coal is that there is some rather unstable constituent present in freshly mined coal that when air is supplied in just the right amount and the cover is sufficient to prevent the dispersion of the heat too rapidly, this unstable substance will oxidize and generate enough heat to bring the coal itself up to the point where it will oxidize on its own account and eventually take fire. In favor of the unstable constituent hypothesis is the fact that fires are more frequent in freshly mined coal than in piles of long standing; also that coal which has once started to heat and has then been cooled by spreading and repiling seldom heats again. Conversely, fires occur, though infrequently, in coal which has lain in storage several months, and the greater number of fires in piles of freshly mined coal may be explained by the far greater number of such piles. Further, no one can say how many of those piles which were used up comparatively quickly would have taken fire if they had been left standing a little longer.

On the subject of air supply there is practically no question. When coal is piled, particularly by dumping from an elevator, the lumps naturally roll down the pile and form a porous floor for the remainder of the coal so that the air can easily circulate in along the ground to the interior and there rises up through the openings between the coal particles. It would seem that the air supply is generally deficient—that is, not enough air penetrates and oxidizes the coal to generate heat as fast as it is dissipated and only gentle warming of the coal is noticed. This is the case with coal piled in summer when the coal and air are at approximately the same temperature and the difference in temperature of the air between day and night is comparatively small. When autumn comes, however, with hot midday sun and sharp, often frosty, nights the coal pile and air contained in it are at an appreciably higher temperature than the outside air and the pile acts like a chimney, increasing the circulation of the air up to the point where serious heating can take place. This is confirmed by the number of fires occurring in the fall months, far out of proportion to the increased amount of coal going into storage at that time, and by the finding of such fires usually almost directly under the highest part of the pile. The height to which coal is piled also has its influence on this as the higher piles not only give greater cover to prevent loss of heat but also an increased chimney effect.

Slow oxidation is apparently always present in coal piles whether there is noticeable heating or not, as gas samples taken from the interior of coal piles always show considerable quantities of carbon dioxide and very little oxygen. Where the temperature of the coal was below 150 deg. F. no carbon monoxide or methane detectable by an ordinary Hempel gas analysis was found, but the analysis seldom accounted for the full percentage of oxygen present in the air, showing that some had been absorbed by the coal.

By making a survey in this way, with points at the corners of 8 or 10 foot squares if the top of the pile is fairly level, or at similar intervals along the peaks of the ridges and to each side if irregular, and subdividing wherever a temperature of 120 deg. F. is found, warm spots can be accurately located and ample warning given to stop piling coal in one location or to begin moving it to prevent a fire. A very satisfactory way to record such observations is to have blue line prints of the storage yard and mark crosses at the points tested with the temperature found below, entering subsequent temperatures in different colored inks to some definite schedule so that the status of the temperature of the coal can be taken in at a glance, which parts are heating up, which steady, and which cooling, if any.

As a rule, coal which reaches a temperature of 150 deg. F. is dangerous and will probably heat up and take fire unless some means are taken to cool it. Where temperatures of 200 deg. or over are found the coal should be moved at once as above this point it heats very rapidly and will take fire in a few days.

Some fires are attributed to spontaneous combustion and the coal condemned as unsatisfactory to store when a complete investigation might disclose other causes. In one case a good quality Somerset County, Pennsylvania, coal which was piled about 20-ft. deep against a building wall in the early autumn showed no signs of heating until late December when a fire was located near the corner of the building. Owing to interference of the posts of an overhead runway this could not be handled by the steam shovel and before the coal could be shoveled out by hand it had spread in a layer of lump about two feet thick a distance of 20 or 30 feet along the pile. This followed the contour of the heap as it originally piled up and fine coal both above and below it was unaffected. It seemed a very strange sort of fire until the cause of it was uncovered in a steam drip which had been carried out through the building wall and down through the pile at some past time and on which the valve was now found to be leaking.

Fires are also started by pieces of wood in the coal, the legs of wooden trestles being a favorite place as they are usually, too, in the deepest part of the pile. It is a very worthwhile precaution to put in cement piers for a trestle or encase the wooden ports with a good solid layer of it as only extra good fortune will escape having one or two burned up every year.

Many methods of storing coal to diminish the risk of its taking fire have been discussed, but aside from submerged storage the cost seems prohibitive as too much labor is required for carrying them out. One very promising suggestion was to lay ducts under the pile and have a fan to supply cooled and washed stack gases so as to obtain a very considerable circulation of inert gas which would both cool and smother any tendency toward heating. From some trials of injecting CO_2 from drums of compressed gas very large volumes are needed.

For the average small plant, piling in as shallow a pile as possible, leveling the top to avoid any definite trend of air currents and keeping a close watch on the temperature are usually sufficient. Where there is a choice in the matter store the better coal and burn the poorer at once, for in a general way the coals that give trouble clinkering in the firebox seem to give trouble heating in the coal pile.

When coal in a pile does take fire there is only one remedy—dig it out, wet it down and if possible burn it up at once. Where the location of the pile will not allow of this the Canadian Pacific Railroad has evolved a very successful method of dealing with fires, first locating the hot spot carefully, then surrounding it with a trench and punching holes down in it all around the fire so that when the trench is filled with water the fire will be isolated with a wall of wet coal and then driving holes so as to carry water into the heart of the fire itself. If this is not done and a hole is driven into the heart of the fire and water turned in the hot gases will be driven out into the pile and the fire only spread further.

Items of Personal Interest

F. Gardner Thorpe has been appointed general storekeeper of the Long Island, succeeding Eugene Wright, promoted.

T. F. Hawley, special agent for the Erie, has been appointed superintendent of locomotive operation, with headquarters at New York.

J. E. Stevens has been appointed master mechanic of the Mobile & Ohio, with headquarters at Murphysboro, Ill., succeeding B. A. Orland.

Walker D. Hines, formerly director general of railroads during Federal control, has been appointed eastern general counsel of the Great Northern.

D. V. Fraser has been appointed assistant to the purchasing agent of the Missouri, Kansas & Texas, with headquarters at St. Louis, Mo.

I. S. Fairchild has been appointed storekeeper of the New Orleans Terminal division of the Illinois Central with headquarters at New Orleans, La.

J. McGowan, locomotive foreman of the Canadian National railways at Strathcona, Alta., has been appointed shop foreman with office at Fort William, Ont.

W. G. McPherson, master mechanic of the Regina division of the Canadian Pacific with headquarters at Regina, Sask., has been transferred to Moose Jaw, Sask.

F. C. Prest, purchasing agent of the Northern Pacific, with headquarters at St. Paul, Minn., has been appointed director of purchases, with the same headquarters.

F. A. Toates has been appointed assistant road foreman of engines of the Los Angeles division of the Southern Pacific, with headquarters at Los Angeles, Cal.

H. K. York, car foreman of the Canadian Pacific, with headquarters at Alyth, Alta., has been promoted to general car fireman, with headquarters at Moose Jaw, Sask.

S. F. Bowser, founder and president of S. F. Bowser & Co., Fort Wayne, Ind., has resigned from the office of president, and is succeeded by S. B. Bechtel, general manager.

G. N. Bichlemeier, purchasing agent of the Union Pacific, with headquarters at Omaha, Neb., has been promoted to general purchasing agent with the same headquarters.

Robert J. Elliott, assistant purchasing agent of the Northern Pacific, with headquarters at St. Paul, Minn., has been appointed purchasing agent with the same headquarters.

W. H. McEwan has been appointed chief despatcher, fourth and fifth district of the Grand Trunk, with headquarters at Montreal, succeeding O. Massee, promoted to inspector of terminals.

Capt. A. W. Fuchs, formerly of the U. S. Public Health Service, has been appointed sanitary engineer of the Missouri Pacific with headquarters at Memphis, Tenn.

W. H. Winterrowd, chief mechanical engineer of the Canadian Pacific, has been elected vice-chairman of the Executive Committee of the American Society of the Mechanical Engineers' Railroad Division.

C. A. Murdock, car foreman of the Canadian National railways at Three Rivers, Que., has been transferred to a similar position at Farnham, Que., succeeding W. Sturgeon, who has been pensioned.

J. A. Conley, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Colma, Cal., has had his jurisdiction extended over the shops at Richmond, Cal., succeeding E. H. Harlow, deceased.

J. McKinnon, night foreman of the Canadian National railways at Fort William, Ont., has been appointed shop foreman with office at Winnipeg, Man., succeeding G. Johnston, transferred to Moose Jaw, Sask.

Burton Mudge, vice-president of the Pilliod Company, manufacturers of the Baker Valve Gear, has been placed in charge of the company's recently established western office at 750 Railway Exchange building, Chicago.

A. B. Shanks, master mechanic of the Missouri, Kansas & Pacific of Texas, with headquarters at Smithville, Tex., has been appointed master mechanic on the newly created South Texas district, with headquarters at Waco, Tex.

J. G. Sullivan, formerly chief engineer of the Canadian Pacific, Lines West, has been elected president of the Engineering Institute of Canada. Mr. Sullivan was president of the American Engineering Association during 1917-18.

R. N. Dodge, formerly senior inspector of car equipment of the Interstate Commerce Commission, Bureau of Valuation, has been appointed car foreman in the heavy freight repair shop of the Chicago & Altoona at Bloomington, Ill.

B. B. Milner, formerly engineer of motive power and rolling stock of the New York Central, and latterly attached to the Frazar exporting company, is proceeding to the Orient to engage in private practice as consulting sales engineer.

H. E. McGee, general manager of the Missouri, Kansas & Texas of Texas, with headquarters at Dallas, Tex., has been appointed general manager of the Missouri, Kansas & Texas, with headquarters at Parsons, Kan., succeeding A. S. Johnson.

C. Moth, division master mechanic of the Canadian Pacific, with headquarters at Edmonton, Alta., has been appointed to the advisory position of district master mechanic of the Edmonton, Dunnegan and British Columbia, with headquarters at Edmonton.

M. W. Boucher, locomotive foreman of the Canadian Pacific, with headquarters at Field, B. C., has been appointed general locomotive foreman of the Edmonton, Dunvegan & British Columbia, with headquarters at McLennan, Alta., with supervision over the locomotive and car departments.

E. Griffiths, division storekeeper of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Iowa, has been transferred to Mobridge, S. D., succeeding G. L. Juel, who has been transferred to Malden, Wash., succeeding H. R. Meyer, who has been transferred to Perry, succeeding Mr. Griffiths.

D. C. Fenstermaker, formerly district engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been appointed principal assistant engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago. He was recently engaged in railroad construction work in Cuba.

W. C. Smith, formerly mechanical superintendent of the Missouri Pacific, has been appointed mechanical superintendent, succeeding J. E. O'Brien, resigned, and Charles Harter has been appointed assistant mechanical superintendent, and in addition will assume the duties and title of mechanical engineer.

Charles H. Stein, assistant to the president of the Central of New Jersey, has been appointed to the office of general manager, with headquarters in New York City. Mr. Stein, in addition to the duties incumbent to the operating department, will have charge of the engineering, mechanical and marine department of the road.

John M. Weir, chief engineer of the Kansas City Southern, has accepted the appointment as general superintendent of construction of the National Boiler Making Company, Chicago. Mr. Weir has had a wide experience in the engineering department of several of the leading railroads, and has also earned a high reputation as a valuation expert.

Julius Kruttschnitt, chairman of the Executive Committee of the Southern Pacific, has been elected a director of the American Railway Association, for the term expiring November, 1924; E. E. Looms, president of the Lehigh Valley, for the term expiring November, 1923, and Howard Elliott, chairman of the Executive Committee of the Northern Pacific, for the term ending November, 1922.

Samuel Rea, president of the Pennsylvania Railroad system was recently elected an honorary member of the American Society of Civil Engineers. The general membership of the Society numbers nearly 10,000 but the honorary membership cannot exceed 20 at any time and is conferred upon persons of acknowledged professional eminence and achievements. Mr. Rea, as is well known, has been prominently identified with the Pennsylvania Railroad for over fifty years. Beginning his remarkable career in the lower branch of the engineering department he was rapidly advanced to the highest position on the road, and it was largely owing to his technical skill and creative genius that made possible the entry of the great railroad to New York and direct communication to New England, involving the construction of the tunnels under the Hudson and East rivers, the beautiful station in Manhattan and the monumental bridge that spans the entrance to Long Island.

OBITUARY

Frank S. Dinsmore

The death is announced of Frank S. Dinsmore, for many years attached to the business staff of the *Railway Age*. The sad event occurred on February 14, in the Long Island College Hospital, Brooklyn, N. Y. Mr. Dinsmore was in the 63rd year of his age. He began the study of medicine in his early manhood but, changing his mind, drifted into various occupations chiefly in the west. Joining the staff of the *Railway Surgeon* he latterly transferred his services to the *Railway Age*. As an advertising salesman of a genial and kindly nature, superadded to which was a richly philosophical vein that saw the brighter side of the darkest hours; he was much esteemed among his wide acquaintance generally, and railroad men particularly, and will be long remembered.

A. T. Hardin

A. T. Hardin, vice-president in charge of operation of the New York Central Lines, died on Februray 21, at New York, in the fifty-fourth year of his age. In 1894 he graduated from the University of South Carolina and, after some years' experience on the Southern railway in the telegraph service, he was engaged by the New York Central as supervisor and division engineer. He was rapidly promoted in the engineering department and in 1905 had reached the position of assistant to the general manager, and was elected vice-president in 1913.

Ericsson's Memory Honored

The exercises in connection with the unveiling of four bronze tablets in memory of Captain John Ericsson, and incidentally culminating with the sixtieth anniversary of the battle between the *Monitor* and the *Merrimac* were participated in by many civic and engineering societies. The flag which formerly flew upon the *Monitor* was much in evidence. The exercises began in the Monitor School and the Ericssson School in Brooklyn, on March 2, and during the first week in March the city fairly rang with the name of the clever machinist, accomplished engineer and great inventor. The exercises fittingly culminated with a banquet at the Waldorf-Astoria Hotel on March 9, at which representatives of the United States and Swedish governments were present. A simultaneous banquet was held in Stockholm, Sweden. Greetings were exchanged by cable, and the memory of the great man fittingly honored.

Baldwin Locomotive Works Report for 1921

S. M. Vauelain, president of the Baldwin Locomotive Works, in transmitting the annual report to the stockholders states that the property has been maintained in a high degree of efficiency and is fully prepared to meet the renewal of activities which he hopes will shortly be realized. In 1920 a net profit was earned amounting to $4,-429,000. In 1921 a net profit of $5,-044,000 after the payment of interest, depreciation, and taxes was made. After the payment of dividends there were $2,244,000 carried to the surplus account.

Texas Company's Divisions Consolidate

The Texas Company, 17 Battery Place, New York, has consolidated its traffic and railway sales departments, which will afterwards be known as the traffic air railway sales department under the supervision of G. L. Noble, vice-president, Mr. Jervis, manager, and W. F. Greenwood, assistant manager. The lubricating division is under the supervision of J. E. Symons. W. H. Barrows has been appointed district manager at Houston, Texas.

Domestic Exports From the United States by Countries

Steam Locomotives, December, 1921

Countries	Number	Dollars
Mexico	26	556,900
Jamaica	1	3,000
Cuba	1	10,580
Argentina	30	1,368,000
Chile	5	225,000
Japan	2	15,140
Total	65	2,178,620

American Railway Association — Mechanical Division

It is officially announced that at the annual meeting of the Mechanical Division, American Railway Association, which will be held in Atlantic City, N. J., June 14-21, inclusive, 1922, it has been decided that the reports of Committees investigating car matters will be received and discussed Wednesday, Thursday and Friday, June 14-16, inclusive, and reports of Committees investigating locomotive matters will be received and discussed Monday, Tuesday and Wednesday, June 19-21, inclusive. As soon as ready a circular will be issued giving program and all other necessary information.

NEW PUBLICATIONS

Books, Bulletins, Catalogues, etc.

Locomotive Engineers' Pocket Book and Diary, 1922. Published by the Locomotive Publishing Co., 3 Amen Corner, London, England.

This interesting annual seems to have the quality of growing in interest year by year, and bids fair to rank with the heavier mechanical engineers' pocket book. As a model of condensation it contains more matter of real value on less space than any work with which we are familiar. The construction, running and repairing of the modern locomotives is described, with all the accessories up to date. As an epitome of locomotive engineering it is unique, as a collection of all that is noteworthy in its chosen field it is a model of clearness and conciseness.

Handbook for Iron Foundries. Published by the Locomotive Publishing Co., 3 Amen Corner, London, England.

The intention of this book is not to upset accepted theories and practices, but rather to draw freely upon all available information and experience with a view to assisting the foundryman on the issues which are all important to him. The choice of pig iron and general foundry practice are inexhaustible subjects, and the foundryman relies as much to-day as ever upon the little things which in his experiences has helped him, directly or indirectly, to produce the ideal casting. All this and more than this will be found in this excellent work.

Westinghouse Instruction Pamphlets

The popular demand for instruction pamphlets on air brake equipment has necessitated the publication of new editions by the Westinghouse Air Brake Company, Wilmerding, Pa., of its special publications including that of No. 6 E T locomotive brake equipment, the U C passenger car brake equipment, and the 3 T triple valve test rack, with codes of tests. These publications have the double merit of clearness and brevity, and are the work of accomplished experts in air brake equipment.

Mechanical Stokers

Based on a paper read before the Stoker Manufacturers' Association on Forced and Induced Draft with Mechanical Stokers, by H. F. Hagan, a leading authority on the subject, the full report appears in the January issue of *Combustion*, and, while the subject matter of the article is written around stokers, it covers the general matter of forced and induced draft that makes it absorbingly interesting to all who in any way are using an artificial supply of air. This article has four original graphic charts. The reading of this article will make clear a subject that is of absorbing interest to all who have to do with the subject of combustion in any of its phases.

Electric Brass Furnace Investigations

The electric melting of brass has been studied by the Bureau of Mines for the past ten years, from the points of view of decreasing the losses of the constituent metals in brass, especially zinc, improvement in labor conditions, aiding in the conservation of fuel oil by substituting electric heat generated by water power or by coal, improving the quality of the brass and decreasing the cost of melting. In the course of the work a furnace type was developed by the Bureau which has found wide use in the industry, both in foundries and rolling mills, more than half of the electric brass furnace kilowattage of the country being connected to furnaces of this type. The Bureau has kept in close touch with makers and users of all other types of electric brass furnaces as well, and a comprehensive bulletin on the design, operation and commercial performance of all the furnaces is awaiting publication.

Abrasive Wheel Safety Code

Under the joint sponsorship of the Grinding Wheel Manufacturers' Association of the United States and Canada and the International Association of Industrial Accident Boards and Commissions, there was organized a sectional committee for formulating a safety code for abrasive wheels. The code prepared by this committee and approved by the sponsors has been approved as Tentative American Standard by the American Engineering Standards Committee.

The code contains rules and specifications considered necessary to insure safety in the use of abrasive wheels operating at speeds in excess of 2,000 surface feet per minute. It consists of sections dealing with scope, types of protection devices, storage and inspection of wheels, general machine requirements, protection hoods, work rests, protection of wheels, flanges, mounting, speeds operating rules and general data. It is well illustrated. Copies of the code may be secured from the American Engineering Standards Committee, 29 West 39th Street, New York City. Price 10 cents each.

Meter Service Switches

Westinghouse meter service switches are described and illustrated in Circular No. 4484, recently issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The switches are designed to meet every condition encountered by central stations in supplying service to homes and apartment houses and they can be used in connection with standard makes of meters on the market, or independently, if desired.

In addition to describing Type WK-54, the publication also contains a description and illustration of the Boston-type outfit. Other features discussed are meter trims, end walls and accessories, methods of banking, dimensions and wiring connections.

Cylinder Oil for Superheated Steam

The Texas Company's technical publication devoted to the selection and use of lubricants begins Volume 8 with a collection of valuable information on its chosen field. Among other items of information it is claimed on competent authority that the proper oil for a superheated steam cylinder is a medium-heavy viscosity cylinder oil, having a fair amount of compounding, something like 4 or 5 per cent of animal oil. Such an oil, on account of this compounding, will emulsify slightly and thereby lubricate the cylinders very efficiently during that period when they are filled with saturated steam. As the compounding is small there will be no bad effects resulting from the exposure of the oil to superheat conditions. It is fully appreciated that this is somewhat contrary to the usual understanding and the general recommendations as to the properties necessary for an oil to withstand superheated steam, but the success which has attended the use of this type of oil, makes the explanation given above appear as the proper one. Of course, there are conditions where the use of a compounded oil may not be advisable, such as in the reciprocating engines used in marine practice. However, since the majority of the cylinders of such engines are vertical, and a very small amount of oil is required for their lubrication, it is not believed that any difficulty will arise from the use of a straight mineral cylinder oil under superheat conditions. In general, it is therefore recommended that a slightly compounded oil be used in cylinders subjected to superheated steam conditions.

Trent Process for Cleaning Coal

The efficiency of the Trent Process in cleaning coal has been determined by the Bureau of Mines for typical coals of the United States. The point of superiority of the Trent Process over ordinary washing methods is the high combustible recovery obtained, in some cases as high as 99 per cent. Low-grade sub-bituminous coals and lignites do not respond readily to treatment by the Process. The Process is not efficient in removing sulphur present as pyrite in the bituminous coals; with anthracite coals, sulphur removal is good. The relation between fineness of grinding and ash separation has been determined on typical coals pulverized to sizes as small as 10 microns, (.01 mm).

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV | 114 Liberty Street, New York, April, 1922 | No. 4

The Landis Twelve-Inch Pipe Threading and Cutting Machine

The Landis Machine Co. of Waynesboro, Pa., have recently brought out a pipe threading and cutting machine which has a range of operation of from 4 in. to 12 in. pipe, and it may be equipped to cut pipe as small as 2½ in. For such work two die heads are used, a 6 in. head for the range from 2½ in. to 6 in., and a 12 in. head for the range from 6 in. to 12 in. The length of the machine is 11 ft., its extreme width is 5 ft. and it weighs 13,000 lbs.

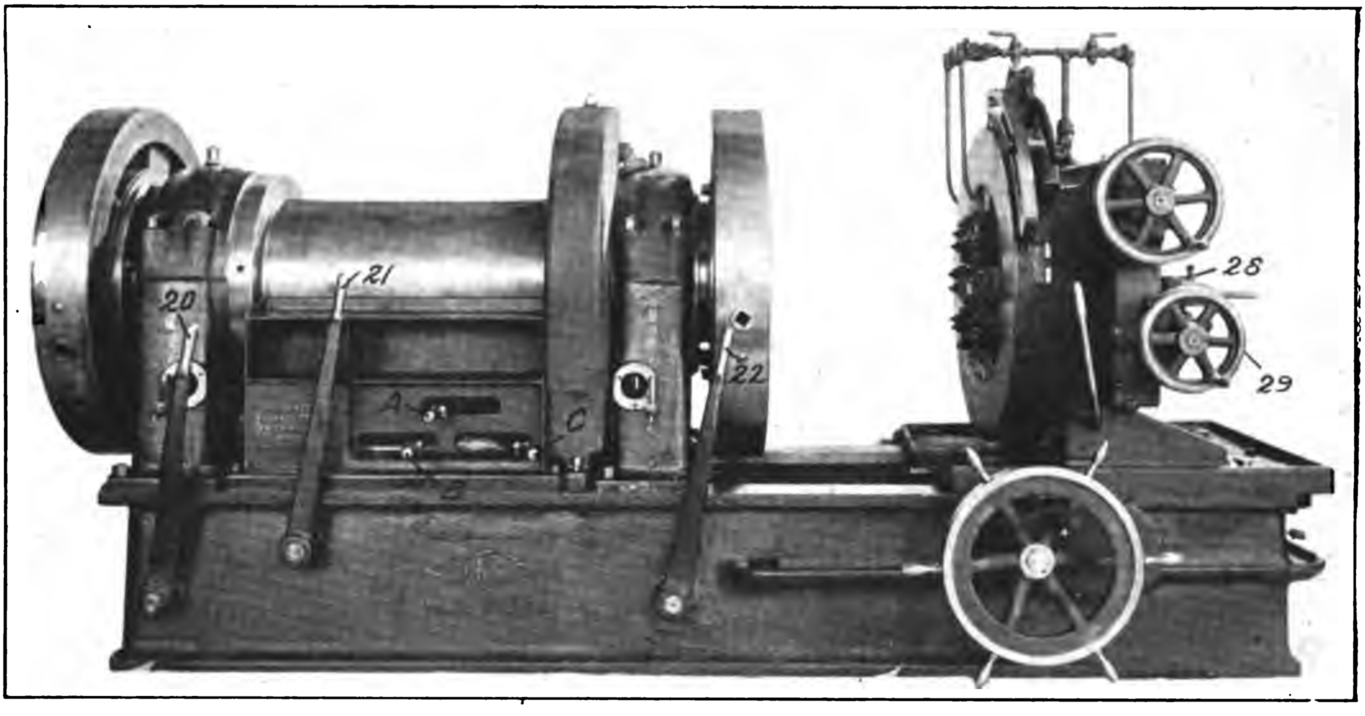
The machine has a single pulley drive, and the variations in speed, which are eight in number, are obtained by means of a speed box, located beneath the main spindle. A plan view of this speed box is shown in the accompanying reproduction of a photograph.

The friction clutch (1) is located on the main driving shaft with the pulley (23) or if driven by an electric motor chain sprocket will be substituted for the pulley. The operating cone (2) of the clutch is moved by levers (20 or 22) which are located at the ends of the headstock within reach of the operator, both when he is threading pipe or making up flanges.

On the same shaft with the clutch are the two spur gears (3 and 4) which are driven by a spline, and are fastened together. They may be moved along the shaft by the lever B so that the gear (4) will be in mesh with the gear (5) keyed to the shaft (24) or the gear (3) will be in mesh with the gear (6) on the same shaft. This gives two obtainable speeds for the shaft (24). Keyed to this same shaft are the gears (7 and 8).

The shaft (25) has two gears (9 and 10) of different diameters, which are rigidly attached to each other and have a keyway readily moving on a rigid key.

They may be moved along the shaft by the lever A so that the gear (9) meshes with the gear (7) or the gear (10) with the gear (8). As they are of different diameters, it is possible to obtain two speeds for the shaft (25) for each speed of the shaft (24). The fixed gear (11) on the shaft (25) meshes with the gear (12) on the shaft (26). This latter shaft carries two sliding gears (13 and 14) which may be moved into mesh with the gears (15 and 16), respectively, on the main shaft, which also carries the driving pinion (17). As the gears (11 and 12) are of the same diameter the ratio of the rate of rotation between the shafts (25 and 26) are constant, and for each speed of the shaft (26) there are two available for the main pinion shaft, thus making eight in all. The route of these powers for the



THE LANDIS 12-INCH PIPE THREADING AND CUTTING MACHINE.

eight speeds depends on the relative position of the levers A, B, and C, which may be adjusted so that the drive follows any one of the following eight routes:

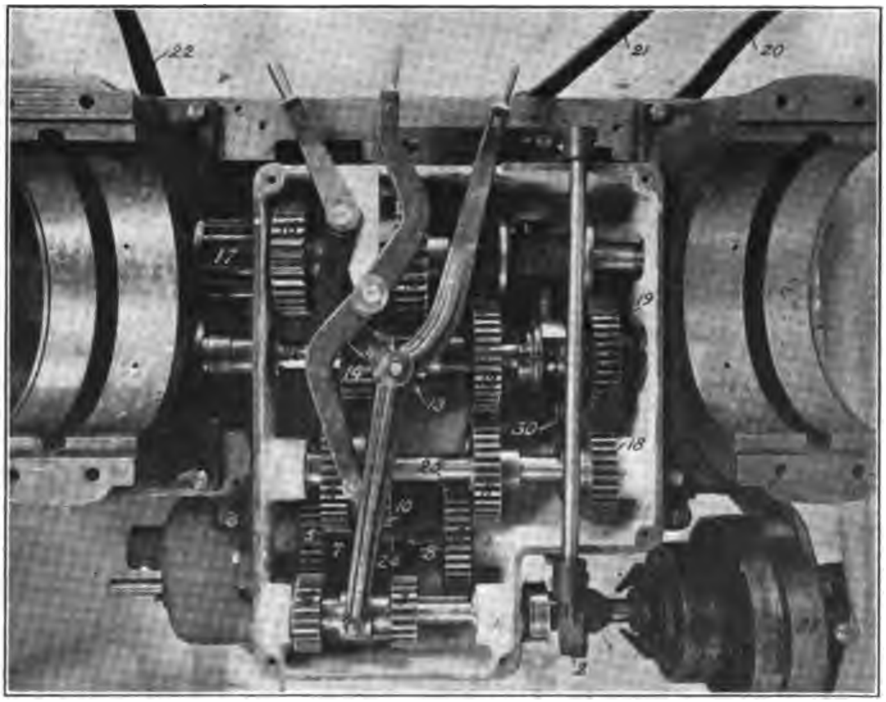
4, 5, 7, 9, 11, 12, 14, 16, 17,
4, 5, 8, 10, 11, 12, 14, 16, 17,
4, 5, 7, 9, 11, 12, 13, 15, 17,
4, 5, 8, 10, 11, 12, 13, 15, 17,
3, 6, 7, 9, 11, 12, 14, 16, 17,
3, 6, 8, 10, 11, 12, 14, 16, 17,
3, 6, 7, 9, 11, 12, 13, 15, 17,
3, 6, 8, 10, 11, 12, 13, 15, 17.

The two gears (12 and 19) are loose on the shaft (26) and between them is the clutch, which is operated by the lever (21) so as to engage the gears (12 or 19). When it is in engagement with the gear (12) the machine is moving in the direction for cutting the thread.

The gear (18) on the shaft (25) meshes with an idle pinion the end of whose shaft is seen at 30 and this pinion is also in mesh with the gear (19), so that the gears (12 and 19) turn in opposite directions. Hence when the clutch (27) is moved, as in the engraving so as to be in engagement with the gear (19), the machine is reversed, this reverse being used for screwing off flanges or cutting left hand threads.

The gears are thus fully enclosed and, with the exception of the main drive gear and its pinion, they run in an oil bath.

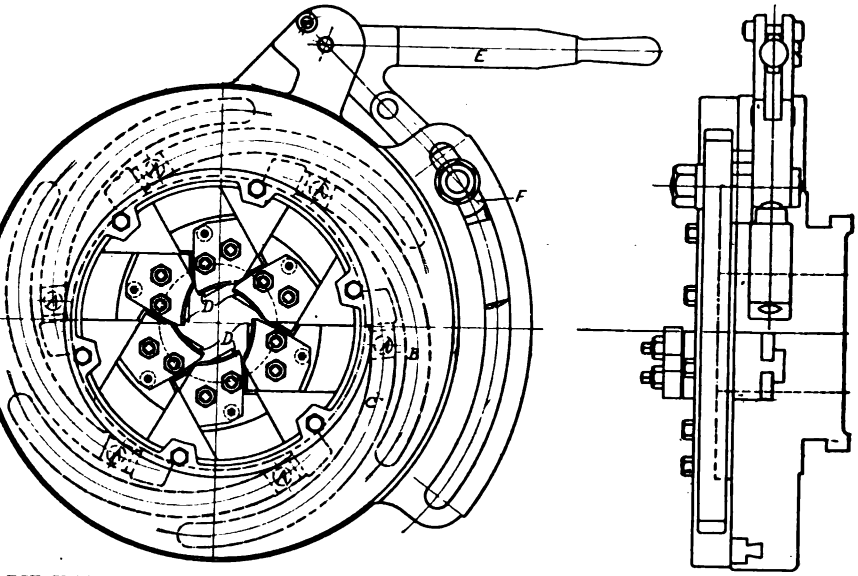
The main bearings of the hollow spindle are lubricated with flat link chains which run in oil contained in large reservoirs in the base. The driving pinion shaft as well as the reverse shafts are lubricated by sight feed oilers.



PLAN OF GEAR BOX OF LANDIS 12-INCH PIPE CUTTING AND THREADING MACHINE.

At each end of the hollow spindle there is a three-jawed universal clutch for holding the pipe, with an ample range for taking all sizes that the machine is adapted to hold. The rear clutch is equipped with flange grips for fitting flanges.

A point of great interest in the machine lies in the threading chasers and the method of their adjustment.



DIE HEAD OF THE LANDIS 12-INCH PIPE CUTTING AND THREADING MACHINE.

The chasing tools are of the regular Landis design and so are used in each head. One of them is illustrated in the accompanying engraving, and the set of six represents a fine example of the exceedingly high grade of work to be found in this machine. Each cutter is of the shape shown and when dulled can be sharpened by grinding the end. As they are located at 60° from each other on the circle and are held with their edges in line, it follows that the successive chasing points must be cut back one-sixth of the pitch from the one in advance, and must be cut with the greatest accuracy in their relation to the face bearing against the holders.

The die head, too, represents a most carefully executed piece of accurate workmanship.

Each chaser is gripped by a clamp which engages the upper side of the dovetail on the back of the tool and seats it firmly in its holder. These holders move in grooves in the die head and terminate in a pin marked A in the engraving of the die head. These pins are set in a block B which is made to slide to and fro in the grooves C of the operating disc of the die head. These grooves are cut on the arcs of circles struck from the points D on the inner circle as shown, and it is here that the

THE LANDIS THREAD CHASER.

greatest accuracy in the machine work must be achieved. It is evident that each of the grooves must be an exact replica of all of the rest and that they must be separated by exactly 60°. If this were not the case then the advancing of the chasers to the work would be unequal and the work would be unequally divided between them.

The chasers are moved in and out by the handle E operating the block F which is set so as to bring the chasers down to the proper point for cutting when the handle is in the position shown in the engraving. It will readily be seen that all of the work from the cutting edge of the chaser to the adjustment of the controlling block must be very accurately done.

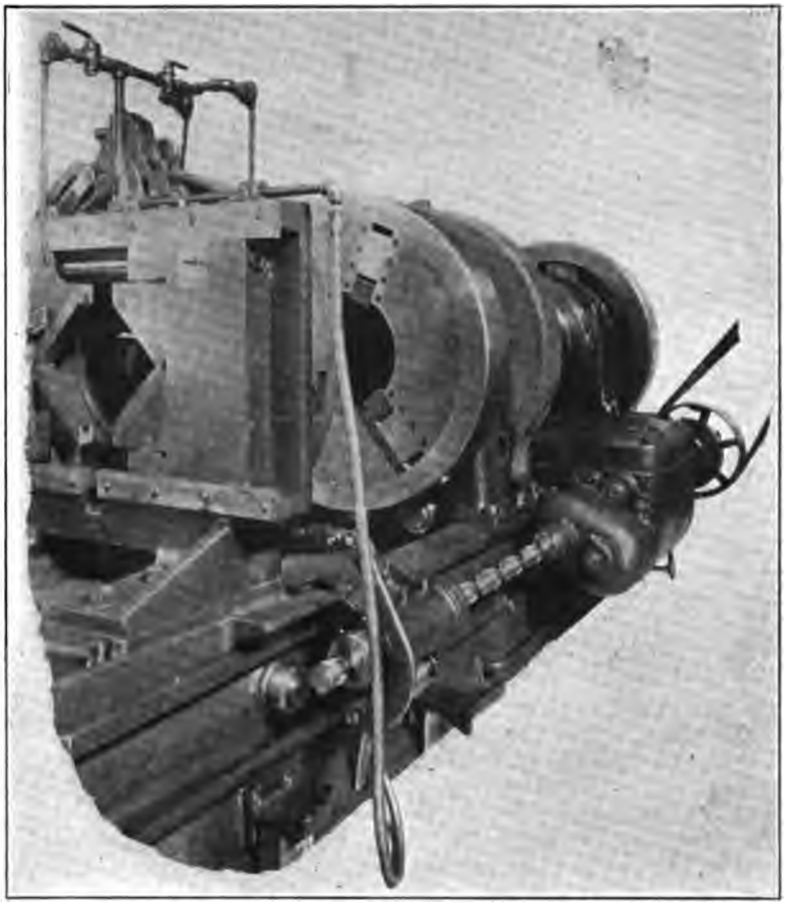
Before threading the pipe, the chasers are opened and the carriage which supports the die head is run up so that the pipe projects through it. It can then be faced off and chamfered on the inside by a tool carried on the crossfeed carriage (28) and operated by the hand wheel (29). The carriage is then run out, the dies closed and the thread cut.

This carriage may be moved either by power or by hand. The power traverse or movement is both forward and backward and is controlled by a lever located on the operating side of the carriage and is seen in the engraving of the side view. In advancing the carriage towards the chuck, the lever is pulled and held until the threading position for the die head is reached. In reversing the movement of the carriage, the lever is pushed forward and held. Releasing the lever stops the carriage at any point within its travel.

Automatic stops prevent the die head from coming in contact with the chuck in the forward movement and the carriage from running off the guides of the machine in the backward movement.

As will be seen, all levers are located on the operating side of the machine, and all working parts are readily accessible.

REAR VIEW SHOWING CHUCKS OF THE LANDIS PIPE CUTTING AND THREADING MACHINE.



DIE HEAD AND CHUCK OF THE LANDIS 12-INCH PIPE THREADING AND CUTTING MACHINE.

Cutting Fluids

Correspondence with the large machine shops in America with regard to their practice in the use of cutting fluids elicited information worthy of record.

The purposes of cutting fluids are to cool the work, lubricate, lessen wear, insure a good finish with accurate dimensions, wash away chips, and prevent the formation of dust. The materials used may be classified as (*a*) oils, (*b*) air, (*c*) aqueous solutions and water, and (*d*) emulsions.

Oils may be animal oils, fish oils, vegetable oils, mineral oils, or compound oils. The edible animal oils are too expensive to use as a lubricant, hence only the inferior grades are used for this purpose. Fish oils are objectionable unless deodorized, vegetable oils tend to gum, and mineral oils are low in adhesion, and are therefore poor lubricants. Compound oils are largely used, containing a large percentage of mineral oil with a smaller percentage of vegetable or animal oil, or both. Air is used merely to remove chips.

Water alone is used to some extent, but on account of the tendency to rust, soda, sodium, silicate, sodium resinate, or other soap are usually added.

Emulsions have the advantage of cheapness while possessing much better lubricating properties than the aqueous solutions. They are of three types. Mineral oil compounded with neutralized sulfonated oil will form a permanent emulsion when mixed with various proportions of water. Mineral oils are compounded with an alcoholic solution of soap. A third variant is marketed as a paste, it being a thick soap solution and mineral oil. The second type is the most desirable, and the third is the least so.

As to the choice of a cutting fluid for a given operation, the character of the operation performed has more to do with the choice of cutting fluid than the character of the metal. For drilling, reaming, milling, planing and sawing, emulsions are generally satisfactory. For tapping and threading and parting off, compound oils and lard oil are often resorted to. Compound oils are used with automatic screw-cutting machines.

The material cut is also of importance. There is a general consensus of opinion that soft steel and wrought-iron are difficult metals on which to get a good surface without lard or sperm oils. They are called "draggy" metals. Cast-iron, on the other hand, being brittle, does not adhere to the tool, and no lubricant is required. Contrariwise, on a hard, brittle steel, lard oil merely produces a "glaze" and turpentine is used with success.

What Shop Equipment Means to a Railroad*

The railroad motive power people particularly are continually being pressed for reasons as to why they demand from the highest officials appropriations to cover machine tool and shop facilities, and the repetition of statements that these facilities are required to take care of current work is usually countered by the statement that the need of such facilities will have disappeared by the time the equipment and facilities can be received and installed.

Operating revenue, having so many mouths to feed, must be largely conserved for purposes which cannot be deferred, and in the face of the large demands, the weak voice of the motive power department is drowned by the clamor of what at the moment appear to be more important demands.

To summarize, the object of this paper is to point out briefly the reason why equipment is compelled to stand idle when it should be at its best condition to meet operating demands, as well as to endeavor to create as a basis for further discussion the actual capital requirements in terms of equipment owned or in future to be purchased.

The purchase of additional hauling capacity immediately entails an obligation on the part of the purchaser to utilize such facilities, and to secure revenue therefrom through the handling of freight or passengers.

In order to make a division line between the freight and passenger service, it is necessary to convert passenger earnings into ton miles. In my opinion this conversion can best be made on a basis of earning capacity, for which purpose the equated ton miles on passenger basis can be obtained by multiplying the ton miles of freight by the total passenger revenue and dividing this figure by the total freight revenue, the underlying thought being that the decreased tonnage will be offset by the increased rate. Such figures, although perhaps of no other value, will result in a ton mile basis which is comparative from year to year. A comparison made on this basis, using Interstate Commerce Commission statistics of Class I railroads for the years 1902 to 1919 inclusive, brings out startingly the fact that in spite of advanced facilities in surveying an 18-year period the amount of work performed by the locomotive was seriously decreased, as is evidenced by the fact that the increase in tonnage available was 233 per cent; the increase in the number of locomotives was 173 per cent, with an increase in the hauling capacity of 299 per cent. The efficiency of the 1902 locomotive being used as a basis, the railroads during the year 1917 could have handled 56,000,000,000 more revenue ton miles than they did; in 1918, 76,000,000,000 more revenue ton miles, and in 1919, 139,000,000,000 more revenue ton miles.

In other words, had each pound of tractive power been utilized at the same efficiency as in 1902 there would have been a large surplus of locomotives during these peak periods.

These analyses cover totals for the 12 months of each year, and it may be claimed that peak traffic demands during individual months produced conditions not reflected by the yearly average. However, it should be remembered that the relative peaks which existed during 1902 also existed in 1919. In other words, seasonal demands will not startlingly increase without reflection in the traffic during those months of lesser traffic movement.

The reasons for the decrease in economic returns are a little complex, but they can be roughly analyzed as follows:

(a) The increased ratio of the power available does not appear to be serious.

(b) The lack of corresponding increases in terminal facilities in the way of increased length of receiving tracks, etc., as well as lack of expenditures for increased passenger facilities, are serious.

(c) The dominating influence affecting the decrease in work performed per unit of power available lies in the lack of capital expenditures for maintenance of equipment purposes. Individual road performance and increase in tonnage per locomotive mile run has been more than offset by motive power delays brought about by inadequacy of repair shop facilities. Power of sizes and weights out of line with shop equipment result not only in increased repair expense but what is more serious, in great delay in getting power back into service.

Adequate provisions in the way of machine tools will have a great influence on recovering, if not passing established records previously made in ton miles per pound of tractive power available.

Capital account expenditures cannot be made to better advantage at this time in any direction by the railroads than through provisions for modern repair shops and equipment.

The selection of machine tools, traveling cranes, small tools, jigs and fixtures can easily be made to meet any motive power requirements. The principal danger in the selection of machine tools is in giving undue weight to maximum performance of individual items, and in expending capital too freely for architectural embellishments. The ideal repair shop is one consisting of the maximum tool facilities in combination with the minimum expenditure for buildings necessary for protection and reasonable life and maintenance expense. The arrangement of shops longitudinally, herringbone, or traverse pit, has little if any influence either on cost or equipment necessary to take care of a given number of locomotive units unless the capital increase in the cost of the buildings themselves is affected.

The purchase and installation of special high-powered individual-purpose tools should be made only after the most minute analysis of the actual immediate and prospective requirements. Each expenditure in the way of machine tool facilities should be made so as to give the maximum return in the way of plant output and not considered on the basis of the output of the individual unit. Over-equipment of individual departments does not assist either the time or cost element of a locomotive which has to be passed through all the departments of the repair terminal.

A more specific explanation for the reasons resulting in this condition is readily found in either one or a combination of the following facts all of which are subject to correction either by the railroads or the Interstate Commerce Commission:

First. The railroad companies appear to have purchased power at a higher ratio than the normal increase in tonnage available justified, causing power to remain idle.

Second. In the efforts of railroad officials to maintain a uniform ratio between income and expenses, it is customary to reduce the maintenance of equipment appropriations during the slack months, thus causing the power in many cases to be unavailable to take care of the peak load transportation in the fall and winter months without the assistance of the locomotive builders.

Third. Unfortunately, it has been the custom of motive power and transportation officials when purchasing new power, to endeavor "to keep up with the Joneses" by purchasing power in large sizes, and in a number of cases the tonnage available, yard facilities, bridge, and right-of-way limitations, and other local causes have prevented the full utilization of all of the extra drawbar pull available.

Fourth. Labor conditions, both in the transportation and motive power departments, have tended to decrease power and operating efficiencies.

Fifth. The amount of money expended by the railroads for logical repair shop facilities has been lamentably out of proportion with the amount of money expended for motive power and cars, resulting in inadequate facilities for needed repair and modernizing work. The reason for this is probably due somewhat to the fact that it is easier to secure financial assistance through car or locomotive trust certificates than it is to secure money on blanket or other mortgages to be used for the purpose of shop extensions or construction.

*Abstract of a paper read before the members of the Central Railway Club, Buffalo, N. Y., March 9, 1922, by V. Z. Caracristi.

Sixth. The analysis of data from individual railroads shows that the purchase of power has in some cases been justified and that the tons hauled per pound of available tractive power show decreases not out of line with changes in operating and labor conditions.

Taken as a whole, however, the figures clearly indicate a tendency to purchase power in advance of traffic requirements and further show inadequate provision for the roundhouse and general repair work necessary to keep the investment for power active.

It might be said that the practice of purchasing equipment ahead of requirements and out of line with ability for full economic use is not confined to railroads but will be found in general industry as well. However, the latter being either equalized through receivership and re-sale at bargain prices affecting only the few original owners and creating no appreciable ripple on the economic life of the nation, or resulting in past profits being largely represented by non-revenue producing brick, mortar, and equipment.

The lack of adequate shop facilities is the greatest factor obstructing the purchase and application of modern fuel saving or other devices which would permit the increase of revenue ton miles per pound of tractive power available. Lack of facilities to take care of such equipment when installed, and the fact of additional engine failures and delays by the lack of attention which inadequacy of repair equipment compels, has naturally resulted in the motive power department's being averse to take an additional obligation for maintenance with the foreknowledge of inability to properly care for the same.

As a matter of self-defense this tendency is a natural one, and as long as reasonably adequate supplies of tools and facilities are not available the position is well justified.

When the fact is taken into consideration that progress in locomotive development in the past few years has been almost entirely in the direction of devices which can be applied to existing power, and that the application of such equipment will make any existing locomotive as efficient as one of equal power just out of the builder's shop, the enormous size of the economic loss to the railroads can be visualized.

A locomotive when out of service for the most trivial cause, is just as expensive to the property as a whole as one legitimately tied up awaiting shop for periodical overhauling, and too much attention cannot be devoted to the necessity for adequate facilities, not only in the classified shops where the legitimate delay is taken care of but also in the running repair facilities which should be provided at the various terminals for the purpose of preventing motive power delay on account of trivial maintenance work.

A locomotive awaiting shop or otherwise in the hands of the motive power department is a liability to the corporation during such periods, as fixed charges never stop accumulating, and the only way they can be offset is to provide the repair organization shops, tools, and labor necessary to make the locomotive available for the transportation department with the minimum of delay.

The only items of intangible expense which should enter into the annual balance sheet in connection with motive power equipment is deferred maintenance to cover impaired ability to produce revenue and the writing off of all equipment which may have entirely lost earning power through inadequacy or obsolescence.

Each railroad should have every locomotive surveyed to determine if its useful life is actually finished through use or inadequacy, and if there is not the possibility of placing this engine on an equal basis with an engine just received from the builder, through application in its own shops of such such modern improvements, as superheaters, feed water heaters, cut-off indicators, brick arches, power reverse gears, valve gears, etc.

Full capital account credit should be given for all betterment work and additions made to old power, and a new value placed on the entire locomotive after the completion of such betterments, in line with its ability to compete with a new unit of equal capacity, irrespective of its old arbitrary or book value.

Adequate general and running repair facilities should be provided on each railroad in proportion to its equipment owned, with the ability to do betterment work consisting of the application and maintenance of such devices as have proven themselves to have a definite earning value for the property as a whole.

Repair work should be equalized over the 12 months' period by arbitrary charges against income in the months of great business for credit and use during periods of revenue depressions.

Each new purchase of new locomotive equipment should be made the subject of special study by the accounting, motive power and transportation officials assisted by outside advice if necessary, to determine:

(a) Actual necessity.

(b) Size and capacity which will give the greatest net returns to the company.

(c) Type.

The requirements for classified and running repair shop facilities, in connection with the operation of locomotives, are so inter-tied with the effectiveness and earning value of the property that it is unusual that so little attention has been devoted to the determination of specific factors measuring the expenditures necessary for economic results.

In other words, it would seem logical to assume that railroad executives, when appropriating large sums for capital account expenditures for purchase account for additions or betterments of new power should coincidentally provide for facilities to take care of this power after it has been put into service.

Uniformity of Firing Produces Smokeless Combustion

Smokeless combustion requires the maintenance of a uniform and proper supply of fuel and air under conditions of suitable temperature, mixing and volume of combustion space. The one word "uniformity" embraces most of the ideals for smokeless combustion. A bed of coals cannot find uniform conditions if the coal is fed in large lumps, so that powdered coal is the ideal limit for coal size. Intermittent hand-firing cannot provide a uniform supply of fuel, since immediately after introducing coal into a fire a great quantity of volatile matter is distilled, calling for a large amount of air to burn it, while less air is required after the volatile matter has burned off. There is, therefore, a deficiency of air immediately after firing, and usually an excess for the remainder of the time. This cause of smoking is particularly bad when the draft is poor. Uniform, continuous mechanical feed of coal is, therefore, the ideal way to supply fuel. The intermittent firing of large amounts of coal, chilling the fire by its cold blanketing effect, and calling for heat for distilling gases, is not conducive to uniformity of temperature, so that continuous fuel feed is the ideal also from this consideration. Uniform mixing of air with the coal products is one of the most difficult things to attain. Irregular thickness of the fire, accumulations of ash and clinker in the grate, placing large amounts of coal on the fire at one time, opening of fire doors, leaky settings, all contribute to an irregular and variable supply of air when uniformity is desired, so that continuous mechanical operation aids again in approximating an ideal air supply. Uniformity in all of these things may be attained and yet a smoky fire produced, because in a small combustion space the gases may not have time to burn before they are chilled by cold boiler surface. Large combustion spaces are, therefore, necessary for smokeless combustion. With these ideals established every approach to them will tend to reduce smoke and give better combustion. The fireman that "fires little, fires often, fires quick" makes less smoke. Coal of approximately uniform size tends towards uniform fuel bed conditions.

It may look at the first impression that the frequent opening of the furnace door admitting cold air would have a pernicious effect on cooling the heating surfaces, particularly the flues, and while this is true to a limited extent, the method of adding a large quantity of fresh coal at one time is much more so and as already stated adds greatly to the increase of smoke, which has the double fault of wasting coal, and in many locations adding a nuisance to the vicinity.

The Calculation and Graphical Representation of the Walschaerts Valve Gear for Locomotives

By S. E. W. Westrén-Doll, Engineer, Petrograd

Introduction

As a result of the direct interdependence of the various steam phases as they occur in the cylinder of a steam engine, so clearly shown in the steam diagrams of Zeuner and Meier-Ruleaux, it is quite evident that any change in one of them, the admission for instance, involves a corresponding change in all of the others. It is very important that the amount of linear lead be kept constant, and it is one of the most prominent of the possibilities. It was to secure this point that Walschaerts, a Belgian, designed a valve gear capable of effecting various changes in the point of cut-off and of reversing the motion of a steam engine and which he patented in the year 1844.

The linear lead is the amount of opening of the live steam port at the end of the stroke of the piston.

A diagram of the ordinary form of the Walschaerts valve gear is shown in Fig. 1, and which is drawn with the piston at the end of its stroke.

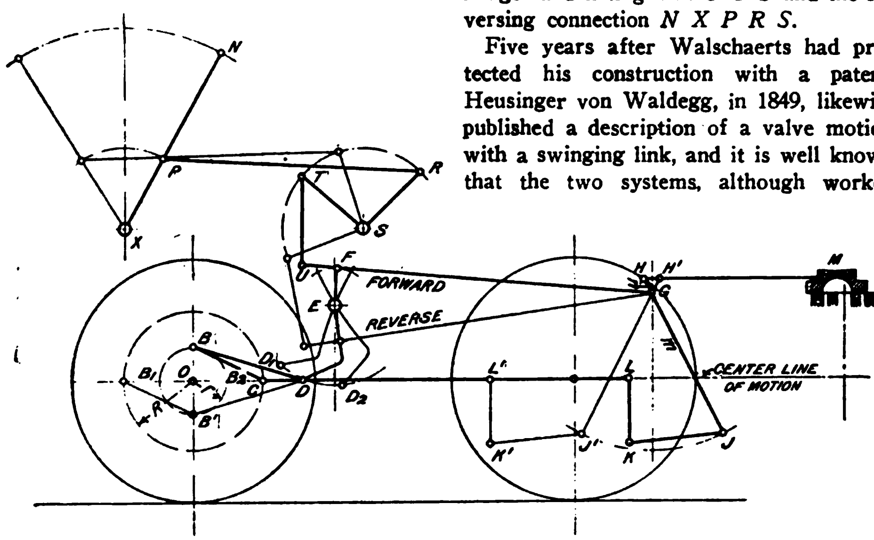


FIG. 1.

The point B of the eccentric crank $B\ C$ describes a circle about the center O with the radius $O\ B = r$, and can also be considered an eccentric with an eccentricity equal to r. As a result of this eccentricity r, and by means of the eccentric crank $B\ C$ and the eccentric rod $B\ D$, the link is made to oscillate about a fixed point E. The motion of the swinging or oscillation of the link at the point F is transmitted, by means of the radius rod $F\ G$ to the point G of the lap-and-lead lever $H\ J$. The lower end, J, of the lap-and-lead lever $H\ J$ receives its oscillating or pendulum motion from the union bar $J\ K$ which is, in turn fastened to the crosshead of the machine by the fixed connection $K\ L$. The composition of the two motions of the points G and J, as received from the link and the crosshead is transferred in a peculiar and special manner to the point H, which is connected, by means of the valve stem to the valve M and gives the latter the motion required for the necessary distribution of the steam.

A change in the running direction of the engine is obtained by shifting the moveable link block F to points above or below the fixed point E about which the link turns, while a change in the point of cut-off, or what amounts to the same thing, a change in the travel of the valve is obtained by moving the link block F to points nearer or more remote from the aforesaid point E.

The shifting of the link block is accomplished by means of the radius rod hanger and lifting arm $U\ T\ S$ and the reversing connection $N\ X\ P\ R\ S$.

Five years after Walschaerts had protected his construction with a patent, Heusinger von Waldegg, in 1849, likewise published a description of a valve motion with a swinging link, and it is well known that the two systems, although worked out entirely independently of each other, differ only in their minor details. In the Heusinger patent the union bar $J\ K$ is missing and the lap-and-lead lever $H\ J$ is attached directly to the point K by a bearing. Heusinger's design has not been very extensively adopted, yet because of the great resemblance existing between the two systems there still exists a good deal of confusion in the matter of terminology. Although the valve motion, in almost universal use, is that made in accordance with the Walschaerts patent, it is only in its home country, Belgium, that it has been so known until very recent years. In all other countries except the United States it was known as the Heusinger valve gear. Since this terminology is admitted to be faulty by all writers on the subject, it is here set forth so that all further errors and mistakes regarding the matter may be avoided.

The development of the comparatively complicated mechanism of the Heusinger valve gear, tended, at first, to prevent its adoption. Later, when its advantages had been learned, by practical experience, it has held its own for more than fifty years in nearly all countries and has been applied to the majority of large locomotives and stands, today, at the forefront of locomotive valve gears.

Section I.

The Valve and the Method of Calculating its Proportions.

Although not entirely dependent on the character of the valve gearing, the moving valve is, itself, the main feature in the regulation of the various phases of the action of the steam in the cylinder. Two types of valves are in common use on locomotives; the plain mussel shell or D valve or its modified equivalent the piston valve and the Trick (Allen double ported) valve. Because of the fact that, in present practice, there is a tendency to use both inside and outside steam admission, and the steam passages in the valve seat are divided into two parts for the respective ends of the cylinder, and also because the exhaust passages lie outside the steam passages these two types of valves are being abandoned, yet it is quite sufficient to study and calculate the D and the Allen valves for the designer to be able to deduce therefrom an accurate development of a valve to meet any special construction.

1. The Mussel-Shell or D Valve

The formula by which the velocity of the incoming live and outgoing exhaust steam can be calculated would always give the most perfect dimensions for the ports in the valve seat and the passages in the casting. But in order that there may be some control over the dimensions used, it is desirable, insofar as practical work is concerned, to establish some sort of a relationship between the sectional area of the passages and the cylinder volume, although exact dimensions are, as yet, impossible. Hence the determination of the cross-sectional area of the passages in this way, is outside of the realm of calculation.

According to Prof. Radinger, the average velocity of live steam in the passages can be taken at from 98 to 115 ft. per second; but, in order to avoid all danger of throttling, 131 ft. per second should not be exceeded.

If the surface area of the piston, or,

what is the same thing, the cross-sectional area of the cylinder be indicated by O, the average velocity of the piston in feet per second by c, the cross-sectional area of the steam port for the live steam in square inches by f and the velocity of the steam, at the port, in feet per second, the cross-sectional area of the live steam port in square inches will be given by the equation

$$O\ c = f\ v$$

whence

$$f = \frac{O \times c}{v}$$

or according to Prof. Radinger,

$$f = \frac{O\ c}{100} \text{ to } \frac{O\ c}{115}$$

The velocity, c, of the piston of locomotives, in feet per second is given by the equation

$$c = \frac{n\ H,}{30}$$

in which n is the number of revolutions of the driving wheels per minute and H is the stroke of the piston in feet.

The number of revolutions, n, of the driving wheels per minute is then obtained from the equation

$$n = \frac{S \times 5280}{60\ \pi\ DR}$$

in which S is the maximum speed in miles per hour and $D\ R$ is the diameter of the driving wheels in feet.

In order that the dimensions of the steam port may be calculated, the length of the same may be assumed. It usually happens that this length, relatively to the diameter, D, of the cylinder is from 2/3 D to D.

The width of the steam port can then be obtained from the equation

$$f = a \times b$$

Still, in the majority of cases, the relationship existing between a and b is that b divided by a is from 6 to 10 with a maximum of 12, and care should be exercised that the last named ratio is not exceeded.

The sectional areas of the live steam ports can also be obtained with sufficient accuracy for practical purposes, for individual cases, by similar calculations, based on the following equation

$$f = O\ (0.01 + 0.03\ c)$$
$$a = 0.1\ D - 0.04\ D$$
$$f = a \times b$$

Hence, as the maximum piston speed, is that corresponding to the highest speed of the engine, and is assumed for all these equations, it follows, that the port will be perfectly adapted to deliver steam at this velocity provided it is fully opened, and that at other and lower speeds it will be all right even though the opening run from a down to $2/3a$. This opening should, however, never be less than $2/3a$, because the loss of power, when this occurs, through the throttling of the steam will be excessive. On the other hand an excessive travel of the valve beyond the edge of the port should be avoided, because, if that occurs, there will be a useless waste of power due to the frictional work involved.

A considerable travel beyond the edge of the port is unavoidable in locomotive work, especially in cases where the Schmidt superheater has been used, and the valve has been adapted to it without making any change in the various parts of the valve gear.

The width a_o of the exhaust port must be great enough, so that it cannot have its area reduced by narrowing, due to the travel of the valve, to a point where it is

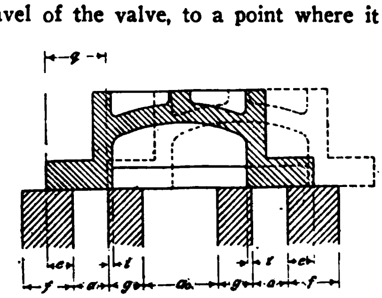


FIG. 2.

the same as that of the steam port; in fact, when the valve is at the limit of its travel, the opening in the exhaust port should, in no case, be less than from a to $4/3a$ in which a is equal to the width of the steam port.

The length of the exhaust port will, for constructional reasons, be the same as that of the steam port.

It may also be remarked, that, in the case of compound locomotives, according to the early calculations for the determination of the size of ports for the large cylinders, the length b for the small or high pressure cylinders was obtained by merely shortening the other, from which it came about that the width, a, was the same for both cylinders.

The calculation of the throw q of the valve should be such that it travels the distance, q, on each side to the right and left of its central position.

From what has just been said, the opening of the exhaust port must be, according to Fig. 2, equal to or greater than

$$a_o\ i + q + a - g$$

For the determination of the width of the bridge g, we have the formula

$$g = 0.5a + .25 \text{ to } .5 \text{ in.}$$

which are admissible values. But it must be clearly understood, that, when the valve is at the end of its stroke, its edge has not traveled beyond the edge of the bridge g so as to open the exhaust port and permit live steam to enter it. From these limitations it is always necessary that

q should be less than $e + a + g$

whence

g is greater than $q - (e + a)$

This condition is fully met, if, when the valve is at the end of its travel, its lap still rests on the bridges for a distance of from 0.2 in. to 0.4. The equation for the width of the bridge will then be

$$g = q - (e + a) + .2 \text{ to } .4 \text{ in.}$$

In order that, when the valve is at the end of its stroke, no live steam will be admitted to the two ends of the cylinder at the same time, (in front of and behind the piston) care must be exercised, that the inner edge of the valve does not travel beyond the outer edge of the outer bridge f, and in this case, also it will be sufficient if a lap of from 0.2 in. to 0.4 in. remains on the valve seat. We therefore, have the following formula for the width of the outer bridge f.

$$f = q - (a + i) + .2 \text{ to } .4 \text{ in.}$$

On the other hand, when the steam is admitted for full stroke, that is with the latest point of cut-off, the corresponding motion of the valve should be such that its outer edge should travel beyond the outer edge of the bridge f by at least from .05 to .10 in. so as to avoid the formation of a shoulder on the valve seat.

When both these points have been attended to, we have the following equations for the width of the bridge f:

$$f \text{ min.} = q \text{ max.} - (a + i) + .2 \text{ to } .4 \text{ in.}$$
$$f \text{ max.} = q \text{ normal} + e - .5 \text{ to } .10. \text{ in.}$$

The outside lap e will vary with the point of cut-off. It is determined by considering the latest point of cut-off to be used.

In the compound locomotives the latest point of cut-off is usually taken at from 70 to 90 per cent of the stroke, and, in simple engines, it is usually put at from 80 to 85 per cent.

When the point of cut-off or the amount of admission has been determined, we can obtain the admission angle ϵ at the same time as indicated in Fig. 3.

When the admission angle and the corresponding point of cut-off has been obtained, as well as the maximum port opening (2/3 a to a) in order that the necessary outside lap and travel of the valve may be calculated therefrom, it is first necessary to decide upon the linear lead or the lead angle during which steam is admitted before the commencement of the stroke.

It is well known that, in the ordinary steam engine, the valve opens the port for the admission of steam before the piston has finished its stroke from the other direction. The amount which the valve has opened the port when the piston has reached the end of its stroke, is called the linear lead and is usually indicated by V_e. The angle corresponding to this lead is called the lead angle and is called γ (gamma).

The linear lead may be from .10 to .15 in. using, in large engines, up to .25 in. while the corresponding lead angle runs from 2° to 4°. At any rate it is essential that the linear lead should not be made too great, else there will result a useless consumption of steam.

When the maximum angle of admission has been determined together with the desired port opening and the linear lead or angle of lead, it then becomes possible, by graphical means, to ascertain the necessary outside lap, as well as the throw of the eccentric for driving the valve as well as the angular advance of the same.

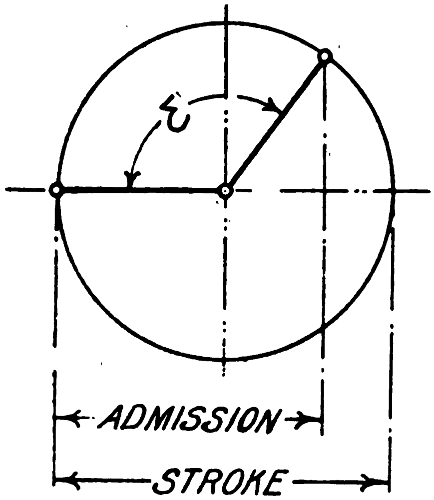


FIG. 3.

The lead angle increased by 90° will give the angle at which the eccentric should be keyed to the crank.

In most cases it is the linear lead and not the lead angle that is assumed. In this matter, for the first example that is given, there will be assumed a given angle of admission ϵ, (epsilon) the maximum port opening $a\ K$ and the desired linear lead V_o from which there is to be determined the outside lap e'; the eccentricity or half throw of the eccentric Q the lead angle γ and the angular advance of the eccentric δ (delta).

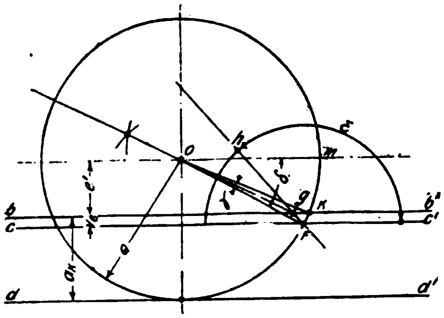


FIG. 4

At the distances V_o and $_aK$ draw the straight lines $b\ b'$ and $d\ d'$ parallel to $c\ c'$ as in Fig. 4. On $c\ c$ take any point f and draw a line from it at an angle equal to the admission angle ϵ. From the point g where this angle cuts the straight line $b\ b$, as a center, lay off the angle $b\ g\ h$. Then bisect this angle. The center of the desired eccentric circle must now lie on this bisecting line so found, while the circle must be tangent to the line $d\ d'$ and pass through the point f that was first taken on the straight line $c\ c'$. It can then be found by trial. Its center will be at O. The distance of the center O from the straight line $b\ b'$ will be the desired outside lap e' and the radius of the circle so found will be the eccentricity Q. Draw a straight line from O to f and also one from O to k where the eccentric circle cuts the straight line $b\ b'$ thus forming the angle $k\ O\ f$. This will be the preadmission or lead angle γ corresponding to the linear lead V_o. The angle $m\ O\ f$ is the angular advance of the eccentric δ.

If, in place of the linear lead, the preadmission or lead angle should be given, the method to be pursued is as follows:

At the given distance $a\ K$ from the straight line $b\ b'$ draw the parallel line $d\ d'$ as shown in Fig. 5. On it take any point n, it being presupposed that the eccentric circle, that may be found, will be tangent to the straight line $d\ d'$ at this point. From n draw a line downwards making an angle with the line $d\ d'$ equal to the admission angle ϵ and from this line

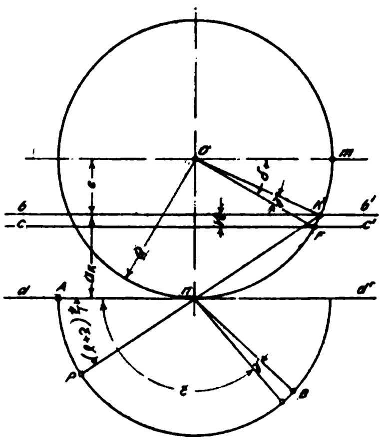


FIG. 5.

lay off the preadmission angle γ. This then, forms the new angle $A\ n\ B = \epsilon + \gamma$ which is to be divided into four parts. From the first of these points from the straight line $d\ d'$, at p, draw a straight line to n and prolong it until it cuts the line $b\ b'$. This gives one point on the desired circle. It is indicated as k. Since the circle is to be tangent to the straight line $d\ d'$ at the point n, its center must be on the line drawn at right angles to $d\ d'$ from n while the circle itself must be tangent to $d\ d'$ and pass through the point k. The eccentric circle can, then, be found by a simple geometrical process. Its radius will be equal to the eccentricity Q and the distance of its center O from the straight line $b\ b'$, will be the desired outside lap e.

In order to find the linear lead, draw a line from O making an angle with $k\ O$ equal to the preadmission angle γ. Through the point f where this line of angular admission cuts the circle, draw the line $c\ c'$ parallel to $b\ b'$. The distance of these two lines apart is equal to the linear lead.

Furthermore, the angle $f\ O\ m$ is equal to the angular advance δ of the eccentric.

In order to obtain a clear illustration of the accuracy of the dimensions thus found, it is only necessary to apply them to the Zeuner valve diagram as shown in Fig. 6.

The accuracy of the results so obtained is evident from the following points. Letting the outer circle represent the total throw of the crank, the eccentric circle whose diameter is Q passes through the center of the diagram and cuts the horizontal axis outside the circle drawn with a radius equal to the outside lap e, by a

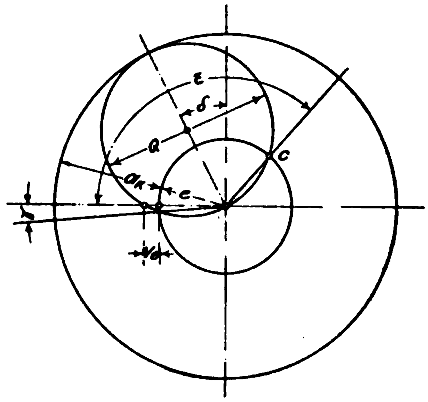


FIG. 6.

distance equal to the linear lead, at the point $e + v_o$, and closes the port at the point C with the lap corresponding to the admission angle ϵ. Further the preadmission angle γ and the angular advance δ will be found to correspond to the angles as found by the method described.

If, in the Zeuner diagram, we have, in addition to the outside lap e, and the required travel of the valve, q, the width of the steam ports, a, in the cylinder as well, it will be readily understood that. for any desired amount of port opening $a\ K$ is less than a as shown in Fig. 7A when only a portion of the port will be opened. On the other hand when $a\ K = a$, as in Fig. 7B, the port will only be open, to its full width, for an instant at the point B, when it will immediately start to close again; finally, when $a\ K$ is greater than a, as shown in 7C, the port is wide open through that portion of the throw of the crank, extending from B to C.

A further examination of the valve motion, as will be seen later, will show that the outside lap and the linear lead are closely related to other parts of the valve gear and that their dimensions are dependent thereon. It frequently happens that a lack of room for some other part of the mechanism requires an increase of the outside lap. In such a case it is used for the adjustment of the valve, a matter that will be referred to again in the proper place.

The dimensions of the inside lap i (Fig. 2) is dependent upon the amount of compression and can be obtained from the Meier-Reuleaux valve diagram, for a given cut-off and the desired amount of compression which runs from 15 to 20 per cent.

Too great an amount of compression should not be used in locomotives, especially on those working superheated steam lest there be imposed an injurious stress on the rods and an uneven action of the machine be produced because of the large amount of negative work that will be done.

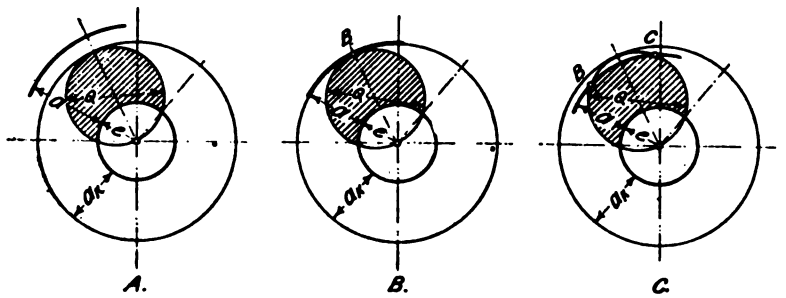


FIG. 7.

The simple D or mussel shell valve made of cast iron is the one most commonly used on small engines, where, without any balance against the steam pressure on the back, they render good service. It is but right to say, however, that the actual pressure on the valve seat must not be too great. A number of experiments have been made in France with cast iron valves which have shown that pressures up to 355 lbs. per sq. in. upon the valve seat can be used and a satisfactory operation still obtained. If higher pressures than this are used the seat will soon cut and be very quickly worn away; thus greatly increasing the frictional resistance due to the movement of the valve.

2. The Trick or Allen Valve

In many large engines the Trick or Allen double-ported valve, as shown in Fig. 8, is used. These valves should invariably be made of brass, although cast iron has been extensively used.

The object of the Trick design of valve is to effect a quick opening and closing of the steam port with a short movement of the valve. For this purpose it is fitted with the so-called Trick or Allen port. If this valve is moved from its central position, a distance equal to its outside lap, it will, at the same time, open the port at its outer edge on one side, and, on the other, it will open it through the port in the valve. It will, therefore, for the same amount of motion, produce double the amount of opening that would otherwise be obtained, and the reverse of this also occurs on the closing of the valve. This continues until the valve has moved through a distance equal to $e + k$ and the port opening is equal to $2\ k$.

From the foregoing it is apparent that the eccentricity of the double port action is equal to $q = e + k$.

The drawing shows that, in order to fully open the port A in the valve seat, with the least possible movement of the valve, the valve port $K = \frac{a}{2}$, and for this special case (in making an application of it to locomotive construction) the necessary eccentricity:

$$q = e + \frac{a}{2}$$

At the same time the width of the port, k, in the valve, should not be less than 0.4 in. in order that there may be the necessary weight of core for casting.

The thickness of the outer lip, s, is usually taken at from 0.4 to 0.8 in. It is well to make it thin so that the width of the port A may be diminished. The calculation of the sectional area of the port in the cylinder is made in the same manner as with the ordinary D valve, except that its width must be increased by the thickness of the lip s, so that, the cross-sectional area of the cylinder ports may not be decreased for this special case. Therefore,

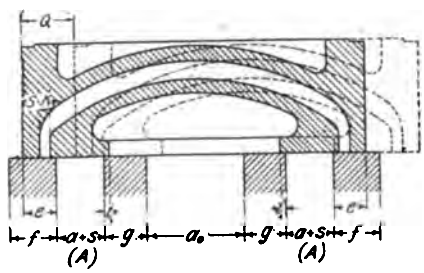


FIG. 8.

$$A = a + s \text{ or } A = a + .4 \text{ to } .8 \text{ in.}$$

In order to prevent the live steam from flowing into the exhaust port it is necessary that, in the dimensions indicated in Fig. 8, q should be less than $e + a + g - h$, and experience has shown that it will be sufficient if it is from 0.2 to 0.4 in. less. Hence we have

$$q = e + a + g - k - .2 \text{ to } .4 \text{ in.}$$

From this equation we obtain the width of the bridge g as

$$g = q - (e + a) + k + .2 \text{ to } .4 \text{ in}$$

When one side of the port is opened by the outer edge of the lip of the lap of the valve, the edge of the Allen port must be opened on the other side at the same time; therefore, for the width of the valve face, f, outside the port, we have the equation:

$$f = 2\ e - s$$

A contraction of the sectional area of the exhaust port can be avoided by the development of

$$q + a + i - g$$

But in order to be perfectly safe in the matter it is well to substitute 3/2a for a. Whence we obtain the following equation:

$$a_r = q + a + i - g \text{ to } q + 3/2\ a + i - g$$

The determination of the outside lap and the eccentricity or throw is made in exactly the same manner as with the plain D valve, except that, with the Trick or Allen ported valve, there are four points of port opening to be observed, in order to ascertain the correct dimensions for $a\ K$ and V_e of the diagrams 4 and 5.

1. Suppose the valve is moved from its central position by the distance

$$Q = e + k$$

as in I and II of Fig. 9, then all port openings will be doubled. For this reason it is necessary, that, in the case of the valve motion fixed, in Figs. 4 and 5, for $a\ K$ that it should only be one-half of the desired port opening, or O to $2\ k$ and thus make $a\ K$ less than equal to k.

Hence the linear lead V_e always drops at this point of the motion of the valve, and in all diagrams for the Trick or Allen valve, it is only necessary to make it one-half the working dimensions that would otherwise be taken.

2. Suppose the valve continues to move and open until $Q^1 = e + k$, and so opens the port until the throw

$$Q^2 = e + A - k - s$$

as shown in the movement from II to III in Fig. 9. In this case in order to determine the whole desired port opening, we must take $a\ K = 2\ k$ to a (that is A — S) as in Figs. 4 and 5, since the linear lead always remains only $\frac{V_e}{2}$ as stated above.

3. From this point the port opening remains constant up to the position

$$Q^3 = e + A - s$$

as shown in the movement from III to IV in Fig. 9. The throw and the outside lap gives, for this position

$$a\ K = a$$

4. In order to obtain the greatest possible port opening, that is for the full width of A, the valve must open the port until it reaches the position Q^4 in which

$$Q^4 = e + A,$$

a motion indicated by that shown from IV to V of Fig. 9. The fixing of the total throw desired as $a\ K = a$ to A, in Figs. 4 and 5 gives the corresponding dimensions of the throw q and the outside lap e.

If the designer assumes the maximum port opening to be used, which is ordinarily taken to be equal to a, it is easy, from the foregoing explanations, to determine the correct dimensions in Figs. 4 and 5 and thus ascertain the outside lap and the throw. It only remains then to determine from the above, as to whether the measurements so found do not call for too large dimensions of some of the other parts of the valve gearing, and whether

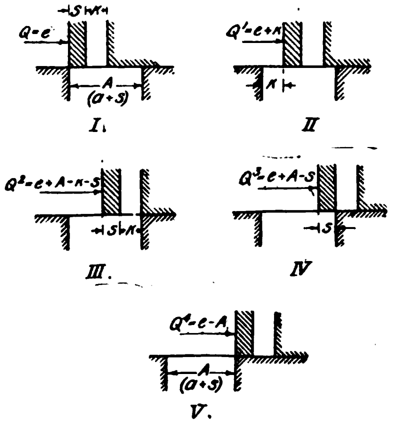


FIG. 9.

because of this, a correction should not be made which can be done by an adjustment of the outside lap of the D valve.

An illustrative diagram of each of the phases for the full width opening *A* of the port, with the Allen valve, is given in Fig. 10, based upon a steam admission for 80 per cent of the stroke.

At the point *B* we have $Q_1 = e + k$ and the port opening is doubled and $B\ f = k$. From *F* on, the increase is in the same proportion to *H*, where the opening is equal to $A - s$. The valve has, at this point, moved so that

$$Q_2 = A - k - s + e$$

from its central position and is at *C*. From here the port opening remains constant until the valve has moved to

$$Q_3 = e + A - s$$

and has reached the point *D*. Further movement opens the valve in direct ratio to the actual motion up to the full-width port opening *A* where the throw becomes *O E* and

$$O\ E = Q_4 = e + A$$

The valve then starts to close the port and the phases follow each other in the reverse order to those given above.

In the second phase the valve moves forward from $Q_1 = e + k$ to $Q_2 = e\ \frac{A}{2} - k - s$. In special cases where $k = \frac{\ }{a}$, when this further movement coincides with the point *F*, instead of there being any further opening of the port, it remains constant from *F* on.

The accuracy of these positions can be readily established from the equation for Q_1 and Q_2, which are as follows:

$$Q_1 = e + \frac{2}{a}$$

$$Q^2 = e + (a + s) \frac{a}{a\ 2} - s = e + \frac{a}{2}$$

$$Q_1 = Q_2 = e + \frac{\ }{2}$$

In order to determine the inside lap

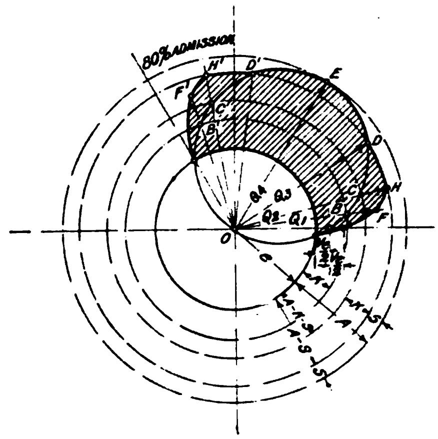


FIG. 10.

the same points for compression are to be taken and the calculation is to be made in identically the same way as for the simple D valve.

This subject will be continued in a series of articles in the succeeding issues of RAILWAY AND LOCOMOTIVE ENGINEERING.

Annual Convention of the Railway Engineering Association

At the twenty-third annual convention of the American Railway Engineering Association held in Chicago, Ill., March 14-16, President L. A. Downs, vice-president and general manager of the Central of Georgia presided, and in his opening address referred pointedly to the fact that among 3,000 graduates in civil engineering only about nine per cent were engaged in railroad work. This he claimed was owing to the small salaries paid to railway engineers in the maintenance of way department. There was great need of technically trained men in railroad work, but in the part of the country where he was particularly acquainted the average salary was only $118 per month, whereas locomotive firemen were paid $175 per month, while as is well known, locomotive engineers are paid more than twice as much as civil engineers.

The secretary reported a membership of 2,063, and total cash assets of $44,742.51. He also reported that the new edition of the *Manual* would be ready early in June, 1922. It was duly reported a large part of the recommendations that the association had adopted last year had been endorsed by the American Railway Association at its recent meeting in November, 1921.

Reports on "Yards and Terminals"; "Economies of Railway Labor"; "Ballast"; "Iron and Steel Structures"; "Standardization"; "Signals and Interlocking"; "Stresses in Railroad Track"; "Roadway"; "Electricity"; "Water Service"; "Rails"; "Buildings"; "Wood Preservation," and other subjects were reported on by special committees.

The report on "Shops and Locomotive Terminals" was presented by F. E. Morrow, assistant chief engineer, Chicago & Northern Indiana. The committee on "Ash-pits" presented a report embracing a summary as follows:

"Ash pits in use at engine terminals throughout the United States and Canada and methods used to remove and dispose of ashes from locomotive ash pans vary greatly. They reflect controlling conditions of an operating, climatic, financial or physical nature, and also show great difference of opinion among those responsible for the selection and construction of ash pit arrangements.

"Operating conditions require that nearly all freight engines and, in exceptional cases, passenger engines, clean fires and dump ash pans on the road between engine terminals. At the terminals, the number of engines handled varies from a few up to several hundred and even at large terminals, there is great difference in operating requirements due to character of traffic, number of diverging main lines and proximity to large yards and industrial centers. Freight engines often arrive in "fleets." Engines in passenger and fast freight service require preferred attention to protect train schedules.

"Climatic conditions vitally affect the supply and dependability of fire cleaners and ash pit men, who must work in the open in all kinds of weather. Some ash pits fill up with snow or ice in severe winter weather, and cars loaded with ashes freeze so solid as almost to prevent unloading at reasonable cost.

"The financial condition of a railroad is often the controlling feature in the construction of ash pit layouts, some railroads being in position to expend considerable sums of money to reduce maintenance and operating costs and to avoid risks to interruption of service, while other roads for financial reasons are compelled to install pits of least first cost. Often facilities for ash disposal have been out-grown, but expenditures for new construction are not warranted until consideration can be given to an entirely new terminal layout. In some cases, operating conditions are not sufficiently definite to justify permanent construction.

"Physical conditions at terminals such as topography, nature of foundations available, drainage, cost and character of construction materials and proximity of waste banks are obviously important considerations.

"Where personal opinion seems to govern in the selection of an ash pit, the judgment of engineers and operating officials seems to vary most as to:

"(a) Method of quenching fires.

"(b) The extent to which satisfactory ash pit operation is dependent upon freedom from interference from other terminal operations.

"(c) The extent of provisions to assure freedom from breakdown and possibility of continued satisfactory operation under abnormal or unexpected demands."

The following were elected officers: President, J. L. Campbell, chief engineer, El Paso & Southwestern Railway; first vice-president, G. L. Ray, chief engineer, Delaware, Lackawanna & Western Railroad: secretary, E. H. Fritch; treasurer, G. H. Bremner.

The Care of Oil Burners

The amount of steam supplied to the oil burners is a point that is quite frequently not given the attention it should have, as the average fireman will open the valve on the line supplying the steam to the burner as wide as he can get it, regardless of the amount of oil he is supplying the burner. This is very wasteful, as the valve on the steam line to the burner should be opened only wide enough to supply enough setam to atomize the oil being fed through the burner. Each time the supply of oil to the burner is changed, the steam supply should be changed so as to give just enough steam to the burner to thoroughly break up the oil into a gas that should burn with a mellow flame.

Quite frequently the air supply to the furnace is cut down too low for good combustion to take place, and the steam valve on the burner is opened wide so as to make an air syphon of the burner. This is both inefficient and wasteful, as the excess steam has a tendency to cool the furnace as well as to make extra vapor to superheat to the temperature of the uptake gases.

The pre-heating of fuel oil is a point that is quite frequently neglected and quite often we see oil being fed to the boiler at a temperature of 120 to 130 deg. F. If the fuel oil is preheated to a temperature of 200 deg. F.. it requires less steam to atomize the oil, and the oil breaks up much easier. In this way good combustion is obtained at fairly high rates of vaporization through each burner. That is, a burner that will only handle 250 pounds of oil per hour at 130 deg. F. temperature, will vaporize 400 pounds of oil per hour when the oil is pre-heated to 200 deg. F. or more.

Fire Fighting on the Pennsylvania

According to a report of the insurance department of the Pennsylvania Railroad system, the loss to the company's properties endangered by fire during the year 1921, was kept down to less than 0.1 per cent. This was largely through efficient fire prevention methods, and promptness of employes in extinguishing fires on railroad property with the company's apparatus before the arrival of municipal fire fighters.

During 1921 there were more fires than in 1920, but the loss was less in amount than in the previous year. The number of fires extinguished by employes with the company's fire-fighting apparatus was 288. The loss caused by these fires amounted to only $26,112.30, while the work of the employe firemen saved railroad property with an insurance valuation of $30,612,653.

A number of these fires were in buildings worth millions of dollars, the destruction of which would have resulted in heavy losses and serious inconvenience to the operation of trains. The average loss, however, amounted to about $90.

An analysis of the insurance department's report shows that organized fire brigades extinguished 63 fires in properties having an insurance valuation of $11,746,-698, with a loss of only $5,386.23. Locomotives equipped with fire apparatus extinguished 21 fires with a loss of only $4,-781.08 in property having an insurance valuation of $405,298, and the company's tug-boats equipped with fire fighting facilities were brought into service in five cases where the loss amounted to only $2,044.56 in property insured for $752,600.

The Railway and Locomotive Historical Society

An organization has been formed among a considerable number of railroad men and others interested in the development of American railroads, and earnestly interested in the publication of reliable data in regard to the history of the railroads. The work of organization has been completed and fifty members are already enrolled, all of them active in the good work. Officers have been elected and among them are names well known as contributors to railroad literature, and the work of the society may safely be expected to be of an authentic and enduring kind. The officers elected are as follows: president, Charles E. Fisher, Taunton, Mass.; vice-president, Herbert Fisher, Taunton, Mass.; recording secretary, C. W. Phillips, Taunton, Mass.; corresponding secretary, R. W. Carlson, Escanaba, Mich.; treasurer, A. A. Loomis, Jr., Berea, Ohio.

Two bulletins have been already issued containing articles on "Yesterdays on the New York Central"; "The Story of the New England"; "America's Most Famous Trains"; "The Fall River Line Boat Train"; "Eddy Clocks"; "Some Experimental and Electrical Locomotives of the Chicago & Northwestern"; and "The Rival Builders." The articles are all highly interesting and bear the impression not only of accurate research, but of a high literary quality of expression.

Reads Like Fiction

It may be readily recalled that during the flood of the Platte river, near Union, Col., in June, 1921, Engineer George Fouts, piloted a locomotive with a long train of Pullmans from Alliance, Neb., into Colorado. Nearing the Platte river bridge at Union the train was moved slowly on to the bridge. The engine was precipitated into the swelling stream. The airbrakes stopped the cars and saved the passengers from drowning when the bridge collapsed. The engineer and fireman went down with the locomotive. The engineer clung to a piece of driftwood and was rescued. The fireman, Elmer Snedeker, was also saved. Six months elapsed before the locomotive was brought up from the river. It is now pulling the regular train from Alliance to Denver. Fouts and Snedeker are in the cab.

Encouraging Laziness

A railway switchman in England, in 1846, had two station signals, some distance apart, to mind. He fastened the two levers together with a long wire, using a broken iron chair for a counterweight, and ran the wire on into his hut, where he sat nightly by the stove comfortably working the signals without setting foot outside. The management of the road learned of the trick, reprimanded him for his laziness, promoted and rewarded him for his ingenuity and adopted his invention.

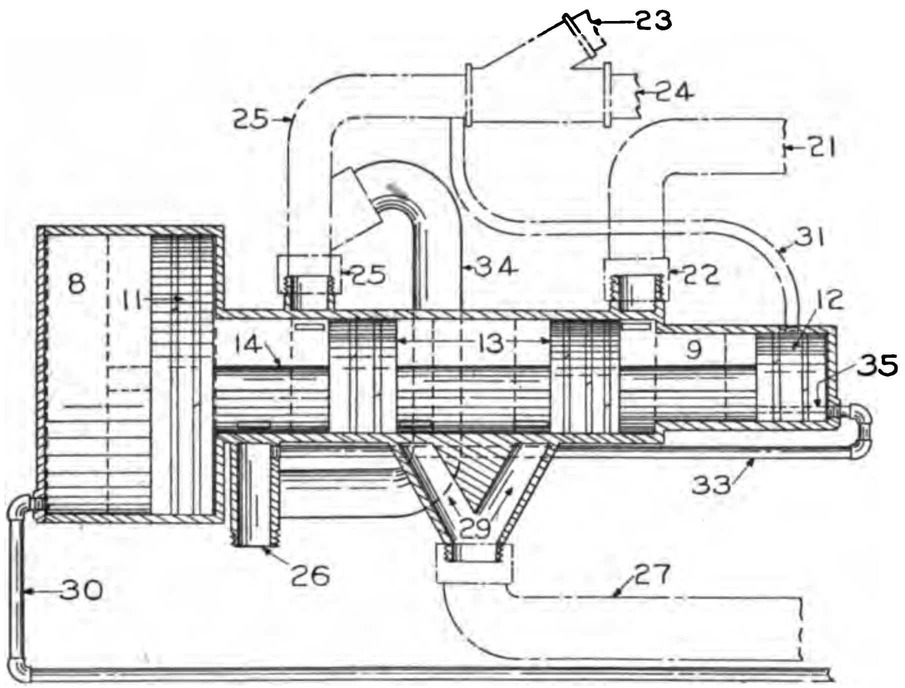
Improved Conditions in Czecho-Slovakia

The repair of railway equipment in Czecho-Slovakia progressed rapidly so that traffic has now reached normal conditions. There are 4,280 locomotives, of which nearly 4,000 are in serviceable condition. There are 106,250 cars, 10,000 of which are for passenger service, with only about 8 per cent in bad order. The mileage extends to 8,488, largely State owned, private companies owning about 618 miles. Branches are being projected into neighboring states, and the prospect of steady employment during the year is very favorable.

Roberts Automatic Drifting Valve

Admitting a Small Flow of Steam When the Throttle Valve is Closed

An automatic drifting valve has recently been developed by H. L. Roberts, of Roanoke, Va. The object of the valve is to automatically open the small flow of steam to the engine cylinders when the throttle valve is closed, and to utilize the exhaust of the stoker and air pump for filling the main engine cylinders as well as the oil that has been fed to these auxiliaries for the lubrication of the cylinders.



ROBERTS DRIFTING VALVE IN CLOSED POSITION.

The engravings represent the valve in the closed and drifting positions. The main body of the valve is composed of a cylinder of three diameters in which four pistons move to and fro. There is one piston in each of the sections of largest and smallest diameters and two in that of the intermediate diameter. All four pistons (11, 13, 13, 12) are attached to the same stem and so move together.

The pipe (30) leads from the outer end of the large diameter (8) of the cylinder to the engine steam chest. The pipe (21) connects the end of the intermediate cylinder to the boiler. The pipe (27) with its *V* connection (29) connects the intermediate cylinder with the steam chests of the main engines. The pipe (23) leads from the stoker exhaust and the pipe (24) from that of the air pump. They unite in the pipe (25) which is connected to the intermediate cylinder at a point just back of one of the pistons (13) when the valve is in the drifting position. A small oil pipe (31) leads from the pipe (25) to the smallest diameter of the cylinder for the purpose of lubricating the small piston. The pipe (26) leads from the end of the intermediate cylinder to the atmosphere and serves as the exhaust pipe for the stoker and the air pump, when the valve is in the closed position. Finally there is a by-pass pipe (34) connecting the pipes (25) and (26).

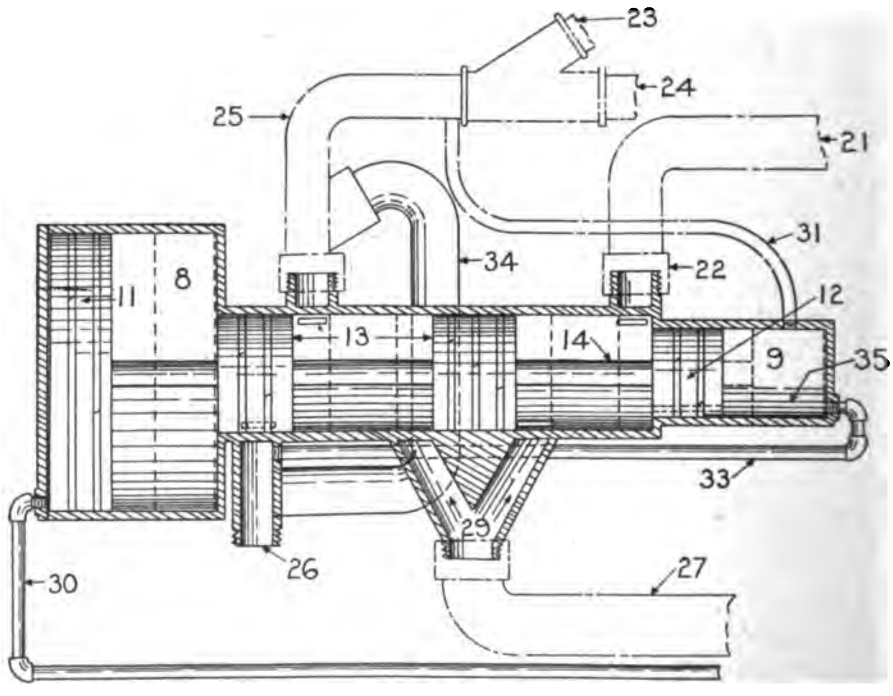
It will be seen that the connection between the pipe (34) and the pipe (25) is so arranged that when there is a flow of steam through the pipe (25) it has a tendency to draw steam out of the pipe (34), and it will thus flow along the line of least resistance directly through the intermediate cylinder.

The two pistons (12 and 13) together form a differential piston. With live steam from the boiler admitted between these pistons the tendency is to move the combination of four pistons to the left and into the drifting position. In this position the live steam flows from the pipe (21) through the intermediate cylinder to the right hand leg of the *V* connection (29) and, thence, through the pipe (27) to the steam chests of the locomotive.

At the same time, the exhaust from the stoker and the air compressor follows the line of least resistance and flows through the intermediate cylinder into the left hand leg of the *V* connection (29) and so out through the pipe (27) to the steam chests. This condition continues in operation as long as the throttle is closed.

As soon as the throttle is opened and a pressure of 8 lbs. per sq. in., has been built up in the steam chests, this pressure acting on the left hand side of the piston (11) overcomes the differential of the boiler pressure on the pistons (13 and 12) and moves the whole system to the right and into the closed position.

In this position, the exhaust from the stoker and the air compressor passes directly through the intermediate cylinder and out at the exhaust pipe (26) and into the atmosphere, being cut off from the *V* connection (29) by the left hand



ROBERTS DRIFTING VALVE IN DRIFTING POSITION.

piston (13). At the same time right hand piston (13) has moved to the right so as to cut off the flow of boiler pressure steam to the *V* connection, and the connections between the exhaust and the live steam with the steam chests is automatically closed.

The by-pass pipe (34) is located, as it is, solely for the purpose of acting as an insurance that there shall never be any choking of the exhaust by any sticking of the pistons.

Reconstruction of the Experimental Locomotive at Purdue University

The locomotive used by the Purdue University in conducting elaborate tests, and which was originally installed under the supervision of Prof. W. F. M. Goss, then Dean of the Schools of Engineering, and which has subsequently undergone several modifications, chiefly by the application of new devices will be again remodeled. The locomotive which is now in operation and known as Schenectady No. 3 will be placed in the shops of the Minneapolis railway at Lafayette, Ind., where new cylinders with outside valve gearing and other improved devices will be applied. Toward this laudable purpose the Baldwin Locomotive Works are donating new cylinders and piston valves, outside steam pipes, pistons, crossheads and guides, main crank pins, and Walschaerts valve gear. The Locomotive Firebox Company are donating a thermic syphon. The Sunbeam Electric Company, complete headlight and cab lighting equipment. The Nathan Manufacturing Company, injectors, boiler checks and water glass, the Locomotive Fuel Economizer Company, the Boyce fuel economizer, and the Southern Valve Gear Company, the Southern valve gear complete. The reconstruction of the locomotive will be rapidly proceeded with, and will be ready for reinstallation at an early date.

Popular Opinion in Regard to the Railroads

The prevailing opinion seems to be that there is a general realization that the days of antagonism to railroads, particularly as a matter of political policy, are over, and that the progress of the country is more dependent now upon the full restoration and extension of railroad service than upon any other one thing. This changed attitude of the public argues well for the legitimate interests of transportation from this time on, provided that these interests justify the hopes and fulfill the desires of the people. Instead of abused and friendless foundlings, the railroads have become the adopted children of the Government and its machinery. There can be more frenzied finance unless the Government closes its eye, and that it is not likely to do. The country acknowledges its mistake of the past and has adopted a new attitude towards the railroads. The railroads, acknowledging their own past errors, must now justify the new policy by their conduct and achievements. All they need, or nearly so, has been granted them, the responsibility now rests upon their shoulders. We are convinced that they will do well, if all of the contributing sources of activity do well by them, especially those who in the last analysis depend upon them for employment. Work, real work, is the need of the hour. There is no satisfaction in life to be compared to that of a day's work well done. It is not a price that we pay for existence, it is existence itself, or rather the purpose and measure of real existence.

Postponements of the Power Brake Hearing

The Interstate Commerce Commission has issued an order postponing its investigation of power brakes and appliances, from April 6 to May 17. The order is published elsewhere in this paper.

Railroad Men Advised to Secure Ship Lines

The operation of fleets of government tonnage by the railroads of the United States so that American products may be transported from their sources to all corners of the world by American carriers is the hope of President Harding and officials of the Shipping Board. It is hoped that the proposed subsidy programme, if put into effect, will be an incentive to American railroads to purchase ocean tonnage, and that through this method the ruinous competition offered by foreign lines will be met successfully.

The idea would be worth the experiment if the railroads had any surplus to experiment with, but as long as the so-called subsidies remain an invisible thing, and the governmental repressive measures handicap the railroads so that many of them barely meet current expenses, it is little else than mockery to point out what they should or what they should not do. Even if the ships could be secured or procured it is doubtful if American seamen could be found ready to serve at the same rates of remuneration as are the seafaring men of European countries, but after our battleships are sunk there is no knowing what our gallant seamen would be willing to do to carry our flag on the highways of commerce and, incidentally, earn a living.

The Shipping Board gives detailed figures on a coal-burning vessel of 6,000 deadweight tons under British and American flags. Prevailing wages on privately owned and Government vessels are compared with those on the British ship effective on May 1, 1922. These show a total monthly pay roll on the Shipping Board steamer of $3,257.50, on the private American steamer of $3,060 and on the British vessel of $2,212, with pounds converted to dollars at the present rates of exchange. Subsistence costs on Shipping Board and private boats are considerably higher than on a British steamer as shown by official reports.

The comparison of wages for some of the important classifications of officers and men is as follows:

	American Owners	United Kingdom
Master	$275	$195.30
Mate	165	88.97
Able seamen (6)	285	260.40
Chief engineer	250	106.33
Firemen (9)	450	410.13
Oilers (3)	165	133.22
Steward	105	62.93

Efficiency of the Railways

Speaking before the Interstate Commerce Commission last month Herbert Hoover stated that "a great deal has been said about the inefficiency of our railway system. I do not sympathize with these statements. Comparison with foreign railways of the fundamental criteria of per ton mile costs, train loading and so forth, in the light of our cost of living, will demonstrate that our railways are of higher standards, better in methods than others and are growing in efficiency.

"The consolidation of our railways into larger systems has been contemplated in our legislatures for some years past as a gain in efficiency. Its value cannot be overestimated—it is not a panacea for all trouble. It does give hope, however, of economies in further efficiency from more complete utilization of rolling stocks and terminals, some small degree of saving in overhead, saving in current inventories, but probably its greatest saving would be decreased cost of proper finance, increased financial stability and fuller independence from the supply companies.

"It is probably unnecessary to refer to the question of Government ownership. No one with a week's observation of Government railways abroad, or with Government operation of industry in the United States, will contend that our railways could ever be operated as intelligently or as efficiently by the Government as through the initiative of private individuals. Moreover, the welfare of its multitude of workers will be far worse under Government operation.

"We are struggling with the great problem of maintaining public control of monopoly, at the same time maintaining the initiative of private enterprise. I believe that we are steadily progressing to solution.

"Great social and economic problems find their solution slowly and by a process of trial and error. We have tried unregulated monopoly and have tried Government operation and found the error in them. We still have much to solve if we are to maintain our transportation. Much of this solution depends upon the successful initiative of the railways themselves and much of the shaping of these matters lies, fortunately, in your able hands."

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Give the Owners of the Railroads a Chance

It is becoming more apparent that while self-government in politics was a generally recognized ideal, it was still regarded as a dangerous paradox in industry. Efficiency depends largely on the employer being master in his own home. Politicians can muddle along. They are handling other people's money. To make a business, such as transportation is, there must not only be the equipment but the skill and experience of the workers, and besides there is a third and more imponderable factor, the spiritual contentment of the worker. It is from the man who felt himself in some real sense free and at home in his work that they would get the most efficient production.

Ownership, above all, it seems there must be, and mastership without communism. But those were not always the best friends of ownership and mastership who advanced their claims to them. In the early days it was not the best men who owned and managed the railroads. Many of them earned a bad name and deserved it. In their hands the plastic politician was a ready tool, and not always a cheap tool. Owners of railroads were necessarily compelled also to be the owners of legislative assemblies. This addition to the plant had to be well watered. The public who bought transportation had to pay for these extra attachments, and clamored for relief. The Federal government sooner or later responded to the call —generally later. Hence the condition that confronted us, and to a considerable extent, still confronts us.

With valuations of the railroads as exact, probably, as any valuation can be made, it takes a long time to live down a bad reputation. The owners and managers of the railroads today are capable and clean men, burdened to some extent with the inherited character of their predecessors. It seems as if they are not yet to be entirely trusted. This is a gross error, and the short period of governmental control has largely, if not altogether, opened the eyes of the people to the fact that governmental supervision of private enterprises should have its limitations. The present generation of railroad owners and managers are as much entitled to a fair chance at managing their own business as the early experimenters were, and more so,—they are trained in the school of experience. No one is fit to go to business, or to go anywhere at all except to perdition, who had not some knowledge and constraining sense of what this inheritance meant and required.

A word might be added in regard to the manual worker. To be overworked and underpaid is degradation. To be underworked and overpaid is debauching. Between these extreme poles there is a temperate zone where there is peace. To be capable of appreciating this atmosphere all that is needed is common sense. Contentment, like every other grace, can be cultivated, and when full-blossomed it is better than fine gold.

Organization in Railroad Repair Shops

While the larger railroad repair shops are now fairly well organized, and while the subject has been so often referred to, it is hardly necessary to state that, like military discipline, unless it is constantly maintained it is apt to become lax, and hence a brief recapitulation of the approved means and methods of shop organization may properly be said to be always in order, and in the first place it may be briefly stated that apart from the financial gain in the systematizing of a repair shop, the aim is to get a team-like organization which is physically and intellectually fit to perform the ordinary duties that are required, as accurately as necessary, and with little or no delay, and to be sufficiently flexible to comply with the extraordinary conditions which from time to time occur, with the least possible friction and, generally speaking, to be there with the goods, no matter what the requirements of the road department may be.

The success of such an organization depends more or less upon the opportunities it is given to prepare to meet the requirements, and to know what the requirements are, and will be, with respect to anticipated repairs to locomotives, so that a staff may be trained and maintained without undue fluctuation. This may, generally speaking, be very materially assisted by the systematic shopping of engines; and the divisional master mechanic having condition records at hand at all times, should endeavor, as far as possible, to do his part of the team play by turning in for repairs each month a certain percentage of the locomotives under his control, such percentage to be that which will maintain the power in a good serviceable condition.

The ideal state of affairs exists at the shop when engines are coming in for repairs in a constant flow from month to month, rather than a spasmodic shopping of say 5 per cent one month and 20 per cent the following month, and as there is a ratio between the number of locomotives in service and the number requiring repairs each month, which will give the most efficient results, it seems from a shop point of view, that this ratio should be fixed and maintained as far as possible, so that any system which may be set up in the shop could be carried through to the best advantage.

It will be admitted that with a more systematic shopping, which would permit of a more uniform output, to follow the average line more closely, the cost line would also straighten out and run more nearly parallel with the output line, and also show a very material decrease in cost for the yearly average per engine required.

A detailed report of each engine should be prepared never later than one week previous to shopping. It should be made out by the locomotive foreman in charge, or other competent person who is thoroughly in touch with the actual condition of the engine, and should outline very clearly the exact nature of the repairs required to the machinery and boiler, so that the shop would be in a position to take advantage of this knowledge by arranging for the preparation of parts for extraordinary work of any nature. This would decrease the number of days the engine would be out of service, and likewise avoid the unnecessary delay which would consequently follow, if shops were not provided with means to anticipate the requirements. This report should particularly cover the defects peculiar to actual service which might not be found, even by most rigid test or inspection in the shop, and so pass uncared for.

Attached to this repair report, or supplementary to it, should be a statement showing any missing parts which may have been destroyed by accident, or have been robbed *en route* for "repairs to other engines," and should detail the method of shipment of defective parts, and advise whether any material is being shipped or not. It should also give detailed distribution of robbed parts so as to eliminate the extra cost to the engine being shopped due to the manufacture of parts not required, and to the manufacture of the parts that may be required.

In repairing locomotives we will agree, no doubt, that any system which eliminates wasted effort is good. It does not necessarily follow, however, that because any particular system has been branded as scientific that the brand alone confirms it.

Conditions in different shops are so variable that an effective system adopted in one shop might be ineffective in another, consequently the best system to set up in any shop is that which, after careful investigation, will fill the required needs.

In generally considering a system from a shop point of view it seems to us that it might naturally be considered in the following parts:—Cutting out lost motion, and standardization of methods; regularity and uniformity of work; stimulation of workmen and co-operation or team play of all concerned; and routing material and repair parts.

An inspectors' or demonstrators' department takes care of the standardization of machine operations and methods,—and its general function is to make detailed study of the elements of every piece of work for the purpose of discovering the best method of handling it, and in the light of the past and present, add whatever may be likely to give the best results.

The elimination of unnecessary motion in doing any work is always a benefit, because it conserves the vitality of the workman and makes his labor more productive. Apart from the machine operations it is the duty of each foreman to observe the methods of his workmen with a view of correcting any improper method and removing any unnecessary motion in his work. This is particularly true where inefficient men are only obtainable to do skilled work, and it becomes necessary to study their movements in order to train them to that standard of efficiency which skilled men have already acquired.

The routing of work in all large shops is a very live subject, and it is one that may either cause a great deal of annoyance or otherwise, dependent entirely on the method adopted and carried out. The routing trouble generally has been more or less overcome by the careful grouping of machines, so that as far as it is practicable, all work required on any particular part will be done within as small an area as possible, and under the same leader. Where it becomes necessary for work to go to more than one shop, the foreman who last handles a part is responsible for its delivery to the next in order, and where delay occurs it is shown up quite clearly by the Material Chasing Schedule or the Work Order System, which is taken care of by a scheduling department.

In considering the schedule it should be remembered that it is better to have finished parts lay unused one or even two a day for the want of it, and for this reason some latitude should be allowed to overcome those little hitches which will occur even in the best regulated families, and as "the best laid plans of mice and men gang aft agley," it is sometimes necessary, on account of some ungovernable delay, to make a very short schedule for one or more engines, to keep the output up to requirements, and a change might be necessary at any time to meet the urgent or extraordinary cases which occasionally occur on account of road conditions.

In the case of heavy boiler work, the boiler is removed from the frames as per schedule and carried to the boiler shop. All other material is loaded on the frame and put out in storage until a certain stage is arrived at in the repair of the boiler, at which point the engine is again brought into the shop and the stripping completed, so that all material may be delivered to the feeder shops for repairs at the correct time, to allow the work on all parts to progress in harmony, and the frame being ready to receive the boiler at test date, the operations will follow as in the case of an ordinary repair.

A word may be added in regard to the criminal haste with which general repairs are frequently completed. A promise is made that the engine will be ready at a certain hour, and at a time when the careful adjustment of the valve gear or other exact work may have involved an unavoidable delay, the engine is thrust out probably in a snowstorm, and the shivering, half-clad mechanics are running here and there, frantically endeavoring to finish some work that should have been done in a kindlier atmosphere.

Possible Locomotive Economies

A great deal has been said and written as to the savings obtainable in locomotive performance by heavier power, compounding, the superheater and the brick arch. Possibly as concrete a statement or proof of this as it is possible to make can be put into tabloid form as follows:

A test was made between a mallet locomotive and two road engines of the mikado type. It should be stated, however, that the mallet had been designed for slow pusher service with exceptionally small valves and passages to suit such service, but was tested in road service against regular road engines at a considerably higher speed than that for which it was designed. Whereas if an engine designed for road service had been used a considerably greater saving in fuel would probably have been effected.

The two regular road engines were without either superheater or brick arch and had an average coal consumption of 136.8 lbs. per 1,000 ton miles. The mallet, also without superheater or brick

showing a saving of 13.8 per cent or an additional service of 2,320 ton miles per ton of coal or a gain of 16 per cent. The mallet was then fitted with a superheater, when the coal consumption dropped to 91.4 lbs. per 1,000 ton miles. This was a saving of 33.2 per cent when compared with the performance of the mikado locomotives and 22.5 per cent in comparison with its own previous performance without the superheater. This was a gain of 7,260 ton miles per ton of coal or 49.7 per cent as compared with the performance of the mikados, and 4,940 ton miles more per ton of coal or 29 per cent more as compared with its own previous performance without the superheater.

The mallet was then fitted with a brick arch in addition to the superheater and then tested when the coal consumption fell to 78.8 lbs. per 1,000 ton miles. This was a saving of 42.3 per cent over the mikados, and 33.2 per cent over the work of the mallet itself before the superheater and the brick arch had been added, and 13.8 per cent over the mallet with the superheater alone. These percentages represent a gain of 73.6 per cent in the ton miles per lb. of coal as compared with the mikados; 50 per cent as compared with the mallet itself without superheater or arch and 16 per cent over itself without the arch, but with the superheater. This represents an increased capacity of 10,760, 8,440 and 3,500 ton miles per ton of coal respectively. In the last analysis it appears, from these figures, that the addition of a superheater and a brick arch to a mallet locomotive will effect a saving of about 33 per cent in coal consumption for the same work, of which about 22 per cent can be attributed to the superheater and 11 per cent to the brick arch.

British Car Builders' Strike

The strike of the car builders in Great Britain assumed serious proportions, but the latest reports indicate that a compromise will likely be effected at an early date. According to reports, which are somewhat conflicting as usual in such controversies, the wages are now 110 per cent above the pre-war times, and the employers demand that a reduction of 15 per cent be made. This is not all, however, as what was known as the "Churchill" bonus, amounting to 12½ per cent added to the current rate of wages is being gradually curtailed. This bonus has been furnished from the Public Treasury, and the public are tired of it. The car builders naturally view with alarm the threatened serious reductions. They are in the position of the dog whose tail was considered to be too long and the owner mistakenly imagined that it would not hurt the dog as much to cut off a short portion at short

Hearing on Automatic Train Control

Brief Submitted by the Joint Committee on Automatic Train Control of the American Railway Association.

As previously announced, an order was issued by the Interstate Commerce Commission early in January to 49 railroads of the leading railroads in the country to install automatic train control, on at least one passenger division of its line, on or before July 1, 1924, and the carriers were given until March 15, 1922, to show cause why the order should not stand. This date was by a further order postponed until March 20. Representatives of 40 of the 49 of the railroads notified appeared before the Commission, and the proceedings were conducted before Commissioners McChord, Esch and Lewis.

The American Railway Association was represented by President R. H. Aishton, C. E. Denney, chairman of the Joint Committee. Mr. Aishton made an introductory statement, wherein he reviewed the work of the Joint Committee on Automatic Train Control up to the present time. C. E. Denney and Mr. Thom, acting as counsel, claimed that it would be shown that the order of the Commission should not be refused at this time. The attitude taken by the Joint Committee was summarized upon the following questions:

(1) Has the art of automatic train control reached a state of development such that the Commission would be justified in requiring the railroads to make the contemplated installations? The answer of the Joint Committee will be "No."

(2) If experimental installations should be deemed advisable, would duplications of experiments be necessary? The answer of the Joint Committee will be in the negative.

(3) Are further developments in the art of automatic train control probable? The answer of the Joint Committee is in the affirmative, particularly with respect to the inductive system of automatic train control.

(4) Are the specifications laid down in the order adequate? Answer: The Joint Committee will offer amendments.

(5) The Joint Committee has not entered into the financial question, but expense is recognized as a large factor as to the advisability of making installations at this time; and in this connection there naturally arises the important question as to whether money available for train control installations had not better be expended on extension of the automatic block signal territory of the railroads subject to the order.

(6) It is a question of importance whether automatic train control would not decrease the traffic capacity of the roads

The Committee's Brief

The following is an extract of the leading points of the brief setting forth the reasons why the proposed order requiring the installation of automatic train control devices should not be issued.

"I. No automatic train stop or train control device has been sufficiently developed to justify the issuance of said order.

"That the state of the art as it existed up to the beginning of 1920 did not warrant any extended use of the devices in question is, we submit, not open to debate. The Automatic Train Control Committee of the United States Railroad Administration (Annual Report of Director General of Railroads for the year 1919, p. 34) summarized the situation as of that time thus:

"'Generally speaking, it may be said that the tests which have thus far been conducted have demonstrated that the functions of automatic train control devices are possible of accomplishment under actual service conditions.

"'But while these functions may be accomplished under the conditions existing at comparatively isolated locations with the high degree of maintenance ordinarily given to test installations of this character, it is an entirely different problem, and a far more complex one, to apply these devices to the various operating conditions encountered in railroad service, and to accomplish these functions day and night, year in and your out, on a large number of trains and on several hundred miles of a busy railroad.

"'From a practical standpoint, automatic train control devices are still in the development stage, and many problems in connection with their practical application remain to be solved.'

"While progress has been made during the past two years in the direction of overcoming the many objectionable engineering and mechanical features of the several devices installed for test purposes on various railroads and in developing such devices to the point where train operations can be conducted under their control without serious impairment of the service, it is still true, as stated by the Automatic Train Control Committee (*supra*) that *'from a practical standpoint, automatic train control devices are still in the development stage, and many problems in connection with their practical operation remain to be solved.'*

"Of the hundreds of contrivances brought to the attention of the Joint Committee on Automatic Train Control of the American Railway Association, the only control, which have been in service under actual operating conditions and dependable and continuous observation for any considerable length of time, are those of the Regan Safety Devices Company, the Miller Train Control Corporation and the American Automatic Train Control Corporation, now in service to a limited extent on the Rock Island, the Chicago & Eastern Illinois and the Chesapeake & Ohio Railroads, respectively. These three are the only installations of which specific mention is made in the Commission's report dated Jan. 10, 1922, which, we submit, warrants the inference that the Commission had them in mind when it said (Report, pp. 5-6, lines 33, 34, 1-6):

"'The fourteen years of investigation and study, the service tests under varying conditions and the results obtained in the actual employment of these devices over periods of years upon some of the roads have clearly demonstrated the practicability of and the necessity for automatic train stop or train control. The time has now arrived when the carriers should be required to select and install such devices or device as will meet our requirements.'

"In any event, the failure of the Commission, in its report, to direct attention to any other particular installation, must lead to the conclusion that in the judgment of the Commission no other system of train stop or train control has been sufficiently tried out to warrant even the suggestion that it be generally adopted.

"The three installations above referred to have been the subject of special investigations conducted by a sub-committee of the Joint Committee on Automatic Train Control of the American Railway Association, for the purpose of determining the present status of the respective systems. A copy of the report of such Committee is separately submitted as part of this return. It shows, among other things, with respect to each of the devices in question:

(*a*) Numerous objectionable mechanical and engineering features remaining to be corrected;

(*b*) Many operating difficulties which have not yet been satisfactorily taken care of;

(*c*) A relatively large number of failures.

"In short, this report conclusively establishes not only that the devices in question have not yet been brought up to the point where it can be said that they show a 'high degree of efficiency' under general service conditions, but also that they, like all other kindred devices, are still in the that many problems remain to be solved before they can be considered as practicable and reliable for the purposes of the Commission's proposed order.

"Automatic train stop or train control calls for the adoption of a device that will function when the human element fails. Its application is complicated for the reason that it will have a restricting effect on the capacity of a railroad and it is, therefore, obvious that we are dealing with a very different proposition from that confronting the railroads when the automatic coupler, the air brake or the block signal were under consideration. In the movement of a train between one terminal and another, the engineman must be depended upon scores of times to use judgment and discretion in handling his train to insure its safety. It is a question for serious consideration how the relief of the engineman from part of his responsibility will affect his alertness and dependability. In providing a device with a view to increased safety, it is necessary to make sure that the device will not set up more dangerous conditions than those it is designed to correct.

"2. *The order would be premature if issued at this time because the carriers have not had opportunity to make adequate service tests of devices designed to function on different principles from the devices specifically mentioned in the Commission's report.*

"Each of the three systems specifically mentioned in the Commission's report is so designed as to require the use of a ramp located alongside or between the rails.

"Many of the carriers object to installations of this type of various grounds—among others, the clearance difficulties encountered when the motive power of one carrier has ocasion to use the rails of another, as well as the element of danger to employees due to the presence of the ramp on the right of way.

"The Commission is no doubt aware of efforts now being made to develop automatic train stop and train control devices designed to function on the induction principle, and it is the opinion of the engineering and operating officers of numerous carriers that such type of device gives promise of overcoming many of the objectionable features inherent in the ramp type.

"Test installations of automatic train stops or train control systems designed to operate on the induction principle have lately been installed or are contemplated in the immediate future, viz.: the Sprague device, on the New York Central R. R.; the Bostwick device on the Southern Pacific; the Union Switch & Signal device on the Pennsylvania Railroad; and, possibly others. These devices appear to possess merit and the result of the test installations may warrant their extension. No order, therefore, should be issued until such time as the carriers have had ample opportunity to ascertain whether or not some one or more of such systems is practicable and reliable for the purposes of the Commission's order.

"3. *The carriers are making every reasonable effort to co-operate with the Commission in testing all meritorious devices and will continue such efforts as the Commission may direct.*

"That the carriers have not been derelict in the performance of any duty imposed upon them to develop automatic train stop or train control devices as rapidly as possible is apparent from the report, dated Feb. 15, 1922, covering the activities of the Joint Committee on Automatic Train Control of the American Railway Association, copy of which is also submitted herewith. In view of the activities of the Joint Committee since its appointment in November, 1920, as disclosed by this report, it would appear that the issuance of the proposed order, which cannot now be complied with, will tend to retard rather than promote the development of a proper system of automatic train stop or train control. The assistance rendered the Commission's staff by the Joint Committee since its organization is acknowledged in the Commission's report (p. 5) in this matter. It is needless to add that the Joint Committee as well as the individual carriers will continue to co-operate with the Commission and render all reasonable assistance in the proper testing and development of these devices.

"4. *The proposed order requires a much greater number of and more extensive installations than are warranted at the present time.*

"The proposed order contemplates the installation of automatic train stop or train control devices on a complete engine division of forty-nine different railroads.

"Answers by all carriers named in the Order to Show Cause except the Pennsylvania, The Pittsburgh, Cincinnati, Chicago and St. Louis and the West Jersey and Seashore companies, indicate that compliance with the proposed order by the carriers answering the questionnaire (46 in number) will require the installation of the devices in question on approximately 6,126 miles of railroad, 10,285 miles of track and 5,525 locomotives, the cost of which will aggregate many millions of dollars.

"In view of the present undeveloped state of the art and the comparatively few devices worthy of service installation at this time, it is manifest that such systems as recommend themselves to the Commission can be just as thoroughly tried out, their practicability and reliability under actual operating conditions ascertained and their proper development progressed as rapidly as possible, by continued co-operation between the Commission and the American Railway Association along the lines heretofore followed, as can be done by the extensive installations contemplated by the proposed order. The latter, if now made effective, will require a multiplicity of test installations of the same devices and the expenditure of vast sums of money unnecessarily.

"The question as to whether automatic block signals had reached a higher degree of development than train control devices have at present before extensive installations were made is largely a matter of opinion. In the opinion of this Committee automatic block signals had reached a much higher degree of development than train control devices have at present before any such extensive installations were made as is contemplated in the proposed order. This was the case in spite of the fact that the installation of automatic block systems was evidently a much simpler matter than the installation of automatic train control devices. Attention need only be called to the one very essential requirement of interchangeability as illustrating this. With an automatic train control system no engines can be operated under it except those equipped with a device that will function in conjunction with the system installed upon the roadway, while with an automatic block system this condition is entirely absent. Signals function entirely irrespective of the character of the engine operating over the rails and provide the same degree of protection to the trains of any company that may be using the railroad."

Following Mr. Denney's presentation, Mr. A. M. Burt, member of the Joint Committee, spoke on the matter of interchangeability of equipment installed with automatic control apparatus. For many reasons it would be desirable to have such interchangeability, and wherever there is a joint use of tracks, it would be necessary, if not indispensable. As for the specifications included in the Commission's order, the only criticism, from the standpoint of the Joint Committee, was that section (b), under "Functions," providing for a manual releasing or forestalling device, had been omitted in the order.

The Automatic Freight Car Coupler

The published records of the Master Car Builders' Association (now Section 5, Mechanical, of the American Railway Association) show that the automatic freight car coupler was a subject of discussion and experimentation from 1870 to 1887, a period of 17 years, before it was adopted by the association as recommended practice. It was six years later than this before its use was required by law, or a total of 23 years between the time that it was made a subject of discussion by the Master Car Builders' Association and its requirement by law. Prior to its requirement by law, or its general adoption, it was a well recognized safety device.

Snap Shots—By the Wanderer

We seem to be learning a lot of things in these days that we knew before; but the short memory with which the average of mankind is endowed has caused us to forget. It would be well for every nation, especially a democratic nation to adopt the motto: "Lest we forget," and tie a string tightly about the body corporate, to keep the motto constantly in mind. Now we all knew, Americans, Canadians, Frenchmen, Englishmen and all the rest, that public utilities will not be economically managed by the public. France started the trial of the thing in 1848, and made an abject failure of it. Then like the forgetful woman who made an unfortunate marriage, we, that is we humans, have let hope triumph over experience in repeated cases since that time, only to meet with as many disappointments. Still the enthusiasts, who as Josh Billings once remarked can prove ten times as much as anyone will believe, and who believe ten times as much as they can prove, the enthusiasts, I say, come to the front with Plumb plans and nationalization plans and public ownership and regulation, regardless and forgetful of the experiences of the past.

The war played havoc with everything, but as the railroads are so necessary to the welfare of the world in the present stage of civilization, the havoc or, as some call it, the macadoodleism wrought upon them stands out more prominently than in other lesser or more personal matters.

We, in the United States, realized the condition more quickly than some other nations where the public or the politicians had been longer in the saddle of control. But wherever it is, there is one long record of deficits and comparative inefficiency and a cry for a change. France is tired of state control; Italy is wondering what she had better do about it; England's nationalization is of the past and our neighbors to the north are at their wit's end to know what to do about it. The deficit of the national railroads up there grows and grows and threatens to bankrupt the state. Meanwhile the big privately controlled line that was second in the field, goes serenely on its way, paying dividends and rolling up traffic and has "Bought golden opinions from all sorts of people."

We cannot tell yet, what they will do, but the chances are that they will follow in the wake of Falstaff, when in his soliloquy on honor, he said:

"Therefore, I'll none of it."

On this side of the line we were quick to shake off the immediate incubus of macadoodleism, but we still have the old chronic trouble of regulation. Perhaps regulation may some day give way to "oversight." Let us hope it may.

The order of the Bureau of Safety that certain roads equip certain sections of their lines with automatic stops has aroused the expected storm of protest on the part of the carriers. The two points upon which this protest is based are those of first cost and the experimental stage of the art which exists. Cost at the present time is a real bugaboo when the roads cannot find money for improvements that are clamoring for attention. The claim is made that the hundreds of thousands of dollars which the automatic stop will cost had far better be invested in signals. In this the case seems to be strong. But, in the matter of the experimental condition of the appliances themselves the testimony did not strengthen the attitude of the railroads. Briefly they claim that the devices are not in shape to be used. On the other hand there is a direct contradiction to this. And the very pertinent question was asked: "What have you done to advance the art?"

"Nothing."

"Why?"

"We are awaiting developments on other roads."

"Suppose, everyone should do that?"

To which no satisfactory reply could be made.

It comes very close to the truth to say that the railroads have not done very much intensive research work on new projects. They have extended facilities to inventors; they have been used by their own officials for the development of devices in which those officials were interested and retained as payment for their outlay the rights to use these devices without royalty. But to start out *de novo* to develop something that was indicated would be needed in the future, that has been left to private enterprise and so the questions as to, "What have you done about it?" carry more or less embarrassment.

There are other things, too, besides the fact that the automatic stop is still in the experimental stage that should be considered. What will be the physical effect on a train? To make an emergency application of the brakes, as the automatic stop will do, is not a thing to be lightly undertaken on a train of one hundred cars. As one superintendent put it in an order instructing engineers to be cautious about making emergency applications: "An emergency application on a loaded train is apt to damage the equipment, and an emergency on an empty train is apt to hurt the men." To guard against the unnecessary use of the emergency, the old engineer's valve had a small pin, that could be sheared off by the brake handle when it was moved to an emergency position, and the shearing of this pin was a telltale that such a movement had been made. With such things as this staring us in the face, it would seem to be the part of caution to look the situation over very carefully before deciding on such a move. One train buckled over on to an adjoining track may result in a greater loss of life and property than the stopping of the train automatically can ever save. The only thing is the prevention of an accident does not prove that the accident would have occurred if the preventative had not been applied.

It does not follow, of course, that every stop made automatically by a long train will spell disaster. Thousands of emergency applications are made every day with no bad effects; triples dynamite, hose burst and couplers break, and the train stops. But once in a while, a train buckles off on to the adjacent track and there *is* trouble. The question arises as to whether it is worth while and strictly in accord with the slogan of "safety first" to deliberately run the risk of such happenings. That is for the doctors to decide.

About a month ago I entered a protest about the open door in cold weather. It is a little out of season to consider such a thing now, but let us keep it in mind we are going to have cold weather again next winter. And while we are about it, suppose we do not limit our attentions to the Pullman cars but take in the day coaches as well, where we all ride occasioually, and ask the trainmen to keep those doors shut also. Possibly, however, this would be impracticable as the extra climbing to the platform involved might not be included in the regular schedule of their regular duties and might call for punitive over exertion. Then it might be necessary to draw up a schedule for the various heights of platform or the distances of the bottom steps from the rail. This brings up so many complications that perhaps it had better be abandoned after all. However, when things return to the normal it may come to pass that all these things can be brought about.

This reforming business is only easy when the reformer himself, his friends and hecklers refrain from asking embarrassing questions. It is so easy to suggest but quite another thing to execute. And in the end it comes back to the council question asked by Æsop's mouse at the conclave that decided that, for the warning of the world of mice, a bell should be hung about the neck of the cat. The little mouse asked: "Who will tell the cat?" So here, who will make the reformation work?

Development in the Construction of Freight Car Roofs

In the development of car roof construction, wood is being rapidly eliminated, or restricted in its use, the wood framing being abandoned in favor of steel, and as a roofing wood is only used to protect or support the metal roof sheets, which is in keeping with the steady advance in car construction. Car roofs to-day are built entirely of steel, and in consequence are known as "all-steel roofs." In comparison with the composite roofs, the all-steel roof presents an entirely new departure in design, both in regard to framing and roofing. The roof sheets are usually of galvanized 1/16 in. galvanized steel, but in many instances the sheets are 3/32 in. in thickness and span the full width of the car, providing in themselves the necessary protection against puncture and other hard usage. Additional reinforcement can be obtained by corrugating the roof sheets at suitable intervals, The carlines in most cases are designed to provide ready means of connecting the roof sheets, in addition to supporting the roof, and having the superstructure of the car.

With the adoption of the all-steel roof, the question of flexibility becomes a very live subject, some types provide for free movement of the roof sheets, in a similar manner to the flexible outside metal roof, while in others the roof sheets are flanged, capped and riveted together, forming in themselves an absolutely rigid roof. It is claimed for the first type that the roof should be sufficiently flexible to take care of the constant straining of the car body, while in the rigid type the roof is made strong enough to resist the straining of the body, and act as bracing for the superstructure.

The all-steel roof lends itself readily to the use of outside carlines, this arrangement giving the car a considerable advantage in loading space. Other advantages being the reduction in fire risk, and final cost, owing to the life of the roof more nearly corresponding with other parts of the car and finally a greater safeguard against leakage is obtained by the use of thicker sheets, which resist corrosion and cracking to a greater extent, and as a result this type of roof is gradually meeting with more general approval.

An objection which is sometimes raised against the all-steel roof is the claim that under certain conditions it is liable to sweat, resulting possibly in damage to lading. For instance, freshly milled flour containing a high percentage of moisture, and which is usually hot when loaded, quickly raises the temperature of the car above that of the outside atmosphere. It is claimed that the metal roof being then subject to two widely varying temperatures commences to sweat, and that the resultant moisture is sufficient to damage the contents. It is questionable, however, if this is of enough importance to warrant special attention when building box cars for general service requirements, but as a measure of precaution effective steps are being taken to prevent the possibility of this occurring even under the most extreme conditions, and eventually there is good reason to believe that the all-steel roof will meet all requirements even to the extent of satisfying the demands of very exacting shippers.

In comparison with the roof of a stationary building, which outside of providing the necessary shelter, has only to contend with wind pressures, the car roof has to withstand considerable more abuse, due to the fact that the car is constantly in motion from the day it is built to the last day of its existence. Consider for a moment what happens to a car, especially a loaded car, when in a switching movement it is shot at a speed varying anywhere up to ten miles per hour, on to a train of cars at rest. Many of us have seen this happen frequently, and still more have heard the report and marvelled that the cars withstood the racket. The underframe of the car in motion is immediately arrested on impact with the other car; but the car superstructure with its contents is not arrested so quickly, with the result that it is strained from end to end, including the roof, which ties the side and end framing together. The car roof must also take care of a bulging load when grain or other material is carried in bulk, uneven track, curving, side wiping, and hump yard switching, all of which set up different strains, which must be considered and provided for in car roof construction in order to keep clear of future trouble.

It is these conditions that persuade many car builders to adopt a roof sufficiently flexible to accommodate the strains in order to ensure it being water-tight. On the other hand, the advocates of the rigid roof believe in making the roof sufficiently strong to withstand the strain, and tie the superstructure together.

A car roof should be so constructed that repairs can be made quickly and at a minimum cost. The position of the roof in relation to other parts of the car does not lend itself to proper maintenance. Trucks, airbrakes and draft gear are constantly being inspected for indications of possible failure, but unfortunately, and all too often, the only warning received of roof failure is when the damage has actually occurred to the lading. Car roofs should, therefore, be as far as possible self maintaining.

Corrosion will be an important factor in modern roof maintenance and calls for a systematic method of painting, for it cannot be expected that the galvanizing will protect the roof sheets indefinitely. The best designed car roof will only last in proportion to the maintenance it receives, and the object should be to make the life of the roof equal to the life of the car.

It may be added that many all-steel roofs are constructed with a means provided for ventilation of the eaves, and with this means, any moisture deposited on the underside of the roof sheets will be evaporated by this circulation. This possibly would not provide circulation enough with hot flour in the car, from 60 to 80 degrees, but this means of circulation will provide for any moisture that may be deposited on the roof sheets under ordinary lading. In confirmation of this we have never yet heard of a report of sweating of roof except of reports made by the people of Minneapolis and St. Paul in loading flour.

With the years of experience that these people have had at Minneapolis and St. Paul, they now admit that moisture will be deposited on roof of any kind when the flour in the car is loaded at a high temperature, and they have given instructions that some covering—paper or tarpaulin—must be put over lading when loaded at a high temperature, in order to prevent the moisture dripping from the roof; either from a wooden or all-steel roof.

Frank Thompson Scholarships

Information regarding rules, regulations and requirements will be furnished upon application for the competitive examinations open to the sons of living or deceased employees of the Pennsylvania System for the scholarships established by the heirs of the late Frank Thompson, formerly president of the Pennsylvania. Two of the eight scholarships will be awarded this year, and cover a period of four years. The College Entrance Examination Board of New York City will conduct the examinations. Applications should be addressed to the Secretary at 451 West 117th street, New York. The examinations will be held in the last week of May, 1922.

Condition of the Spanish Railroads

The condition of the Spanish railroads has shown a marked improvement in comparison with last year. The rolling stock of the municipal lines is in better condition, and, although there is still considerable congestion and need for more adequate equipment as well as repairs on a large scale, it is hoped that with the lowering of the prices of coal and necessary raw materials the railroads will soon recover from the critical situation in which they were, particularly in the period immediately following the war.

Shop Kinks in Use on the Erie R. R.—Chuck for Flat Drills—Rod Truck—Portable Boiler Test Pump

Details of Construction and Application

CHUCK FOR FLAT DRILLS

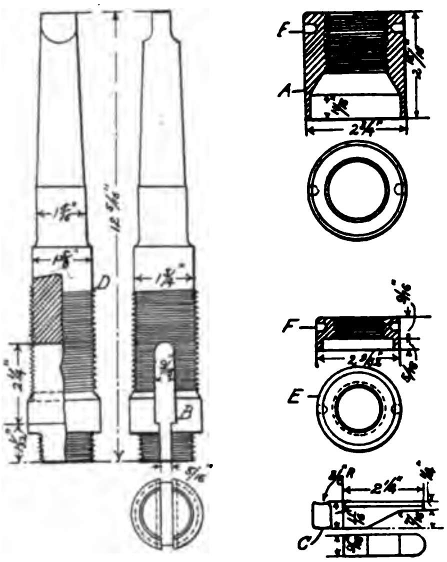
The holding of flat drills is usually a very troublesome thing because special preparations are not made for it and the ordinary chuck is quite insufficient for the purpose, and though the use of the flat drill is now quite uncommon, it is still sometimes a necessity.

The chuck shown herewith has been designed to meet this emergency work and will serve to build drills of quite a wide range of diameters.

The shank of the body of the chuck is turned to a No. 4 standard Morse taper to fit in the spindle of the drill press. The body below the shank is turned to a diameter of 1⅝ in., below which it is cut with a thread of 10 to the inch on a diameter of 1¾ in. This is so that the nut *A* can be slipped down over the shank and engage the threads. Below the threads there is a tapered section having an axial length of 7/32 in. and increasing to a diameter of 2 in. This diameter holds for 15/16 in. and below this there is a tapered thread ¾ in. long cut on a taper of ⅛ in. to the inch and with 12 threads to the inch. The lower portion is slotted for a distance of 3 9/32 in. The upper portion of the slot is 9/16 in. wide, is semicircular at the upper end and has a shoulder *B* at the lower end of the wide section.

The nut *A* that screws on to the threaded portion *D* of the body is of the section shown, and it will be noticed that it has a tapered section below the thread, that lies at an angle of 28° with the axial line.

The jaws *C* of which there are two, fit into the enlarged portion of the slot in the body and rest upon the shoulder *B*. They are put in with the tapered portion to the outside as shown in the left hand assembly drawing. Where it will be seen that if



DETAILS OF CHUCK FOR FLAT DRILLS.

the nut *A* is run down so that its tapered portion has a bearing against the tapered portion of the jaws *C*, the latter will be forced inward and will grip the edge of the drill that has been put in the slot in the body between them.

In order to hold the drill at right angles to the gripping action of the jaws *C*, the nut *E* is used. This is cut with a taper thread to fit that at the bottom of the body and, as it is screwed home pinches the body in against the sides of the drill.

Both nuts *A* and *E* are knurled so that the preliminary tightening can be done by hand. And both are further provided with holes *F* ¼ in. in diameter in which a bar can be inserted to effect the final tightening.

ROD TRUCK

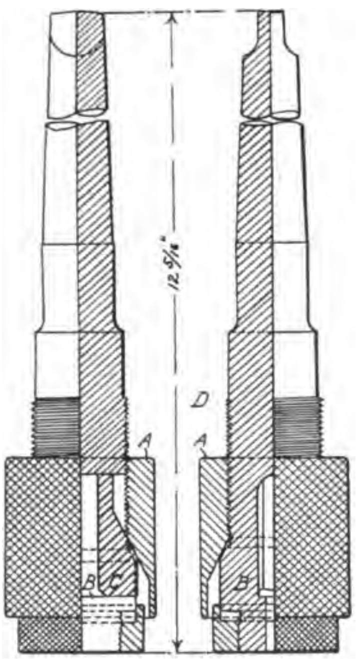
The side and main rods of the ordinary locomotive of today are far too heavy to be carried about and so a truck or crane must be used to move them from place to place, otherwise more than one mechanic would be required to handle the rods.

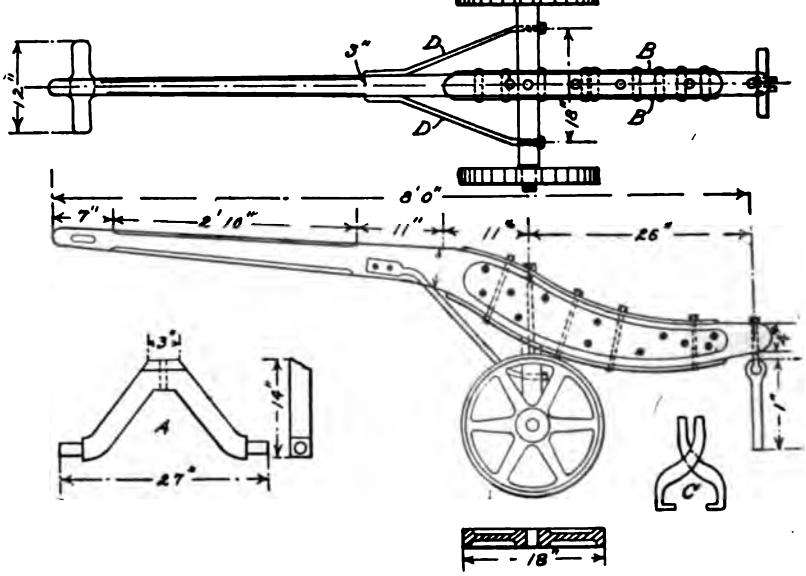
The truck here shown is a substantial one designed for this purpose.

It is carried on two wheels 18 in. in diameter and with a 2 in. diameter of tread. These run loose on a V-shaped axle shown at *A*, and turn on bearings 1½ in. in diameter. The tongue and body of the truck is of wood stiffened at the axle, where it measures 3 in. by 7 in., with steel straps ⅜ in. thick at the top and bottom and plates *B* of the same thickness at the sides. These plates are riveted together, through the wood, by ¾ in. rivets, and the top and bottom straps are held together in the same way by ¾ in. bolts.

The short end of the tongue or body carries a pair of tongs *C* slung from a 1¼ in. bolt to the bottom of the tongue. These tongs have a width of 1 in. and a depth at the belly of 2 in. so that they have ample strength to carry the heaviest rod.

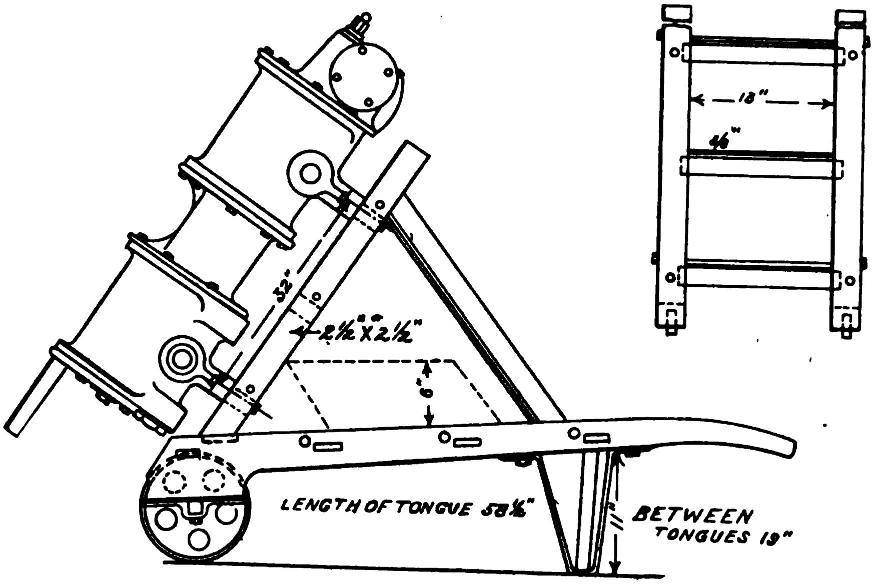
The tongue is braced diagonally to the axle by two round braces *D*, ¾ in. in diameter. At the front end there is a T handle for hauling the truck from place to place.





A PORTABLE BOILER TEST PUMP

A portable boiler test pump is an almost absolute necessity in locomotive repair The one shown is one of the many adaptations that have been made of the Westinghouse air pump. It is mounted on an ordinary hand truck upon which a substantial rack has been built of wood. This rack has such a backward inclination that when the truck handles are raised so that they are in the position in which they would be held by a man, the pump is thrown forward into a nearly vertical position with almost its whole weight resting on the wheels.



BOILER TEST PUMP.

When in use it is thrown still farther forward until the pump rest *A* is upon the floor and the pump stands nearly vertical, its weight being carried by the rest and the wheels.

It is intended that the steam cylinder of the pump should be operated by compressed air; and in order that the air pressure ordinarily carried may be able to develop a sufficiently high hydrostatic pressure for boiler testing purposes, the lower cylinder is bushed to a diameter of 4½ in.

Inspection and Maintenance of Car Equipment

It is unnecessary to recapitulate the orders that have been issued in recent years regarding the standardization of materials for freight car repairs in order that repairs could be promptly and uniformly made. It is enough to know that the Master Car Builders' rules have been given to every car inspector, car foreman and supervising official in the car department and motive power department to work by. The instructions are that a car should be inspected and repaired and put in condition for two years' service, barring running repairs and accidents. It is also well known by men of experience that cars have been shuffled over the roads,

looking for somebody to be good enough to repair them, and they have not been repaired and they are running now and will continue to run for some time because the facilities for obtaining material needed for repairs have been overtaxed beyond the power of the managements.

Not only so but it takes months to collect material together before being ready to undertake repairs. We cannot expect these cars to be re-enforced before the material is received from the manufacturers, and we cannot expect them to deliver the material until they can be induced to cherish a hope that a prompt payment will be made for the work when it is accomplished.

In the hope which begets an assurance of a nearer approach to normal conditions, it is well to remember that even the necessity of requiring certain things being done does not always mean that they will be done, or that the instructions issued will be complied with. There is something more to be done than to only realize the necessity of doing things and issuing the instructions. The men in charge should be capable of not only issuing instructions but capable of knowing when instructions are being complied with. They should also be capable to the extent of knowing how to issue workable instructions and to select men who are capable of complying with their instructions.

When selecting a man as foreman car inspector or a leading inspector, it should be known that the man selected is not only capable of inspecting a car and know when it is properly inspected but he should be as well capable of selecting men as inspectors who are able to inspect cars properly.

Otherwise one assuming such authority, may by his act, become an enemy to safety and a promoter of disaster, that may result in loss of life or limb, and destruction of property as well as to de-

operation of the railroad with which he is employed.

It should be considered just as serious and dangerous for one to remove a shop card from a defective car and permit it to go into service without necessary repairs being made, or permit a car to go into service with shop card on it, without repairs being made, as it would be for one to change a red signal to white, before an approaching train, without knowing whether or not the block into which the train is to move is safe and clear. One act is just as serious and just as liable to cause disaster as the other.

As no car should be permitted placed for loading until first inspected and given needed repairs; unless we are able to obtain these desirable conditions, our inspection or our repairs are not uniform, or our supervisors are not capable and efficient, or someone is removing shop cards or causing cars to leave inspection points or repair yards before they are in proper condition for service.

Unless such conditions are corrected (if they exist) we cannot expect to establish the unified requirements which would result in safe and economic operation. To have unified inspection and repairs to equipment we will have economic and safe operation, which will mean to our railroads: Less loss of life and limb of passengers and trainmen, greater car mileage, fewer accidents, less destruction of equipment and property, less repeated shopping of cars, greater car supply, less need for purchase of new equipment, decrease in cost of operation, less maintenance cost, prompt handling of business, greater satisfaction to shippers, better earnings for railroads and a more satisfactory dividend for the stockholders.

Many matters of detail might be referred to, and by way of illustration it might be stated now that all freight cars are equipped with air brakes and the Federal law requires that at least 85 per cent of the cars in a train should be operative, including the locomotive, it means, in order that the air brakes maintain their proper efficiency, they must be given constant attention. Here is a field for investigation to ascertain how many railroads have proper facilities for testing triple valves and have their yards equipped with air so they can get the proper pressure for the testing of air brakes and what facilities are furnished to car men throughout the country for this important work.

"The Abandoned Railroads"

The question is becoming a vexed one in those districts where railroads have been abandoned, whether it should be within the discretion of the railroad corporation, or whether the government should not temporarily continue the operation of the roads in the interest of the people, who may be said to be cut off

The American Superintendent of Motive Power—His Development and Present Status

The superintendent of motive power, the superintendent of rolling stock or the mechanical superintendent, as he is variously called, of the American railroad is as good an example of evolution both in man and position as can well be found. In 1867 and 1868, at the time of the organizing of the Master Car Builders' and Master Mechanics' Associations, there was not a man in the country bearing any one of the three titles with which this article opens. Not only was there not a single man a superintendent of motive power bearing the title, but there were none with the duties and responsibilities now pertaining to those positions. In fact it was not until April 1, 1872, that the title was created and used on the Pennsylvania Railroad.

The names of the two great railroad mechanical associations fully express the position and status of the men in charge of the car and locomotive departments. They were "master car builders" and "master mechanics" in the strictest sense of the words. They were masters of their trades; they were men who had entered the shops as boys, and frequently as very young boys, and who by ability, energy and perseverance had worked their way up in spite of all obstacles through the several positions of apprentice, journeymen, shop foreman and master. A great majority of the master mechanics had been locomotive engineers, and not a few had come up through the successive steps of wiper, fireman, engineer, roundhouse foreman and master mechanic. Their educational advantages had almost invariably been meagre, and what they knew they knew not by study but by the hard knocks of practical experience in a rough life upon the road or in the shop. Many of them were readers, and an examination of their libraries would show a collection of the few books that were available upon locomotive work at the time. In this respect the master mechanics were better off than the master car builders, as there was some literature on the locomotive but absolutely none in regard to car construction. Indeed this paucity of literature on car construction and maintenance has been one of the wonders of the day, for it was not until very recently that there has been anything on the subject, barring the Car Builders' Dictionary first published in 1887. This may have had some influence, but probably it was due to the fact that the locomotive is a more intricate and higher type of a machine than the car, that the master mechanic considered the superior of the master car builder, though the two departments were entirely separate and distinct, and it was not until later years that the former had any jurisdiction over the latter.

Growing up in this way, and with none of the incidental advantages coming from a higher education, these men were frequently lacking in the refinement of manners that goes with that training, and were therefore regarded as skilled mechanics and were treated as such. They were supposed to know, and did know, all there was to be learned of the practical operation of a locomotive, but they did not have the scientific training to work out new designs, or the courage to execute ideas that seemed to their own good sense worthy of adoption. If a certain part of a locomotive gave trouble by breaking, they remedied the trouble by making it heavier, but did little to study the stresses to which the part was subjected and dispose the metal so as to best meet the same. The indicator was an unknown factor in locomotive operation, and an indicator card might as well have been a cuneiform inscription as far as any information it would have given to the majority of these men.

It must not be inferred from this that the master mechanic of the early seventies was a stupid person or an ignoramus. That is very far from the case. He was alert with the keenest of intelligence and equipped with a world of information that never has been and never will be learned from books. He had the confidence of his superiors up to a certain point, but unfortunately that point fell far short of his deserts.

Few of these men really undertook the designing of new locomotives. In fact it is almost incredible how few roads had a draughtsman among its employees of the mechanical department. It is less than thirty-five years ago that one of the greatest trunk lines of the country employed its first draughtsman in the locomotive department at a salary of $50.00 a month. If a new locomotive was to be built in the shops it was usually a copy of one already in existence, of if changes were to be made the master mechanic indicated what they were to be, and probably made a few drawings, that were to be used, with his own hands, and the rest was done by the rule of thumb in the shop.

Under these conditions salaries were low. It was not an uncommon thing to find a master mechanic working for lower pay than some of his own engineers in fast passenger service. Salaries of $100.00 a month were considered good and the man who received $2,500 a year was a nabob.

Such a state of affairs is incomprehensible if reviewed from the standpoint of the necessities of the railroad for trained men; but is readily understood if the sources of supply are considered. At that time there was but one technical school in the country that gave an approach to real training in mechanical engineering, and even that was far below its own present grade of efficiency. It was absolutely necessary that the man in charge of the locomotives of a railroad should be thoroughly familiar with them in all of their practical details, and the only way in which this familiarity could be obtained was by work in the shop and on the road. At the time the country was held in the grip of the scholastic system of education, men who could afford to give their sons an education sent them to college to train their minds on Latin and Greek, and the whole social instinct of the class shunned every thought of contact with the grease and dirt of the shop. The natural result was that these positions were left open to the hard-working boy who had to earn a living first and get an education afterwards.

The struggle of the technical schools for recognition as institutions of learning was gradually successful, and their trained graduates in looking about for positions naturally turned to the railroads as a promising field. Their entrance was by no means easy. The whole railroad community from the president to the water boy of the train was steeped in the idea that "these theoretical fellers" were "no good," and what was wanted was "practical experience." The latter part of the idea so far as "practical experience" is concerned is all right, and it remained for the graduate of the technical school to show that when he had added "practical experience" to his theoretical training he was far and away a better man than the one with the practical experience alone ever was or could ever hope to be.

We find, then, in the early eighties that when an old-time master mechanic died or retired that he was being succeeded by one of the new school: a man who had had a technical training, and who after graduation had donned overalls and served time in the shop or on the foot plate of a locomotive; a man who brought a trained mind to bear upon the problems of his work and with whom much of the delay incident to trial and error in gaining experience under the old régime was eliminated. In short, he was capable of taking short cuts to results and did not depend upon a long series of mistakes to indicate the proper course.

With the advent of this man into the field we find a gradual change in the character of the proceedings of the associations. The title of superintendent of motive power began to appear; then it became common, and at last it, or its equivalent, is held by the head of the motive power department of all large roads and some small ones, while that of master mechanic is given to those who have risen to a position in charge of shops or divisions. Gradually, too, the head of the locomotive department has taken charge of the cars, and his title is sometimes varied to "superintendent of rolling stock," or "mechanical superintendent" to meet this condition, although very frequently the superintendent of motive power is in full charge of the car department. It is a mere matter of name and does not change the ordinary duties of the office. Under this changed conndition of affairs the master car builder has become really an assistant superintendent of motive power in charge of the car department. His authority is the same as it ever was; but he, too, has changed from the self-made man who has worked his way up from the ranks to one technically educated.

The duties of these men have grown with the office. We no longer find the superintendent of motive power in the roundhouse, keying up an engine with his own hands as the master mechanic frequently did in the old days, for his duties are largely executive. Still behind it all must be a wide and intimate knowledge of the details of the practical working of the mechanisms under his care. The demands that are made upon him in ability, knowledge and experience are such that the master mechanic of the old school cannot hope to meet, and he will soon, except in cases of exceptional ability, cease to exist as the recognized head of the mechanical department of American railroads.

It would naturally be inferred that the abler man with increased responsibilities and duties would have a greater influence in railroad affairs than his predecessor. It is time that he has, but his real position is not at all in accord with his deserts, his responsibility or his ability. It is safe to say that there is no more able body of engineers on earth that the superintendents of motive power of the United States who constitute the membership of the old Master Car Builders' and Master Mechanics' Association, now Section V of the American Railway Association.

And it is safe to say that the great majority of railroad managers will not demur to that assertion. But, as a matter of fact, their authority is sometimes limited, so limited in some places that they are little more than clerks in charge of their departments. They are capable of designing and operating every type of machine that falls within their jurisdiction, and their judgment is as good as the best, but in the matter of final decisions as to the policy to be pursued or the type of engine to be used for certain services, these are tcc frequently made by the general manager or even the chairman of the board. It takes years to eradicate an old idea, and the old idea that is the bane of the present motive power service is to the effect that the master mechanic is merely a skilled laborer, that he has practical experience, but if a new locomotive is to be designed or built, it had best be left to the contracting builder, who for years stood behind that official and did that class of work for the line. The superintendent of motive power is all very well, but to invest him with the power and pay him the salary of his European brother is an almost unheard of condition, though it does exist. That he will grow up to this position in time there is no doubt, but at present he is in a transitory state between the old and the new. Sometimes he is not even consulted as to the type of power to be used, and, as we have attempted before, we will give a few examples from personal knowledge that will serve to illustrate the humiliating conditions in which these men frequently find themselves.

A certain road had a number of consolidation engines that were giving satisfactory service, but which the superintendent of motive power thought could be improved. The general manager knew of the first but not of the second proposition. Without the knowledge of the motive power official or without so much as informing him that the road was in the market for locomotives, an order was placed for a number in duplications of those on hand, and the first intimation received was a request to send an inspector to look them over.

A representative of a locomotive building firm was in conference with the general manager of a road regarding a lot of engines for which he was in the market. They were talking over the general conditions of the track, grades, service speeds, train weights and the like when the representative suggested that before a final decision was reached, it would be well for him to consult with the superintendent of motive power. "Oh, there is no need to go and see him," said the manager, "we don't pay any attention to what he says."

On another accasion an effort was being made to persuade a superintendent of motive power to try one or more compound locomotives among a lot of engines that were to be ordered. He flatly refused to entertain the idea, and added that he would not consent, under any circumstances to have a compound locomotive on the road. Within ten days the general manager placed an order for 25 compound locomotives without his knowledge. This, of course, was several years ago.

Added to this unsatisfactory condition of affairs is an uncertainty as to the tenure of office that is appalling to the man who is dependent upon his salary. The railroads are often essentially governed from Wall street. A change in the holding of stocks means a change of management, and when the new president comes in he brings his own train of supporters, and departmental heads are apt to drop off all along the line. Previous records of faithfulness and ability apparently count for nothing. An intimate knowledge of the road and the requirements of its service cannot compete with personal acquaintanceship. The result is that the new man, however able he may be, fails from the lack of this personal knowledge of local conditions, to make as good a showing as his predecessor, and his head is apt to drop too, unless he has a strong personal influence that will hold him in place until he can learn what is needed and adapt himself to these new conditions.

It must not be thought that this is a universal state of affairs, as it is not, for in some places tenure of office is practically for life, but in the majority of cases it exists to such an extent as to make a most unpleasant condition of affairs.

There are indications, however, that we are growing out of it, and that the time is rapidly approaching when the nominal will be the real head of the mechanical department in all cases and receive the reward that the merits of the individual deserve. In the meantime the roads are being faithfully served by as competent a set of men as can be found, and it is to them, and the vast amount of original work done by them individually and in their associations that the material progress in American railroading is due, and all that they need is either to be let alone or encouraged with the same degree of appreciation that is common to well-directed effort in many kinds of work that is less strenuous and certainly far less important than that of transportation, which is unquestionably the arterial life of the great commonwealth in which we live.

The Use of Copper Steel

In the August, 1920, issue of this paper a résumé was published of a report to the American Society for Testing Materials on the rust resisting properties of copper bearing steel. Since that time the merits of the steel have become more fully recognized and it is now reported that a number of railroads are specifying copper-steel for the bodies of new and repaired cars. Among the roads that have done so are the Baltimore & Ohio; Chicago, Burlington & Quincy, the Rock Island and the Virginian and it is expected that the Norfolk & Western will make extensive use of this material in the car building program which the road now has in contemplation.

The conditions of the Pittsburgh test were so severe and the copper steel sheets gave such a good account of themselves and were so conclusive, that the indications are that the copper steel has at least twice the resistance to corrosion under the sulphurous conditions obtaining there, of any other type of metal. Its use is sure of meeting popular favor in a short time.

Notes on Foreign Railways

Electrification of the Norwegian Railways

By information received from Commercial Attaché Norman L. Andersen, at Copenhagen, it appears that the board of the Norwegian Engineers' Union has appointed a committee to investigate whether the time has come for electrifying Norwegian railways and whether the railways now being planned should be constructed for electric power. The committee is expected to present a report at an early date.

Construction of a New Railway in Spain

An appropriation has been made by the Spanish Government amounting to $250,000 for the preliminary work on the construction of a railway in the provinces of Avila and Navarre. The Government, on its part, promises to expend $3,000,000 in this work during the next five years. The increased costs of material necessary for this work have forced the Government to call upon the two Provinces for the additional funds to carry out the work.

Locomotive Repairs on Italian State Railways

At the beginning of the year there were 6,150 locomotives owned by the Italian State railways, the general condition of which was not as bad as might have been expected. Three hundred and fifty were out of use, and 200 were to be dismantled. About 125 locomotives were formerly returned to the shops for repairs each month, but at the present time not more than 60 are being repaired. Efforts are being made to greatly increase the needed work during the year. There were 500 locomotives under construction at the end of last year, and 150 electric locomotives are to be built annually. Extensive additions to six of the largest shops have been completed and much progress is expected during the year.

The Soviet Government Hires Railroad Men

The Russian Soviet Government is reported to be making arrangements to resume railroad traffic and a firm of constructing engineers and railroad men of experience are engaged to operate eight large locomotive shops near Moscow. Three thousand broken-down locomotive engines and 50,000 freight cars are expected to be put in commission by September, in time to handle the year's harvest.

Col. R. F. MacDonald of Mesopotamian wartime reputation has been hired by the Government to head the job. He expressed confidence it could be accomplished without outside aid.

"The railway problem in Russia, which has brought the country to a point of virtual impotence, is almost entirely one of rolling stock," Col. MacDonald said. "The roadbeds are generally in good shape, owing to the fact that snow protects the ties a good part of the year. All the tracks need is engines and cars to run on them."

The Moscow-Baku line, which formerly averaged twenty trains daily, has now one a week. Wood is burned in place of coal and trains have to stop every hour to dry out the lumber in order to get up steam to proceed. Trains make about 100 miles a day. The price agreed upon for rehabilitating Russia's rolling stock is stated to be about $12,000,000.

Railway Ties in Britain

Nearly all the railway ties used in Britain are exported from America, and during the past two years importations amounted to nearly nine million railway ties. This is larger than the normal average consumption, and was due to the fact that during the war the railway beds had gotten to be in rather bad condition and repairs were not kept up. The ties were imported in the expectation that conditions would permit a large amount of repair work to be done. These repairs, however, were not made as rapidly as anticipated, and consequently large stocks of ties are still on hand.

Railway Electrification in Switzerland

The General Management of the Swiss Federal Railways has requested the Administrative Council to approve of the plan for electrification of the Lucerne-Olten-Bale line (92 kilometers) and to provide it with a credit of 28,300,000 francs to purchase the necessary installations, materials, and tools. The management also requests that it be permitted to alter the present construction plans at its own discretion whenever the present credits might be greatly surpassed.

Receipts on the French Railways

The gross operating receipts of the French railways for the calendar year 1921 exceeded those of 1920 by over 400 million francs, yet there was a larger deficit for 1921 by over 120 million francs than for the year previous. Advances of from 70 to 80 per cent in passenger fares and of 140 per cent in freight rates accounted for the increased gross revenues, but these were offset by operating expenses exceeding those of the previous year by over 560 million france, the figures for expense being estimated.

Factors in bringing the operating expenses to a higher level than that of the previous year were an augmented personnel and enlarged pay roll, due to the eight-hour law; increased rates of wages; threatened strikes, and the high cost of living; and excessive prices for fuel, construction material, and maintenance supplies.

Yugoslavia

According to the local press, an agreement was signed in January between the German and Yugo-Slav Governments for the sale to Yugoslavia of (a) 100 express locomotives, 200 passenger locomotives, and 50 locomotives for other uses; and of (b) 4,000 box cars, 3,500 cars for coal, 1,500 cars for heavy freight, and a large number of tank cars. It is further stated that about 80 per cent of the ties in Serbia and 60 per cent of the ties in the new Provinces must be replaced, and that on account of the defective state of the ties the speed of the trains has been reduced without, however, preventing frequent derailments. Rolling stock is inadequate and in bad repair.

New Railroad in Mexico

It is reported that a new railway line, 35 miles in length, is to be constructed from Navojoa, a station on the Southern Pacific Railroad of Mexico, in the southern part of the State of Sonora, to the proposed port of Yavaros. The road will tap the rich garbanzo district of the Mayo River valley and will touch the towns of San Pedro and Huatabampo.

Progress in Hungary

The State railways are reported to have placed orders with a consortium of Hungarian car manufacturers for 2,000 cars, practically all for freight. The State railway shops were given an order for 50 locomotives, while an order for 100 more is under consideration. The installation of a double track at the Budapest-Szabadka line is to be continued, and other lines will be double-tracked as may be possible.

New Australian Railroad

The Government of Queensland, Australia, has recently negotiated a loan from American bankers for the purpose of constructing a railroad to develop lands on the Upper Burnett, Callide Valley, upon which it is intended to locate settlers upon very favorable terms. The Bureau of Foreign and Domestic Commerce is endeavoring to arrange to have American manufacturers given an opportunity to bid upon the rails, equipment, construction machinery, and other materials needed for the project. The specifications have not yet been completed, but information on this subject can be obtained, as soon as it is received from Australia, from the Iron and Steel Division of the Bureau at Washington.

It seems certain that the work undertaken by the Australian government in regard to railroad extension will attract a large influx of emigrants, and a consequent rapid development of the resources of that country, which are said to be great.

Notes on Domestic Railroads

Revived Activity in Order for Locomotives

Among recent orders for new locomotives are 15 Mikado 2-8-2 type, and 10 Mountain 4-8-2 type for the Seaboard Air Line. The Savannah & Atlanta are also reported as asking bids for the construction of 5 road locomotives, while the Chicago, Peoria & St. Louis is arranging to issue an order of 3 locomotives, while the New York, Ontario & Western has ordered 4 locomotives of the Mountain type, which are expected to be delivered at an early date by the American Locomotive Company. The Toledo, St. Louis & Western has also ordered 5 Consolidation 2-8-0 type locomotives from the Lima Locomotive Works. It is also reported that the Chicago, Milwaukee & St. Paul is inquiring for estimates on 50 Mikado type locomotives, and the Florida East Coast is increasing its motive power with 7 Pacific and 3 6-wheel switching locomotives, which are being built by the American Locomotive Company.

New Locomotive Shops for the Wabash

The Wabash railway purposes at an early date to build new locomotive shops at St. Thomas, Ont., at a cost of at least $500,000. The general repair work on the Wabash locomotives has been done for a number of years at that point at the local shops of the Pere Marquette, but the increasing business on the road and the growing need of more rapid and thorough repairs renders the construction of new shops at that point indispensable. Bids for construction material and shop equipment will be asked in the near future.

Powerful Crane for the Lehigh Valley

An order for the largest gantry crane that, it is said, has hitherto been received by the McMyler-Interstate Company of Cleveland has been received from the Lehigh Valley for the purpose of handling heavy freight at the Claremont terminal, New York. The crane will have a radius of 50 ft. and 65 ft. boom. It is expected to be placed ready for operation in the early spring.

Additional Equipment for the Chicago, Burlington & Quincy

Fifty-five locomotives were ordered by the Chicago, Burlington & Quincy last month. The Baldwin Locomotive Works are at work on 47, of which five are of the Santa Fe 2-10-2 type, 32 Mikado 2-8-2 type, and five light Mikado type. There are also three coal burning passenger locomotives, and two oil burning locomotives, known on the road as the S-3 type, in the course of construction at Baldwin's. The Lima Locomotive Works are engaged on eight of the Mountain 4-8-2 type. In the matter of added rolling stock the Pullman Company are furnishing 500 automobile cars, 40 ft. 6 in. in length which have the quality of being adapted to serve as grain cars.

Brisk Demand for Coaches and Cars

With the approach of the tourist season a needed supply of new passenger and other cars are being ordered from the builders. Among these may be noted 250 all steel cars ordered by the Pennsylvania Company, including 190 coaches, 35 combination passenger and baggage cars and combined baggage and mail cars. The Boston & Maine is also said to be making inquiries for 43 coaches, 12 smoking cars, and 5 combination baggage and smoking cars, all to be 70 ft. in length, also for 4 combination baggage and mail cars, 61 ft. long, and 25 milk cars, 51 ft. long. The Central of New Jersey has placed orders for 20 coaches and 10 consolidation passenger and baggage cars with the American Car & Foundry Company, 30 coaches to the Standard Steel Car Company and 10 baggage cars to the Harlan plant of the Bethlehem Shipbuilding Corporation. To these may be added an order for 700 refrigerator cars given by the Pacific Fruit Express to the General American Car Company. The Chicago & North Western is also asking bids on 1,250 box cars, 80,000 lbs. capacity, 500 stocks cars and 250 refrigerator cars of the same capacity, and 500 flat cars of 100,000 lbs. capacity.

Coaling Plants for the St. Louis Southwestern

A contract has been awarded by the St. Louis Southwestern the Roberts and Schaefer Company, engineers and contractors, for the designing and erecting of two electrically operated, 100-ton capacity, reinforced concrete locomotive coaling plants for installation at Camden, Ark., and Plano, Tex.

Railroad Ties

As previously announced in our pages, the United States Forest Service and the American Railway Engineering Association called upon the various bodies interested in specifications for railroad cross ties to decide whether the unification of specifications for cross ties should be undertaken. After a full discussion of the question it was unanimously decided that such a unification should be undertaken and that the work should include switch ties and cross ties for all classes of work, including mining ties, and also classification in regard to the need of preservative treatment, but not methods of treatment. The Forest Service and the American Railway Engineering Association were recommended as sponsors. All the recommendations of the conference were formally approved by the Main Committee, and the work is now under way.

More Machine Shop Tools for the New York, Chicago & St. Louis

The purchasing department of the New York, Chicago & St. Louis is making enquiries for one new 48-inch 400-ton carwheel press, one air compressor, and also for machines that may have been used including one 42-inch drilling machine; one 18-inch lathe; one 2-inch triple head bolt cutter; one 4 by 24 inch 2-wheel emery grinder; one 48-inch hydraulic carwheel press; one 10-hp. and one 15-hp., 440 volt, 60-cycle induction motor.

Railroads Reducing Expenses

Drastic curtailment of operating expenses together with large deferred maintenance has enabled most of the Class 1 railroads of the country to finish the year 1921 in a more satisfactory manner than many officials thought possible several months ago. These facts have been brought out by the publication of the December earnings statements, the majority of which have been issued by the Interstate Commerce Commission.

A preliminary compilation of revenues and expenses of 163 of the 201 Class 1 roads indicates a net operating income of $39,555,000. For these roads the revenues decreased 23 per cent. but the expenses showed a decrease of 31.2 per cent. Applying that ratio of loss in revenues to the aggregate gross for all the roads would mean a shrinkage in the month's revenue of $121,000,000, railroad statisticians point out. Estimates for the net operation revenue for all the carriers in December range from $30,000,000 to $40,000,000, amounting to from 2 per cent to slightly more than 3 per cent earned on property valuation.

Orders for New Rolling and Repair Material for the New York Central

The American Car & Foundry Company has received an order from the New York Central for 250 steel underframe double sheathed box cars of 40 tons capacity. Orders have also been issued for 750 steel hopper cars of 55 tons capacity, divided equally between the Pressed Steel Car Company, the Standard Steel Car Company, and the Pullman Company. Extensive bids are also being examined and are expected to be reported upon at an early date covering details of track equipment, as well as driving and truck tires for locomotive service, axles for car and locomotive service, repair parts for turntables and other miscellaneous material.

The Alaska Railroad

The recently completed Government railroad in Alaska running from Fairchild to Seward has been officially designated "The Alaska Railroad." The railroad has a total mileage of 540 miles. Confident hopes are expressed that rich new coal fields will be opened up in the region traversed by the railroad, which will be officially opened next month.

February Railroad Reports

The railroad reports for February issued on the last day of March for the most part continued the favorable showing thus far received for that month which indicates a return to six per cent on the tentative valuation fixed by Interstate Commerce Commission.

Increase in Car Traffic on the New York Central

It was announced at the offices of the New York Central that car loadings on that railroad for the month of February, 1922, had totaled 127,021, as compared with 102,505 for the same month last year. Loaded cars received from connections in February amounted to 160,382, while the figure for the month of February, 1921, was 127,012, showing an increase of slightly over 20 per cent. In other words, 287,403 loaded cars were handled by the New York Central during February as against 229,517 for the same month last year, which is practically a 25 per cent increase.

Investigation of Power Brakes and Appliances for Operating Power Brake Systems

In a notice under the above caption in the March issue there was published a copy of the order issued by the Interstate Commerce commission for an inquiry into the action of air brakes. At a general session of the commission, held on March 4, 1922, the following questionnaire was drawn up and issued:

It is ordered, That each carrier by railroad subject to the Interstate Commerce Act, named in the appendix attached hereto, furnish the commission the information called for below not later than the first day of April, 1922:

1. Copies of rules, bulletins and other instructions pertaining to operation, inspection testing and maintenance of air brake equipment.

2. List of locations where facilities are provided for inspection, testing and repair of air brake equipment, together with a brief description of facilities and number of employes engaged in this work at each of such points.

3. List of locations where tests of pressure retaining valves are made, and description of such tests.

4. Statement showing location, length and gradient of all grades more than one mile in length and having a maximum gradient of one per cent or greater.

5. Description of practices in manipulating brake equipment for controlling trains descending said grades, showing types of equipment and brake pipe and main reservoir pressures used; limiting number of cars or tonnage for each of said grades, and speed limits specified.

6. Statement showing locations, if any, where trains are required to stop on said grades for the purpose of inspection of brakes or cooling of wheels.

7. List of accidents on said grades which occurred during the calendar years 1919, 1920 and 1921, resulting from failure properly to control speed of trains on grades, which caused personal injury, loss of life or property loss of $500 or more, together with number of injuries and fatalities and the property loss sustained by the carrier as a result of each such accident.

8. Statement for each of three years named, showing number of couplers broken, drawbars pulled out, and break-in-twos from other causes, together with derailments resulting therefrom, which occurred on said grades.

9. Statement for each of three years named, showing number of car wheels renewed for the following causes: (a) Burst, (b) Cracked, (c) Brake burn, (d) Slid flat.

10. Statement showing in detail to what extent, if any, hand brakes are used for controlling the speed of trains.

11. Statement showing what power power brake equipment other than air brake equipment, if any, is used and extent of such use.

12. Number of accidents which occurred during the calendar year 1921, resulting in personal injury or loss of life from each of the following causes: (a) Burst or parted air hose, (b) Emergency application of air brakes, (c) Undesired quick action of brakes, (d) Train parting, (e) Faulty manipulation, and (f) accidental interference with proper operation of brakes. Show the cause, number of injuries and fatalities in each case, and the total property loss sustained by the carrier.

13. Statement for the calendar year 1921, showing terminal and road relays to trains, due to causes attributable to improper manipulation or operation of air brakes or defective brake equipment.

14. Suggestion for improvement of air brake conditions or practices, and any other data which may be of value in connection with the commission's inquiry into this subject.

It is further ordered, That a copy of this order be served upon each carrier named in the appendix attached hereto.

By the Commission:

George B. McGinty,
Secretary.

Then follows a list of 196 railroads upon whom this questionnaire has been served.

General Committee of the American Railway Association Replies to the Commission

An order by the Interstate Commerce Commission requesting information in regard to power brakes from the various railroads was promptly taken up by the General Committee of the American Railway Association, and a meeting was held in Chicago, Ill., on March 14, and the following conclusions were drafted and forwarded to the Secretary of the Commission:

(a) That the time was not sufficient to assemble the data required; (b) that for the hearing on April 6 it is suggested each carrier send its representative to Washington with whatever information can be obtained by that date; (c) that the Committee on Safety Appliances of the Mechanical Division, consisting of C. E. Chambers (chairman), superintendent motive power and equipment, Central Railroad of New Jersey; C. E. Fuller, superintendent motive power and machinery, Union Pacific; W. J. Tollerton, general mechanical superintendent, Chicago, Rock Island & Pacific; J. T. Wallis, chief of motive power, Pennsylvania System; C. F. Giles, superintendent machinery, Louisville & Nashville, and T. H. Goonow, superintendent car department, Chicago & North Western, be delegated to handle the matter for the association and that it be given any assistance necessary by the Train Brake and Signal Equipment Committee; (d) further, that the Committee on Safety Appliances be directed to advocate that present brake arrangements are satisfactory and that the percentage of mileage on grades is too small in proportion to total mileage to warrant any greater investment in brake appliances.

The committee further requested that all information secured by the carriers in reply to the questions submitted by the Commission be forwarded to C. E. Chambers, superintendent of motive power and equipment of the Central Railroad of New Jersey. It is expected that a supplementary order will be issued by the Interstate Commerce Commission extending the time specified in order that the replies may be as nearly complete as possible. Meanwhile the official data is being rapidly collected and the General Committee of the American Railway Association will promptly forward the replies as early as possible.

The task is no easy one, if it is expected that the details are to be looked upon as being complete, and while the members of the Interstate Commerce Commission are all men of wide experience and not apt to look for miracles in the Twentieth Century, especially at a time when the railroads are hampered by the lack of means to do all that they would wish to do in obedience to the order.

Items of Personal Interest

G. F. Tier has been appointed master mechanic of the Atchison, Topeka & Santa Fe, with office at Chanute, Kan.

A. Young has been appointed master mechanic of the Chicago Great Western, with office at Des Moines, Iowa.

Walter L. Barr has been appointed master mechanic of the Kent division of the Erie, with headquarters at Kent, Ohio.

George E. Lund has been appointed master mechanic of the Mahoning division of the Erie, with headquarters at Youngstown, Ohio.

C. A. Washer has been appointed to the position of general coal and ore agent on the New York Central, with headquarters at Cleveland, Ohio.

Frank Lockard has been appointed general foreman of the Atchison, Topeka & Santa Fe, with office at Emporia, Kan., succeeding G. F. Tier, promoted.

A. J. Wells has been appointed purchasing agent of the San Diego & Arizona, with headquarters at San Diego, Cal., succeeding S. P. Howard, resigned.

B. S. Barker, vice-president and general manager of the Gainesville & Northwestern, has resigned to become Secretary of the Chamber of Commerce, Atlanta, Ga.

C. M. Scott, general manager of the Arizona Eastern, with headquarters at Phoenix, Ariz., has been elected vice-president and general manager with the same headquarters.

J. B. Merritt has been appointed road foreman of engines on the Atchison, Topeka & Santa Fe, with office at Denver, Colo., succeeding A. M. Nye, transferred to Alburquerque, N. M.

J. L. A. Sinclair, locomotive foreman, Canadian National Railways, at West Toronto, Ont., has been appointed assistant superintendent of the Toronto Terminal division, West Toronto.

J. Hawkins has been appointed assistant master mechanic of the Canadian National, with office at Hornepayne, Ont., succeeding J. F. Spiegel, resigned on account of failing health.

G. T. Depue has been appointed mechanical superintendent of the Ohio and Chicago regions of the Erie, with headquarters at Youngstown, Ohio, succeeding Charles James.

C. M. Starke, assistant master mechanic of the Illinois Central, at Memphis, Tenn., has been promoted master mechanic with headquarters at Centralia, Ala., succeeding J. W. Branton, deceased.

J. Ashcroft, assistant boiler foreman, Canadian National Railways, at Winnipeg, Man., has been promoted to boiler foreman, with office at Ogden, Alta., succeeding F. W. Hind, transferred to Winnipeg.

Winfield S. Haynes, formerly master mechanic of the Erie, with headquarters at Dunmore, Pa., has been appointed superintendent of shop operations, with headquarters at New York. Mr. Haynes will report directly to the general manager.

J. B. Finley, general superintendent of the Southern Pacific of Mexico, with headquarters at Empalme, Sonora, Mex., has been promoted to vice-president and general manager, with the same headquarters, succeeding L. H. Long, retired.

W. C. Stone, master car builder, Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has been appointed to a similar position on the St. Louis Southwestern, with headquarters at Pine Bluff, Ark., succeeding P. M. Kilray, resigned.

S. M. Kintner has been appointed manager of the Research Department of the Westinghouse Electric & Manufacturing Company, with offices in the research laboratory building near East Pittsburgh, Pa. Mr. Kintner was graduated from Purdue University in 1894, and has served as instructor and professor in electricity, and later became connected with the railway engineering department and was for some time in charge of the New York, New Haven & Hartford Railroad tunnel and other notable installations.

W. F. Hayes has been appointed general time inspector of the Official Bureau of Railroad Time Service, succeeding the late Webb C. Hall, with whom he has been associated since 1903, having had jurisdiction over the Chicago, San Francisco, Houston and Winnipeg offices and territories. In assuming the duties of the general time inspector, Mr. Hayes has as his assistants H. J. Cowell in charge of the Cleveland office, Laurence Doty of the Chicago office, O. H. Pyper of Winnipeg office, S. A. Pope of the San Francisco office and V. A. Corrigan of the Houston office.

E. S. Fitzsimmons has been appointed manager of sales of the Flannery Bolt Company, Pittsburgh, Pa. He has a wide experience as foreman boiler maker and boiler inspector in the leading eastern railroads, and latterly as master mechanic on the Erie, and in 1912 was appointed mechanical superintendent of the Erie, Lines West, and in 1914 was transferred to a similar position on the Erie, Lines East, which he resigned to become manager of the McCord Manufacturing Company, Detroit, Mich. Mr. Fitzsimmons joined the staff of the Flannery Bolt Company in 1920 as salesman, which position he filled with ability, and has been promoted in the service of the company as noted above.

C. E. Skinner, manager of the Research Department of the Westinghouse Electric & Manufacturing Company, has been appointed assistant director of engineering in that company. His duties will cover research, standards and other work along these lines. He will be located in the main engineering offices of the company at East Pittsburgh, Pa. Mr. Skinner graduated with the class of 1890 from the Ohio State University. He joined the Westinghouse organization in the same year, and supervised the construction of the first controller turned out by that company. Soon afterward he was placed in charge of the testing of insulation, and in 1892 was transferred to the research laboratory. He has contributed extensively to the literature of the industry, and is well known for his researches abroad, as well as in this country. He is a member of many of the leading electrical and engineering societies and was chairman of the American delegation to the Brussels meeting in 1920.

OBITUARY

Otis Henderson Cutler

Otis H. Cutler, chairman of the board of directors of the American Brake Shoe & Foundry Company, died at Miami, Fla., after a lingering illness on March 4, in the fifty-sixth year of his age. Mr. Cutler was a graduate of the Rockland Military Academy, Nyack, N. Y., and of the Washington Law University, Washington, D. C. He was appointed clerk of the United States Senate in 1884 and continued in that office twelve years. He was a member of the New York State Assembly from 1895 to 1897. He was prominently identified in the activities of many of the leading manufacturing companies. and particularly in the American Brake Shoe & Foundry Company, in which he had served as secretary, general manager, vice-president, and latterly as president of the company from 1903 to 1916, since which date he served as chairman of the board. During the war period he acted as manager of the insular and foreign division of the American Red Cross. He was possessed of great mental activity and an unerring judgment, and had the happy faculty of winning the confidence of all with whom he came in contact.

Webb C. Hall

Webb C. Hall, manufacturer of railroad watches and the originator of the time inspection service now in operation on the railroads, died in Cleveland, Ohio, last month. Thirty years ago Mr. Ball was called upon as an expert witness in a disastrous railroad collision involving the death of nine persons, arising from the fact that the trainmen carried defective watches. Mr. Ball suggested feasible plans for the installation and maintenance of standard clocks, and a system of inspecting watches, which were adopted with gratifying results.

The International Railway Fuel Association

The fourteenth annual meeting of the International Railway Fuel Association will be held at the Auditorium Hotel, Chicago, Ill., May 22nd to May 25th, 1922.

The following is a tentative list of addresses and papers to be presented at the meeting, which may be added to, in addition to which there are committees on special subjects submitted to them whose reports bear on almost every subject relating to fuel and its conservation, as well as feed water heaters, front ends, grates and ashpans, and other accessories.

ADDRESSES AND PAPERS

(1) Fuel Conservation from the Standpoint of (a) Division Superintendent, Sidney U. Hooper; (b) Representative of Department Operating Coaling Station, W. S. Barnett; (c) Locomotive Engineer, C. J. Barnett; (2) The Economic Consideration Governing the Use of Oil as a Locomotive Fuel; (3) Colloidal Fuel, Lindon W. Bates; (4) Mechanical Mining of Bituminous Coal, George T. Peart; (5) Standard Grading of Coal or Stabilization of Bituminous Coal, George H. Cushing; (6) Assigned Cars for Railroad Fuel, C. G. Hall; (7) The Relation of Overdevelopment of the Bituminous Coal Industry to Transportation, C. F. Lesher; (8) Paper on Lignite Coal, Prof. E. J. Babcock; (9) The Government and the Coal Industry, T. H. Watkins; (10) Considering the Locomotive as a Big Investment—How Can We Get More Service Out of It? G. M. Basford; (11) The Various Items of Saving by Using a Better Quality of Coal, Earl Cobb (E. H. Irwin, C. H. Hoinville, M. J. Barrett and E. Perrin to be asked for written discussions); (12) The Effect of Tonnage Rating and Speed on Fuel Consumption, J. E. Davenport; (13) Comparative Practice—United States, United Kingdom, France and Germany, Harrington Emerson; (14) Educational Work Along Fuel Economy Lines, D. C. Buell; (15) Standard Railroad Coal Contract, W. J. Tapp; (16) The Railroad Fuel Problem from the Standpoint of the Coal Operator, F. S. Peabody; (17) Incentives for Promoting Fuel Economy—A Survey of Existing and Proposed Practices, O. S. Beyer, Jr.; (18) Opening Address, L. W. Baldwin.

The Committee on Exhibits are busy making arrangements for a display of improved appliances and other interesting material, and the Secretary-Treasurer J. C. Crawford, 702 East 51st street, Chicago, Ill., will issue a completed programme embracing fuller details in time for members and others who may desire copies of the meeting.

The Westinghouse Air Brake Company

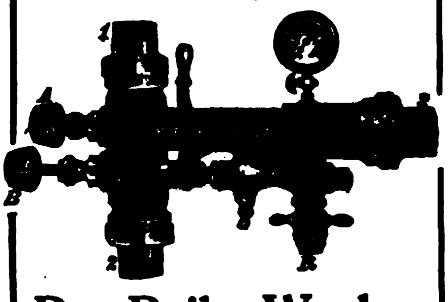
The annual report of the Westinghouse Air Brake Company, and which will be submitted to the stockholders of the company at the annual meeting held at Wilmerding, Pa., on April 11, 1922, has been issued, and in common with the great body of manufacturing companies shows a fairly satisfactory statement of operations during the first quarter of 1921, with a considerable falling off below normal during the rest of the year. It is noteworthy, however, that while the American and British branches of the company have felt the general depression, particularly the curtailing of purchases by the railroads of the leading countries, the operations of the Canadian, French, German, Italian and Australian companies have been quite satisfactory. The company is in an excellent condition of preparedness for the expected revival in business, and by the exercise of strict economy during the year, even in considerable reduction in salaries and wages, against which there has been no complaint, the company remains in point of assets in the same enviable position which it has maintained for many years, to which may be added the marked improvements in the property at Wilmerding, including the extensive erection of houses for workmen, and the addition of tracts of land. The report shows assets amounting to $47,648,901.78, with liabilities including taxes, not yet due, $29,144,200.

Honoring the Engineers

The names of engineers running passenger engines on the St. Louis and San Francisco are being emblazoned in black and gold on the locomotive cabs. One hundred and thirty will be thus distinquished as a start, and the list will be added to as occasion arises. The enamelled plate, of course, may be readily transferred to another cab, when the locomotive may be out of service. In the old days an engineer was not supposed to run any engine except his own. The engineers express keen gratification at being thus honored.

His Last Trip

Some thought it was a noted Bruiser or a royal prince passing between Syracuse and Buffalo on the last day of March. It was a more honorable occasion. It was Edward J. Haley an engineer running his last trip. After fifty-two years of service he was going home for good. It was a continuous ovation along the line. Mr. Haley had passed his seventieth winter, and he had fought a good fight, he had finished the course. The acclamation of thousands, the clanging of bells, the shriek of whistles, and a banquet spread where he was the guest of honor. The runner of the Empire State Express had his hour of triumph. Some mathematicians claimed that he had been fifty times around the world, or five times to the moon, but whatever distance he may have come or gone he is hale as ever and seemed half sorry to let go the throttle lever.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

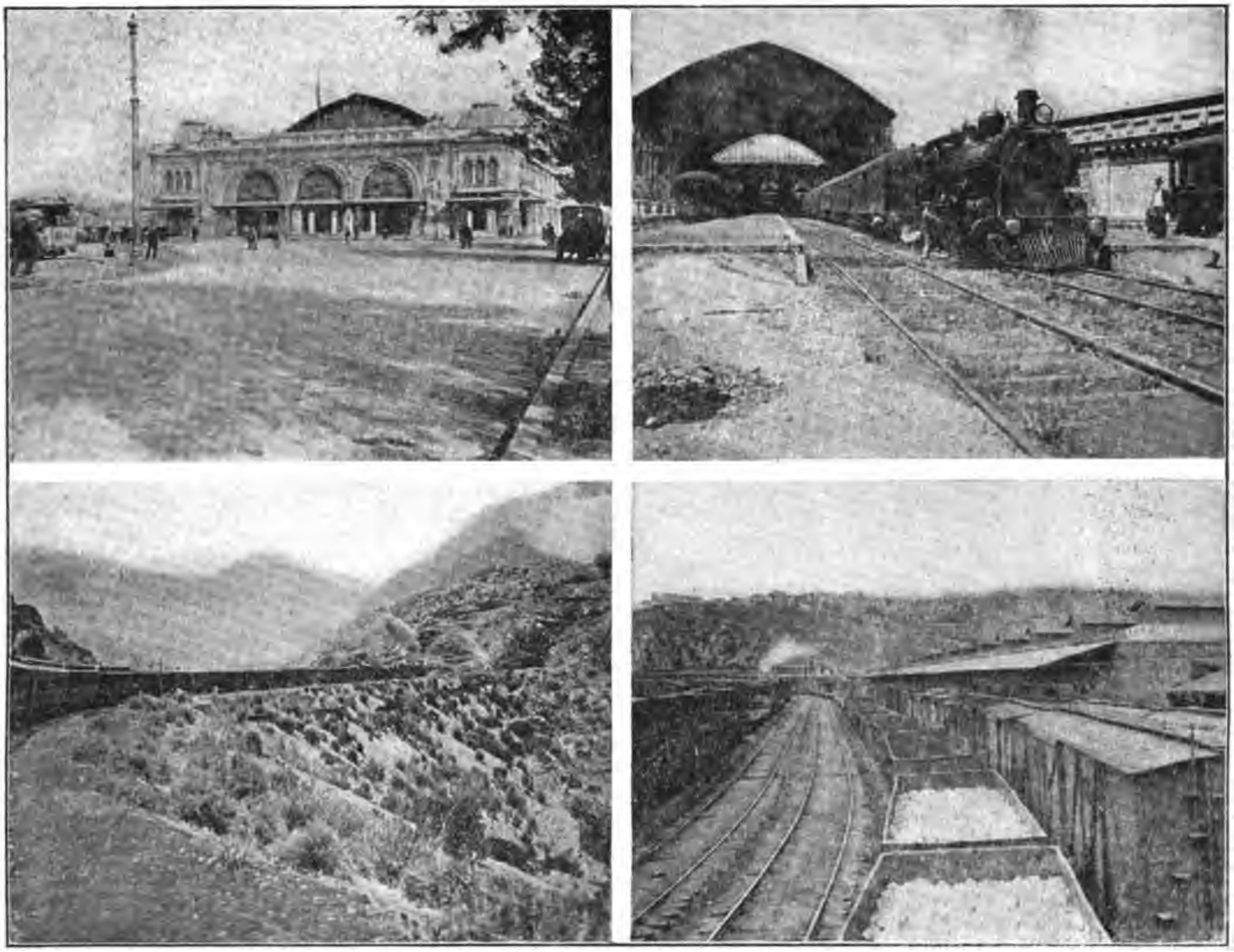
Vol. XXXV | 114 Liberty Street, New York, May, 1922 | No. 5

Electrification on the Chilean Railway

The Solution of High Cost of Fuel, and Congested Traffic. Descriptions of the Locomotive Equipment

The Republic of Chile, which is 2,600 miles long, and only 100 to 250 miles wide, is hemmed in between the Pacific Ocean and the Andes Mountains. Although there is considerable coastwise shipping, the railroad system is the main artery of transportation and quite naturally has a vital influence on the development of the country.

During the world war traffic in the first zone became very congested and was so rapidly approaching the capacity of the line that it was considered necessary to lay additional tracks on a considerable part of the line. This condition was temporarily relieved by the purchase of Mikado type steam locomotives but nevertheless a commission was appointed to study the advisability of electrifying the broad



SCENES ALONG THE CHILEAN STATE RAILWAYS, WHICH IS BEING EQUIPPED FOR ELECTRIC OPERATION BY THE WESTINGHOUSE ELECTRIC AND MFG. COMPANY.

gauge lines which extend from Valparaiso southward to Puerto Montt.

Chilean engineers have recognized for many years that the tremendous amount of water power available could be used profitably both for industrial and railroad transportation purposes. The economies and advantages set forth in the report given by the Commission in 1918 resulted in a decision to immediately electrify the first zone comprising the section of line between Valparaiso and Santiago and the branch from Las Vegas to Los Andes, a total distance of 144 miles.

The contract to supply all electrical equipment and to execute the construction work was awarded to Errazuriz, Simpson and Company, the electrical equipment to be furnished by the Westinghouse Electric International Company. This contract included 39 electric locomotives and 5 substations and amounted to a total of approximately $7,000,000.

This extensive electrification comprises a complete steam engine division—a distance of 116 miles between Valparaiso and Santiago, and 28 miles between Las Vegas and Los Andes. The curvature, considering the entire line, may be considered to be of medium severity. The maximum surves are ten degrees and are located near Los Loros. On the eastern slope the maximum curve is 9.5 degrees, located near San Ramon. The line between Batuco and Quilicura is practically level tangent track. There are six tunnels in the electrified zone.

The road is double tracked between Valparaiso and Limache, a distance of 27 miles; between Ocoa and Llai Llai, 8 miles, and between Yungai and Mapocho Station, a distance of 1½ miles, making a total distance of 36½ miles of double track line. The track is 5 ft. 6 in. gauge, laid on Chilean oak ties and rock ballasted practically the entire length of the line in the first zone. Eighty-five pound rails are used between Llai Llai and La Cumbre and between Calera and Ocoa. The rest of the line between Valparaiso and Santiago is laid with 80-pound rails, while the branch to Los Andes is laid with 75-pound rails.

The grade conditions have always been an obstacle in the way of moving advantageously the traffic in the first zone. It has been necessary to maintain several helper sections to handle the freight traffic, while practically all passenger trains require helpers ascending the Tabon grade between Llai Llai and La Cumbre. With electric operation all helper service will be eliminated, except in connection with the freight trains ascending the Tabon grade. This maximum grade is 2.25 per cent. The summit has an elevation of 2,600 feet (800 meters) above the level of the sea. The maximum grade on the eastern slope is 1.81 per cent and is located near San Ramon. The elevation of Santiago is 1,800 feet (550 meters) above the sea level.

The Fuel Situation

The fuel problem has two serious phases; first, the cost of fuel; and second, partial dependence upon imported coal. The railroad fuel bill has in the past few years reached excessive figures due to the high price of coal. This price is governed, not by the price of coal mined in Chile, but by the price of imported coal, much of which in the last few years, has come from the United States Up until the beginning of the war, the cost varied from $7.00 to $10.00 per ton for imported coal of good quality. During the war it is understood to have risen as high as $25.00 to $28.00 per ton, while more recently the price has ranged from $15.00 to $20.00 per ton. The price of Chilean coal has been slightly less than these values, but it is readily seen that with the almost unlimited hydro-electric power available, and sold at a reasonable rate, the electrification program is not only justified, but is the solution of the fuel problem.

Present and Future Freight Service

The freight tonnage southbound from Valparaiso averages approximately 3,600 gross tons daily, while that passing Las Vegas in the same direction is 3,900 tons. The northbound traffic is only slightly less than that of the southbound.

At present the freight trains going toward Santiago are made up of 20 to 30 cars each, or a trailing load of 550 tons. These trains are hauled by Mikado type steam locomotives assisted by a Borsig Consolidation between El Salto and Pena Blanca and on the Tabon grade. In the opposite direction a helper locomotive is used between Til Til and Rungue.

With Baldwin-Westinghouse electric locomotives 770-ton trailing loads will be hauled by one locomotive in either direction, except in ascending the Tabon grade a second engine will be used. The trailing weights will be increased 40 per cent and the number of trains reduced approximately 28 per cent.

A considerable reduction in running time will be made by the freight trains. Through freight trains that now make the one trip in 10 to 12 hours will be capable of going through in 6 to 7 hours.

Helpers Will Be Eliminated in Passenger Service

Under normal conditions the express passenger trains carry six to ten cars, or a trailing load of 200 to 300 gross tons in either direction between Valparaiso and Santiago. Occasionally, these trains are composed of as many as 16 cars, and helper engines are used on the Tabon grade. The express passenger trains are for the accommodation of first and second class passenger traffic and are the fastest trains in the service, making only a few stops in the 116 mile run. The omnibus trains which make all stops between Valparaiso and Santiago are always the most heavily loaded passenger trains in the service, and carry cars for the accommodation of first, second and third class passengers. The Baldwin-Westinghouse electric locomotives for this service will be capable of hauling the 300 ton trains in either direction without the aid of helper engines on any section of the line.

With electric operation it is proposed to reduce the running time of the fastest passenger trains between Valparaiso and Santiago from three hours and forty minutes to three hours and fifteen minutes, or a twenty-five minute reduction in running time.

Six Baldwin-Westinghouse electric locomotives are being built for express passenger service on the railways capable of hauling 300 ton trains in either direction between Valparaiso and Santiago. These electric express locomotives will weigh 127 tons and will have 105 tons on the drivers. Each will have a nominal rating of 2,250 hp. corresponding to a speed of 37 miles per hour at a tractive effort of 23,400 lb.

The wheel arrangement is 2-6-0 + 0-6-2, consisting of two main trucks, each of which has three driving axles and a two-wheel guiding truck. The cab is of the single-box type and the motors are geared direct to the driving axles. The general dimensions and weights are as follows:

Classification, 2-6-0 + 0-6-2. Length over buffers, 57 ft. 4 in. Length over cab, 38 ft. 0 in. Total wheel base, 48 ft. 4 in. Rigid wheel base, 14 ft. 5 in. Diameter of driving wheel, 42 in. Diameter of guiding wheel, 30 in. Weight of complete locomotive, 253,000 lb. Weight of mechanical parts, 160,000 lb. Weight of electrical parts, 93,600 lb. Weight per driving axle, 35,000 lb. Weight per guiding axle, 21,800 lb.

The trucks are connected at the inner ends by a draw bar held in tension by spring buffers. The frames of cast steel, bar type, located outside of the wheels are connected by cast steel bumpers and cross ties and carried on semi-elliptic springs over the journal driving boxes.

The express passenger locomotives will be equipped with six 275 hp. driving motors provided with field control and geared direct to the axles by Nuttall flexible spur gears. These motors are designed for operation two in series on 3,000 volts and will be grouped in three speed combinations, all six in series for low speeds, three in series with two groups in parallel for two-thirds speed and three groups each with two motors in series for full speed.

There will be six running positions, the change from one motor combination to another being made by the shunting method of transition.

The control equipment is designed for operation of the locomotive from either end and provision for regenerative electric braking is included. This enables the locomotive to return energy to the overhead system when descending grades. The main motor armatures will be connected in the same combinations when regenerating as when motoring, the excitation for the motor fields during regeneration being supplied by a constant voltage motor-generator set.

There will be two master controllers, one in each end of the cab, and the same controller will be used for both motoring and regulating. This controller will have four levers with a total of 51 notches available in the three combinations. Westinghouse type HLF control establishes the main circuit connections by the use of individual unit switches operated by compressed air controlled by electro-magnetic valves.

Motor-generator sets will supply low voltage current for the control equipment, blowers and compressors. This is a two-bearing type of machine with a common frame for both motor and generator. The normal rating of the set is 35 kw. at 95 volts with 3,000 volts at the motor terminals.

On level tangent track these locomotives will have a running speed of 61.5 miles per hour when hauling a 300-ton trailing load. On the Tabon grade, which is 2.25 per cent, the average running speed will be 33.5 miles per hour. The maximum tractive effort based on 25 per cent adhesion will be 52,500 pounds, and the maximum speed 62.6 miles per hour. The range of speed in regenerative braking will be 12½ to 50 miles per hour.

In general appearance the 11 Baldwin-Westinghouse electric locomotives for local passenger service will be somewhat similar to the express passenger locomotives. This locomotive will weigh 80 tons and the wheel arrangement will be 0-4-0 + 0-4-0. It will be capable of hauling a trailing load of 350 tons from Puerto to Vina del Mar, 260 tons from Vina del Mar to Llai Llai and return and 300 tons from Las Vegas to Los Andes and return. These locomotives will have a rating of 1,500 hp. corresponding to a tractive effort of 15,600 pounds at a speed of 31 miles per hour. The maximum tractive effort under starting conditions will be 40,000 pounds and the maximum speed will be 56 miles per hour. The cab will be of the single box type and the motors will be geared direct to the axles. The general dimensions and weights will be as follows:

Classification, 0-4-0 + 0-4-0. Length over buffers, 40 ft. 9½ in. Length over cab, 31 ft. 0 in. Total wheel base, 28 ft. 0 in. Rigid wheel base, 9 ft. 0 in. Diameter of driving wheel, 4 ft. 2 in. Weight of complete locomotive, 160,000 lb. Weight of mechanical parts, 96,000 lb. Weight of electrical parts, 64,000 lb. Weight per driving axle, 40,000 lb.

The two trucks each having two driving axles will be connected at the inner ends by an articulated coupling in the form of a Mallet hinge. The frame and cab construction, the couplers and the brake equipment will be similar to the express passenger locomotives.

The local passenger locomotives will be equipped with four 275 hp. driving motors provided with field control and geared direct to the axle with Nuttall flexible spur gears. There will be two combinations by connecting the motors in series and in parallel and additional speed variations will be obtained by varying the fields of the motors.

The control equipment is designed for operation of the locomotive from either end but the grade conditions on the section of line on which these locomotives will operate does not justify the use of the regenerative braking feature. There will be two master controllers, one in each end of the cab, each controller having two levers, namely speed and reverse, with a total of 23 notches available in the two combinations. The switching equipment duplicates that on the express locomotives.

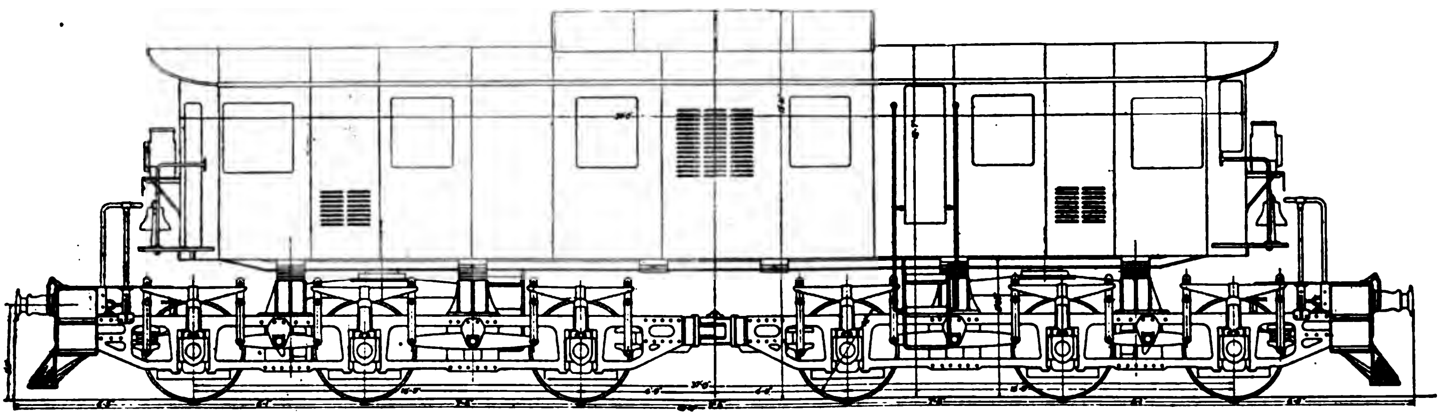
The motor generator set will be a double armature machine, each armature consisting of a motor and a generator. The normal rating of the set will be 22.5 kw. at 95 volts with 3,000 volts at the motor terminals. The current collectors will be the same as on the express passenger locomotives.

On level tangent track these locomotives will have a speed of 56 miles per hour when hauling a 220-ton trailing load. The maximum tractive effort based on 25 per cent adhesion will be 40,000 pounds.

The Road Freight Locomotives

The cabs for the first eight of the fifteen road freight locomotives have been delivered by the Baldwin Locomotive Works to the Westinghouse Electric & Manufacturing Company for the installation of the equipment. There will also be seven switching locomotives.

An outline of the road locomotive is shown in an accompanying illustration. The cab is of the box type, carried on two articulated trucks, each having three driving axles with direct geared motors. The estimated weight is 226,000 pounds. The locomotives will operate at 3,000 volts direct current.



OUTLINE OF ROAD FREIGHT ELECTRIC LOCOMOTIVE FOR CHILEAN STATE RAILWAYS.

This locomotive rates 1,680 hp. at 3,000 volts and will be able to develop a maximum of 3,200 hp. for short periods. With natural ventilation the locomotive will deliver for one hour a tractive effort of 27,950 pounds at a speed of 22.6 miles per hour at 3,000 volts. The continuous capacity of the locomotive with forced ventilation is 20,880 pounds tractive effort at 24.8 miles per hour. The maximum speed is 40 miles per hour.

The general dimensions and estimated weights of the locomotive are as follows:

Track gauge, 5 ft. 6 in. Length over buffers, 49 ft. 10 in. Length over cab, 38 ft. 0 in. Total wheel base, 37 ft. 0 in. Rigid wheel base, 13 ft. 9 in. Height, top of rail to cab roof, 12 ft. 7 in. Height, top of rail to clerestory, 13 ft. 10 in. Width over cab sheets, 10 ft 0 in. Height of coupler, 41 in. Wheel diameter, 42 in. Weight of complete locomotive, 226,000 lb. Weight of mechanical parts, 140,000 lb. Weight of electrical equipment, 86,000 lb. Weight per driving axle, 37,670 lb.

One electric locomotive will haul a trailing load of 770 short tons in either direction between Valparaiso and Santiago without assistance except on the Tabon grade. On level tangent track the speed with such a load will be 35 miles an hour at 3,000 volts. The average running speed on the Tabon grade will be approximately 24 miles per hour. The time saved by the elimination of delay to take fuel and water and by the higher running speed will shorten the time of a trip from four to five hours in each direction.

The two six-wheel trucks are connected at the inner ends by a mallet hinge. The bar-type cast steel side frames are located outside of the wheels and connected by cast steel bumpers and cross-ties. The semi-elliptic driving springs over the journal boxes on each side are connected to one another by equal beams. The ends of each set of three driving springs connected thus are attached to the side frames through coil springs.

The 38-foot box type cab, including an engineman's compartment in each end and two in series on 3,000 volts. The nominal rating of this motor on short field is 280 h. p. at 155 ampres and 1,500 volts. Field control is secured by the use of two separate field windings on the main poles. The motors are geared directly to the axles with a ratio of 3.94 to 1. The gear is of the flexible type.

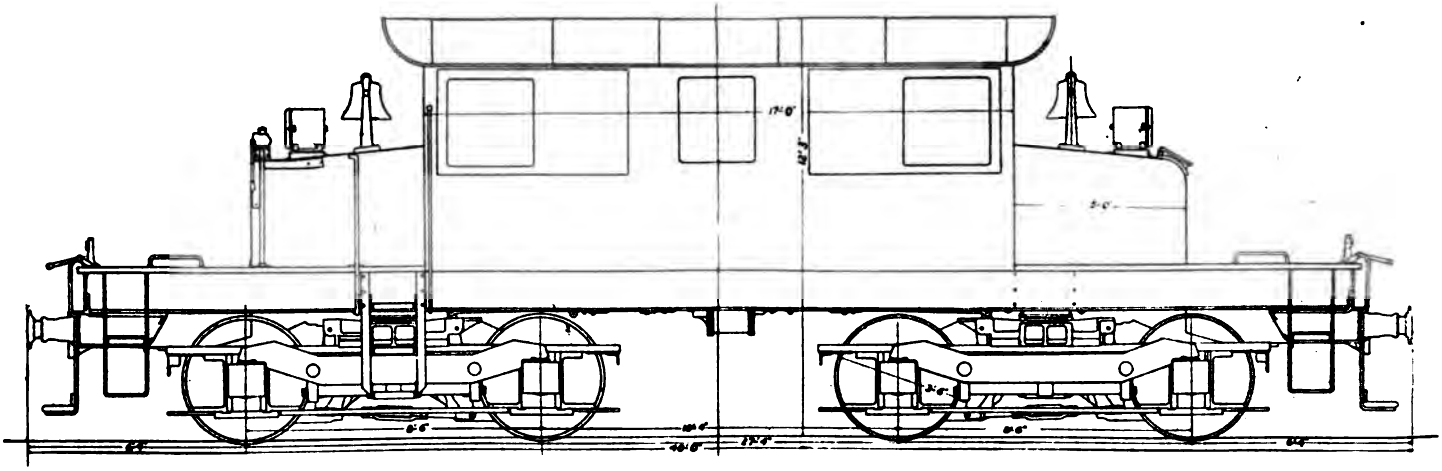
A motor-generator set provides low voltage power to compressors, blowers, control equipment and lights. This set has a single frame and two armatures carried by a common shaft. The 3,000 volt motor is a bi-polar double-commutator machine. The continuous rating of the generator is 35 kw. at 92 volts.

A master controller is located in each engineman's compartment to provide double end operation, the same master controller being used for both motoring and regenerative braking. This controller provides 50 control notches in acceleration so that tractive effort variations are small, thereby permitting exceedingly smooth handling of trains.

is 19,600 pounds at a speed of 10.6 miles per hour and the continuous capacity is a 11,400 pounds at 12.7 miles per hour. With 25 per cent nominal adhesion the starting tractive effort is 34,000 pounds. The maximum speed is 35 miles per hour. For short periods the equipment is capable of developing 1,000 hp. In view of an expected increase in traffic these locomotives will be capable of handling trains of 1,200 short tons in yards with level tracks.

The following table gives the general dimensions and estimated weights of the locomotive:

Track gauge, 5 ft. 6 in. Length over buffers, 40 ft. 0 in. Length over central cab, 17 ft. 0 in. Length over hoods, 27 ft. 0 in. Total wheel base, 27 ft. 4 in. Rigid wheel base, 8 ft. 6 in. Height, top of rail to cab roof, 12 ft. 3 in. Width over cab sheets, 10 ft. 0 in. Height of coupler, 36 7/16 in. Wheel diameter, 42 in. Weight of complete locomotive, 136,000 lb. Weight of mechanical parts, 86,000 lb. Weight



OUTLINE OF ELECTRIC SWITCHER LOCOMOTIVE FOR CHILEAN STATE RAILWAYS.

a central equipment compartment, is carried on center pins located approximately over the midpoint of each rigid wheel base. One center pin is restrained both longitudinally and laterally and the other in the lateral direction only, which permits free longitudinal movement of the cab relative to one truck.

Individual switches mounted in banks establish the main circuit connections. Each switch is a complete unit in itself and may be removed without disturbing adjacent switches. Compressed air controlled by electro-magnetic valves is used to operate the switches. For certain circuits where no current is broken and for low voltages, cam switches are used. These also operate by compressed air controlled by electro-magnetic valves. The cam group comprises a number of switches mounted on a single shaft, connected through a rack and pinion to a double acting air piston.

Each axle of the locomotive is driven by a Westinghouse No. 350-D motor, wound for 1,500 volts and insulated to operate

The control in Westinghouse HLFR providing speed combinations by varying the grouping of the motors to give one-third, two-thirds, and full speed. Field control gives three additional speeds. Transition from one motor combination to another is made by the shunting method.

For regenerative braking, the main motor armatures are arranged for the same combinations as when motoring and the motor fields are separately excited by the motor-generator set. The range of speed in regenerative braking will be from 8 to 30 miles per hour.

The switching locomotives, an outline of which is shown in an accompanying illustration, will be the last ones built. The cab is of the steeple type and is carried on two swivel trucks. On each truck are mounted two motors driving direct through standard helical gears. The estimated weight is 136,000 pounds. The control is arranged for double end operation.

The nominal rating of this locomotive is 560 hp. With 3,000 volts, and natural ventilation, the tractive effort for one hour

of electrical equipment, 50,000 lb. Weight per driving axle, 34,000 lb.

The trucks are of the rigid bolster equalized type with rolled steel frames located outside of the wheels. A center pin is located at approximately mid-length of each rigid wheel base. The central cab has an engineman's stand in each end and control apparatus centrally located and suitably protected. The control equipment also comprises apparatus similar to that already described for the road locomotives.

The four Westinghouse No. 350-D-2 motors are of the series type wound for 1,500 volts and insulated for operation two in series at 3,000 volts. This motor has an hour rating of 140 hp. at 75 amperes and 1,500 volts.

The motor-generator set, to supply power for the compressor motor, lights and control circuits, has a two part frame, each part containing two bearings in which runs a common shaft carrying two armatures, one a 1,500-volt motor (insulated for 3,000 volts) and the other a low voltage generator. With 3,000 volts applied to the motors, the generators will deliver 22.5 kw. at 92 volts.

The main resistance, connected ahead of all motors, is designed with ample capacity for frequent, heavy acceleratations and for a reasonable amount of emergency operation with one pair of motors cut out. The number of accelerating steps assures moderate changes in tractive effort in starting, which in turn tends to minimum wear and tear on the locomotive and rolling stock.

The automatic air brake equipment is the Westinghouse type 14-EL, a standard similar to that used on the present steam locomotives. With this equipment, straight air is available for handling the locomotive alone and the automatic feature for both locomotive and train.

M. C. B. couplers will be used with Continental spring buffers. Although eventually all drawbar equipment on the Chilean railways will be changed to M. C. B. standard, the Chilean freight cars now use the Continental type drawhooks and for this reason the M. C. B. couplers will be provided with attachments for chain couplers.

The current is collected by spring raised, air-lowered pantagraphs, controlled by compressed air and arranged to be mechanically locked in the lowered position.

American Railway Association

The forthcoming annual conventions of the American Railway Association Divisions V and VI, gives every indication of being in several respects the most notable meeting, or series of meetings, among railroad mechanical men hitherto held. In addition to the usual display furnished by the Railway Supply Manufacturers' Association, which will, as formerly, cover the entire space of Young's Pier, together with the enlargement of space made possible by new allotments on spaces hitherto occupied by buildings not accessible for exhibits, the coincident meetings of the Air Brake Association with its display of air brake accessories at Haddon Hall, which is in close proximity to Young's Pier, will give an added interest to the occasion, and undoubtedly embrace the largest and most complete display of the mechanical appliances used in connection with railroad operation that has been made possible, with the exception perhaps of the International Exhibitions, and in their own chosen sphere of activity the marked improvements exhibited this year will surpass anything possible of accomplishment in the past.

The attendance will doubtless greatly exceed that of any similar meeting. During the war period, it will be remembered, not only were many of the leading railroad men in France, but those in service at home were necessarily confined to their posts. The meetings were suspended, and on being resumed, depressing conditions to some extent affected the success of the meetings. Conditions are not yet such as we would like them to be, but the marked improvement gives an assurance of hope that brightens the future and in the light of this spirit we rest assured that the meetings of the mechanical railroad men, and those who are associated with them will be of the most noteworthy kind and add much to that spirit of progress begotten of American enterprise.

Engineering Exposition

Announcement has been made of the National Exhibition of Power and Mechanical Engineering to be held at the Grand Central Palace, New York, during the second week in December, 1922. The exposition will immediately follow the annual meeting of the American Society of Mechanical Engineers, and it is expected that the exhibits will supplement the reports of special committees and discussions at the meetings of the society.

American Society for Testing Materials

The 25th annual meeting of the American Society for Testing Materials will be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., beginning June 27, and continuing to July 1, 1922. As formerly, a number of committees have been preparing papers to be submitted to the convention. Among the subjects selected are "Physical Properties and Tests of Steel Castings"; "Fatigue of Materials"; "Effect of Sulphur in Rivet Steel"; "Impact Testing of Materials"; "Specifications for Coal," and papers relating to the inspection and specification of concrete. In addition to these special technical papers are expected, and ample time is assured for a full discussion of the same by qualified experts.

Exhibits and Entertainment at Fuel Association Convention

Detail arrangements are being completed for the convention of the International Railway Fuel Association to be held at the Auditorium Hotel, Chicago, May 22-25. The International Railway Supply Men's Association is arranging for exhibits and space is being taken rapidly. Entertainments are planned for Monday, Tuesday and Wednesday evenings, including moving pictures of coal mining operations, an informal reception and dance, and a dinner.

The Air Brake Association

The Executive Committee of the Air Brake Association has decided to transfer the 29th annual convention of the Air Brake Association, the date of which had been previously arranged to occur on May 9-12, at Washington, D. C., to Atlantic City, N. J., June 19-21, 1922. The plans have been changed to coincide with a growing feeling towards a closer affiliation of the Air Brake Association with the American Railroad Association. This will be a decided advantage. Of course the Air Brake Association will not be changed. An unusual opportunity will be offered for the members to witness and inspect the mechanical exhibits on Young's pier. The Air Brake exhibits will be made at Haddon Hall headquarters. Detailed information may be had on application to the Secretary, F. M. Nellis, 165 Broadway, New York, N. Y.

All Returned War Veterans Re-employed on the Northern Pacific

Of the 2,997 employees of the Northern Pacific Railway who entered military service during the world war, 2,597 have returned and applied for their positions in the railroad service, and without a single exception have been taken care of. J. M. Rapelje, vice-president, states that "at the time our men were leaving the railroad by the hundred to go to war, we were forced to employ many women to fill their places and often women were put in positions in which men had formerly been employed. Some of these women are still holding their positions. The Northern Pacific policy has been that where women have made good in their positions, they have been retained, except in those instances where ex-service men with seniority rights have returned from the war to ask for reinstatement in their old jobs. In such instances, to keep our pledge to our employes who left us to enter the military service, we have protected their rights and have been compelled to discharge or transfer the women from such positions."

The Promise of Renewed Activity

Secretary Hoover states that "unemployment has decreased by more than one-half, and that the product of American industry is now 85 per cent of capacity." The railways, one after another, are making their preparations for moving their increasing traffic. The Pennsylvania purposes to spend $8,000,000 around Pittsburgh. The Union Pacific announces plans for spending $29,000,000 for betterments and equipment. In the first four months of this year much more equipment has been ordered than in all of 1921. In that year of real depression only 28,358 cars were ordered, against approximately 80,000 this year to date. These orders are not given when it may be even imagined that the cars will stand on the sidings. Activity in the locomotive shops is already in progress, the marvel being that they could have remained in comparative quiescence so long. Inquiries are as plentiful as delayed spring buds, and the assurance of a full-blossomed activity is inevitable.

The Various Parts of the Walschaerts Valve Gear and Their Influence on the Action of the Whole

By S. E. Westrén-Doll, Engineer, Petrograd

Part II.

When the dimensions of the valve have been determined it is possible to go on with the projection of the valve mechanism itself. The general arrangement of the designs varies little, one from another. It is always necessary that certain points should be known at the start: the center, of the driving axle, the distance of the center of the valve face from the center of the eccentric crank, the distance of the center of the valve stem from the center of the cylinder, also the length of the eccentric crank arm R and the length of eccentric rod L.

In order that the defects of the valve motion may be reduced to a minimum, it is desirable that the whole make-up of the mechanism should be as substantial as possible. For this reason the point J of the lap-and-lead lever $H\ J$ should be carried as close to the cylinder as possible, and the back throw of the lever can be taken as equal to the forward from the vertical position of the same at $a\ a$. It is also found that when the point J of the lap-and-lead lever is connected by the union bar $J\ K$ with the body of the crosshead, its extreme position to the left, due to the motion of the crosshead $2\ R$ stands to the left of $a\ a$ in the vertical plane $a'\ a'$ of Fig. 11.

In order that the valve motion may work in accordance with its principal characteristic and that the linear lead may be constant for all points of the cut-off and be symmetrical for the two ends of the cylinder, it is necessary that the pivotal point G of the lap-and-lead lever should be in the same position when the crank is at either end of its stroke. This is only possible, when G, for the two positions of the piston, is on a center line, at right angles to the center line of the cylinders, and in a vertical plane midway between the planes $a\ a$ and $a'\ a'$.

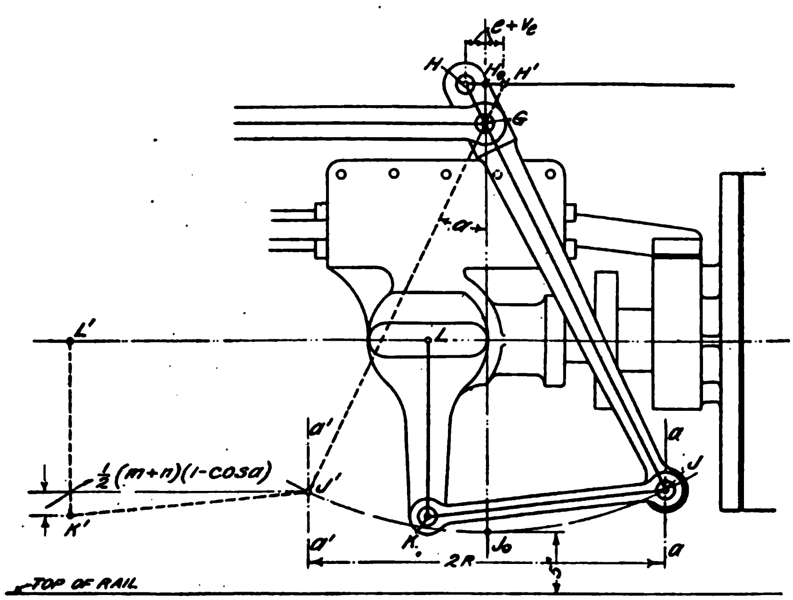


FIG. 11.

The third point, H of the lap-and-lead lever has exactly the same motion as that of the valve, and hence it must have moved to the right or left of its central position H_o, when the piston or crank is at the end of the stroke, a distance equal to the sum of the outside lap and the linear lead, or to $e + v_e$.

The amount of outside lap and of linear lead are dimensions that are determined by the calculation of those of the valve.

In Fig. 11, because of the similarity of the triangles $J\ G\ J_o$ and $H\ G\ H_o$, we have the following proportions:

$$m : n = JJ_o : HH_o$$

In which JJ_o is equal to one half the stroke of the piston or the length of the crank (R) and HH_o is equal to $e + v_e$. By substituting these values we have the equation

$$\frac{m}{n} = \frac{R}{e + v_e}$$

Then since the dimensions of R and $e + v_e$ are known, the ratio of $m : n$ can be determined.

In this ratio it is advisable to make m as great as possible, in order that n may be of practicable size, that is from 2 in. to 5 in., but it must also be taken into account that when the end J of the lap-and-lead lever is at its central position J_o it should not be so low down as to be below 5 inches above the top of the rails.

If it should so happen that with the greatest possible length of lap-and-lead lever that can be obtained the length of n is still too small, there is but one way out of the difficulty; and that is to make a change in the ratio $\frac{R}{e + v_e}$, and this ratio must be reduced. The length of R due to the piston stroke of the engine is fixed, so that the only possibility or reducing the ratio to the required amount lies in increasing the sum of $e + v_e$. This case of the correction of $e + v_e$, or rather of e involves the calculation of the outside lap for the individual valve motion and can be done in accordance with the method already laid down.

After the determination of the proper values for m and n, the outside lap can also be regarded as fixed and whatever changes may be called for in the valve itself, this is the main point to be considered.

One of the principal parts of the Walschaerts valve motion is to be found in the union bar that transmits the motion from the crosshead to the lap-and-lead lever. In practice every effort is made to copy or transmit this motion as exactly as possible. It is evident that this accuracy can be more nearly approached the longer the lap-and-lead lever $H\ J$ and the union bar $J\ K$ of Fig. 11.

In the drawing, because of the length of L required for the connecting rod, the lap-and-lead lever will not equalize, so that in order that this may be done the extension or arm for the attachment of the union bar $J\ K$ is so made that, when in its central position, the union bar shall stand parallel to the direction of motion of the piston, and that it shall be of such a length that its horizontal projection in its position at the end of the stroke shall be shorter than the length as $L\ (1 - \cos\beta)$ is shorter than its length. In which β (beta) is the angle made by the connecting rod with the center line of the cylinder when in its central position.

On account of the movements due to the action of the springs this ideal equalization of the motion is impossible of attainment on locomotives, therefore, in practical locomotive designing, this point is neglected, for the most part.

On the other hand the position of the point K at the end of the stroke of the piston is usually put at

$$\frac{1}{2}(m+n)(1-\cos\alpha)$$

lower down than the point J, so that the up and down motion of the end of the union bar, due to the movement of the lap-and-lead lever may be equalized. In this α (alpha) is the maximum angle made by the lap-and-lead lever with its central vertical position so that it is determined by the equation.

$$\sin\alpha = \frac{R}{m}$$

Hence, since this angle ordinarily runs from 20° to 30°, the formula gives the position of the point K below J at about 1.18 in., the exact distance being most quickly determined by the graphical method as shown in Fig. 12.

J' H' indicates the position of the lap-and-lead lever at the end of the stroke of

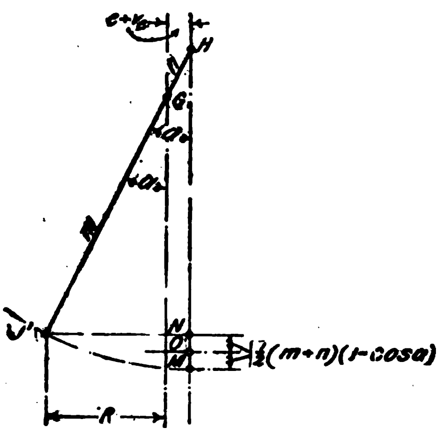


FIG. 12.

the piston With J' H' as the hypothenuse, draw the right-angle triangle J' $H'N$ J'. From H' as a center and with a radius equal to $n+m$, strike an arc of a circle cutting the extension of H' N at M, wherein the distance M N will be equal to

$$(m+n)(1-\cos\alpha)$$

Half of the distance is the desired distance of K below J or

$$N\ O = M\ O = \frac{1}{2}(m+n)(1-\cos\alpha)$$

The defects, in the valve motion resulting from a failure to reproduce exactly the motion of the crosshead at the end of the lap-and-lead lever, are of no essential influence in practical operation, so that the matter is allowed to rest, for the most part, with this equalization of the end positions of the lap-and-lead lever, and designers are content to so locate the point K that the positions of the lap-and-lead lever correspond exactly with those of the crosshead. That is to say, when the crosshead is at the end of its stroke, the lap-and-lead lever must also be at the end of its stroke, and when the crosshead is at its central position the end of the lap-and-lead lever must also have reached its central position as indicated in Figs. 11, and 12, at J.

The determination of the corresponding positions of the point K is also readily and accurately determined by the graphical method in connection with a drawing of the valve motion as a whole.

The length of the extension or arm K L is taken from the crosshead L to the point K, and it only remains to be noted that it must always be at right angles to the center line of the cylinder.

A further motion of the valve, which, combined with the pendulum motion of the lap-and-lead lever, is required in order to permit of the necessary amount of admission is obtained from the oscillation the link block F (Fig. 1) about the fixed point E and the transmission of this motion by means of the radius rod F G.

It is known that the point G of the lap-and-lead lever, in order that there may be a constant and symmetrical linear lead at both ends of the cylinder for all points of cut-off, must be in one and the same position at each end of the stroke of the piston, for all points of cut-off. In order that this may be brought about, the radius rod which connects the lap-and-lead lever with the link block, must be so arranged that it will put the point G in this position at the ends of the stroke of the piston. In order, further, that this may be done for all points of cut-off, that is when F is at any and every distance from the pivotal point E, for both the forward and backward motion of the engine, that is to say with the link block above or below E, and with the length of the radius rod given, then, the curvature of the link must be the arc of a circle of which F G is the radius, and whose center is at G. It also follows that the position of the link must be the same for both ends of the stroke of the piston, and must coincide for all points of the cut-off.

In order to determine the location of the pivotal point E of the link it is first necessary to make a close study of it both as to the character of its motion and its influence on the action of the valve motion as a whole.

The link, as shown in Fig. 1, is given a swinging motion by means of the return crank B C the eccentricity of whose working end is r, and the eccentric rod B D. In order that it may occupy its central position at each end of the stroke of the piston, it is necessary that the point of attachment, D, of the eccentric rod to the link, should lie on a line drawn at right angles to the center of the diameter connecting the two points B and B' of the end of the eccentric crank, indicating its position when the piston is at the ends of its stroke. It must, therefore, follow that

$$B\ O = B'\ O \text{ and } O\ D$$

should be at right angles to B B'

In the case of the smaller engines, the location of the point of attachment to the link, D, falls in the plane of the axis of the machine, O L. In such a case, when O D is at right angles to B B', the eccentric, that is the return crank, stands at an angle of 270° to the center line, or to the crank, so that B O is at right angles to O C. But, on those machines where the center line of the valve stem is at a considerable distance from that of the cylinder, as is especially apt to be the case where piston valves are used, greater dimensions will be called for and there will be a wider variation from this rule; and the point of link attachment, D, known as the heel of the link, will be raised above the center line of the engine and brought nearer the pivotal point E, so that the line O D will make the angle α with the center line of the machine. Then in order to meet the condition that O D shall be at right angles to B B', the eccentric is, in this case, moved so as to make an angle of $270° - \alpha$ with the center line of the engine or the crank.

The transference of the motion of the link to the valve is indirect. In order that the motion of the latter shall be symmetrical it is of the utmost importance to see to it that the positions of total throw to the right and left shall be at equal distances from the central position.

By taking the position of the point, D, on a straight line drawn at right angles to E G through E, the throw of the link, on each side of its central position, will be symmetrical. But this peculiar arrangement is out of the question in practical work as will be shown later, so that the location of the point, D, on a straight line drawn at right angles to E G through E is, practically, improper. Fig. 13, clearly shows, in an exaggeration of the ratios of $I : r$, the unequal throws resulting from this faulty assumption. The arcs DD_1 and DD_2 as well as the corresponding angles α_1 and α_2 are quite different from each other.

In order to equalize the throw it is necessary to reduce the ratio of the size of $I : r$, that is to say, the point D on the link must be moved to the left, from the aforesaid position on the line drawn at right angles to E G at E.

The correct position of the point D and the length of the radius c of its arc of movement cannot be obtained by any definite formula, but can best and most quickly be obtained by trial on a diagram. The graphical solution of this problem as used at the locomotive works of Krauss & Co. is given in the *Zeitschrift des Vereins deutsches Ingenieurs*, 1907, but as it gives results that are inaccurate, or it may be better to say "incorrect," it is passed by here. A second solution has also been put out by these same works which is a method of calculation and was published in 1905 of the *Zeitschrift des Vereins deutsches Ingenieurs.* Although it may be used in practice it is not recommended because of the greater amount of time that will be consumed in making such a mathematical calculation, whereas the results can be obtained, in one half the time, in all of their completeness, by the method of trial that is suggested.

Suppose, then, that the point D is so located that it fulfills the requirement of

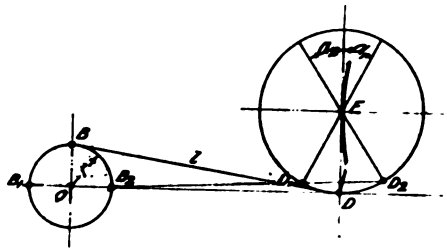


FIG. 13.

$DD_1 = DD_2$, it then becomes possible to deduce the following equations from Fig. 14:

$$\text{Chord } DD_1 = \text{Chord } DD_2$$

Hence $a^2 + b^2 = c^2 + d^2$

Because a, b, c and d are the two sides respectively of the triangles $D_1\ D\ H$ and $D\ K\ D_2$ of which the two equal chords are the hypothenuses. Also from the triangle $D\ A\ E$ we have

$$x^2 + f^2 = R^2$$

and from the triangle D_1CE

$$(x + b)^2 + (f - a)^2 = R^2$$

and from D_2FE

$(x - c)^2 + (f + d)^2 = R^2$

from $B\ O\ D$ $r^2 + (g - x)^2 = l^2$

from $D_1\ HB_1$ $a^2 + (g + r - x - b)^2 = l^2$

from D_2KB_2 $d^2 + (g - r - x + c)^2 = l^2$

Because of the equalization of the arcs DD_1 and DD_2 we also have an equalization of the distances

$$K\ L = d$$

because the angles $D\ M\ D_2$ and $D\ M\ D_1$ are equal, and from the similarity of the triangles $D_1\ H\ M$ and $K\ L\ M$, we also have

$$a : 2x + b = d : 2x - c$$

After eliminating the unknown quantities a, b, c, d, l, and R from these equations, we obtain an equation of the third degree for the value of x:

$$g^2 x^3 - g^2 x^2 - f^2 (r^2 + f^2) x + g f^2 (f^2 - r^2) = o$$

whence

$$x = \frac{f}{g} \sqrt{f^2 - r^2 \frac{g + x}{g - x}}$$

The further determination of the value of x depends upon the method of approximations. In order to find the value of x by this method, the conditions of the above equation are fulfilled, for example, when the left side is equal to the right. It is solved by the substitution of different values taken near the proper one for x and they are found by changing them slightly.

1. Take x_1 (on the left side of the equation) very slightly less than the calculated value of x_2' (on the right hand side of the equation).

2. Take x_2 (on the left side of the equation) very slightly more than x_2' (on the right hand side of the equation).

Thus the exact value of x can be most quickly determined by the graphical method.

Draw Fig. 15 on the largest scale possible, and in a system of rectangular co-

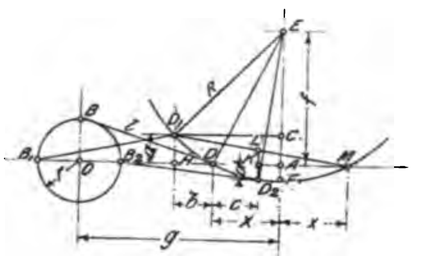


FIG. 14.

ordinates take the largest values of x_1 and x_2 as abscissas representing the left side of the equation and the calculated values of x_1' and x_2' as rectangular ordinates for the right hand side of the equation. By making the difference between these values very small, it is possible, without involving any appreciable error, to consider the curve of the values of x between the points 1 and 2 as a straight line, so that, on this basis, the point of intersection of a straight line bisecting the system of coordinates, with this straight line connecting 1 and 2, will give the desired value for x.

To check this, the substitution of the value of x, so found in the principal equation, must fulfill the condition that the right side of the equation must equal the value of x as found by the graphical method.

Taking the equation of x when $x = o$, then the point D will fall upon a line drawn at right angles to $E\ G$ at E, so that the equation becomes $f = r$, whence it follows that it is, in this case only, that, when D is in the aforesaid position, the

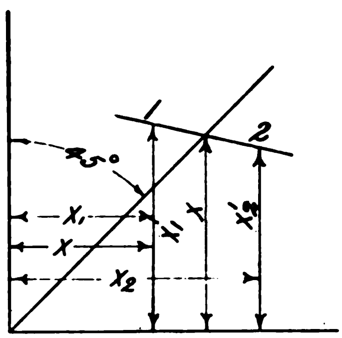


FIG. 15.

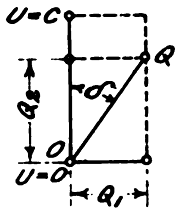


FIG. 16.

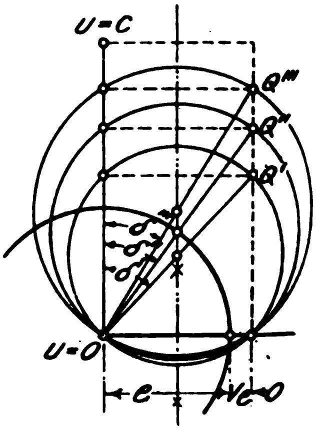


FIG. 17.

link at the ends of its throw will have swung out symmetrically on each side of its central position. In practice it is impracticable to secure this relationship of $f = r$, and, for this reason, as has been remarked already the above assumption of the location of D is a wrong practice.

From what has been said, it is evident that a symmetrical swinging of the link can be obtained, when it describes equal arcs to the right and left of its central position. Yet the horizontal projections of the path of travel are not equal. It is readily seen that they can only be so if the link were straight and were at right angles with it when in its central position. The variation from symmetry (and this also applies to the motion of the valve) increases with the reduction of the radius of the link, increasing the distance x (Fig. 14) of the point D from the vertical, an increase of the resultant angle of the link, and with the distance of the link block from the point E.

The only possibility of overcoming all of these defects, as already stated, lies in the use of a straight link, but with that the maintenance of a constant lead would have to be abandoned. We are, therefore, compelled to equalize this unsymmetrical action by the use of a radius bar $F\ G$ (Fig 1) of as great a length as possible.

When the proper position of the point D has been obtained, we can, then, obtain the final length of the eccentric rod $B\ D$.

It is, therefore, well, in the calculation of the length of the radius rod, to shorten the eccentric rod.

Another practical means of accomplishing this equalization, lies in taking a short length of the link, that is of the distance of D from E.

When these defects have been removed, as far as practical, it can be assumed with all of the accuracy that is necessary, that the point F has an eccentric motion with an eccentricity of

$$r \frac{u}{c}$$

moving about E, and which is set diametrically opposite to the eccentric r.

Since the motion is a symmetrical oscillation on each side of the central position and the horizontal projections of the arcs described are equal to each other, we can thus find the end position of the point F

upon a horizontal plane, it being understood that u is any distance of the link block F from E and that c is the distance of the point D from E.

The eccentric motion of the point F is transmitted by the radius rod F G to the point G of the lap-and-lead lever. The point H and, with it the valve, receives this motion, when outside steam admission is used as in Fig. 1, in the opposite direction, and as though the eccentricity were equal to

$$r\frac{u}{c} \times \frac{m+n}{m}$$

The motion of the valve with outside admission is compounded as follows:

1. Of an eccentric having an eccentricity R, which is keyed at an angle of 270° in advance of the crank. With this the eccentricity is changed in the same proportion as the legs of the lap-and-lead lever have to each other or n to m, hence $q = R\frac{n}{m}$; and the lead angle remains the same through the turning back of the motion of the lap-and-lead lever 90°.

2. Of the above described eccentric having an eccentricity of

$$q = r\frac{u}{c} \times \frac{m+n}{m}$$

and a lead angle of 0°.

When a valve with inside steam admission is used, as in Fig. 23, the eccentric r is located at 90° below the crank and the point G of the lap-and-lead lever is located above the point H. Hence, in this case, the eccentricity q is again $R\frac{n}{m}$ but the lead angle, at which the eccentric is located, remains 270°.

The second eccentricity, that of the link, $r\frac{u}{c}$, remains, and is set diametrically opposite to the point at which the eccentric r is keyed. Transferred to the valve, this then becomes

$$q = r\frac{u}{c} \times \frac{m}{m+n}$$

The lead angle at which this eccentric is placed is equivalent to 180°.

In both cases the eccentrics Q_1 and Q_2 are located at right angles to each other, so that the resultant eccentric q, of the valve, may be taken as the diagonal of a rectangle formed by the other two as shown in Figs. 16 and 17.

The line $Q_1 = R$ is equal to the sum of the outside lap of the valve and the linear lead. This dimension is constant. In order that the travel of the valve may be changed, it follows that the eccentricity must be changed, which can only be done by changing the value of u. And this will be explained later.

From Fig. 11 it appears that with Q_1

eccentric is correspondingly changed, and the centers of all of the resultant eccentrics must also lie on a straight line drawn at right angles to the center of Q_1 or $(e + v_o)$.

The dimension of the resulting maximum necessary eccentricity is fixed by the determination of the properties of the valve, as are also the dimensions m and n of the lap-and-lead lever; it is, therefore, possible, to calculate, first, the eccentricity Q_2 and from it, after assuming the maximum distance of the link block F from E, the radius of the circle, u maximum on which the point D must lie.

Now we are in a position to take up the location of the fixed pivotal point E of the link.

Its horizontal position had best be fixed at about the center between the center of the driving axle O, and the symmetrical axis J_o H_o (Fig. 11) of the lap-and-lead lever. This position is subject to slight changes, if, in order to obtain a greater length of radius rod, it is desired to move it back to a position nearer the driving axle. It frequently happens that the location of the frames, which have been made with a place adapted for the attachment of the bearings for the trunnions at E, and which has been fixed by other parts of the engine, is such that the range of location, in a horizontal direction available for the use of the point E is exceedingly restricted.

In locating the position of the point E vertically, it must be noted as to whether the point D for the attachment of the eccentric rod is in the same plane as the center of the engine or is higher.

If the latter is the case, it is determined for the known dimensions of R, n, m and r,

the circle, through which the point D must move. Since the point D, in order to produce a symmetrical motion of the link, must lie to the left of a line drawn at right angles to E G through E, it follows that the direct distance of the point D from the pivotal point E is somewhat less than the calculated radius c. It so happens, in practice, that, when the point D is located above the center line of the machine, this difference is ordinarily so slight, that it can be neglected in the determination of the location of E. If the distance of the point D from the center line of the engine is known the distance of the pivotal point establishes itself, and will be found to be the sum of the distance of D and the calculated radius c. This, then, would give a very unfavorable location for the point D, as already explained (due to the size of x, Fig. 14, and very unequal horizontal projection of the reciprocating motion), so that a correction must be made and the point E either raised or the radius c increased. By means of a few trials a suitable location will soon be found.

If the point D falls on the center line of the engine, the radius c can be calculated from the selection of u' for the latest point of cut-off. In this case the vertical position of the point E will be so chosen that its distance from the center line of the engine will run from 14/15 to 19/20 of the calculated distance for c'. By a few trials it will not be difficult to select an essentially correct distance to be used.

When the point E has been fixed in this way, the correct location of the point D, as well as the exact dimensions of u maximum and c can be determined. We then treat it in the following manner: with the

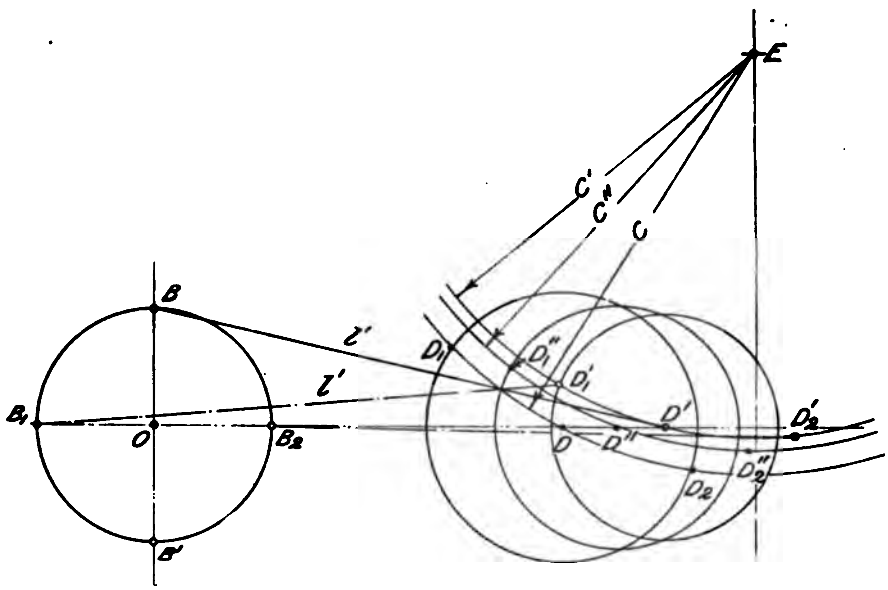


FIG. 18.

by the selection of the greatest distance of the link block from the point E, with the maximum steam admission:

calculated distance c' as a radius, and from E as a center, draw a circle whose point of intersection with the center line of the radius strike arcs of circles which intersect the circle struck from E, and these give the extreme positions D' to D_1' and D_2'. The arcs $D_1' D'$ and $D_2' D'$ must be equal to each other. If this is not the case, then, when $D' D_2'$ is greater than $D' D_1'$ the correct position of the point D is more to the right, and when $D' D_2'$ is less than $D' D_1'$ it is more to the left on the center line of the engine. For this we take the corresponding point D'' and, in a few trials will be able to find the correct location of the point D. D E then gives the corrected length of c and we can then calculate the greatest theoretical distance u maximum of the link block from the pivotal point of the link E.

The length of c in practice will run from 11.8 in. to 15.7 in, so that the angle of oscillation of the link runs from 20° to 23°.

In order to determine the different points of cut-off in the cylinder, as well as the changes in the direction of motion of the locomotive, the link block must be placed at different distances u above or below the fixed pivotal point E. This is done by means of the lifting shaft arm and radius rod hanger U T S (Fig. 23) and the reach rod and lever P R S. On small engines the point P is usually moved back and forth with a lever, but on large locomotives this is usually done with a power reversing gear. Care must, therefore, be taken that the mechanism is so designed that the point P is moved forward (to the right) when the engine is to run forwards, and to the back (left) when it is to run backwards. It has often happened that accidents have occurred because of failure to observe this precaution.

A movement of the lever R S from its central position is that ordinarily used to adjust the steam admission for the forward motion, while a corresponding movement to the left serves to adjust it to a backward motion of the engine.

In order that the adjustment of the link block may be made as easily as possible, the distance U F (Fig. 1) is made as short as possible, to the right or left of F, and the point of attachment, U, may be to the left or right as convenient, but care must be taken that the link, when at its extreme position to the right or left, does not strike the hanger U T. In practice the distance of the point of support U from E runs from 4.7 to 11.8 in.

As already stated herein, it is the customary practice to have the link block above the pivotal point of the link for the forward motion, and the eccentric r is keyed at an angle of 270° in advance of the crank. In small locomotives, the hanger is sometimes arranged so as to use the lower half of the link for the forward motion, because of the excessive slip of the link block that might occur if the upper half were used, and because the greater portion of the work of locomotives is done in the forward motion. In this case the eccentric r is keyed 90° in advance of the crank and the point F works either as an eccentric with an eccentricity of $r \times \frac{u}{c}$ which is keyed at the same angle or as an eccentric r, which is set with a lead angle of 0°. Hence it follows that the motion of the valve is the same as with the ordinary arrangement.

In order that the important rule for the motion of the point P relatively to S may be observed and at the same time the proper motion at U may be obtained, it is necessary to locate the pivotal point S to the left or right of U as the case may demand. The location of the center, S, of the lifting shaft is usually provided for in the frame, and it is also to be found in a vertical plane not far to the right or left of E. We, therefore, swing about S and not about U as the fixed point to be determined and U is to the right or left of S according as F is to be in the upper half of the link for the forward or backward motion.

In order that a symmetrical motion may be given to the valve, it is essential that the link block should, not only in its extreme outer positions in the link, but in all intermediate positions, give an equal and predetermined amount of steam admission at both ends of the cylinder; in other words the distance u of the link block F from the pivotal point E, must be the same for the extreme positions of the link to the right or left. In order that this may not be influenced by the hanging of the radius rod, the point T must be moved in a curve about S for both forward and backward motions, so that this point T is always on the straight line drawn at right angles to the center of a straight line connecting the two extreme points of the throw which the point of support U must occupy.

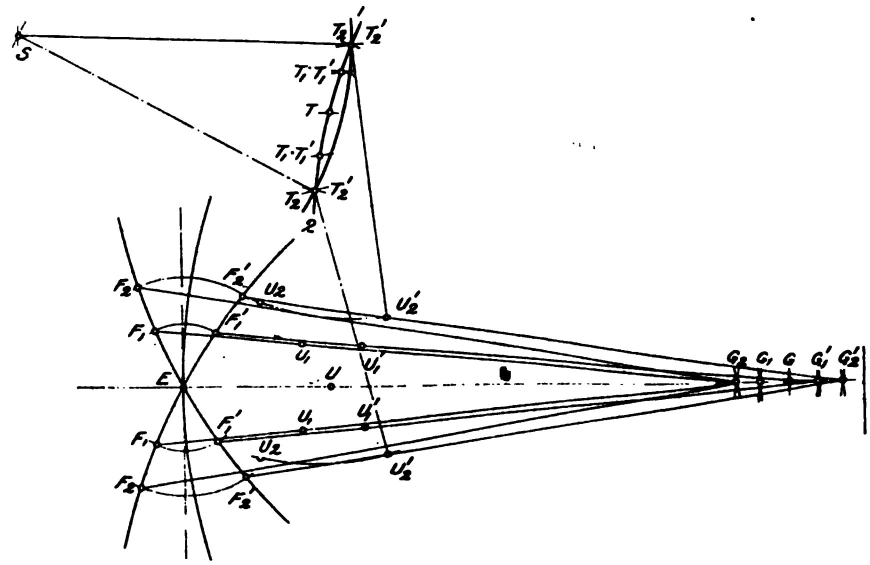


FIG. 19.

In working out these details in practice, the point T is allowed to describe an arbitrary curve, and the designer is content to secure an approximation to that which is theoretically correct. Instead of the given curve, the arc of a circle is taken, which coincides with the first named one as nearly as possible, at least for the forward motion of the engine, and especially for those points of the curve where it is desired to work the locomotive for the greater portion of the time. The center of this arc will be at S.

A further explanation of what has just been said is shown in Fig. 19. For the two indicated points of cut-off, for the forward and backward motions of the engine, the position of the block in the link is shown for the extreme positions of the link at the ends of its throw, and the distance of the block from E is the same at each of these extreme positions. In this motion the radius rod is moved from $F_1 G_1$ to $F_1' G_1'$, or from $F_2 G_2$ to $F_2' G_2'$. At the same time its point of support at the end of the hanger moves from U_1 to U_1' or from U_2 to U_2' and the lower end of the hanger T U must have no influence on the motion of the link block, because of the movement of that lower end, while the upper end of the hanger T U must be held at one point so as to control the point of cut-off. This is only possible of accomplishment when the point of suspension T lies on a straight line drawn at right angles to the center of the straight line connecting $U_1 U_1'$ or $U_2 U_2'$. Its proper position lies at the point of intersection of the two circles, having the radius U T struck from the centers U_1 and U_1' or U_2 and U_2'. The line connecting the points of T, thus found, gives the curve 1 — 2 upon which the point T must be located for the different points of cut-off for the forward and backward motion of the engine, under the conditions of movement of the link block that have been under consideration. If this movement is to be accurately determined, as indicated in Fig. 19; in the first place it will be seen that a very unfavorable position has been taken for the point S and secondly that an excessive length for the arm $S\ T$ has been assumed. For this reason we will have to be content with an approximation and the point T will be moved through the arc of a circle struck about the center S, so that the positions of the point T for the maximum points of cut-off will fall upon the curve 1 — 2 drawn as indicated.

In choosing the length of the hanger $U\ T$, it may be taken at from 15.75 in. to 23.62 in. and a suitable radius $S\ T$ will run from 11.81 in. to 23.62 in. from which the location of S will be easily determined. It is well to make the length of the lifting shaft arm $S\ T$ as short as possible so as to obtain the maximum leverage at the reversing lever.

The extreme positions of the link block as found according to this explanation of Fig. 19, are based upon the supposition that the point G moves in a straight line. In practice, however, it describes a curve, because of its position on the length of the lap-and-lead lever, that resembles a figure 8 laid upon its side. Under the influence of this motion, the end of the radius rod, as well as that of its point of suspension, does not permit the link block to simply move back and forth but causes it to slip up and down in the link. It is not possible to prevent this "slip" of the link block, because, in the first place, the block wears very quickly, thus producing lost motion in the link; and secondly, because, if the distance u of the link block from the pivotal point E is changed, the resultant throw of the valve to the front and back becomes unsymmetrical, and the working of the motion is not exact.

The radius rod hanger can be used as a means of equalizing this motion, and can be made to reduce the slip of the link block to a minimum, at least for those points of cut-off that are in most common use. It should not be more than 0.4 in. as a maximum, though, in practice it is frequently found to amount to as much as 1 in.

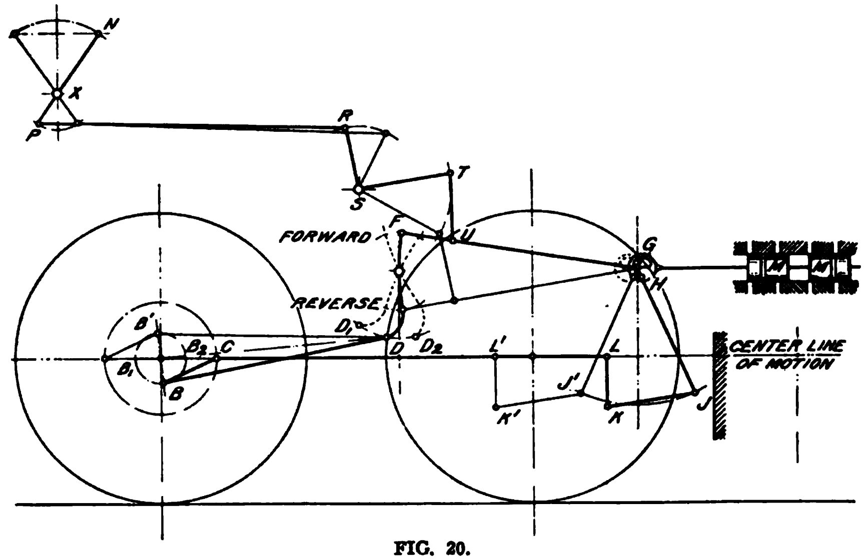


FIG. 20.

This subject will be concluded in the next of this series of articles in the June issue of RAILWAY AND LOCOMOTIVE ENGINEERING.

Freight Car Design*

By Louis R. Endsley

Consulting Engineer and Professor of Railway Mechanical Engineering University of Pittsburgh

It would be an easy thing to design a freight car if it stood in one place like a house or building, and the problem of a design of an interurban or street car is not a difficult problem from a structural side, but the design of a freight car that is connected up with other cars in trains and switched in yards, either hump or level, and comes in contact with other cars at varying differences of speed, is quite a problem, and these problems are getting larger as the cars increase in size and capacity. By some designers it is only a problem of weight in the underframe and the connecting parts which they are thinking about, but I am thinking that there are other things to take into consideration besides the mere increase in weight. In the design of a freight car, there are two distinct problems to be taken into consideration. One is the direct vertical load and the other is the shock or pressure produced between the cars when they come together at varying speeds. Let us consider first the direct vertical load. There are some parts that need to be heavy to absorb the shocks of the direct vertical load, but none of the parts above the springs should receive shocks from a direct vertical load. What I mean by shocks is that force which is produced after the part which is designed to give under varying movements of the car, has gone solid. These parts in the direct vertical design are the springs; and I am confident that the springs should be designed with a greater capacity than some designers are now using. Some cars are now designed and put in service with the capacity of the spring only 160 per cent of the normal weight of the car and lading, normal weight being considered as the load on the springs when the car is standing still. In my opinion, this capacity of spring should not be less than 200 per cent and 250 per cent would probably be a better percentage. That is, we should only have 40 per cent of the total movement of the spring taken out of the spring when the car is loaded and standing still.

In some tests that I made on the Pennsylvania Railroad in 1914, I used a recording arrangement to determine the movement of bolster up and down upon the springs, with respect to the side frame, and by the use of calibrated springs I was able to determine whether the springs went solid and if they did not go solid, the maximum force upon the side frame. I used for this series of tests two different capacity springs, one set had a capacity of a little more than 200 per cent of the normal load and the other had a little more than 300 per cent of the normal load. In the 200 per cent capacity springs in trips of the car between Pittsburgh and Alliance, many solid impact blows were delivered between the bolster and side frame. That is, the springs went solid many times. Now, this solid impact never occurred from one low spot in the rail or crossover, but was an accumulation of vibration up and

*Abstract of a paper presented at a meeting of the American Society of Mechanical Engineers at Newport News, Va., April 7, 1922.

down on the springs, usually from synchronizing of low spots in the rails or from vibration, up and down, of the car synchronizing with one revolution of the wheel, and it usually took thirty up and down vibrations as shown on the recording apparatus, to cause the springs to go solid. The other set of springs, which were 300 per cent of the normal load, never went solid. In fact, there was only one impact recorded that was over 225 per cent of the normal load. This car was run both in local and fast freight. The total movement of the springs, free to solid, was 1¾ in. on the 200 per cent capacity springs and 1⅛ in. for the 300 per cent capacity springs. This is a point which I wish to emphasize. I am of the opinion that some designers allow too much movement in the car, up and down; that is, allow too much spring travel. I am of the opinion that an inch travel or thereabouts of the spring will give less chance for excessive impact blows than if we used 2 in. or thereabouts.

The two sets of springs which I referred to before were of the same total height, but the free movement was reduced on the heavy capacity springs due to the increase in capacity. If, as I said before, a designer uses a capacity of 160 per cent of the normal load and the springs are designed for a maximum stress of 80,000 lb. per square inch, he will have ⅝ of that stress upon the spring when the car is standing still, or 50,000 lb.; while if he uses a 250 per cent capacity spring, he will only have a stress of 32,000 lb. per square inch when the car is standing still. This last spring will not be under near as heavy strain and the breakage of springs will, in my opinion, be materially reduced, and we will get very few impact blows upon the bolster and side frame of our freight car.

Of course, those parts of the car which are below the springs, namely, the side frame, need some extra weight in them, and I do not expect that the same light weight can be below the springs, due to those parts coming into contact with any abrupt irregularity of the track and producing an impact blow, due to the side-frame's own weight; but on those parts above the springs, if they do not go solid, the design is easy from a direct vertical standpoint. In some tests that I ran some years ago to determine the effect of the impact blow upon the side frame, after the springs went solid, I mounted in the standard M. C. B. drop testing machine a cast steel side frame. This cast steel side frame was supported upon blocks of wood to represent in a way the give of the track and was mounted also upon the 17,000 lb. anvil of the standard M. C. B. machine, which in turn is mounted on springs and a 9,000-lb. weight was allowed to drop and strike upon two ends of a short improvised bolster which rested upon the standard set of springs that were supported by the side frame. I found that a drop of this 9,000-lb. weight of 12 in. would just put the springs solid. If I raised the hammer another inch, or 13 in., and then dropped it, the side frame, which had an elastic limit of double that of the spring capacity would take set. Or, in other words, it only takes a little more energy than that necessary to close the springs to cause some very excessive forces. This is what is occurring in some cars when the bolster springs go solid, so that if you design a car with springs that go solid, you are somewhat in the dark as to the stress being produced in the car. It is perfectly safe to use a stress of 16,000 to 18,000 lb. per square inch in the underframe of the car from a direct vertical load standpoint, if you know with certainty the force coming upon the springs, but if the springs are going solid, it may be necessary to use a stress of only 10,000 lb. or, in other words, a factor of safety of considerably more than that which would be necessary, if the springs were not going solid.

In the detail of the design of the underframe, I am of the opinion that rolled members will give more satisfactory and more uniform results than will pressed sections. This is due to the fact that the corners of the rolled section materially add to the strength of the member and also pressed sections are not as a rule as straight and uniform as the rolled sections.

With regard to the forces which come upon the car due to their being switched or allowed to run into another car, there are some other problems which have not as yet been solved, but we are here confronted with the same problem that we are confronted with in the bolster springs. If we had a draft gear in each car that would never go solid without a pressure above the coupler and sill strength, when it came into contact with another car, we would have the problem practically solved, but as we have never yet been able to keep our switching speeds below the impact point, we are confronted with the same problem by reason of the impact, which is indeterminate after the draft gear goes solid. Some years ago we used a wooden underframe for our freight cars, and the line of draft was considerably below the center line of sills due to the fact that the sills were upon the body bolster and raised the center line of sills. Now, when we have steel construction and the sills of the car and the body bolster can be on the same horizontal plane, we are able to get the line of impact almost in the center line of sills in car. We have, though, taken away some of the relieving qualities which allowed the old wooden frame to bend and give, for wood, having much lower modulus than steel, gives approximately fifteen times as much under the same stress as steel, and this mere fact made the underframe of the old wooden car quite a giving medium. Today the underframe of the car, if strained from end to end, above its the old wooden car would give more than elastic limit, will give less than 1 in., while 2 in. and not overstrain it, and the old wooden car and its lading was much better protected than the new cars with the steel underframe. Today we are attempting to put in a draft gear that has a travel of two or more inches, most of the draft gears having something like 2¾ in., some draft gears have been constructed with 3½ in. and a few have been built with 4¾ in. In my opinion, we are now ready for an increase in the travel of the draft gear itself, because if we attempt to absorb in the average travel of say 2¾ in., we are expecting entirely too much of the draft gear. In other words, to get the capacity that is necessary out of the 2¾ in. travel, draft gear will require, if the line is a straight line relation, between movement and pressure, a very excessive final pressure, or above that which any designer has yet obtained, while if we should go to 4½ in. or 5 in. travel, we would design a draft gear of almost four times the capacity of the 2¾ in. travel and still have no greater increase in the relation between pressure and travel.

The weight of the underframe today has been increased for the protection mainly of the impacts between cars. In some tests which I made a few years ago, it was found that two 30-lb. 12 in. channels with a cover plant of 5/16 in. will stand an impact force of over 1,200,000 lb.; while if these channels were of the same weight and 15 in., the web and flanges were thinner and did not give as high an impact force as the 12 in. channel. Some designers have gone to the high channels for the mere purpose of protecting the car from the vertical oscillation, while if they would go to a heavier capacity spring in the truck, they could still retain the 12 in. channel of less weight and have as good impact and absorbing medium as if they had the 15 in. channel.

We now have a standard coupler which is a very good coupler. This coupler is of such strength that we will have to design the underframe of the car a little stronger than we have been designing it in order that the underframe will be of greater strength than the coupler, because the underframe should be stronger than the coupler, as it is much easier and cheaper to replace a coupler than it is to repair the underframe.

The old and light weight coupler was plenty strong enough for the wooden underframe car, but the steel underframe car, which was of greater strength, caused a great many coupler failures due to the impacts coming upon the coupler after the draft gear went solid.

I am of the opinion that we should take steps to keep our draft gear capacity up so that we can keep in the service longer the old and medium weight cars. If our old cars have an impact capacity of only

600,000 or 700,000 lb., and we design cars with a new underframe that has a capacity of over 1,000,000 lb. and these cars come in contact, without an adequate draft gear in each of them, there is not much doubt which one of the cars is going out of commission. As long as we keep together two cars of equal strength, they will stand a great many impact blows in the switching, after the draft gear goes solid, but when they come into contact with cars of greater capacity, the old cars will go out of commission very fast; while if we should design the new cars with draft gear and arrangements that would take care of a reasonable switching speed, we would keep in service many cars which are now going out of service. Today we have draft gears which will take care of switching speeds between 3½ and 5 miles an hour when new, but unless they are kept under repairs, this speed at which they will protect the car will be reduced considerably. After the draft gear goes solid, as with the springs, the force goes to the strength of the next weakest part, and it does not make any difference how strong you make all the parts of the car, you will still be overstraining them if the switching speed is sufficient to close the draft gear. There are now in service many draft gears which are doing good work on the modern size and capacity of car, but in our new 70-ton and 120-ton cars, we will never be able, in my opinion, to take care of the necessary absorption with a 2¾ in. travel.

I have been, for some years, an advocate of a gear with a longer travel, and I hope that in the next few years, some designers will see the necessity of a gear with a longer travel.

Some important things to be kept in mind in the design of a car is to get the line of draft as near the center of the channel that makes up the underframe as possible. Some designers have felt that it should be slightly below the center of the channel, but I believe that an inspection of bent underframes will show the weakest point of the car is just behind the bolster on the bottom of the sills. This is due to this point being under compression, due to the direct vertical load, also due to the impact on the end of the car, and I believe if the center line of draft cannot be put upon the center line of sills, it would be better to put it a little above than below. Some designers are attempting to design the draft gear and attachments so that they can be easily taken down and inspected and repaired, but some roads do not seem to appreciate the benefit of keeping the draft gears in repairs. I believe that taking out the slack, which is bound to be produced by bending of parts after the draft gear goes solid, should be periodically carried out, in this way, we would be able to materially reduce the uncontrolled slack in operation of cars, as, in my opinion, there is a marked difference in uncontrolled slack of a long train and draft gear travel.

Electrification in Austria

Progress is being made in electrifying the railways. The Arlberg division, on the line between the Atlantic and the Black Sea, will probably be completed in 1922. Work on the Salzkammergut line (Steinach-Irdning to Attnang-Puchheim) and the Vorarlberg (Bludenz-Bregenz) and connecting lines, is also proposed for 1922. Preparatory work has begun for electrification of the station and yard in Innsbruck, and the contract for the mechanical equipment is to be awarded in the near future. Twenty-seven electric locomotives for passenger service and 20 for freight trains are ordered.

Pacific on Great Northern of England

The accompanying illustration shows a new Pacific type express locomotive of which two have recently been built at Doncaster, England, and placed in service on the Great Northern Railway. A striking feature of the New locomotives is an important variation in the details of the application of the Walschaerts valve gear, consisting as usual of two external motions, driving inside admission valves by a conjugated system of rocking levers which are located ahead of the cylinders.

In the following table of the leading dimensions the weights refer to full working order, and the tons to what are known as the British Imperial Standard of 2,240 lbs.

PACIFIC—4-6-2 TYPE ON THE GREAT NORTHERN RAILWAY OF ENGLAND.

Cylinders (three), Diameter	20 ins
Stroke of pistons	26 "
Wheels: Coupled, diameter	6 ft. 8 "
Bogie, diameter	3 " 2 "
Radial truck	3 " 8 "
Wheelbase: Coupled	14 " 6 "
Total	35 " 9 "
Boiler: Diameter of barrel (cylindrical ring)	5 " 9 "
" " (Max. conical ring)	6 " 5 "
Height from rail to axis	9 " 4½ "
Length between tube sheets	19 " 0 "
Firebox: Type, round top wide sloping crown and sloping back sheets.	
Length of firebox (outside)	9 " 5½ "
Heating Surface: Tubes, 168, 2¼ ins. ext. dia.	1,880 sq. ft.
Flues, 32, 5¼ ins. ext. dia.	835 "
Firebox	215 "
Total	2,930 "
Superheater: 32 Elements, tubes 1¼ ins. int. dia.	525 "
Grate Area	41.25 "
Working Pressure	180 lbs. per sq. in.
Tender: Eight wheel rigid frame type. Water lifting apparatus fitted.	
Diameter of wheels	4 ft. 2 ins.
Wheelbase	16 ft. 0 ins.
Capacity Water	5,000 Imperial Gallons
Capacity Coal, (Tons-2,240 lbs)	8 Tons
Total Wheelbase of engine and tender	60 ft. 10⅝ ins.
Length of engine and tender	70 " 5⅛ "
Height from rail to top of stack	13 " 4 "
Maximum width	9 " 0 "
Weights, Engine: On bogie	17 tons 1 cwt.
Engine: On coupled wheels (20 tons each)	60 " 0 "
Engine: On Radial truck	15 " 8 "
Engine: Total	92 " 9 "
Tender: Total	56 " 6 "
Engine and Tender, Total	148 " 15 "

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Some Views of the Coal Strike

All reports agree that during April the people are not taking the coal miners' strike as seriously as might have been expected. The impression seems to be that the miners having been well paid for some time are merely having a few holidays during the fine spring weather, and the mine owners, as usual, having had good profits and a considerable supply of coal on hand, are ready to raise the price of the commodity as the coal pile lessens. It is expected that when the miners have spent their limited pile of savings, and the coal yards are getting clear of their superflux of rubbish, we will all start off together again as if nothing had occurred.

The largest losers will be the miners themselves. They have created a new grievance known as the "check-off." This is a system whereby the operator deducts a check-off from the miner's wages, his union dues and assessments, and pays the money to the representative of the mine. This practice has hitherto been unknown in the industry. Not only is this coercion against non-union mines, but the operators claim that this fund is employed against the operators who are the collectors of the fund. In life insurance and other beneficial schemes this is commendable. As a sustainer of strikes it seems something beyond endurance, and a proper subject for the Federal or State courts to readjudicate.

The strike is also an additional interference or hindrance to our transportation system, already severely handicapped. The transportation of coal which constitutes their largest asset is suddenly and almost completely cut off, so that the miners' strike may be said to be a strike against the railroads in a much more injurious sense than it is against the mine operators, and has apparently evidences of a conspiracy in violation of the Sherman law.

We are not yet convinced that it would be wise to take away the right of working men to strike. It has, in many instances, been the only weapon of defense left against oppressive conditions, but we are absolutely convinced that it is unfair to take away the right of the operators to strike against the collection and safe-keeping of funds to sustain a strike against themselves. This is a reversion of the laws of nature which forbids us injuring ourselves deliberately even to the advantage of others.

In the much more alarming strike recently made by the British coal miners, threats were made by eminent authorities that other kinds of sources of heat would be found to take the place of the rapidly diminishing supply of coal. We are of opinion that there is no pressing need of such threats. Our Secretary of the Interior recently published a diagram showing that our supply of coal, as far as authentic estimates were made, represented a block of coal ten miles high, ten miles wide and ten miles thick, a 1,000 cubic miles. Of this obout two cubic miles are all that have been known to be used so far, so that there need be no immediate fear of not being able to keep the home fires supplied with coal for many thousands of years to come.

At the first glance the figures look like an overestimate of the world's supply of coal, but we hold our minds in a solution of doubt. The unknown is ever the magnificent. One thing is painfully evident. In normal times there have nearly always been too many people engaged in mining coal, and by a clever system of almost compulsory agreements it has become hardly possible to discharge the superfluity. The miners have established a system of lessening or circumscribing the output. An excess of holidays are indulged in that further offset the quantity of days' work done, and lessens the quantity of production by others who are to some extent dependent on the assistance of the absentees. We make no pretence at suggesting a remedy. This is the province of our statesmen, if there be such amongst us, but the statesmen, or more properly speaking, the politicians seem to be the first cousins of the miners—they are thinking about themselves all the time not only in the natural attitude of sustaining their present positions, but in projecting their minds into the undiscovered future so that they may land safely in the next turn of events.

Meanwhile the public is paying for all this, while the railroads—the arterial life of the country, already sorely hampered and repressed, are shorn of a portion of the world's work which should be theirs, and the promise of better conditions and the re-employment of thousands of worthy and deserving men are retarded, and "enterprises of great pith and moment with this regard their currents turn awry and lose the name of action."

Objectionable Patent Law Proposals

Of course it would not do for our politicians to let well enough alone. No sooner is a meritorious law passed increasing the force of the Patent Office and thereby facilitating the work necessary to the securing of proper protection to our inventors than a tinkering process begins. In brief, bills are now pending in the form of amendments to the Patent Law proposing to make patents expire in five or six years unless the invention has been placed upon the market within such period. In other words if the inventor is not a manufacturer and lacks the means to create a market for his article, somebody else who has these qualifications can proceed and probably grow fat on other men's brains.

This compulsory license system is not new. It has been tried before and failed. It does not lead to the establishment of new industries. It tends to discourage the making and disclosure of invention and retards progress. It is based upon the erroneous assumption that patents cover things for which a market already exists. Some lawmakers seem to forget, or perhaps they do not know, that before the manufacture of a new article can become profitable it must be introduced; probable purchasers must be made acquainted with it, and a demand created. Many clever inventors set out, unfortunately, without financial resources. The difficulty in getting others to risk money on the success of some new contrivance is increased when by ignoring the inventor for a few years they may secure a competitive compulsory license, if and when a demand for the thing arises, without bargaining with the inventor.

As is well known some of the most important inventions have been made by men who took many years to place their inventions on the market in a really valuable commercial form, the patent law giving the exclusive right to the inventor for seventeen years has been a help in the marvelous development of many inventions. If the intention of the proposers of the amendment is to compel foreign inventors to come to America and establish new industries, we are not disposed to hinder progress in any form, but the proper encouragement and protection of the people who happen to be in America already are nearer to our minds than those who are more remote, and any profit that we could make by the compulsory introduction of foreign means and methods should not outweigh the paternal duty of looking after our own, or at least giving them a fair chance under such circumstances and conditions as are calculated to give them time to see of what stuff they are made.

The College Graduate as a Railroader

Samuel Rea, President of the Pennsylvania, commenting on the advantages of a college education being an aid to advancement, takes the occasion to point out whatever may be said of those who have attained important and responsible positions in the past by having that practical education which comes from hard work in the day and from that self-denial which places education above recreation through intense study at night and in the holiday season, there can be no doubt of the advantage to the young man who begins his work with an intensely trained mind. This is not to be denied but it is a noteworthy fact that comparatively few college graduates take kindly to mere mechanical work. The special apprentices are not especially fond of the rougher portions of locomotive repair work. As a necessary step towards mechanical engineering it is something to be endured rather than gloried in, and if it were not that the lamp of hope is kindled in his forehead and the apprenticeship period looked upon as a kind of penance having its limitation, the college graduate would walk to preferment by some softer route. That the few who heroically met the situation, like men, they have already the quality in them that leads to success in any walk of life, and the fact that at the end of the race many who never saw the inside of a college outstrip the majority of the college men shows that there is a latent quality in men, or in some men, that colleges cannot give. In other words education of the higher kind may be compared to a pair of spectacles that may be, and very often are, useful to a man who can see some, but are merely doubtfully ornamental to a man who is born blind.

Help for the Exporter

According to the census report for 1919 there are more than 4,000 factories in the United States producing industrial machinery, of whose products an amount valued at about $400,000,000 is exported annually.

In order to defend and promote this trade an Industrial Machinery Division has been organized in the Bureau of Foreign and Domestic Commerce at Washington, and there is every reason to believe that the volume of these foreign orders can easily be increased, because the Bureau can do more than has been done to assist the individual manufacturer to develop his foreign business.

The division gives attention to industrial machinery, and this classification of every kind of machinery used in any kind of factory, power plant, or mine, or that runs on a railway, or is used in the construction of engineering enterprises.

In order that the division may be practical in its work men have been placed in charge who are engineers and who have sold a great variety of machinery in South America and Asia, and are familiar with conditions existing in many of these in those sections of the world.

In order that it may be of the greatest possible service to American manufacfacturers of machinery. The best way to accomplish this is to establish close contact with the interested parties and learn of their particular export problems. Having done this it will be possible to secure help in their solution from the large number of representatives the Government maintains in foreign countries; or, should circumstances justify, arrangements could be made to send special investigators into those fields, and such tasks would be assigned to experts peculiarly qualified for the work. No problem is too large or too small for this service.

The division proposes to adopt the methods of selling to that prevailing in each of the several markets of the world, and of distributing the information as to methods and requirements obtained by its over seas representatives to American manufacturers. This information is intended to cover the laws and regulations of all foreign countries covering the inspection and operation of all classes of machinery.

Advice and suggestions from interested manufacturers will be welcomed by the division in preparing its plans, and every effort will be made to have the contact between American manufacturers and the markets abroad as direct and perfect as possible.

Important Decision Affecting the Development of Rustless Irons and Steels

Judge Learned Hand of the U. S. District Court, Southern District of New York, has just rendered a very important decision on the rustless and stainless iron and steel patents of the American Stainless Steel Company, in their case against the Ludlum Steel Company of Watervliet, N. Y., for infringement. The bill was dismissed for non-infringement and costs were awarded to the defendant.

The manufacture of rustless and stainless steels were first commercially developed in England where there are no patents controlling their manufacture but full and unrestricted development. Evidences exist of the successful coating of iron which has stood up for hundreds of years without deterioration by rust. The Delhi column of India and a few other Oriental columns of iron have withstood the ravages of ages. The reason for this somewhat startling instance is the surface of these columns was efficiently protected from rust by the reason that the hammering of these iron columns on stone anvils resulted in the surface of the iron taking up silicon which, when oxidized, formed an impervious rust-proof coating. The defendant in this patent suit has used this accidental method of protecting iron by incorporating large quantities of silicon with their iron and this coupled with the valuable element chromium has resulted in a truly non-rustible iron, the American Stainless Steel Company using chromium and iron without silicon. Judge Hand's decision is to the effect that these two combinations are not the same.

Modern methods of manufacture of the important elements in rustless irons and steels will enable users of structural materials to purchase this new and wonderful development at prices lower than those of brass, copper and bronze and but very little more than iron and steel, if the coating which iron and steel must have is taken into consideration. In other words galvanized material of today will cost about as much as rustless materials will do in a few years when the development has been carried on to a greater extent. One has only to think for a moment or two and a whole mass of immediate uses is mentally pictured—bridges, ships, wire cables, rails for locomotives, locomotives themselves, rolling stock, stacks, tanks, roofing, guttering; structural steel for buildings, pipes, water fittings, etc., without limit.

As manufacturers and users of iron and steel naturally desire that their products will be of as long life as possible, therefore it is reasonable to expect that there will be a universal and immediate demand all over the world by progressive manufacturers for large supplies of this very important material. Doubtless, also, a large number of investigators may arise who will still further develop this very interesting and important phase of the iron and steel industry.

Real Service

The valuable employe is one who does the right thing without being told—who senses the requirements of his work and meets these requirements in a way that reflects credit upon the company. There is no railroad man but who has it in his power to become an expert in his line of work.

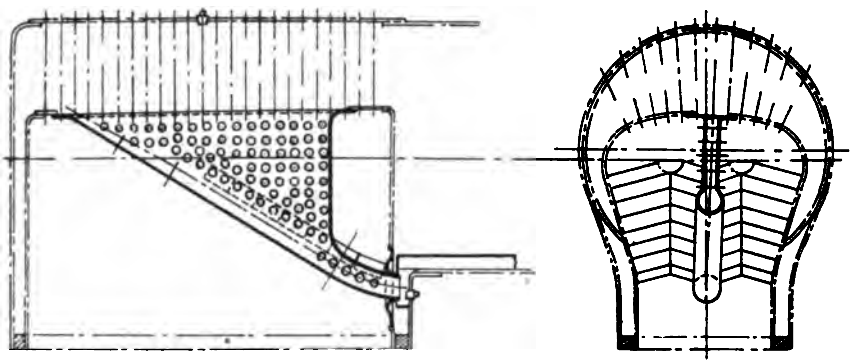
Details of Test of Nicholson Thermic Syphon Showing Reduction in Fuel and Increase of Tractive Force When Applied to Locomotives

The construction of the Nicholson Thermic Syphon, as is well known, consists of one or more compartments so constructed and attached in the firebox of a locomotive as to increase the heating surface exposed to the fire and greatly increases the rapidity of the circulation of the water within the boiler. Each Syphon compartment is made of an approximately square plate of ⅜-in. firebox steel folded over a 6¼-in. round mandrel along a diagonal thereby forming a triangular-shaped water leg.

The staying or bracing is of the conventional manner. The bottom or channel portion of the Syphon being circular in form is self-supporting, and at the lower end is extended out from the body of the syphon forming a cylindrical neck 6¼-ins. inside diameter. The vertical edges of the sheet are flanged inwardly and joined by autogenous welding. It is supported throughout its length by staybolts, the upper edges of the sheet are flanged out to a width of about 12 ins. and adapted to the firebox crown sheet, the flanges being drilled to suit the crown stay locations. Syphon necks are cut off to suit and inserted into flexible diaphragm plates projecting through sufficiently to allow for beading over, and then welded and riveted to flange of diaphragm.

Thermic Syphons, when installed become an integral part of the firebox and are automatic in their action. The increased heating surface causes an increase in evaporation. The application of from one to three syphons increases the normal firebox heating surface from 15 to 45 per cent and gives a corresponding increase of firebox evaporation. The effect is lower front end temperature, increased boiler efficiency and enlarged capacity. The higher hear absorption induces a syphoning action resulting in a current of water through the neck of the syphon having a velocity of about 4½ ft. per second. The high velocity keeps the syphons clean and entirely free from mud or scale. Repeated tests have demonstrated the stability of the device, as well as the marked degree of economy particularly in fuel, and also in water, and the result of a special test made in the Northwest will attract wide attention as emphasizing the comparisons between a locomotive equipped with the Nicholson Thermic Syphon, and another locomotive not so equipped.

The Spokane International Railway operates through passenger trains over its main line from Spokane north, a distance of 140 miles to Eastport, Idaho, where connection is made with the Canadian Pacific Railway. Ordinarily, five car trains are operated on this run including standard sleepers and a dining car. While the time on this run is not fast, the trains are required to do a considerable amount of local work and grades encountered are severe so that the schedule has proved difficult to maintain with the locomotives now in service which are of the ten-wheel type with 19 in. by 24 in. cylinders and 22,000 lb. tractive effort. Another condition affecting the steaming capacity of these locomotives and limiting their ability to handle heavy trains over this road is the quality of the coal burned combined with a grate area of only 27 sq. ft. The locomotive coal used on the Spokane International Railway is a slow burning fuel containing approximately 75 per cent fixed carbon and averaging 12,500 B. T. U. It is difficult, therefore, to keep full steam pressure at all times and the fuel consumption frequently exceeds 160 lb. of coal per sq. foot of grate surface. Under these conditions the capacity of these locomotives is not only limited but their fuel performance is not as economical as it should be so that the officials of the Spokane International Railway have recently been looking into the possibility of improving the efficiency of these locomotives and increasing their capacity so that they will be able to haul additional cars when necessary and still make the running time, thus obviating the necessity for purchasing heavier locomotives for the present.


LOCOMOTIVE SYPHON AS APPLIED TO ENGINE NO. 102

As a result of this investigation the Spokane International Railway decided to apply the Nicholson Thermic Syphons to one of these ten-wheel type passenger locomotives and to test this locomotive in comparison with another locomotive of the same class having a plain firebox. In selecting the Thermic Syphon for this test in preference to other devices designed to improve locomotive capacity and efficiency, the railroad was goverened largely by the fact that the application of a thermic syphon would enable an immediate increase in the diameter of the locomotive cylinders on account of the increased boiler capacity resulting from the heating surface which the syphons add to the firebox. As the weight on driving wheels was sufficient in this case to permit of an increase in the cylinder diameter without reducing the factor of adhesion too greatly, the application of a single Thermic Syphon made it possible to increase the diameter of the cylinders ½ inch without reducing the ratio of boiler capacity to cylinder capacity. In view of the character of fuel burned, it would not have been practical to have increased the cylinder diameter without a corresponding increase in the capacity of the boiler and while this increase may seem small, it should be borne in mind that this increase in cylinder size not only added more than 60 h. p. to the capacity of the locomotive but increased its maximum tractive effort by 1,160 lb. In addition to insuring an immediate increase in the capacity of the locomotive, it was thought that the application of Thermic Syphons would improve the efficiency of the locomotive, not only on account of the improved boiler circulation, but because any considerable reduction in the rate of fuel consumption per square foot of grate surface on these locomotives would, in itself, tend to improve the fuel efficiency of the boiler. Factors taken into consideration in the selection of the Thermic Syphon were its ready adaptability to the locomotive without involving extensive alterations, and low maintenance charges since the syphons become virtually a part of the firebox and necessitate no repair work not common to firebox maintenance. Moreover, the application of this device has proven a relatively inexpensive means for increasing locomotive capacity and efficiency.

The application of the Nicholson Thermic Syphon to locomotive 102 on the Spokane International Railway was made during the past summer and on September 27th, 1921 a test of this locomotive was begun in comparison with a locomotive of the same class and operating in the same service but not equipped with this device. The manner of applying the syphon and arch is shown in an accompanying illustration and the principal dimensions of both locomotive 102 which is equipped with this device and locomotive 104 without the syphon are given in the accompanying table.

LOCOMOTIVE DATA

	Non-Syphon Locomotive 104	Syphon Locomotive 102
Type	10 Wheel	10 Wheel
Cylinders	19x24	19½x24
Boiler pressure	200 lbs.	200 lbs.
Firebox heating surface	153 sq. ft.	178 sq. ft.
Tractive power, pounds	22,000	23,160
Grate area, sq. ft.	27	27

As previously stated, items of interest on the syphon-locomotive is the increase in cylinder horse power, in tractive effort, in firebox surface and the evaporative capacity of the boiler. In conducting these tests, it was so arranged that both locomotives handled the same equipment and weight of train during all trips. The same engineer and fireman handled both engines. Care was exercised to make all conditions uniform in every respect. The tender was carefully weighed at the beginning of the trip, the water in the tender being measured at the same time. At the end of the trip the tank was filled up so that it contained the same amount of water as it did when starting. Then the tender was weighed to determine the total coal consumption.

Although the tractive effort and cylinder horse power were increased by the application of Thermic Syphons to locomotive 102, the results of these tests show clearly the decidedly better firebox conditions, as indicated in the accompanying table, and boiler conditions on the syphon equipped locomotive. The increased boiler and cylinder capacity of this locomotive made it possible to handle the same train with greater ease while the additional heating surface and improved water circulation caused by the syphon made a marked improvement in the steaming capacity of the locomotive. Maximum steam pressure was maintained at all times and the boiler was fully supplied with water during all of the runs with the syphon equipped locomotive while with the non-syphon locomotive it was necessary to trade water for steam in hard places. The general performance of the syphon-locomotive was reported as being much better and the coal consumption per sq. ft. of grate area was reduced to 133 lb. The results of these tests are shown in an accompanying table.

As a result of these tests the Spokane International Railway have ordered syphon equipment for a freight locomotive which will enable the railway to increase the diameter of the cylinders on this locomotive one inch, thus materially increasing the tractive effort and cylinder horsepower of this locomotive.

PACIFIC TYPE LOCOMOTIVE, SPOKANE INTERNATIONAL RAILWAY, WITH NICHOLSON THERMIC SYPHON.

SUMMARY OF RESULTS
TEST OF NICHOLSON THERMIC SYPHONS
(SPOKANE INTERNATIONAL RY.)

		Non-Syphon Engine 104	Syphon Engine 102	Difference Favor 102
1	Date of test	Oct. 1921	Sept. 1921	....
2	Tonnage, average per trip	269	269	....
3	Mileage per trip	145	145	....
4	Gross ton miles, average per trip	39,020	39,020	....
5	Number of cars, average per trip	5	5	....
6	Car mileage, average per trip	725	725	....
7	Total coal used (as fired) lbs. average per trip	22,190	17,980	19.00%
8	Total water used, lbs. average per trip	82,942	77,833	6.16%
9	Lbs. coal (as fired) per 1,000 gross ton miles	569	461	19.00%
10	Lbs. coal (as fired) per locomotive mile	153	124	19.00%
11	Lbs. coal (as fired) per car mile	30.6	24.8	19.00%
12	Lbs. water evaporated per lb. of coal	3.738	4.329	15.81%
13	Lbs. water per 1,000 gross ton miles	2,126	1,995	6.16%
14	Annual fuel consumption, tons	4,900	3,987	....
15	Annual cost at $5.70 per ton on tender	$27,930	$22,726	....

Number of Railroad Employes

Statistics just made public by the Interstate Commerce Commission show that the railroads of the United States in 1921 paid their employes a total in wages of $2,809,-896,614, a decrease of 22.9 per cent, compared with the total wage bill in 1920.

The average number of employes in 1921 was 1,661,301, or 19.1 per cent less than for the preceding year. In 1921 the number of employes decreased from 1,-804,822 in January to 1,542,716 in April. Beginning with May the employment increased from month to month until in October it reached 1,754,136. November reports showed a decrease of 21,783 and a further decrease of 95,202 was shown for December.

The greatest decrease in December compared with November was in the number of employes engaged in the maintenance of ways and structures. The decrease amounted to 59,553. Reports showed a decrease of 14,962 in the number employed in the maintenance of equipment and stores, while there was a decrease compared with November of 12,471 in the train and engine service.

For the month of December alone the number of employes totaled 1,637,151, while their compensation totaled $214,921,-396.

A Point Not Sufficiently Understood by the People

Senator Cummins, of Iowa, chairman of the Senate Committee of Interstate Commerce, stated to the Committee in its hearings on the railroad situation, that in his opinion "the Railroad Administration did not return the railroads to their owners self-sustaining. It ought to have established rates before the railroads were returned that would make the railroads reasonably self-sustaining.

I feel that there is a very just complaint against the Railroad Administration in that regard, far beyond any other controversy that it may have with the railroads. It was just as much the duty of the Government to return these roads with rates that would sustain them in their operation as it was its duty to return them in as good condition physically as it took them. And that is a matter that has not been sufficiently understood by the people of the country. And I think when it is fully understood, that very much of the criticism that has fallen upon the railroads since that time will disappear."

Traveling Engineers' Association

The annual convention of the Traveling Engineers' Association will be held at the Hotel Sherman, September 12-15, 1922. The Railway Equipment Association will, as formerly, meet with the Traveling Engineers, and preparations are being made to make an exhibit under the joint auspices of the associations during the con-

Snap Shots—By the Wanderer

The skipper of Captains Courageous once remarked that, "there is no use swearing at things." It is probably equally true that there is no real or permanent use in swearing at humans taken as a whole or individually. And still less of profit in bemoaning the shortcomings of our fellow creatures, because few, if any, can ever hope to rise to our own high standard of excellence. Internally we constantly echo the complaint song of Dan Daly in the Belle of New York: "Of course you can never be like us, but try to be as like us as you can." All of which points to the lamentations heard on every side and in every industry as to the difficulty or impossibility of obtaining skilled workmen. Where does the fault lie? The most systematic and carefully worked out and applied systems of apprenticeship do not seem to be materially relieving the situation. The boys go through their work, but as for pride in what they are doing! Well it seems to be lacking. And yet there are occasional groups of men whose standards are high, whose self respect is on such a high level that it never enters their heads that they are not of the best, and so they never mention it.

The question is how do these rare communities happen to exist, and what are their accompaniments? I have found that they are invariably located in small towns or villages, that they come from old New England stock or early settlers; that they have been brought up in the fear of the Lord; and that they have been taught to obey the law and their parents. It is to this last that I think most of their excellence as citizens and workmen is to be attributed.

They have been taught faithfulness and obedience from childhood and they practice it in their maturity. And when they undertake a task they finsh it.

Isn't it a possible explanation for the pancity of skilled labor; a partial explanation of present conditions that the boys and men have not had the proper early training to fit them for later efficiency and reliability?

For example, and examples are good things wherewith to point a moral and adorn a tale. A few years ago an engineer was engaged in the establishment of an industry in a city of a few thousand, where there were no factories. As he was installing his machine tools he was called upon by nearly every mother in town, asking for a job for their boys. As he had some ideas as to giving boys a chance he had elaborated a scheme of apprenticeship that he thought would produce a skilled workman at the end of the four years. So he gave positive promises to the first half dozen mothers and entered the rest on the waiting list, not expecting to call on any of tered upon their apprenticeship with all the spirit of a galley slave. Even that spirit soon died away and in a week the whole force of apprentices had undergone a complete turnover. This continued until the full waiting list had been called upon and vanished.

A few days after the disappearance of the boy, his mother would call and ask if there was any money due him. When asked why he had left, she would say that they did not know that the work was so hard or so dirty, or that they would have to get up so early in the morning, or that they did not think they would learn anything or any of the thousand and one reasons that a lazy boy, who has never been made to work, can give for remaining idle. In short there was not a boy in the town who had stamina enough or who had been subjected to enough parental discipline to stick to a job long enough to find out what there was in it.

Boys can't see very far ahead, and until they are given the early training that they need and are encouraged by precept and example to take an interest in their life's work. the scarcity of real mechanics will continue.

This same spirit is exemplified by the records of correspondence schools. Too much cannot be said of the benefits that certain boys can receive from these institutions. They cannot and do not pretend to touch a college training, but for the boy or man who must support himself they may be made to be invaluable. "Maybe made to be," just expresses it. The trouble is to excite enough interest to make a start, and then to hold the interest to the end. I am told that about 75 per cent of those who start, fall by the way.

As an employer and observer I have found that the boy or girl who will do things out of working hours for the sole purpose of increasing their own value is a very rare bird. They will work under the lash; they will learn under pay; but to work on their own time with the idea of bettering their condition, is a thing they will not do. They fail to recognize the fact that to secure an increase of pay they must be giving their employer a bargain. That is, they must be earning more than they are being paid. Not that this is the whole of the matter with our industrial conditions, but it seems to be a potent contributing factor.

The flange lubricator looks like a good thing when taken by itself. It probably is a good thing or so many would not be in use. But isn't it possible to spoil even a good thing by putting it into bad company? The flange lubricator is usually applied to the front pair of drivers of a locomotive The sand pipe delivers sand to the rails in front of that same pair of wheels. rub a combination of oil and emery on the surface to be ground and think that we are doing the work in the most efficient manner.

There has been no means yet developed to prevent the sand that is put on the rail from mixing in with and adhering to the oil that is put on the flange. The combination cannot fail to make a good cutting and grinding compound that will have a tendency, at least, to cut away the flange. That is what some close observers of the subject say. Observers whose duties keep them in the roundhouse and on the road. Isn't their opinion worthy of attention?

The remedy, if both sand and oil are to be used, is to drop the sand in front of the second driver, instead of in front of the first. This is not quite in accord with the practice of the ancients, but there are other things in which we do not follow in their footsteps. So, it might possibly be of advantage to bring in another variant in this particular also.

From what little I have been able to see, I am rather inclined to think that the roundhouse men are right when they object to the combination of oil and sand as a smear for driver flanges.

It has always seemed strange to me that the users of tools and machines are not consulted more frequently than they are by designers. If there is an unhandy thing about a tool, that looks well and is easy to build, its unhandiness is apt to be perpetuated in future designs. And, sometimes, this is even perpetuated because of precedent and a conservative clinging to what is and what has been.

This is very apt to be the case with cab fittings. The general position of cab fittings are indicated only on the drawings, and it is left to the ingenuity of the pipe fitter to put them in place. And a change of location may mean more trouble than a little to the pipe man. But——

Well, let us take the engineer's brake valve as an example. It is usually placed just inside the line of the back head, and handy to the engineer when he is running ahead. But if he has much backward running to do, the brake handle is too far away to be reached conveniently when he is leaning well out of the window, and the best he can do is to look, take a jab at the brakes, let go and look again; a cycle of action that cannot be very vociferously claimed to be a first class contributor to safety first.

So why not throw looks and precedent to the winds and move the brake valve well out toward the side of the cab, where the backward-looking engineer can reach it and keep control of the brakes? We have done more revolutionary things than that, and it is always well to remember

New and Improved Shop Devices for Railroad Work

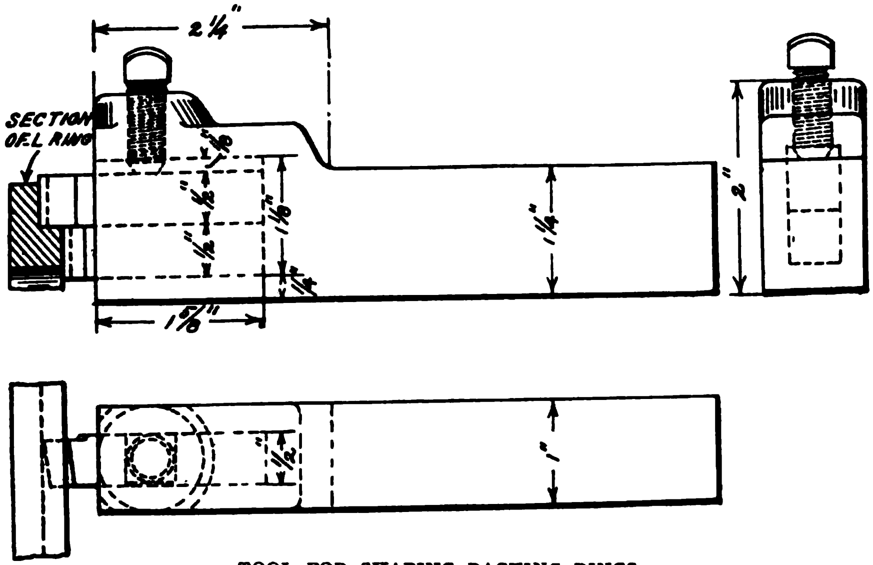
Tool for Shaping Packing Rings—Water Front for Ferguson Furnace—Flue Gauge—Twist Drill for Drilling Flue Sheets

Tool for Shaping Packing Rings

The finishing or forming of L-shaped packing rings usually involves the careful adjusting of the tool and the use of a gauge for each ring that is cut, or else the making of a special tool with its cutting edges ground to a gauge. When such a tool becomes dull and has to be reground, the work required is nearly as great and involves the same amount of care as the making of a new tool.

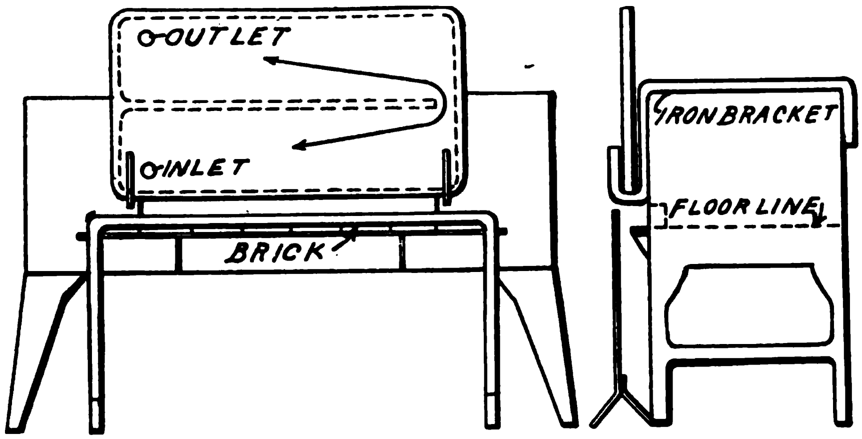
With the tool here shown all of this work is avoided and when the cutting tools have been set they can be used until dulled, in the same way as a special cutter; and can then be removed, reground, re-adjusted and work continued with them until they are worn out.

The tool consists of a holder of 1 in. by 1¼ in. steel whose shank is held in the tool port in the usual way. The working end in. high that is threaded for a ⅜-in set-screw. The end is slotted out with a rectangular hole for the reception of the cutting tools that measures 1⅛ in. by ½-in. with a depth of 1⅝ in.



TOOL FOR SHAPING PACKING RINGS

The cutting tools are made of ½-in. square steel, as shown, one of which is longer than the other. The cutting edges of these tools are set so that as one faces off the side of the ring the other will cut to the depth of the L. With this no forging of the cutting tool is required, but simply the grinding to shape of a piece of square tool steel and when adjusted with a gauge or scale they are held in place by the set screw.

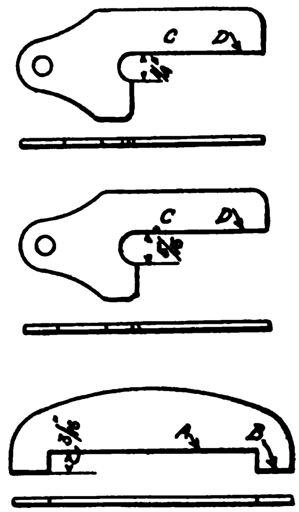


WATER FRONT FOR FERUGSON FURNACE

Water Front for Ferguson Furnace

The water front is a necessity for the comfort and efficiency of the men working before heating furnaces. The old method film of water is kept flowing is more or less efficient and has been made to answer the purpose, but it is sloppy and dirty. The form of front shown in the accompanying engraving can be made to always present a cool front to the men and is neat, clean and devoid of the sloppiness of the old front.

It is formed of two plates riveted to either side of a foundation ring, and having a horizontal partition between the two sheets that extends from the ring on one side to within a few inches of the ring on the other. The water is admitted near the bottom on one side, flows beneath and past the end of the partition and back over the top of the same to a point above the inlet and thence into the outlet and overflow. The two sheets need no staying as it is not necessary that any pressure should be put upon them. The face temperature can also be controlled by regulating the amount of flow of the water.



FLUE GAUGES

Flue Gauges

In order to secure a proper bead at the firebox end of a tube, it is necessary that they should be properly set; and, then, when they have been beaded, inspection is difficult and because of the difficulty it is apt to be lax.

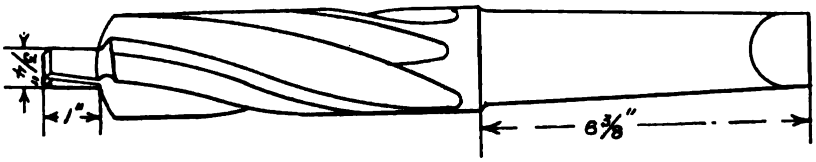
In order to meet the requirements of proper setting, and enable the beading to be properly and rapidly inspected the three gauges shown in the accompanying engraving have been designed.

The lower one is designed to set against the end of the tube and regulate the amount of its projection through the tube-sheet. With the edge *A* against the tube and the leg *B* against the tube-sheet this is accomplished. A tube projecting this dissufficient metal for the formation of a suitable bead.

The middle and upper gauges are really limit gauges. The middle one shows form of the largest admissible bead and the upper one the smallest. With the leg *C* put into the tube with the edge *D* against the inner surface of the same the curve of 5/16-in. diameter of the middle gauge must set down over the bead and the one of ¼-in. diameter of the upper gauge must not.

TWIST DRILL FOR DRILLING FLUE SHEETS

The drilling of tubesheets should be carefully done. The old method of punching the holes to nearly the proper size and then reaming has the advantage of rapidity of execution but is possessed of the disadvantage of putting stresses and strains in the metal of the tubesheet that are not entirely removed by the reaming.



TWIST DRILL FOR DRILLING FLUE SHEETS.

A new method that is giving very satisfactory results consists in locating the center of the hole and punching it to a diameter of ¾-in.

This hole serves as a guide for the teat at the end of the three-groove drill shown in the engraving. The three-groove drill has the advantage of always having a bearing against the metal being drilled directly opposite the cutting edge, so that the tendency to run out and drill large is reduced to a minimum.

The diameter of the drill is made the same as that of the tube, which allows 1/16-in. for reaming.

The shank is of the ordinary No. 5 standard Morse Taper.

Modern Trend in Locomotive Design*

By James Partington, Estimating Engineer, American Locomotive Company

The types, weights and general details of construction of locomotives have undergone striking changes in the last 20 years. These changes emphasize the necessity which faces all of the railroads of the United States to have their locomotives conform to certain prime requisites that may be stated as follows:

1. A drawbar pull that will handle the largest tonnage that the road conditions will permit.

2. The production and delivery of drawbar horsepower at minimum cost.

3. Careful designing to embody road standards to meet Interstate Commerce requirements and to keep maintenance charges down to a minimum.

To meet the first requirement all of the physical conditions of the road must be carefully studied, the horsepower curves of different types of locomotives at the speeds they will have to operate analyzed and the type that best fulfills the needs of the service.

In designing locomotives to meet the first requirement all the physical conditions of the road must be carefully studied, the horsepower curves of different types of locomotives at the speed they will have to operate analyzed and the type selected that best fulfills the needs of the service. The second requirement calls for a careful consideration of all of the devices which make for economy, not only those which have been in use for a number of years but those of more recent introduction. A more careful consideration of the diameter of tubes as a factor of the length over tube sheets may be particularly cited. For the best results with bituminous coal the length of the boiler tubes should be approximately within the following limits:

Out. Dia. of tube	Distance over tube sheets
2 in.........	18 ft. 0 in. to 19 ft. 6 in.
2¼ in.........	22 ft. 6 in. to 24 ft. 6 in.
2½ in.........	28 ft. 0 in. to 30 ft. 0 in.

These proportions are based on the evaporate values of tubes of varying lengths and can serve only as a guide in deciding tube diameters, especially for the intermediate lengths not covered by the table where a choice of either of two diameters can be made without sacrificing efficiency.

The tendency which was frequently indicated after the introduction of superheaters, to curtail the steam space of the boiler is being avoided to as large an extent as possible in the locomotive of today. Sufficient steam space and a throttle designed and located to deliver dry steam to the superheater are recognized items having an important bearing on the performance of the locomotive. The type of throttle usually applied now is designed to permit entrance to the boiler through the dome without removing the throttle, thus avoiding the use of an auxiliary or inspection dome.

Present day locomotives are usually designed to be as large and powerful as the roadbed, bridges and clearances will permit. This makes it necessary to apply automatic stokers to supply the large amount of coal consumed, the limit per hour for hand firing by the fireman being about 6,000 lbs.

In connection with the economical production of steam there are a number of other devices coming into use important among which may be mentioned. The application of two or three thermic syphons; the number depending on the width of the grate. These provide a considerable amount of additional heating surface in the most effective location, *i. e.*, in the firebox and contribute toward a better circulation of water over the firebox crown.

Another method of improving circulation has been applied on a number of recent locomotives. This embodies the application of a horizontal plate laterally in the boiler shell located so that about one-half of the tube heating surface is above this plate, the balance below it, causing a lower circulation of water toward the back tube sheet and sides of firebox and an upper circulation forward.

On account of the weight necessary to provide for boilers of ample size and the auxiliary attachments necessary for the most economic production of steam, the weight of the machinery parts must be carefully proportioned to keep them down to a safe minimum. This has caused a demand for the employment of special alloy steel for many of the parts subject to severe stress and fatigue. To secure materials which can be readily repaired or replaced by the ordinary railroad shop, the present trend is toward the employment of alloy steels which will give the required additional strength and tenacity without the necessity of heat treatment of these special forgings.

The employment of a booster to gain additional tractive power by utilizing the adhesive weight on truck wheels and the application of cylinders on the tender in a number of cases, may be noted as one of the recent developments intended to provide increased tractive power for emergencies, such as short, steep grades, starting trains on a grade, etc. In designing locomotives to meet the third requirement—keeping down the maintenance charges—

*Abstract of a paper presented at a meeting of the American Society of Mechanical Engineers at Newport News, Va., April 7, 1922.

the engineers of the railroads and of the locomotive builders are giving special attention to careful determination of the stresses in all parts of the locomotive and tender and securing proportions and materials which will withstand these stresses and avoid costly failures in service, the adoption of designs which will reduce the number of parts all possible, thus keeping bolted conections down to a minimum.

Whether the design of locomotives of the future will continue along conventional lines will depend largely on the amount of experimenting that may be done along new lines and the success or failure of such experiments.

The writer believes we will see more successful adaptation of three-cylinder locomotives in which the advantages secured will be greater and the complications of construction will be simplified. Increased efficiency will also be sought by the employment of higher boiler pressures and higher degrees of superheat. To secure higher boiler pressures without entailing prohibitive increased charges for boiler maintenance, a new type of boiler may be necessary. To secure higher degrees of superheat, the changes involved can readily be worked out and adapted as required.

It may be that the merits of internal combustion will be tested out on our railroads, although the complications involved do not appeal strongly to the maintenance departments. Several locomotives of this type are being developed in other countries.

Progress is being made abroad in condensing turbine driven locomotives and the results thus far obtained have been encouraging.

Further improvements in the draft appliances and reduction in the back pressure of exhaust are being diligently sought. The improvement of locomotives from the standpoint of design and operation is a fascinating subject on which much time and study has been expended in the past, is being expended at the present time and will undoubtedly attract as much if not greater effort in the future. The promise of the future is bright.

DISCUSSION

In the course of the discussion that followed the presentation of the paper, L. D. Freeman, Assistant Superintendent of Motive Power of the Seaboard Air Line, stated the interesting feature in the design of modern locomotives is found in a comparison of the mountain type locomotive of the Seaboard Air Line with locomotive No. 50000 built by the American Locomotive Company in 1910. In 1913 the largest passenger locomotive on the Seaboard Air Line was a Pacific type of 36,000 lb. tractive effort, the maximum permissible wheel load at the time being 47,000 lb. per pair of driving wheels, necessitating double-heading on regular

Based on the proportions of the locomotive No. 50000, ten Mountain type locomotives were built in 1914 by the American Locomotive Company having 47,800 lb. tractive power and weighing 209,000 lb. on four pair of drivers, or 52,250 lb. average per pair, which is still the maximum permissible wheel load on that road. After experience with these locomotives five more were built in 1917 and ten more in 1922.

The performance of these locomotives over a period of seven years indicates that the original design was correct and no changes were found necessary in the two repeat orders. It is felt that in view of this performance the statement that the basic principles developed in the design of locomotive No. 50000 were correct is fully justified.

The locomotives in question are successfully operating over a very congested section of single track regularly handling 11 steel cars weighing 75 tons each or 825 tons behind tender at 28 m. p. h. over ruling grades of 1.1 per cent with a maximum speed restriction of 50 m. p. h. over a division of 154.7 miles, making an average speed of 34.9 m. p. h. On the next division under the same conditions the train is handled 202.3 miles, making an average speed of 36.7 m. p. h. When conditions require, these locomotives handle up to 13 cars weighing 75 tons each, or 975 tons behind the tender over the 1.1 per cent ruling grade at 22 to 25 m. p. h. and maintain the regular schedules.

The average fuel consumption in winter months is 120 lb. of coal per locomotive mile with an average of 12 cars per train which takes into account the varying condition of the entire group of locomotives of this class. The first ten locomotives have performed since 1914 a total average mileage of 370,000 per engine, with an average mileage between the general repairs of 95,000 miles and in a few exceptional cases of 180,000 miles, indicating proper design of details.

In recent years many improvements tending to economy in steam production have been made in the locomotive boiler by the addition of superheaters, brick arches, feedwater heaters, mechanical stokers, power grate shakers and improvements in grate arrangements, ash pans and front ends.

Unfortunately the same degree of improvement in the use of steam in locomotive cylinders has not been attained. After nearly a hundred years of locomotive building we have still retained the slide valve, or in cylindrical shape the piston valve, to admit steam to and to exhaust steam from the cylinders, the latter with increased cylinder clearances. The most objectionable feature in connectionable feature in connection with the use of a single slide valve or piston valve is the fact that when the valve travel is decreased to

earlier, causing high back pressure and necessitating comparatively large cylinder clearance space to prevent compression in excess of boiler pressure, which results in considerable loss due to the comparatively low ratio of expansion at short cut-off and early release periods.

Experiments are now being made of applying to a locomotive a valve arrangement consisting of four valves for each cylinder, two for intake and two for exhaust, operated by a modified Walschaerts valve motion, the object being to apply the best principles of the four-valve non-releasing Corliss valve mechanism as used in high speed stationary engines to a locomotive, with a view of reducing the cylinder clearance, delaying the exhaust closure to reduce the back pressure and increase the ratio of expansion by providing a constant point of exhaust opening independent of the point of cut-off of the steam inlet valves. While this arrangement is still in the experimental stage it appears to point the way for a substantial increase in steam economy for locomotives.

French Try Railway Radio Outfits

In recent tests carried out by the Compagnie du Nord under direction of the French Ministry of Public Works, experimenters succeeded in transmitting orders from different points in the station at Bourget-Triage to the switching towers up to a distance of over 400 yards. According to reports of the United States Consul at Bordeaux, portable apparatus used is described as consisting of an antenna in a frame, a commutator, a stick tipped with iron to place in the ground, and a microphone, the total weight of which was 15 pounds. Other experiments were made between places in the station and a train moving at a speed of 19 miles per hour. The results were satisfactory as far as hearing the messages was concerned. They could be heard satisfactorily during the entire time the train remained in motion for a distance of over 10 miles, irrespective of the speed of the train.

English Turbo-Electric Locomotive

Interesting details are at hand during April in connection with trials on the London & Northwestern Railway of England, of a turbo-electric locomotive weighing about 30,000 lbs., with a length of 69 ft. 7 ins. The boiler, which is placed in front, has a working pressure of 200 lbs., and is equipped with a superheater. The main three-phase turbo-generator and also the auxiliary exciting turbo-generator are in front. There are four 275 horsepower electric motors, two of which drive the front wheels and two those of the back. A specially constructed condenser receives the exhaust steam which is used in heating the water supplied to the boiler. The exact data in regard to economy in fuel and

Important Decision Affecting the Action of the Labor Board

Injunction Granted to the Pennsylvania Railroad Company Against a Decision of the United States Labor Board Sustained by the United States District Court at Chicago—Case Likely to Go to the Supreme Court

It will be recalled that the Pennsylvania officials decided last year to deal with its employees directly on any question affecting the mutual interests and outlined a general regulation in regard to the selection of representatives of the railroad men from those only who were actually engaged in the employ of the company. It was clearly understood that the company decided to meet with no officials of the labor unions who were not employees. The Labor Board had ordered the various roads to receive all complaints in regard to wages or working agreements submitted and to meet with the men with a view to arrive at amicable agreements in regard to questions that might be in dispute, and failing to do so such questions might then be submitted to the consideration of the Labor Board.

The representatives of the union officials including some of the heads of the labor unions went before the Labor Board claiming that the Pennsylvania railroad officials had refused to meet with representatives of the employees. After a full hearing of both sides of the matter in dispute the Board issued a decision which the Pennsylvania claimed was an attack on the management and went into the Federal Court and obtained a preliminary injunction prohibiting the Board from making public its decision, on the ground that the Labor Board had exceeded its legal powers by reason of attempting to dictate particular conditions in which the election of the representatives of the employees should be made. The attorneys for both sides are preparing proposals for an order carrying the rulings into effect. The court has granted the request. The decision of the court meanwhile holds that the United States Labor Board has exceeded its powers in taking up cases which had been referred to it by only one side of the representatives in a matter in dispute. James M. Beck, solicitor general of the Department of Justice, will determine the course of the Government in the future conduct of the questions involved.

In denying the petition of the Railroad Labor Board that the injunction granted the Pennsylvania railroad be dismissed, the following are the chief points of the decision as issued by Judge George T. Page, United States District Court, Chicago:

This is a bill by the Pennsylvania Railroad Company against the Labor Board and its members to enjoin them from functioning as a Board generally, and specifically from exercising the asserted right to control the selection of the conferees provided for in Section 301 of the Transportation Act.

Two claims are urged: (1) That the act is unconstitutional if, and in so far as, it attempts to impose compulsory arbitration; (2) That the act gives the Board no right on *ex-parte* submission, nor on its own motion, to do any act under Section 301.

Defendant move to dismiss the bill, and urge: (1) That the Labor Board is an administrative arm of the Government over which the courts have no jurisdiction; (2) That the Board had the power exercised by it under Decisions 119 (Exhibit 2) and 218 (Exhibit 4).

Defendant's so-called answer is no more than a statement of grounds urged for dismissal, with the orders and decisions referred to in the bill attached.

What the Board is shown on the exhibits filed, and the only authority therefore is found in Title III of the Transportation Act.

I. The Transportation Act is entitled: "An Act" (a) "to provide for the termination of Federal control of the railroads"; (b) "to provide for the settlement of disputes between carriers and their employees"; (c) "to further amend the Commerce Act of 1887." (41 States at L. p. 457, approved Feb. 8, 1920.) Title III creates the Labor Board and other Boards, and also covers the subject matter of "Disputes between carriers and their employees."

II. The Adjustment Boards that may be established under Section 303 of Title III have not been appointed so that the powers vested in the Labor Board under Section 303 need not be considered.

Sections 301, 307, 308 and 313 have, in the main, been made the subject of attack and discussion.

In arriving at the purpose of Congress and the right interpretation of the act, it will be helpful to look briefly at previous legislation, and the conditions that produced such legislation.

In 1887, the regulation of common carriers in their relations to the public, particularly as to rates and service, was inaugurated by the passage of the Interstate Commerce Commission Act. That act has been extensively amended from time to time, and Title IV of the Transportation Act consists wholly of such amendments. At other times, Congress has legislated upon the question of safety appliances and other related matters.

In 1888, 1898 and 1913, acts were passed for the appointment of boards of arbitration. In none of those acts were there any compulsory submission to arbitration or mediation. These acts seem to have been produced by conditions in the relations between the carriers and their employees, and were for the purpose of preventing the interruption of business and consequent inconvenience and loss to the public.

The exigencies of the late war made it necessary that the Government should take over the operation of the railroad and produced the "Federal Control Act" in 1918. The termination of Federal control is provided for in Title II of the Transportation Act.

Late in 1916, after a conference for the purpose of adjusting disputes between the carriers and their employees had failed and steps were being taken to call a general strike, the President said to Congress that there were no resources at law at his disposal for compulsory arbitration to prevent commercial disaster, property injury and the personal suffering of all, not to say starvation, which would be brought to many among the vast body of people if the strike was not prevented, and asked for legislation. Congress responded with the Adamson law.

That law has been the subject of wide discussion, and it is not necessary to dwell upon it here, except to note that Congress there provided for an eight-hour day, and made other provisions that resulted in the actual raising of the wages of the employees of carriers. The Supreme Court sustained that act in *Wilson* v. *New*, 243 U. S. 332. The majority opinion was presented by the Chief Justice. Strong dissenting opinions were written, denying the constitutionality of the act.

Not only because of the diversity of opinion expressed in the new case, but because of its wide public discussion, Congress must have had clearly before it the question as to the conditions under which it had the right, if at all, to establish machinery by which to compel the compulsory fixing of wages, rules, etc., as between carriers and their employees.

I am of opinion that when Congress framed and adopted Section 301 it did so with the deliberate intention of imposing, as the plain language of the act indicates, the duty on all carriers and their officers, employees and agents to exercise every reasonable effort and adopt every available means to avoid any interruption of the business of any carrier growing out of any dispute between the carriers and their employees, and that Congress intended that all such disputes should be considered, and, if possible, decided in conference solely between a carrier and representatives of its employees directly interested in the dispute, and that, as hereinafter noted, the only power given to the Labor Board under that section was to hear and decide a dispute which the conferees provided for in Section 301 were unable to decide and then only in the event that the parties jointly referred the matter to the Board.

The further conclusions is inevitable that the Labor Board was without power to intervene in any way in the proceedings contemplated by Section 301 preceding a reference to it jointly by the parties, except that the Board might on its own motion suspend the operation of a decision by the parties if it was of the opinion that such a decision as to salaries and wages would make a readjustment of the rates of any carrier necessary, and thereupon as soon as practicable affirm or modify such suspended decision (Sec. 307b).

It is, in a general way, claimed that the Board has the right to direct or control the method of selecting the representatives of the employees under Section 301, under the provisions of Section 308 (4), which is as follows:

The Labor Board "May make regulations necessary for the efficient execution of the functions vested in it by this title."

The meaning of that language is too plain to need interpretation or construction.

Section 307 (b) authorizes the intervention of the Labor Board in precisely the same manner as provided in Section 307 (a) for the purpose of deciding "all disputes with respect to the wages or salaries of employees or subordinate officials of carriers, not decided as provided in Section 301."

In considering the intent of Congress as to the force of the Labor Board's decision as to other matters than those jointly submitted to them under Section 301, there are two views pressing upon the minds of the court for consideration:

(1) Do the provisions of the act authorize the Labor Board merely to hear, determine and publish in an advisory decision that which in its opinion would be a fair and just wage, or what would be a fair and just solution of disputes involving grievances, rules or working conditions? or

(2) Does the act authorize the Labor Board to make such findings, and to render such decisions and judgments as will make its determination upon those questions final and binding, so that a rule determined to be a fair and reasonable rule by the Board, shall thereafter be a governing rule between the parties, and so that a wage determined to be a fair and reasonable wage shall thereafter be the wage that shall be paid by the carrier, and that shall be accepted by the employees, and that may be recovered in the courts?

The appointment or method of election of conferees under Section 301 was not one of the functions delegated to the Board, and therefore it had not the right to make the regulations provided for in Division No. 218 on pages 8, 9 and 10. I am of opinion that the purpose of section 301 was to leave to the carrier and its employees full liberty to get together in their own way.

The language of Section 307 strongly supports my conclusion upon Section 301, because Section 307 makes ample provision for intervention on the part of the Labor Board in all cases arising under the Act where the carrier and the employees have failed to compose their difficulties or upon such failure to join in a submission to the Labor Board, as provided in Section 301. This will more fully appear from the following discussion:

III. As noted above, no Adjustment Board has been appointed; therefore, Section 307 may be read without consideration of the provisions therein relating to the Adjustment Board. Such a reading shows that the Labor Board shall receive for hearing, and as soon as practicable and with due diligence decide, any dispute involving grievances, rules or working conditions which is not decided as provided in Section 301, under the following circumstonces:

"(1) Upon the application of the chief executive of any carrier or organization of employees or subordinate officials whose members are directly interested in the dispute;

"(2) Upon a written petition signed by not less than 100 unorganized employees or subordinate officials directly interested in the dispute; or

"(3) Upon the Labor Board's own motion if it is of the opinion that the dispute is likely substantially to interrupt commerce."

There is no direct provision in the act that decisions by the Board shall be final and have the binding force of decrees to be performed. Nor is there any provision that that which is determined to be a just and reasonable wage or rule shall thereafter be the wage, or the rule, between the carrier and its employees and upon which either may maintain an action in the courts. There is no provision for the enforcement of the terms of the decisions, nor any penalties for their violation, except the publication provided for in Section 313, if that may be considered a penalty.

All those matters seem to me to indicate that the decisions are only advisory.

On the other hand, Section 307 (d) provides that:

"All decisions of the Labor Board * * * shall establish rates of wages and salaries and standards of working conditions which in the opinion of the Board are just and reasonable."

Nevertheless, I have reached the conclusion that it was the belief of Congress that the results desired by the legislation could be attained through the force of public opinion and that that public opinion would follow the publication made as provided in Sections 307-(c) and 313, and would support the decisions of a board, composed of men each of whom would have special knowledge of the difficulties within and the necessities of the group that he was chosen to represent. I am further of the opinion that, acting upon that belief, Congress provided in Section 307 (d) for a wide and searching investigation so that the Board would have before it all the facts necessary to enable it to reach just and reasonable decisions upon every dispute.

IV. The remaining, and of course fundamental, question in this case is whether or not the act is within the constitutional power of Congress to regulate commerce. In *Gibbon v. Ogden*, 22 U. S. 1 Chief Justice Marshal said:

"Commerce, undoubtedly, is traffic, but it is something more—it is intercourse. It describes the commercial intercourse between nations, * * * and is regulated by prescribing rules for carrying on that intercourse." (p. 188.)

After an extended discussion, the court further said (p. 195):

"We are now arrived at the inquiry—what is this power? It is the power to regulate; that is, to prescribe the rule by which commerce is to be governed. This power, like all others vested in Congress is complete in itself, may be exercised to its usual extent, and acknowledges no limitations, other than are prescribed in the constitution."

Undoubtedly some character of intercourse by transportation is involved in every completed commercial transaction. Boys trading upon the playground; people trading in the market places make and lay the way for their transactions by discussion or correspondence, but the commercial transaction must somehow, somewhere be completed by delivery. It may be the mere passage of the commodity involved in the trade from the pocket of one by hand to the hand of another, or it may be the carrying across the continent of bulky commodities involving every kind and character of handling and transporting devices and of men engaged in many kinds of employment, but whatever be the character of the transaction, whether it is great or small, the instruments, of intercourse and transportation are indispensable elements in every commercial transaction.

If the common carrier system of this country may lawfully be stopped for one hour by the carrier or by the employees, organized or unorganized, not by reason of any necessity in the business of common carrying, but because either party wills it, or through the disagreement of the parties, that it may be stopped for the same reason or for no reason at all for an indefinite period or perpetually, and the constitutional power of Congress would be as impotent and useless as a dead hand upon the ship's rudder in a storm.

In the case of *Wilson v. New,* 243 U. S. 332, the constitutionality of the Adamson Act was challenged by some of the dissenting justices upon the ground that it violated the Fifth Amendment, first, because an attempt to fix any wage is in violation of the right of private contract, and second, that the provision of the Adamson Act that only an eight-hour's service by an employee should be given for ten hours' pay was in violation of the inhibition in the Constitution against taking property without due process of law: The argument then was that the act, with due investigation on the part of Congress or under its authority as to the conditions of pay and employment by the carrying trade, wrongfully and arbitrarily gave to the employees some $600,000,000 of the carrier's money. The method that was then asserted to have been an arbitrary exercise of power is not present in this case. The act here, on the contrary, makes very careful provision, as hereinbefore shown, for the selection, of a well-qualified board, prescribes a wide field of investigation and a careful consideration of every element involved, to the end that conclusions may and shall be reached by the Labor Board which shall be just and reasonable

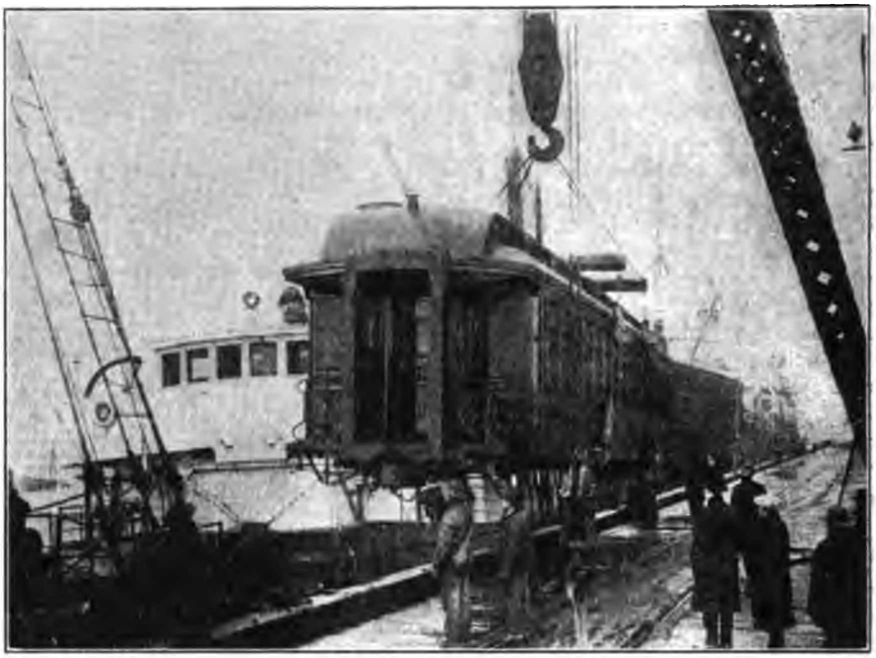
There is, and can be, no conflict between the Fifth Amendment and the commerce regulation clause of the Constitution because whenever men and property enter into and become a part of an interstate common carrier system, they so far lose their private character that they become wholly subject to all reasonable regulatory measures prescribed by Congress. Motion to dismiss is denied.

Judge Page's decision seriously affects the members of the Labor Board, but they refuse commenting on it until they have had a full opportunity to carefully scrutinize the opinion. It is currently reported, however, that an appeal will be taken to the United States Supreme Court, but naturally the Attorney General will first act as advisor in the matter on the various important points involved.

Shipping Railroad Cars to Alaska

The accompanying illustration shows a 125-ton crane on one of Seattle's half-mile long docks lifting a railroad car onto a ship to be transported to Alaska to become a part of the equipment for the new Government railroad there, which has just been opened between Seward on the ocean and Fairbanks in the interior. All railroad construction material and supplies for this project, which cost $56,000,000, were moved from Seattle.

The Alaska railroad is now completed, and traffic is maintained over the entire line from Seward to Fairbanks, a distance of 471 miles. Seward is an ice-free port. Branches bring the total mileage to nearly 600 miles. An extensive territory rich in mining and farming is being opened up. Seward coal fields containing vast areas of high-grade bituminous coal is looked forward to be a great acquisition to the Pacific coast, which, as is well known, is lacking coal. Extensive lignite fields also will supply the interior country with fuel for industrial and domestic purposes, displacing wood, which has been rapidly disappearing from around the more settled districts. The opening of the completed railroad by President Harding, accompanied by other high officials, will call marked attention to this notable achievement in railroading, that will be of incalculable benefit to Alaska, and, doubtless, will induce a large influx of new settlers.



SHIPPING RAILROAD CARS TO ALASKA.

What Work Railroads Did in the Year 1921

In 1921 the Class 1 steam railroads carried 1,691,617,051 tons of freight, according to a report issued by the Interstate Commerce Commission. Of this amount 222,722,672 tons were made up of agricultural products, 878,645,798 tons of mining products, 333,150,182 tons of manufactured and miscellaneous articles, 148,138,456 of lumber products, 41,794,508 of animals and their products, and 67,165,435 of general merchandise.

The total tonnage carried as compared with the figures of 1920 showed an average decrease of about 25 per cent., but the haulage of agricultural products showed an increase of 1.2 per cent.

The total number of carloads of revenue freight carried was 49,834,619. Of this number 25,733,740 were carried in Eastern territory, 1,668,177 in the Pocahontas region, 6,449,406 in the Southern district, and 15,983,296 in Western territory.

Electrification of Chicago Terminals

Stockholders of the Illinois Central Railroad have voted their approval of a plan to issue $50,000,000 in preferred stock to finance electrification of Chicago terminals. Members of the board of directors predicted that work will start in ninety days.

The electrification project marks the first step in a program outlined by the road and city officials to give Chicago the greatest water front in America. Under the contract the road will spend more than $80,000,000. It will receive in return riparian rights and title to made land along the shore. On adjoining land, the park board will erect a harbor, nine bathing beaches and motor-boat courses.

The operations will give employment to a large number of skilled as well as unskilled labor, of which there is still a considerable amount in Chicago.

Notes on Domestic Railroads

Radio Tests on the Lackawanna

A series of tests with a view to determine whether a swiftly moving train could be kept in touch with wireless stations were made last month on the Delaware, Lackawanna & Western Railroad. The tests were made under the supervision of David W. Richardson of Princeton University, and a car was equipped with three 4½ inch, 6-wire cages, one on each side and one in the center. A 15-watt phone set was installed and a detector two-step amplifier, in conjunction with a regenerative set. Conversations were kept up all the way from Jersey City, N. J., to Scranton, Pa. In the Bergen tunnel, nearly a mile long, local stations and even ships were distinctly heard. As an emergency means of communication the future is full of possibilities.

New Shops and Other Accessories in the West

Construction work is reported to have been begun on an extensive shop plant for locomotive and rolling stock repairs and renewals at Denver, Colo., to accommodate the Western lines of the Chicago, Burlingthon & Quincy and also that of the Colorado & Southern. The buildings and new equipment involve an expenditure of over $2,000,000. The Peninsular Railway has on the way a new machine and repair shop to be erected at Shelton, Wash., which, including machinery, will cost about $100,000. The Chicago, Milwaukee & St. Paul has also extensive plans for shop extensions and new equipment, which, together with the relaying of the main line between Seattle and Tacoma, Wash., will cost about $10,000,000. To these may be added $400,000 for the erection of an ice manufacturing and loading plant for the Southern Pacific Company at Bakersfield, Cal. A contract for the erection of a hospital building for the St. Louis-San Francisco, at Springfield, Mo., costing $800,000; and the construction of a 450-ton mechanical coaling station and ash handling apparatus for the Chicago & Northwestern, to be erected at Chicago avenue, Chicago, at a cost of $100,000.

The American Locomotive Company's Busy Week

In addition to orders for new locomotives ordered during April, some of which are noticed elsewhere, the last week in April equaled the best for several years. No less than 99 locomotives were ordered in one week. This is said to be more than the total of all orders placed in the United States during the first three months of the present year. The orders were as follows:

Camp Manufacturing Company, one prairie type locomotive; Norton Griffith & Co., five four-wheel tank locomotives and three Mikado type locomotives; Tennessee Coal, Iron and Railroad Company, two consolidation type locomotives, one six-wheel switching locomotive and one six-coupled double-ender locomotive; Mobile & Ohio, ten Mikado type locomotives; Alabama Great Southern, ten Mikado type locomotives; Cincinnati, New Orleans & Texas Pacific, ten Mikado type locomotives; New York Central, 35 eight-wheel switching locomotives; New York, New Haven & Hartford, 15 eight-wheel switching locomotives; Long Island, six eight-wheel switching locomotives.

Increase of Orders for Locomotives

The demand for new locomotives is increasing. Among others the Baldwin Locomotive Works is reported to have received orders for 25 consolidation locomotives for the Philadelphia & Reading, 12 saddle tank, 4-wheeled switcher locomotives for shipments to Brazil, and 2 of the same type for the International Paper Company. The Lima Locomotive Works has received an order for 40 switching locomotives from the New York Central, and the American Locomotive Company has received an order for 35 locomotives of the same type for the New York Central. The Mobile & Ohio has ordered 30 locomotives, the Denver & Rio Grande, 10 locomotives, and the Tennessee Central, 8 locomotives, from the American Locomotive Company. A large number of inquiries have been made by other railroads and the prospects are that the locomotive builders will soon be at their full running capacity.

Orders for Cars

The Chicago & North Western are canvassing bids for 2,750 freight cars, 1,250—40-ton, single-sheathed steel underframe box cars; 500—40-ton steel under and underframe stock cars; 250—40-ton steel underframe and wood floor flat cars; 250—40-ton steel underframe and wood upper structure refrigerator cars, and 250—50 ton steel underframe and composite body gondola cars.

Operations on the New Haven

President E. J. Pearson reports that for the month of March the New Haven operated at a ratio of about 77.74 in comparison with a ratio of 95.37 during the same month a year ago. The net income after all expenses, rentals, and charges is estimated at about $72,000, compared to a deficit during the same month a year ago of $1,600,221. The volume of freight showed an increase. While the expenditures for maintenance were not as much as they would normally have been, nevertheless they are in proportion to similar expenditures for the preceding year, so that the comparison of operating ratios indicates better results during recent months.

March Railroad Returns

All of the important railroad companies, whose March earnings reports have been made showed marked increases in net operating income over the corresponding month of 1921. The total net is when the reports are completed or expected to approximate the month's proportion of the 6 per cent investment intended under the transportation act. In February, 1922, the net rate of return was reported to be equal to 4.57 per cent. Among those showing the largest amounts of increase the Pennsylvania System showed an increase in gross of $2,569,510, while net operating income was up $8,757,958. The Illinois Central increased its gross earnings by $818,263 and net by $524,346. Northern Pacific had an increase of $589,-643 in gross and a gain in net of $899,060. Great Northern did even better, with an increase of $8,757,958. Chicago, Milwaukee & St. Paul reported a net operating income of $1,055,922 an increase of $1,232,087.

New Freight Equipment for the Northern Pacific

Prospects for development and prosperity in the Northwest are so good that the Northern Pacific has increased its order for new freight cars, according to announcement by President Charles Donnelly. Early in the year the Northern Pacific ordered 1,000 refrigerator cars. Now an additional investment of $3,250,000 in improved freight equipment has been authorized to include 1,000 box cars, 250 convertible work and coal cars, 250 steel coal cars, 250 stock cars and 70 passenger train refrigerator cars. The supplementary order for 1,820 cars is placed in conformity with the Northern Pacific policy to aid the revival of production and business activity generally by such enlargements of facilities as are possible.

That "Guarantee"

Ever since the Transportation Act went into effect a great deal has been said about the railroads getting a "guarantee" of 6 percent return on the value of the properties. Facts are now available which show how utterly without foundation was all this talk about a "guarantee."

The railroads of the United States earned in 1921 a return of 3.31 percent. They did not earn 6 percent and, therefore, they did not get it. If the railroads are allowed a fair chance it is expected that they will soon get it.

Notes on Foreign Railways

Another Railway Extension in Mexico

The manager of the Mexican railway has announced the purchase by his company of the Fachnea and Zimapan line, which is partly constructed but delayed in completion by internal disturbances and by the death of the original concessionaire. Already 83 kilometers have been built, leading northwest across the State of Hidalgo to Immiquilpan. The proposed line is to pass through Zimapan, Jacala, Hidalgo, Tamazunchale, San-Louis Potosi, and Panuco in Vera Cruz. The road is to be of standard gauge and completed in four years, proceeding at the rate of 70 kilometers a year. The line will open up a rich and fertile region, it is stated.

South African Railway Deficit

Operating expenses for the fiscal year 1921-22 show a deficit of about £3,855,000, including £2,598,000 carried over from last year in spite of the many economies practiced. Many employes have been discharged and but few improvements have been made out of the operating receipts. However, extensive improvements are to be made on the Government railways within the next year or two, but these will be financed by loans. The purchase of additional rolling stock, construction of new branch lines, and the electrification of about 174 miles of main line between Johannesburg and Durban are the principal features of the program.

Better Regulations and Increase of Equipment in Poland

The Ministry of Railways in Poland announce that the Government would assume full liability for internal shipments. Heretofore foreign shippers had to provide insurance to the point of destination. An increase of about 12,000 cars was recently added. Most of these were from the German lines in compliance with the treaty of Versailles. The number of cars out of order has increased considerably while over 1,500 locomotives are also out of service, the new repair shops not yet being in full working order.

Investigation of the Irish Railways

As a result of the conference held between the Ministers of Labor of the Irish Provisional Government and the Northern Parliament, the railway managers and the representatives of the railway men's unions, an agreement was reached to set up a Government commission to inquire into the entire working of the Irish railways. Finances, consolidation of the railways, wages, conditions of service, and steps looking toward the building and repair of rolling stock in Ireland will be considered.

The main features of the settlement so far arrived at are: An 8-hour guaranteed day and a 48-hour guaranteed week; an increase in pay of 4 shillings a week to all employes whose pay was reduced on January 1, 1922; a reduction in pay of 2 shillings a week on May 1, 1922, and no further reductions within six months from February 15, 1922; reductions in pay for night and Sunday duty; rates of pay prescribed for women clerks.

Electrification of the London Under-Ground Railways

Late developments of the project for certain extensions and improvements of the London Underground Railways show that the Trade Facilities Committee of the Government has reported favorably on the plans which have been proposed and has recommended that the Government guarantee the principal and interest upon a sum not exceeding £5,000,000 for this work. Press comments state that there is every reason to believe that the recommendation of this committee will be accepted and that the guarantee will be given. A survey of the situation is being made by representative at London of the Bureau of Foreign and Domestic Commerce and further details relative to the commencement of this work are expected soon.

Proposed Railway to Mecca

Pilgrimages to Mecca on foot will soon be a fading memory, the camel may also remain in the shadow. A group of wealthy Arabs is reported to have organized recently in order to undertake an extension of the railroad from Medina to Mecca—a distance of about 375 miles. This extension would give Mecca rail connection with Damascus and Aleppo, Syria, and thence with Scutari on the Bosphorus, opposite Constantinople.

Specifications of Belgian Rolling Stock

The Transportation Division has received from Commercial Attaché Samuel H. Cross, at Brussels, prints and specifications of the locomotives and cars in use on the Belgian State railways. These are now available for use of American locomotive and car builders and other interested parties, and may be obtained from the Transportation Division of the Bureau of Foreign and Domestic Commerce by referring to Exhibit No. 1342.

New British Type of Freight Car

A new type of freight car has been built by the North Eastern Railway of England in its own shops at York. This car, capable of carrying loads up to and including seventy tons, either concentrated or in the center of the car or distributed over the well, was designed primarily to convey electric stators for turbo-alternators from Tyneside so that they may leave the builders' works complete with turbines in position, thus eliminating the necessity for shipping the stators in parts and reerecting them at destination.

Rolling Stock in Austria

About the end of last year there were 2,365 locomotives, 6,700 passenger cars and 41,000 freight cars in the possession of the State and private railways of the Austrian Republic. It is reported that only 119 locomotives and 2,151 cars have been purchased or constructed for service in Austria since the war.

Railway Electrification in Southern Sweden

Plans are being made to electrify a number of the private railroads in Scania, a province of southern Sweden. Concessions have been requested from the Government to enable the companies to commence operations as soon as the plans have been fully consummated. It is uncertain when these companies will commence the work of electrification.

Motor Cars Proposed for Norwegian Railways

An American car distributor at Christiana has already discussed the project of supplying motor cars to replace steam locomotives on the lines of lesser importance and on all branch lines throughout Norway. It is estimated that operating expenses can thus be reduced from $36 for locomotives to $23 for automobiles on a 125 mile run. The railway officials base their estimate on an 11-ton 80-horsepower car.

Oil-Burning Locomotives in Argentina

It is reported that oil burners will be installed on the locomotives of the Argentine State railways. The oil storage tanks in Santa Fe for the State lines have been completed, and the ministry of Agriculture has issued a decree that the petroleum from the fireal workings at Comodero Rivadavia will be sold to the State railways for 27 pesos per ton delivered in the port of Santa Fe.

The Central Norte Argentino State railway serving the north of the Republic consumes at the present time nearly a million tons of quebracho wood annually for locomotive fuel, at a cost of 12 pesos per ton. It is nearly a million tons of quebracho wood annually for locomotive fuel, at a cost of 12 pesos per ton. It is estimated that a ton of petroleum will equal 4 tons of quebracho, and the use of oil-burning locomotives is expected to effect a large economy and to conserve the lumber resources of the country. Petroleum will be resold by the railways to the public among the lines.

Items of Personal Interest

J. S. Brever has been appointed master mechanic of the New Orleans & Northwestern, with headquarters at Meridian, Miss., succeeding C. L. Bunch.

William S. Wollner, general safety agent of the Northwestern Pacific, has been elected vice-president of the Society of Safety Engineers of California.

G. Fred Collins has been appointed sales representative of the Gould Coupler Company in the Chicago territory, with headquarters in the Rookery Building, Chicago.

R. M. Nelson has been appointed purchasing agent of the Chesapeake & Ohio, and A. W. Ibix has been appointed assistant to the director of purchases and stores.

W. C. Bower has been appointed assistant manager of purchases and stores of the New York Central Lines. Coincidently the title of general purchasing agent of the New York Central and the Pittsburgh & Lake Erie has been abolished.

C. C. Kyle, acting general storekeeper of the Northern Pacific, with headquarters at St. Paul, Minn., has been appointed general storekeeper with the same headquarters, succeeding O. C. Wakefield, deceased.

President Harding in the first week in April sent the names of G. W. W. Hanger, J. H. Elliott and A. O. Wharton for reappointment as members of the Railroad Labor Board for a renewal of their term of office which expired on April 15.

M. J. McGraw has been appointed superintendent of motive power and cars of the Wheeling & Lake Erie, with headquarters at Brewster, Ohio, succeeding J. F. Hill, who has been appointed assistant superintendent of motive power and cars.

Harry T. Bentley, superintendent of motive power and machinery of the Chicago & Northwestern, has been promoted to general superintendent of motive power and machinery, with headquarters at Chicago, succeeding Robert Quayle, retired.

Eldred Byron Hall, principal assistant superintendent of motive power and machinery of the Chicago & Northwestern, with headquarters at Chicago, has been promoted to superintendent of motive power and machinery, with the same headquarters.

U. W. Perkins has been appointed general manager of the Georgia & Florida, with headquarters at Augusta, Ga., succeeding D. F. Kirkland, who resigned the position of general manager to become director of development of the railway with offices at Augusta, Ga.

J. P. Pruette, assistant to the supervisor of electrical appliances, New York Central lines west of Buffalo, has been appointed supervisor of electrical appliances, with headquarters at Cleveland, Ohio. Mr. Pruette has been in the employ of the Central lines over 30 years and is an acknowledged authority on electric car lighting and other electric appliances.

E. C. Blanchard, general manager of the Northern Pacific lines, west of Paradise, having been elected to serve on the train service board of adjustment for the Western Region, with offices in Chicago. A. V. Brown has been appointed acting general manager, lines west of Paradise, with headquarters at Seattle, and W. C. Showalter, superintendent.

L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul, has arranged with a number of leading educational institutions of the country to have a series of lectures delivered by technically trained members of his staff on the subject of electrification. The lectures will be free to all, and illustrated with lantern slides and moving pictures.

Barton Steveson, manager of the Power and Railway divisions of the Pittsburgh office of the Westinghouse Electric & Manufacturing Company, will, on account of the separation of the two important and rapidly expanding divisions, continue as manager of the Power Division and will devote his entire time to activities in connection with that unit, and F. G. Hickling has been appointed manager of the Railway Division. The separation of the two divisions under different heads will facilitate the handling of both power and railway business.

Robert Quayle, general superintendent of motive power and machinery of the Chicago & Northwestern, with headquarters in Chicago, has retired from active duties on May 1. Mr. Quayle entered the service of the company in 1871, and served a regular apprenticeship as a machinist, and served as journeyman, gang boss and foreman, reaching the position of master mechanic in 1885. In 1894 he was appointed superintendent of motive power and machinery, and in 1913 was appointed general superintendent of motive power and car departments, which title was latterly changed to that of superintendent of motive power and machinery.

OBITUARY

John Wynn

John Wynn, assistant to the general manager of the Northern Pacific, died on March 9. He was 57 years of age, and had been 33 years in the service of the company. As fireman, locomotive engineer, road foreman of engineers and trainmaster, he had a wide and varied experience, and was a fine example of the best [...] had occupied the position of assistant to the general manager for several years. He had the rare double merit of an amazing capacity for work, coupled with the fine faculty of developing good men out of commonplace material. He also found time to contribute articles to the engineering press.

John Carstensen

John Carstensen, vice-president of the New York Central Lines, died at Scarsdale, N. Y., on April 14, in the 68th year of his age. He was over fifty years in the service of the railroad company and was an eminent authority on finance, serving as assistant treasurer and comptroller, and latterly elected vice-president of the New York Central system and also director on a number of subsidiary companies.

George L. Davis

George L. Davis, president of the Idaho Central Railroad, and widely known as a railroad builder, particularly in the west and northwest, was found dead in the Pacific Ocean near Mussel Rock, San Mateo County, near San Francisco. His last important work was the construction of the Pacific Railway & Navigation Company, connecting Portland and Tillamook City, Ore.

Railway Executive Committee

Ralph Budd, president of the Great Northern, and W. G. Besler, president of the Central Railroad of New Jersey, were elected members of the Standing Committee of the Association of Railway Executives, at the meeting of the Railway Executives held last month.

NEW PUBLICATIONS

Bulletins, Pamphlets, Catalogues, Etc.

A report received by the Weather Bureau of the United States Department of Agriculture from one of the large railroad systems of the West shows that the rainfall charts prepared by the Bureau save this railroad considerable expenditure.

During the war this road was unable to get creosote and had to substitute zinc chloride as a preservative for ties. The zinc salt is a satisfactory preservative in dry climates, but where the rainfall is heavy it leaches out. When the war ended this company had on hand 2,500,000 ties that had been given the zinc treatment. Instead of re-treating them with creosote the engineers secured a Weather Bureau chart and transferred the lines of average precipitation to a map of the system. Then they distributed the zinc-treated ties for use on those parts of the road in rela-

New York Central Lines

An Industrial Directory and Shippers' Guide, published by the New York Central Lines, is a notable illustration of railroad enterprise unique in the element of thoroughness. The work extending to nearly 1,000 pages describes every large manufacturing establishment along its extensive lines, and classifies altogether over 50,000 concerns with information for buyers and shippers. There are 20 specially-drawn maps, one 20 by 28 inches, showing in color the entire New York Central system, and others charting the existing railroad terminal facilities of the larger cities. There are also over 400 half-tone illustrations. The book gives an array of facts and figures of real service to business by the 13,000 miles of New York Central lines which pass through 12 States and two of the busiest Provinces of Canada.

The names of the presidents and secretaries of the commercial and business organizations and number of members as well as all banking institutions located on the New York Central system, are alphabetically listed. Every station on the lines is listed, with its connections, and the names of officers in charge at all points. In brief, it is the most complete publication of its kind that has come to our hands. The book may be examined at our office, and requests for copies may be sent direct to the Publicity Department, New York Central Lines, Grand Central Terminal, New York.

Pulverized Fuel

A book, entitled Lopulco Pulverized Fuel System, has been published by the Combustion Engineering Corporation, New York. In addition to an interesting description of experimental work on applying pulverized coal to locomotives it contains detailed results of a number of tests that show the advantages of this method of firing locomotives.

Railroad Accident Casualties

From reports furnished by the Interstate Commerce Commission it appears that an important reduction in the number of fatalities and injuries from steam railroad accidents in 1921 has been made. The total number of persons killed was 5,587, as compared with 6,495 in 1920, or 14 per cent reduction. The number injured in 1921 was 43,324, a reduction of 32.1 per cent, as compared with 1920. These reductions represent, to some extent, the falling off of traffic, and are the lowest in number recorded during the present century. The only increase shown in the commission's report were in the number of trespassers killed and injured. Of the 5,587 persons killed in train and train service accidents 2,481 were trespassers, an increase of 14.5 per cent over 1920; and of the 43,234 injured, 3,071 were trespassers, an increase of 29.7 per cent. Of the 3,106 non-trespassers killed, only 205 were passengers; 658 were trainmen, 438 were other employes, and 1,805 were other persons.

Westinghouse Electrification Data

A new publication just produced by the Westinghouse Electric & Manufacturing Company is Westinghouse Electrification Data, Vol. III, No. 2. In this issue the foreword points out that electrification of railroads is conservation, not only of material things, but also of human energy. This is followed by an abstract of a letter on Standards for Railroad Electrification addressed by George Gibbs to the Electrification of Railways Advisory Committee in England. This letter indicates that power should be developed at 25 cycles and the use of both alternating and direct current on the trolley continued. Existing railroad electrification is excellently described and illustrated. This includes the Hoosac tunnel, the Chicago, Milwaukee & St. Paul Railway, the Norfolk & Western Railway, the Pennsylvania Railroad, besides that of South American and other foreign countries.

Simplex Jacks

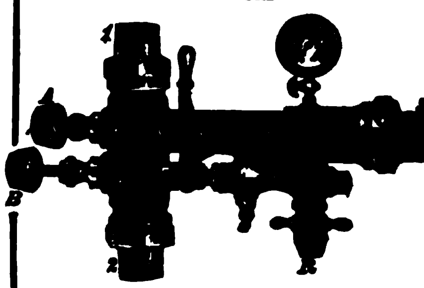
An elegant 24-page pamphlet, Form No. 22, canceling all former lists, has been issued by Templeton, Kenly & Co., 1020 South Central avenue, Chicago, Ill. The principles that govern the capacities of jacks, the adaptation of trunnions, the bridge, universal, emergency, car, track and ballast, and other standardized jacks manufactured by the company are fully described and finely illustrated. There are about 40 illustrations and drawings showing with an uncommon degree of clearness all the details of the latest improved mechanism of the Simplex jacks which are the result of 23 years of concentrated engineering effort towards perfection encouraged by great popular approval, particularly in railroad service. Copies of the pamphlet may be had on application to the company's main office, or at No. 2 Rector street, New York, or other offices.

Traveling Hazards

Railway men are well aware that the traveling public are seemingly often indifferent to safety, and a report from the New York, New Haven & Hartford railroad company, shows of the 229 fatalities occurring in railway passenger travel during the year 1920, about two-thirds were cases in which the individual himself was in some way involved in the chain of circumstances. For example, 28 persons were killed by falling from coach steps, 18 by falling from moving trains, 64 by being struck or run over, and 10 met their death by deliberately jumping from trains while mentally deranged.

Lectures on the Locomotive

The sixth edition of Lectures on the Locomotive, by the late Dugald Drummond, has been issued by the Locomotive Publishing Company, 3 Amen Corner, Paternoster Row, London, England. The work has already met with much popular favor among enginemen and firemen in Britain and elsewhere. The volume extends to 240 pages and is finely illustrated. The lectures were originally delivered before the members of the leading railway institutions in England, and the proceeds from the sale of the published lectures are devoted to the London & South Western Railway Servants' Orphanage.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV | 114 Liberty Street, New York, June, 1922 | No. 6

Fifty Heavy 2-10-2 Type Locomotives for the Southern Pacific Lines

Notable Audience Witnesses Movement of "Prosperity Special" from Builders Details of the Design of the Engines

It will be of surpassing interest to the public generally and to railroad men particularly to observe that the greatest train of locomotives that the world has ever seen is now being moved across the continent. Fifty locomotives of the 2-10-2 type are completed at the Eddystone plant of the Baldwin Locomotive Works for the Southern Pacific Lines, and twenty of the number are already more than half way on their journey in one train, and the others will follow in rapid succession. This train is nearly half a mile in length without the pushing and pulling locomotives. The movement of the train has been arranged by the Pennsylvania Railroad, and each locomotive is manned by an experienced engineer of the Baldwin Locomotive Works. Our frontispiece illustration shows a view of the entire fifty locomotives, and while there were during the war period many remarkable groups of locomotives to be seen at Baldwin's and elsewhere, this amazing group, a single section of which is the most valuable ever moved in the country as a single unit, and is the most memorable group of its kind in the history of the Baldwin Works.

It is also interesting to recall that the first Baldwin locomotives of the 2-10-2 type built for the Southern Pacific were constructed in 1917 and were designated as Class F-1. These locomotives weigh 348,000 pounds and develop a tractive force of 65,300 pounds, and have been successfully used not only in heavy freight service but also in passenger service on grades exceeding 2 per cent. They were followed, in 1921, by a group of larger locomotives, known as Class F-3, having a total weight of 385,900 pounds and developing a tractive force of 75,150 pounds. The new locomotives (Class F-4) are generally similar to Class F-3, the most important changes being the addition of a feed-water heater and booster. All the locomotives referred to above burn oil for fuel, and are equipped with superheaters.

The boiler used on Class F-4 is of the straight-top type, with a slope on the bottom of the middle ring in order to provide a sufficiently deep water space under the combustion chamber. This increases the shell diameter from 90 inches at the first ring to 100 inches at the throat. On the second ring, which carries the dome, the longitudinal seam is placed on the top center line and is welded throughout its length, in addition to being reinforced by inside and outside welt-strips. The inside strip is wide enough to cover the entire area under the dome base. The auxiliary dome is on the third ring immediately ahead of the combustion chamber, and is placed over a 15-inch man-hole, so that the boiler can be easily entered for

FIFTY 2-10-2 TYPE LOCOMOTIVES FOR THE SOUTHERN PACIFIC LINES ASSEMBLED AND READY FOR DELIVERY AT THE BALDWIN LOCOMOTIVE WORKS

inspection purposes or other operations.

The combustion chamber is 64" long and has a complete installation of flexible bolts in the water space, while four rows of such bolts stay the front end of the crown. The throat is also stayed by flexible bolts, and they are used in the breakage zones in the sides and back. Two fusible plugs are applied, one at the front end of the crown and the other over the outlet of the oil-burner. The oil-burning equipment is arranged in accordance with Southern Pacific standards.

The feed-water is supplied by one Nathan non-lifting injector, placed on the right-hand side, and one Worthington combined feed-water heater and pump of 7,200 gallons capacity per hour, placed on the left side. The pump is supplied by a steam pipe leading frcm a valve in the turret. With the heater and pump, and an air drum, located on the left-hand side, it has been necessary to place the two cross-compound air compressors on the right-hand side. These are low down, under the running board, so that they do not obstruct the engineer's vision when looking ahead.

With limited space available, special attention had to be given the arrangement of the piping in order to render it accessible and at the same time not exceed the limit of width. On the left side, the feed-water heater requires a 4-inch feed-pipe, which is placed under the running board and above one of the air-drums. The latter is hung on cast steel supports, which are specially designed to provide room for the feed-pipe. On the right-hand side there is no room to place the 4-inch booster exhaust pipe outside the frames, and it is therefore placed between them. This pipe enters the smoke-box and discharges into an annular opening surrounding the main exhaust nozzle.

SAMUEL M. VAUCLAIN, PRESIDENT OF THE BALDWIN LOCOMOTIVE WORKS, ADDRESSING THE DISTINGUISHED AUDIENCE GATHERED TO WITNESS THE START OF THE SOUTHERN PACIFIC'S "PROSPERITY SPECIAL" ON ITS TRANSCONTINENTAL JOURNEY

The cylinders are fitted with cast iron bushings, and the pistons have cast steel heads and cast iron bull-rings. The piston rods, main crank pins and driving axles, are heat treated and hollow bored. Flanged tires are used on all the wheels, notwithstanding the fact that the locomotives are designed to traverse 20 degree curves. The lateral play between rails and flanges on the first, third and fifth pairs of drivers is ⅞", and on the second and fourth pairs, and the truck wheels, ⅝". There is, in addition, a lateral play between wheel hubs and boxes (including shoe and wedge play) of 1 13/16" on the front drivers, and 5/16" on the remaining pairs. Long main driving boxes are applied, the journals measuring 13" by 22"; while the lateral motion boxes on the first driving axle have journals 11" by 20".

The rear truck is of the Delta type, and is equalized with the three rear pairs of driving wheels. In this design the back equalizing beams are fulcrumed on the truck frame, and the main frames are supported on the truck center pin and also on two sliding supports placed wide apart back of the truck wheels. The load on the center pin is transferred through a spherical bearing. The booster is supported on the rear transverse member of the truck frame, which is depressed sufficiently to provide the necessary clearance.

The piston valves are 15" in diameter, and are set with a maximum travel of 7" and a constant lead of ¼". Walschaerts valve gear is applied and is controlled by the Ragonnet power reverse mechanism.

The main frames are of massive construction, with a uniform width of 6" and a maximum depth under the cylinder saddle of 14". The Commonwealth rear frame cradle is applied.

A comparatively short cab is used, but it has large window openings in the sides, and special attention has been given the arrangement of the fittings. The steam turret is placed outside the cab, and the various valves have extension handles which are clearly labeled. The lubricator has seven feeds, including those to the water pump and the booster engine.

The maximum width over the cab boards is 10'—10", and the overall height of the locomotive is 16'—4".

The tender is notable, both because of its design and capacity. It is of the Vanderbilt type, carrying 4,000 gallons of oil fuel and 12,000 gallons of water. The water tank has a diameter of approximately 8'—6", and an overall length of 36' —7¾". It is carried on a Commonwealth cast steel frame, made in one piece with the bumpers and the transverse bolsters which serve as tank supports. The transverse distance over the outside edges of the two longitudinal frame members is 51", and the ends of the front and back bumpers are braced by diagonal members which join these longitudinal members at the frame truck bolsters. The trucks are of the Commonwealth design, with cast steel frames and swing bolsters. This is an equalized pedestal type of truck, fitted with both helical and triple elliptic springs. The journals are 6½" x 12". Side bearings are used on the rear truck only. The weight of the tender loaded is about 223,000 pounds.

One of these locomotives will be exhibited at the Atlantic City convention. Their general dimensions are as follows:

Gauge	4 ft. 8½ in.
Cylinders	29½ x 32 in.
Valves	Piston, 15 in. diam.

BOILER

Type	Straight top
Diameter	90 in.
Working pressure	200 lbs.
Fuel	Oil

FIREBOX

Material	Steel
Staying	Radial
Length	132 in.
Width	90 in.
Depth, front	88¾ in.
Depth, back	73 in.

TUBES

Diameter	5½ in., 2¼ in.
Number	50, 261
Length	21 ft. 0 in., 21 ft. 0 in.

HEATING SURFACE

Firebox	251 sq. ft.
Combustion chamber	130 " "
Tubes	4,722 " "
Total	5,103 " "
Superheater	1,329 " "
Grate area	82.5 " "

Driving Wheels

Diameter	63½ in.
Journals, main	13 in. x 22 in.
Journals, front	11 in. x 20 in.*
Journals, others	11 in. x 13 in.

Engine Truck Wheels

Diameter, front	33 in.
Journals	6 in. x 12 in.
Diameter, back	45½ in.
Journals	9 in. x 14 in.

2-10-2 TYPE LOCOMOTIVE FOR SOUTHERN PACIFIC LINES. BALDWIN LOCOMOTIVE WORKS, BUILDERS

Wheel Base

Driving	22 ft. 10 in.
Rigid	22 ft. 10 in.
Total engine	42 ft. 4 in.
Total engine and tender	82 ft. 7½ in.

Weight

In Working Order

On driving wheels	306,000 lbs.
On truck, front	31,500 "
On truck, back	60,500 "
Total engine	398,000 "
Total engine and tender	621,000 "

Tender

Wheels, number	8
Wheels, diameter	33 in.
Journals	6½ in. x 12 in.
Tank capacity, water	12,000 U. S. gals.
Tank capacity, oil	4,000 U. S. gals.

Tractive force	75,150 lbs.
Service	Freight

The Mason Locomotive of 1857

By J. Snowden Bell

The six locomotives, road numbers 231 to 236, that were built for passenger train service on the Baltimore & Ohio Railroad, by William Mason & Co., of Taunton, Mass., and placed on the road in August, 1857, were examples, not only of the most advanced practice at that date, but also of the handsomest and most symmetrical design that had then been produced. Imitation is the sincerest form of approval and appreciation, and the good judgment and good taste of other locomotive builders were speedily manifested by the general, if not universal, adoption of all the characteristic features of the Mason design.

Such illustrations of these locomotives as have been published were of small size, reproduced from more or less indistinct photographs, and fail to fully show either their general appearance or their details. The writer, who was thoroughly familiar with them in their service on the Baltimore & Ohio R. R., has had a drawing made, under his supervision, of engine No. 236 and tender, of which the accompanying illustration is a reproduction and he believes it to be the only drawing of the historic Mason engine of 1857, now in existence, which is absolutely correct in all its details. However unusual or uninteresting they may appear to designers of the present day, their perfection of structural features and symmetrical elegance of appearance are undeniable.

The following general dimensions may be noted, viz.: Cylinders, 16x22 inches; driving wheels, 60 inches; weight, about 24 tons (of 2240 pounds); boiler diameter, 46⅝ inches; 106 tubes, 2¼ inches diameter and 11 feet, 2½ inches long; firebox heating surface, 80.5 square feet; tube heating surface, 694.5 square feet; total heating surface, 781 square feet, grate area, 15 square feet.

It is needless to point out the general details of construction as they are clearly shown in the illustration. The type is what was long and favorably known as the American 4-4-0 type of locomotive, many of which are still in service. The valve gear is of the Stephenson or shiftink link type. The type of smoke stack is well adapted for both wood and coal burning locomotives.

PASSENGER ENGINE BUILT FOR THE BALTIMORE & OHIO R. R. BY WM. MASON & CO. IN 1857

Coal Car of 120-Tons Capacity—Norfolk & Western Ry.

Details of Construction and Design

The tendency to increased car capacity has not yet died out and it would be hazardous to predict, with the idea that a certainty is stated, as to just where the upward tendency will stop. For a number of years the Norfolk & Western Ry. has had cars of 100-tons capacity in service, and the Virginian has been using cars carrying 120 tons for some time.

The Norfolk & Western has also developed a car of 120-tons capacity and has had a sample car in service for a number of months. The performance of the car has been so satisfactory that it is probable that an order will soon be placed for its duplication on a large scale.

As will be seen from the photograph, the car is of the hopper type in which it differs from the cars of 100-tons capacity illustrated in Railway and Locomotive Engineering for June, 1921. Like that car, however, it is carried on six wheeled trucks, and though the car here illustrated is shown with the usual center plate and side bearings, it is probable that the new cars will be fitted with the four-point support after the manner of the 100-ton capacity cars already referred to.

240,000 LBS. CAPACITY COAL CAR—NORFOLK & WESTERN RY.

The general outline of the car is very clearly shown in the engraving, and it has the following general dimensions:

Length over striking plates	52 ft. 5½ in.
Coupled length	54 ft. 11 in.
Center to center of trucks	39 ft. 11 in.
Height from rail to top of car side,	11 ft. 6 in.
Height from rail to top of brake staff,	12 ft. 2 in.
Height of center of gravity, loaded,	6 ft. 10¼ in.
Inside length	51 ft. 4 in.
Inside width at center	10 ft.
Inside width at end	9 ft. 3½ in.
Capacity level full	3,800 cu. ft.
Capacity including 30° heap	4,405 cu. ft.
Capacity	237,600 lb.
Weight of empty car	77,400 lb.
Total weight loaded	315,000 lb.
Weight per foot of coupled length,	5,736 lb.
Weight of one truck	16,440 lb.

In calculating the capacity of the car the density of the coal has been taken at 53.9 lb. per cu. ft.

The drawing in of the ends so that the end width is less than that of the center, serves the double purpose of making it possible to put the ladders on the side without exceeding the center width, and of stiffening the whole frame work against end thrusts.

The axle journals are 6 in. in diameter and 11 in. long. This gives an axle load of 380 lbs. per sq. in. of projected area, with an allowance deducted from the gross weight of 15,000 lbs. for the wheels and axles. Or allowing 80 per cent of the projected area for the bearing area the weight becomes 475 lbs. per sq. in.

The framing of the car is so arranged that the load is carried in to the center sills, which also sustain all of the end thrusts. These sills are made of 12 in. channels weighing 25 lb. to the foot and they are spaced 16⅜ in. apart. Their combined sectional area is 14⅜ sq. in. The bottom of the channels is stiffened by a 4 in. by 3½ in. by ½ in. angle, and the top by a cover plate ⅜ in. thick. The combined sectional area of these three pieces is about 15⅝ sq. in., making a total sectional area of 30 sq. in. for the resistance of end thrusts.

The channels end at a distance of 2 ft. 3⅜ in. outside the center line of the body bolster, at a point about 1¼ in. inside the rear follower; while the cover plate is carried out to the back face of the end sill. The reinforcing angles at the bottom of the channels extend 14⅝ in. beyond the center of the bolster. At the bolster the sills are tied together by a steel casting (1) which also contains the center plate. This casting is riveted to the sills by three rows of ¾ in. rivets on each side and 13 rivets in a row. This casting extends 2 ft. 4⅝ in. beyond the center and forms the base for the thrust of the back follower of the draft rigging. Starting from a point ¼ in. beyond the reinforcing angle, there is a pressed steel draft sill of U section that runs to the end of the car. At the inner end this is riveted in with the center bearing casting (1) and the side sills. At the back it has a depth of 12 in. corresponding to that of the center sills, deepening to 14 in. at the end sill.

At the end another steel casting (2) is riveted to take the thrust of the outside follower. Arrangements are made with the draft sills for carrier irons for both the Miner and the Westinghouse gears, the depth of the draft sills being made to meet the requirements of the gear to be used.

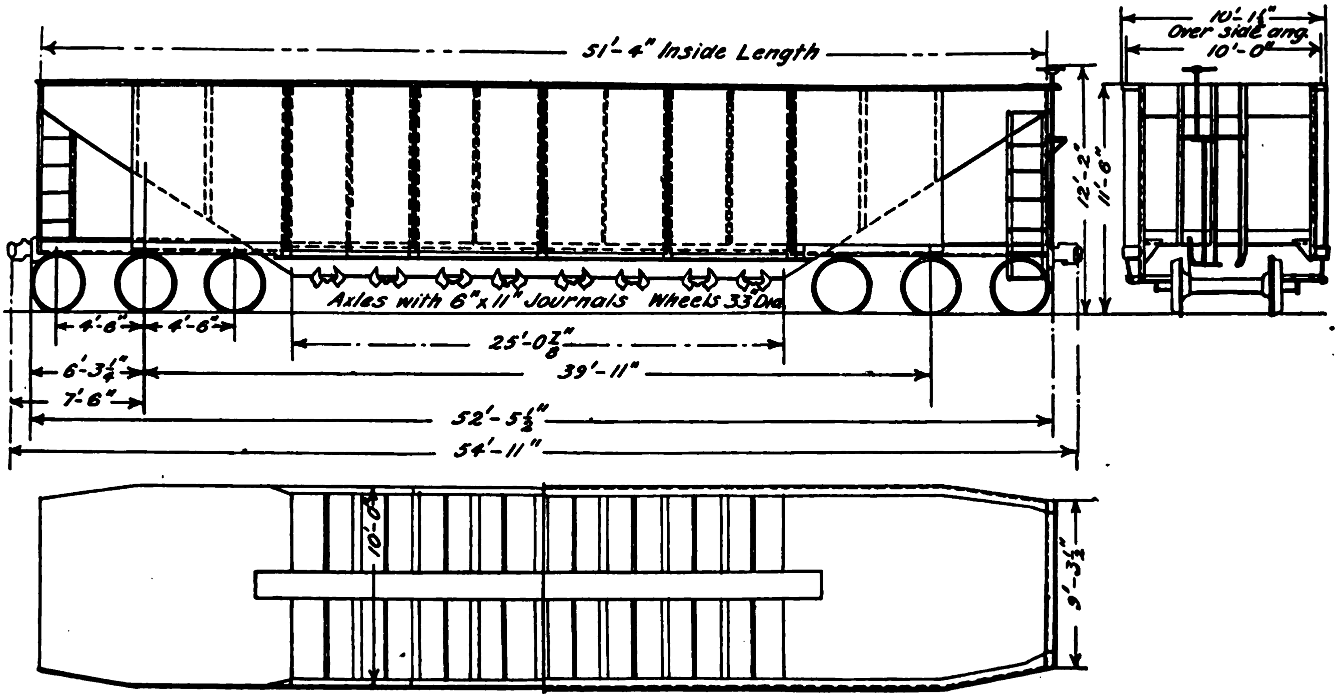
Finally there is a hard pine filler (3) outside the sills to take the direct blow of the coupler.

The side sills are very light and are formed of a 7 in. by 3½ in by ⅜ in. (5) angle with the long leg set vertically and the short one at the bottom and projecting inwardly. The outside body sheet is riveted to the inside face of this angle and extends out to the body bolster. A short floor angle (4) (3 in. by 2½ in. by 5/16 in.) is riveted inside the sheet. With this construction the side plates serve to give an ample longitudinal strength to the bolster to sustain the end thrusts that are put upon it. At the center a gusset plate (6) ¼ in. thick is riveted on top of the cover plate of the center sills. This plate extends out to a distance of 27 13/16 in. on each side of the center and has a horizontal depth along the center line of the car of 17½ in.

The vertical web of the bolster is formed of a plate 5/16 in. thick which is held between and riveted to two 5 in. by 3 in. by ⅜ in. angles at the bottom and is turned and riveted to a welt sheet on the bottom of the hopper incline at the top. In addition to this direct fastening it is also held by a pressed steel V angle, as shown in the section of the bolster at the center.

Both of the angles just referred to are riveted to the cover plate of the center sills and to a steel bracket casting (7). One of the angles extends all of the way across the car and at the sides is riveted to the bracket casting (8) by five ¾ in. rivets. The other angle extends out to a distance of 28 15/16 in.

The longitudinal stiffening of the web plate is accomplished by a series of angle and channel stakes. There are a pair of 3 in. by 3 in. by 5/16 in. angles set on either side of the web with their rivet holes 10 1/16 in. on each side of the center line of the car. Then at a distance of 13 15/16 in. outside of these there are a pair of 3 in. channels, weighing 3 lbs. per ft., set back to back on the two sides of the web. At a distance of 16¼ in. outside of the channels there is a pair of 2½ in. by 2½ in. by 5/16 in. angles. All of these are offset so as to lip over the vertical legs of the bottom angles as shown in the sectional engraving.



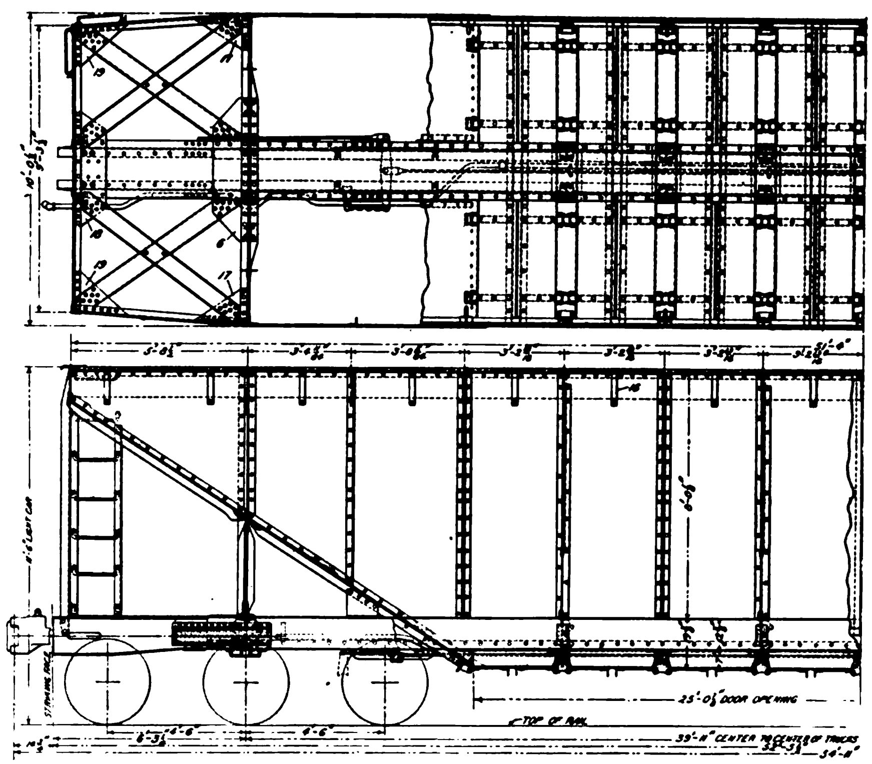
GENERAL OUTLINES, 240,000 LBS. CAPACITY COAL CAR

Finally, the tie between the vertical web of the bolster and the side sheet is accomplished by means of a 4 in. by 3 in. by ⅜ in. angle with the short leg laid against the side sheet.

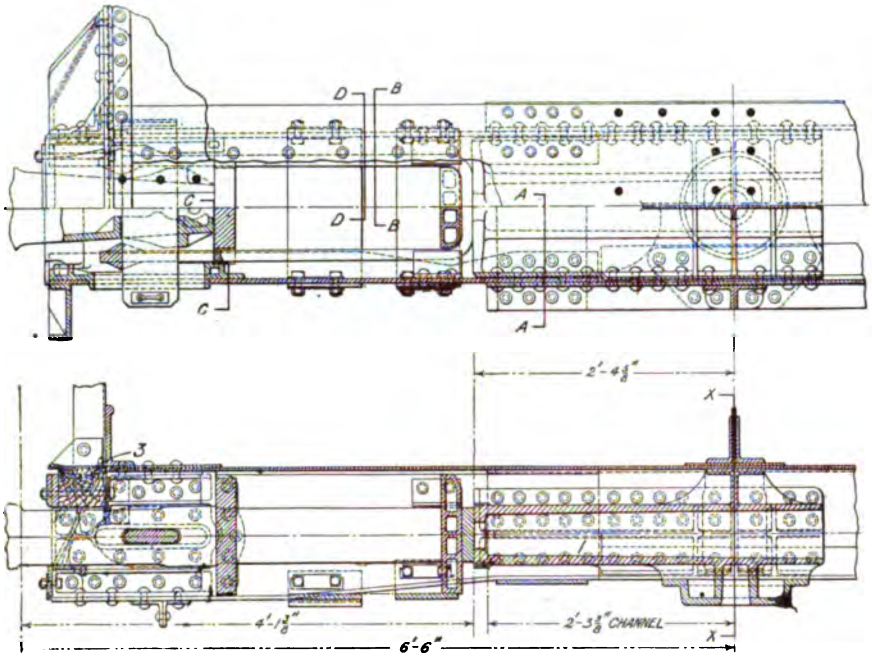
At the bottom the union of the vertical and horizontal angles, the web plate, the side plates and the angles forming the side sills is effected by the bracket casting (8). This, as will be seen from the half elevation, is riveted to all of these parts and serves to attach them firmly together.

As the car body has a depth of 8 ft. ⅛ in. above the top of the center sills and as it must be possessed of sufficient stiffness to withstand the stresses put upon it by the car-dumping machine at Lambert's Point, it is essential that the sides should be thoroughly well braced.

This is accomplished by means of four stiff plate braces and five bar cross ties. There is a bar cross tie at the center of



LONGITUDINAL SECTION & PLAN, 240,000 LBS. CAPACITY COAL CAR the car, and on each side of it at intervals of 3 ft. 2 13/16 in. the plate and bar braces are alternately spaced. The construction of the two methods of bracing is shown in the two half cross sections of the car.

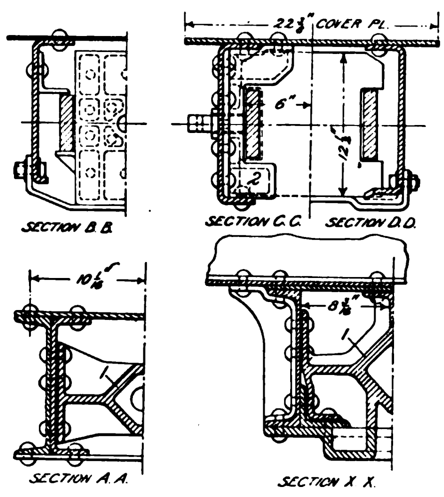


DRAFT RIGGING, 240,000 LBS. CAPACITY COAL CAR, NORFOLK & WESTERN RY.

The one at the left shows the plate bracing. This divides the car into a series of spaces each of which is emptied by its own doors.

The brace is formed as follows:

A 2½ in. by 2½ in by 5/16 in. angle (9) is riveted to the side sheet to take the end of the web sheet. This web is 5/16 in. thick and runs across the car at a height of 27 in. above the top of the center sills to a distance of 3 ft. on each side of the



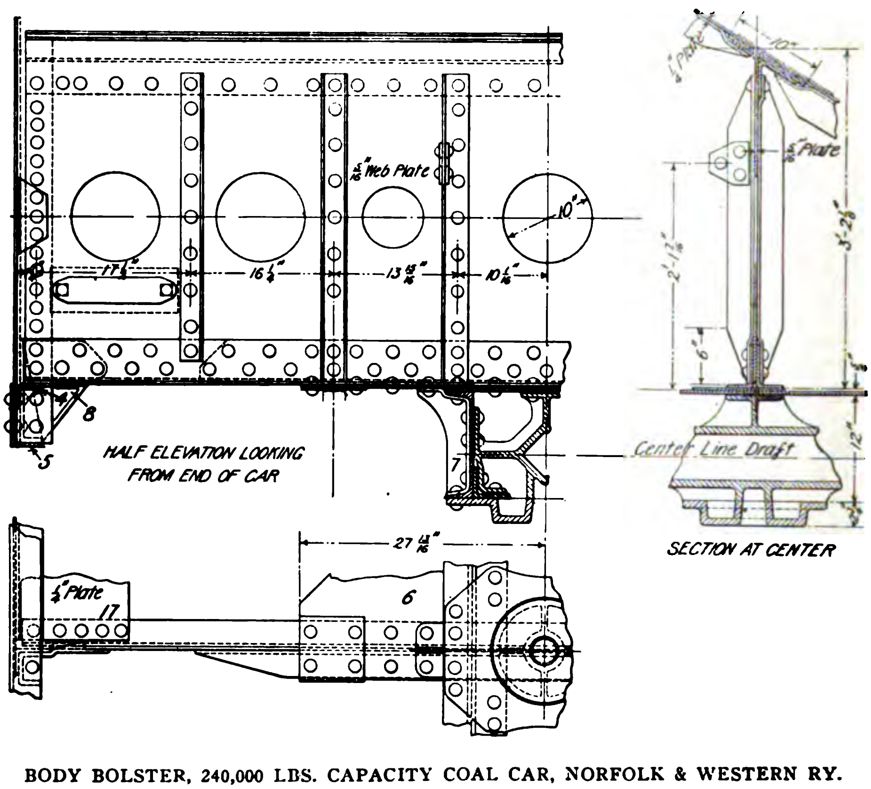
SECTIONS OF SILLS
(SEE DRAFT RIGGING)

center line. It then rises on an angle to the top of the body. The horizontal upper edge is stiffened by a 3 in. by 2 in. by 5/16 in. angle (10) 5 ft. 3¼ in. long. The sloping edge is stiffened and protected by a 2½ in. by 2½ in. by 5/16 in. angle (11) which is bent, as shown, and runs to the bottom of the web plate. This serves to stiffen it and is supplemented by a second 2 in. by 2 in. by 5/16 in. angle (12) set with its rivets 14 in. from the center line of the car. The web is held at the bottom between two angles (13), one of which extends across the car and the other has a length of 5 ft. 3¼ in. Five holes each 12 in. in diameter are cut in the plate to lighten it.

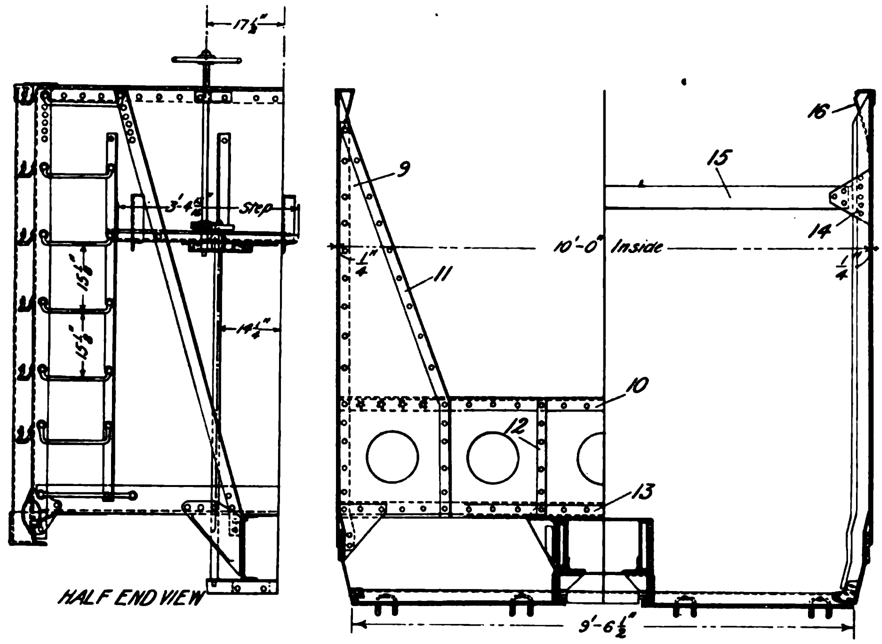
The bar brace construction is shown by the right hand section of the engraving. There is an inside stake formed of a bulb angle. To one side of its upper end the triangular plate (14) is riveted. This plate serves as a footing to which the cross tie bar (15) is riveted. This bar is of 5 in. by ½ in. steel and is set on edge. It has depth and rigidity enough to withstand the punishment that it must receive from the coal as it is dumped into the car at the tipples and also when dumped out by the car dumping machine. In this it replaces the bolts and light angles formerly used on lower capacity cars and which were notorious for the distortions to which they were subjected.

The top of the body is stiffened by a bulb angle measuring 4 in. by 3½ in. by ½ in. with the horizontal leg projecting inwardly. This horizontal leg of the angle is supported by flat steel braces (16). It forms such a stiff and effective top edge that the clamps of the dumping machine have no distorting effect upon it.

These details are shown in assembled form in the plan and longitudinal section of the car. In addition thereto, the plan shows the method of bracing the end. For the purpose of fastening the diagonal braces there are six gusset sheets. There is one at each end and one at the center of the bolster, the one at the center being the plate (6) already referred to. At the ends of the bolster there are two gusset plates (17) which are riveted to the top of the horizontal leg of one of the angles forming the base of the bolster. There are similar plates (18 and 19) at the center of the end sill and at the car corners. Diagonal channels are riveted to these



BODY BOLSTER, 240,000 LBS. CAPACITY COAL CAR, NORFOLK & WESTERN RY.



SECTION AT BRACE. SECTION AT TIE. END ELEVATION AND CROSS SECTION

plates and set back to back and riveted together where they cross as shown. These channels are 7 in. wide and weigh 12¼ lb. to the foot.

With this arrangement the poling stresses at the corners are carried directly back to the center while the center or ends of the center sills, are protected against buckling by the diagonal running to the outer end of the bolster.

Reference has been made in the August, 1920, and April, 1922, issues of Railway and Locomotive Engineering to the efficiency of copper-steel as a rust resisting metal. The proof of this quality has been so well established that it has been specified for the new coal cars of the Norfolk & Western.

The hand brake is of the geared type of very simple construction. A casting *A* is bolted to the foot board, and this casting has the bearing for the lower end of the upper brake staff and a pin for the ratchet pawl. The ratchet *B* and the pawl *C* thus occupy their usual positions. Beneath the foot board there is a plate *D* and beneath it is bolted a housing *E* for the gearing. The gearing consists of a pinion *F* working on an internal gear *G* to which it bears the ratio of 1 to 2.

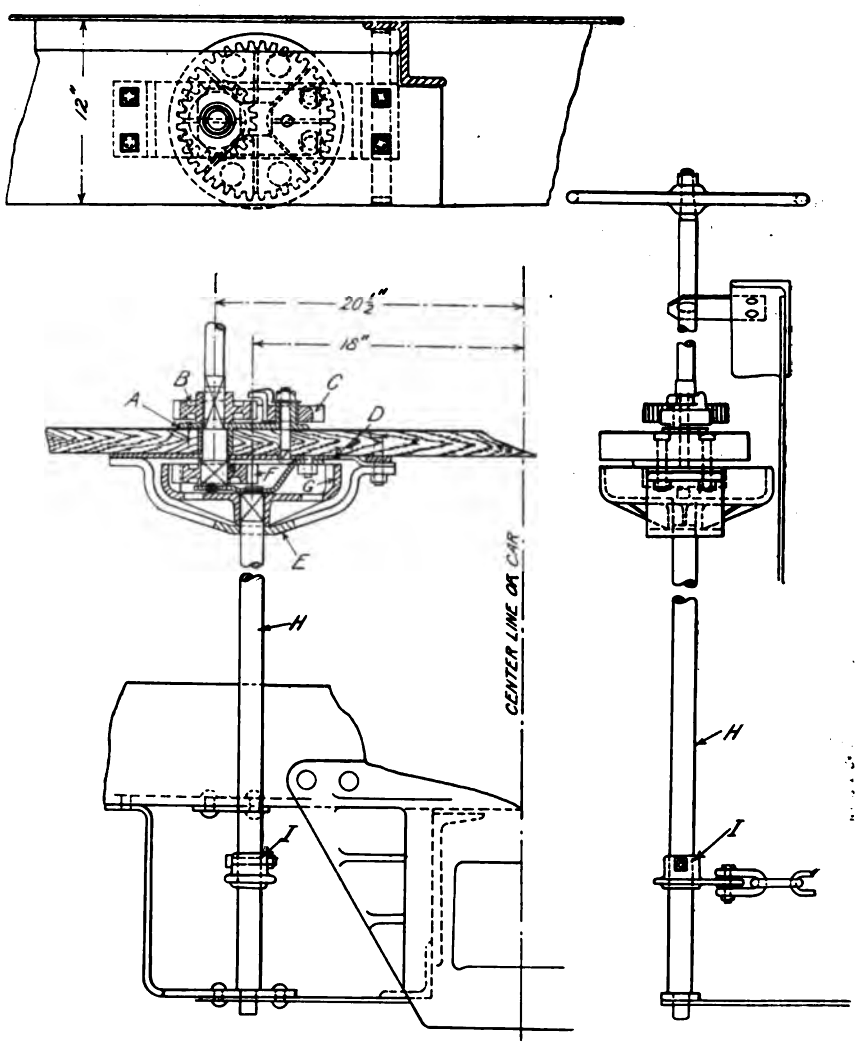
The internal gear is keyed to the lower brake staff *H,* which is carried by the usual step and to which the rapid take-up *I* for the brake chain is attached. This is merely an arm to which the brake chain is fastened, and which serves for a rapid take-up during the first half revolution of the brake staff. This arrangement of the gear and the use of 16-in. brake wheels makes it possible to exert the same brake shoe pressure without the use of a club, that is exerted by a full service application of the air brake.

The use of the geared hand brake is rather unusual on freight cars and this is a simple and efficient example of its kind well adapted for the purpose.

Loose Pulleys

Troubles occur with loose pulleys running dry, and screeching and wearing fast. Generally oil is put in the hole and it is let go at that, and if the pulley runs soon afterwards the centrifugal force prevents the oil from getting to the shaft, as it cannot gravitate down to it as in the case of an ordinary bearing. It is best to get the belt off the loose pulley, then turn it round so that the lubricator or oil-hole is uppermost; fill up with oil, and, holding the weight of the pulley up, watch the oil and see that it sinks down in the hole or lubricator, and if it will not do this something is wrong.

In such a case, the best thing to do is to slacken the collar and slide the pulley along the shaft, and it is likely that where the pulley has been running will be found to be dry. This may be due to the oil hole being stopped, but not always so, for we have seen a bearing torn badly and yet the oil-hole was full of oil. When a shaft has once got dry, a dust seems to form, and this appears to prevent the oil from adhering to the shaft. It should also be made certain that there is a proper oil channel in the pulley.



HAND BRAKE STAFF, 240,000 LBS. CAPACITY COAL CAR

Graphical Determination and Investigation of the Walschaerts Valve Gear

By S. E. Westrén-Doll, Engineer, Petrograd

Part III

According to these statements all of the dimensions for individual parts of the valve motion under consideration, can be determined by means of what has been given, as well as a study made of its method of action. The results can best be clearly shown in the plates that have been prepared, from which the various phases of the steam distribution on both sides of the piston can be observed, as well as the movement of the valve in both directions for the forward and backward motion of the engine, thus making it easy to study the action of the motion.

The determination and investigation of the Walschaerts valve gear is frequently carried on by means of a model; yet, because the provision of such a model for each type of locomotive would require much time for its preparation and be quite expensive, the work is usually done by means of the graphical method for the study and determination of the gear. What follows is an off-shoot of the same method and will show what is to be done in any specially given instance.

Suppose the Walschaerts valve gear is to be studied and designed for a two-cylinder locomotive and that a simple *D* valve is to be used.

It will be sufficient if the several points and details of the mechanism are determined for one side of the engine as those of the other side will be precisely the same. Of course it is understood that the reverse lever will be found only upon the right hand side of the machine (It is the left in European practice *Trans.*), and that, upon the other side, the lifting shaft arm *S T* (Fig. 1) is keyed to the lifting shaft *S* which extends across the engine from one side to the other, whereby a similar motion is given to the lifting shaft arm *S T* on the left hand side. In the example given, the right hand side of the locomotive will be used.

In order that the drawing developed may be as clear as possible it is well to use the maximum scale available, and, in practice it has been found best to make this one-half size.

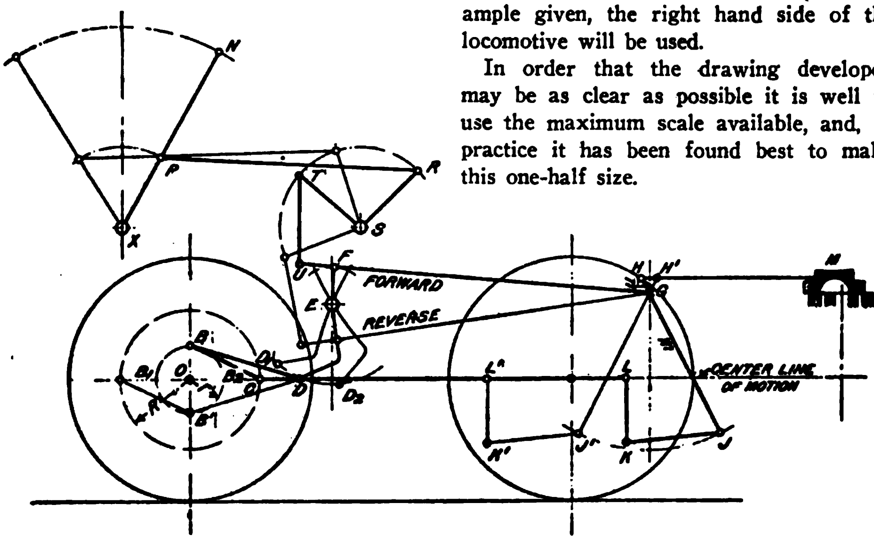


FIG. 1

From the center of the driving wheel, which is located at the left of the drawing given in Fig. 29, a circle is to be struck with the length of the crank as a radius in which $O\ C = R$, the diameter of which corresponds to the stroke of the engine. With the length of the connecting rod given, and the straight line drawn through the center of the driving wheel, it is possible to locate the two end positions *L* and *L'* of the crosshead.

Since the crosshead is rigidly attached to the piston and the motions described by the two are identical, it is convenient to take the positions of the piston direct from the crosshead, and, for this reason, the cylinder is not brought into the drawing at all.

Generally the desired points of cut-off in the cylinder are expressed in tenths, so that the stroke of the crosshead may be divided into ten equal parts in order to show the position of the piston at the various points of cut-off. For the indication of the various points of cut-off for the forward and backward motions of the piston, the Arabic and Roman figures are used respectively. If the point of cut-off is carried back to the end of the stroke, this is indicated by the position of the piston at the end of its stroke.

Further, when it is desired to find the position of the crank corresponding to the several positions of the piston, it is merely necessary to strike arcs of circles with the length of the connecting rod as a radius, from the different positions of the piston or crosshead, cutting the crank circle. These points of intersection with the latter give the desired positions of the crank and, as in the case of the piston, they are indicated by the Arabic figures 0 to 10 for the forward motion of the piston, and by the Roman figures O to X for the backward motion.

The construction of the cylinder gives the distance of the center of the valve

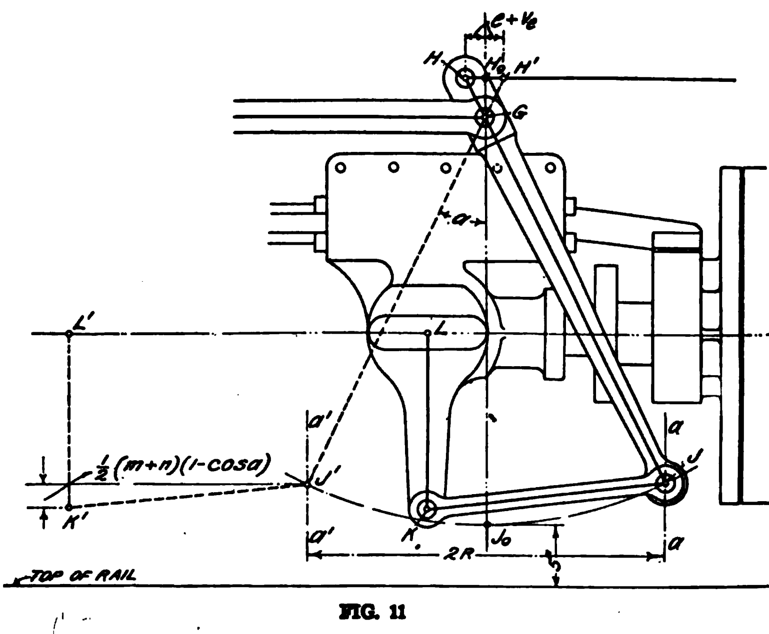


FIG. 11

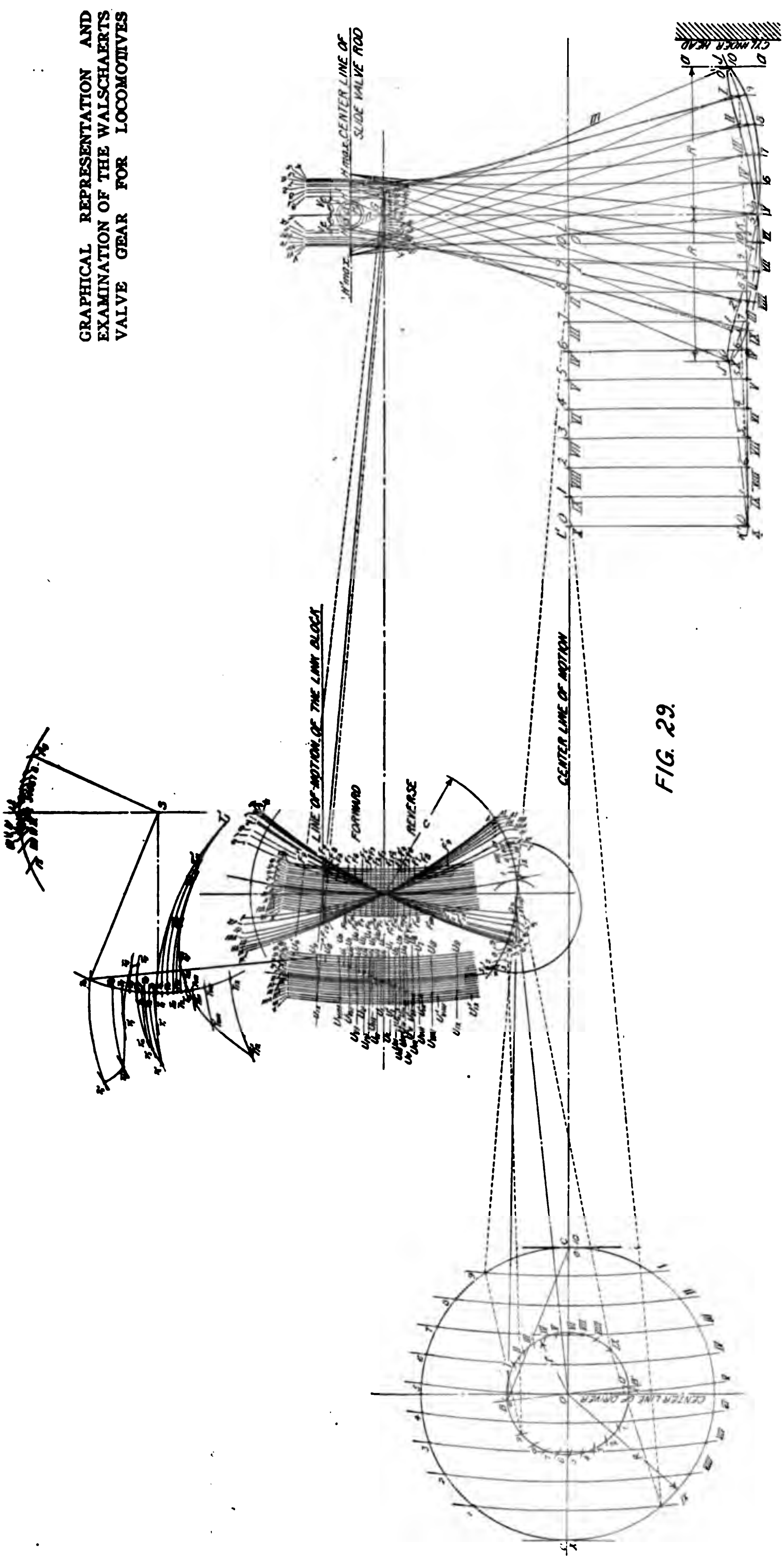


FIG. 29

GRAPHICAL REPRESENTATION AND EXAMINATION OF THE WALSCHAERTS VALVE GEAR FOR LOCOMOTIVES

stem from that of the cylinder or what is the same thing, from the center line of the engine, and it can be laid down on the drawing from the distance so obtained. Further, the distance of the center of the cylinder from the center of the driving axle, will be fixed from the general design of the locomotive, and, then, the position of the vertical plans, *a a*, (Fig. 11) for the extreme right hand throw of the lower end *J* of the lap-and-lead lever, can be obtained from the construction of the cylinder and back cylinder head casing. This will enable the designer to calculate the distance of this vertical plane *a a* from the center of the driving wheels and to lay it down on the drawing. At a distance, *R*, to the left of the plane *a a*, draw a straight line at right angles to the center line of the engine. This will be the center line or symmetrical axis of the lap-and-lead lever, and will also pass through the geometrical location of point *G* on the lap-and-lead lever when the piston is at either end of its stroke. The point of intersection of this symmetrical axis with the center line of the valve stem will give the point H_o.

From H_o (Fig. 29), as a center, draw two circles, with radii equal to e and $e + v_o$ (when the Allen ported valve is used, the radii to be used are e and $e + v_2$), draw the back steam port in the valve seat to the right of the point H_o, and the front steam port to the left, as shown in Fig. 21.

If the back steam port is to be opened by the valve, the latter must be moved to the right of its central position, that is it must be moved from H_o towards the right.

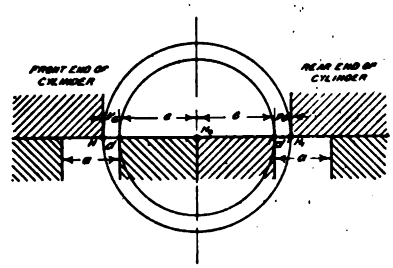


FIG. 12

From the point H_o to d', we have $q = e$, when the port starts to open, so that at the end of the stroke of the piston, the port will be opened beyond the point d' by a distance equal to v_o, when $q = e + v_o$. With the further movement of the piston the valve continues to open the port up to a certain point and then closes it by returning to d' when the piston has reached the desired point of cut-off. The front steam port is shown in a similar manner on the drawing; to open which the valve moves to the left from H_o to d, and at the end of the stroke of the piston, it has traveled the distance $H_oH = e + v_o$ to the left, after which the port is opened a certain amount and is then closed when the valve has moved to the right and has reached the point d.

In order to obtain the shortest possible length of lap-and-lead lever arm n we use the equation

$$e + v_o = R \frac{n}{m}$$

the length of m, together with the total length of the lap-and-lead lever, $J\ H$ and $J'\ H'$ are (Figs. 11 and 29) to be so taken that the points J and J' must lie at equal distances on either side of the symmetrical

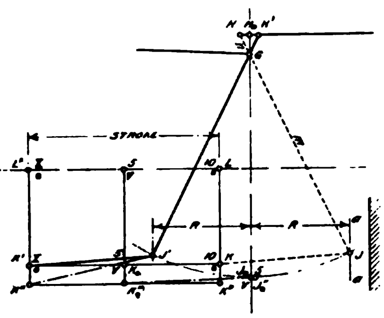


FIG. 22

axis that passes through G, as shown in the drawing (Fig. 22). If we consider G as a fixed point and that the end J of the lap-and-lead lever moves in the arc of a circle drawn with a radius equal to m about G as a center, the point of intersection of this arc with the symmetrical axis of the motion of the lap-and-lead lever will give the point J_o. This will be the lowest point which the end of the lap-and-lead lever will reach relatively to the rails. It is well known that the greater the distance of the point J_o from the rails, the greater should be the ratio of the lengths of m and n be made, up to certain limits, so as to obtain an improved action of the motion. On the other hand, the outside lap of the valve must also be increased.

The motion of the lap-and-lead lever is derived directly from the crosshead and necessarily has some defects, that are beyond the control of the designer, which are due to the union bar by which it is driven, but the motion of its lower end should be an exact copy of that of the crosshead, and necessarily of the piston also, in that when the crosshead is at the ends of its stroke the point J must be at the end of its throw also, when the crosshead is at its central position 5 V, the lap-and-lead lever must also be in its central position half way between J and J' and be at the point of intersection of the circle struck from G as a center with the symmetrical axis of the motion of the lap-and-lead lever:

In order that the up and down motion of the end of the union bar and with it that of the end of the lap-and-lead lever, shall be equalized the length $K\ L$ of the rigid crosshead arm must be so adjusted that circles struck, with the length of the union bar as a radius, from the three positions of the crosshead, K' — 5V and K, as centers, shall cut through the two end positions J' and J and the middle position J_o. The correct position of the point K and, with it, the length of the crosshead arm can be obtained by a simple trial as indicated in Fig. 22.

Take any point as K'' that is below J or J'. From the center line of the engine draw a line, at right angles to the same, downwards, and the distance $L'\ K''$ will be the length of the corresponding crosshead arm. The distance of the point K'' from J' gives the corresponding length of the union bar. Then from the several positions of K'', that is from K'', K_o'' and K'', as centers draw arcs of circles cutting the arc $J'\ J_o\ J$, and the points of intersection, so obtained, will usually coincide with J' and J, but at the central point, the intersection will usually be to the left or right of J_o; being, in the case shown, to the right of J_o. In order, then, that the central arc may pass through the point J_o it is necessary to look for the proper position of K either above or below the point K'' that has been chosen. After a few trials it will be quickly located.

When the correct length of the crosshead arm has been obtained it is possible to locate the point J of the lap-and-lead lever for any point of cut-off that may be desired and the corresponding location of the piston. The positions of the piston, or, what is the same thing, those of the crosshead can be laid down on the line $K\ K'$, and from these points, as centers, arcs of circles may be struck, using the length of the union bar $J\ K$ as a radius, on which the end of the lap-and-lead lever must lie for each of the corresponding positions. By taking the point G as a fixed center, the intersection of the arc $J'\ J_o\ J$, with the above mentioned arcs, will give the several locations of J corresponding to the figures of the different positions of the piston.

Suppose the point of cut-off is taken at 90 per cent of the stroke; then, when the piston has reached this position, the valve must have just closed the port, that is to say the outside lip of the valve H' or H (Fig. 21) must, at that instant, be in line with the outside edge of the port d' or d, or rather, the points H' or H must be at the corresponding points d' or d. At the same time the lower end of the lap-and-

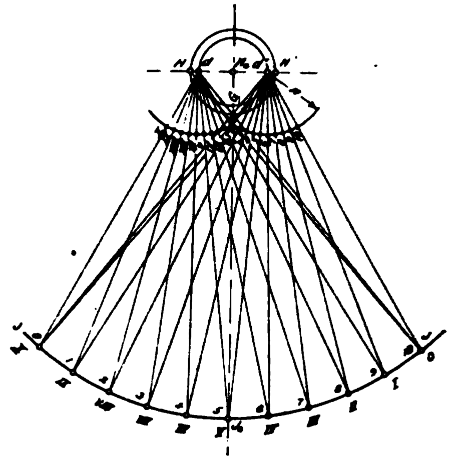


FIG. 23

lead lever J, has reached the positions 9 or IX together with the piston. If we now connect these last points with d and d' respectively and lay off, on this connecting line, from d and d', a distance equal to n we will have the positions of the point G when the desired cut-off takes place at the front and back ends of the cylinder. In a similar manner the positions of G for the valve closure at all points of cut-off can be laid down. The simplest method of doing this will be to draw arcs of circles from d and d' as centers and with the length n as a radius and the points of intersection of these arcs with the straight lines drawn from the several positions of J to d and d' will be the several locations of G that it is desired to find as shown in Fig. 23.

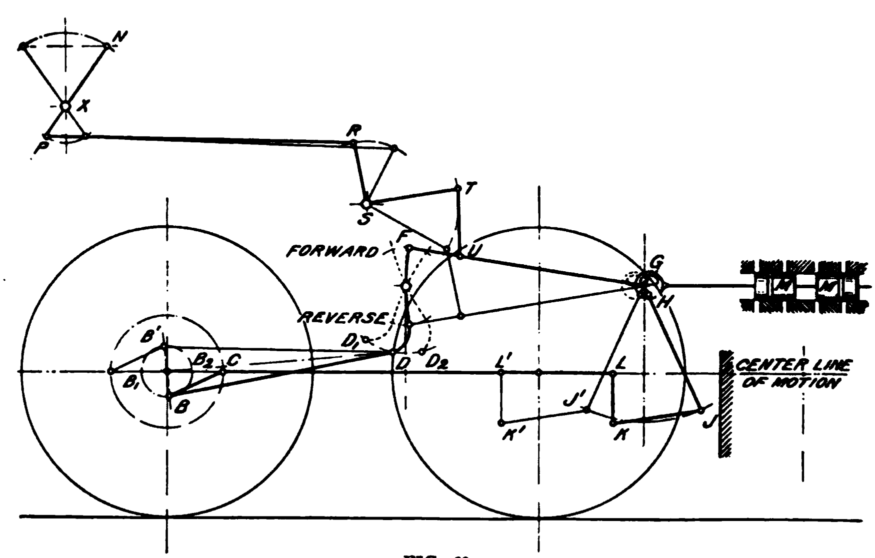


FIG 20

When the engine is fitted with a valve having inside admissions, as is shown in Fig. 20, the point G of the lap-and-lead lever is usually above H, that is the points H and G have changed places.

The different positions of the point G at the time of the closure of the valve for the different points of cut-off are obtained in the same manner as for the valve with an outside lap except that the arcs of circles struck from d and d' as centers and with n as a radius are not drawn below but above their centers as shown in Fig. 24.

It is also to be noted that for a valve with an inside admission, that half of the circle $e + v_e$ to the left of H_o is for the back port, while that to the right is for the front port, which is just the reverse of what obtains when outside admission is used.

In order that the point of cut-off may be at the commencement of the stroke the

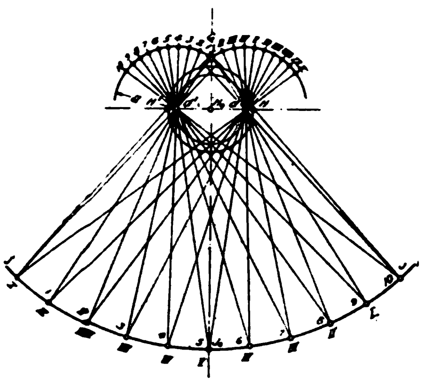


FIG. 24

valve must close the port when the piston is at the points O/X and O/10 respectively, that is when it is at the ends of the stroke. This is impracticable because of the linear lead, and because of which the point G, falls at the same place for both ends of the stroke of the piston and for all points of cut-off.

If the given throw of the eccentric r is laid down on the drawing from O, (Fig. 1) it is possible, in view of the examples already given, to proceed in the same manner with the determination of the radius c of the point D of the link as well as of the position of the pivotal point E, and the point of attachment D for the eccentric rod. After these points have been determined and laid down the positions of the link, corresponding to the various points of cut-off or the positions of the piston, can be located. This is done as follows:

Draw a straight line connecting D and O and at O (Fig. 29) draw a line at right angles to the same, cutting the circle, described from O as a center and with r as a radius, at the points B and B'. These points of intersection, above and below the center O, mark the position of the eccentric when the crank is on its centers and the piston at the ends of its stroke, and from which the upper or lower ends of the link will be used for forward or backward gear. For the usual valve with outside admission the upper position is the one that will be occupied by the eccentric, and this will be assumed for the present case. The distance of B from C gives the length of the return crank, and the distance of B from D, the length of the eccentric rod. Now, with the length of the return crank as a radius, and from the several positions of the crank, draw arcs of circles cutting the eccentric circle, drawn with the radius r, and the points of intersection thus obtained, will be the positions of the center of the eccentric for the corresponding ones of the crank and they have been marked with the figures OO — X and O — 10.

Because of the rigid connection between the link and the eccentric, the former has a motion corresponding to that of the point B. If, then, from any position of B as a center, and with $B\ D$ as a radius, arcs of circles be drawn cutting the arc of the movement of the point D, the position of the point D will be obtained for the corresponding position of the eccentric and, with it, of the piston. For facilitating the reading of the drawing the same method of numbering is used. At the same time the movement must be checked in order to see whether or not the point D moves an equal distance to the right and left of the neutral or central position.

If from the point G as a center, when it is in the position which it occupies when the piston is at the end of its stroke, an arc of a circle be struck through E and prolonged until it intersects the arc of motion of the point D, we obtain, first, the length of the radius rod, $G\ E$ and second, (see Fig. 29) the distance, $D\ f'$ of the point of attachment, D, of the eccentric rod from the arc forming the center line of the link. Then, if we lay off points, to the right of the several positions of D, distant therefrom on the arc of its movement, by the distance, $D\ f$, we will have the positions of the arc of the link corresponding to them and to the corresponding positions of the piston. It is then only necessary to draw arcs through these points and the point E to correctly indicate the positions of the link. In order to facilitate this work first draw, from E as a center, an arc of a circle with the length of the radius rod as a radius. The centers from which the link positions are to be drawn will be found on it, and from them the arcs can be drawn.

On closer observation we will find that, when, for example, the cut-off takes place at 90 per cent of the stroke, at the instant of port closure, the point G will be at 9 or $I\ X$ according to the direction of the stroke, while the link block will be at the corresponding positions of 9 or $I\ X$ upon the arc of the link. The radius rod connects the link block F with the point G; since its length is constant; and with the position of the point G given for the desired point of cut-off hence that of F upon the corresponding position of the center line of the link must lie upon the arc 9 or $I\ X$, hence the position of the link block for the aforesaid point of cut-off can be found at any moment, for either directions of motion of the piston as well as for forward or backward gear, by striking an arc of a circle from G_9 and $I\ X$ as a center, with the length of the radius rod as a radius, and intersecting the link arcs 9 or $I\ X$. In this way we can obtain the locations of the points F_{IX} and F_9 for the forward gear and F'_{IX} and F'_9 for the backward gear and for the left and right hand motions of the valve. The distance of these points from the fixed pivotal point of the link, indicates the position of the link block for the above mentioned point of cut-off.

In a similar manner we may determine

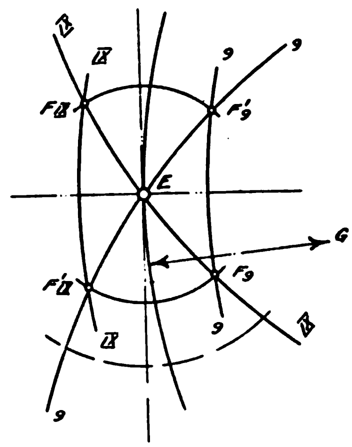


FIG. 25

the distance of the link block F from E for all points of cut-off, by simply drawing arcs of circles from all positions of G with the length of the radius rod $G\ E$, as a radius, which will cut the corresponding positions of the link center line at the desired position of the link block.

Suppose the positions of the points E and D have been properly located, it will be found that the distances of the link block at F_{IX} and F'_9 or F'_{IX} and F_9 from E (for the cut-off for the backward and forward strokes of the piston) may be slightly different from each other or exactly the same, as shown in Fig. 25. If this is not the case and there is a greater difference, a correction of the points E and D must be made from the locations previously found, since otherwise the adoption of an eccentric motion of the point F having an eccentricity of $r = \frac{n}{c}$ would invalidate its accuracy and influence the action of the valve gearing as a whole.

If this correction is made according to the possibilities of the case, the means of its accomplishment will be found in an investigation of the method of suspending the radius rod,

According to the choice of the position of U, (Figs. 1 and 29) as already described, to the left or right of F, will arcs of circles be struck from the cut-off positions of the point G (O — 10 and O — X) be struck with the radius $G + U\ F$ or $G - U\ F$ as U is to the left or right of F. Connect the points of G and F that belong together, as G_{ix} with F_{ix} or F'_{ix}; G_9 with F'_9 or F_9, etc., and prolong these lines from G, until they intersect the corresponding arcs of motion of the hanger ($I\ X$ or 9, etc.), and there will be obtained, for the corresponding points of cut-off in the cylinder, the necessary positions of the points U_1 for the right (U'_9 and U_9) and left hand (U_{ix} and U'_{ix}) motion of the valves as well as for the forward (U_{ix} and U'_9) and backward (U'_{ix} and U_9) motion of the engine.

From the projection of the engine, the approximate position of the point S as well as the length of the hanger $U\ T$ can be determined. With the latter as a radius and the points to be occupied by U, for the extreme positions of the valve to the right and left, as centers (as U_{ix} and U'_9 or from U_{viii} and U'_8) a cut-off arc can be drawn. By connecting the points of mutual intersection of these arcs thus found as T'_9, T'_8, etc. (Fig. 29) a curve is obtained over which the point T must travel in order that the movement of the link block be not influenced by the hanger. It will not be possible to duplicate this curve by the arc of a circle whose center must be in the approximately determined position of S since its location must be built into the frames. At the same time it is desirable that the radius $S\ T$ of this arc through which T must move should be as short as possible because otherwise the moving of the link block from the cab will require considerable effort.

It frequently happens that the curve is so unfavorable that, though the lower half, for the backward motion is well covered by the arc swept through by T, there will be a wide variation in the upper portion. In such a case, from an operating standpoint, and since the locomotive is worked more in the forward than the backward gear, it may be well to use the lower portion of the link for the forward motion, since the action of the valve gear will thus be better, because of the greater influence of the hanger upon the upper positions of the block in the link. This condition occurs most frequently in small engines where the lengths of the working parts are short. It then follows that the eccentric pin, which, as already stated, must be moved through 180°, as well as the link must be redrawn and its motion investigated anew.

Now after all of the dimensions and points of the mechanism of the valve gear have been determined, it still remains to carefully look into its action as a whole. The method to be followed is the same for all points of cut-off for forward and backward gears. To explain it, a search into the action of the valve gear for a 90 per cent cut-off in forward motion will be used as an example.

Through the movement of the point T through the arc of a circle, the point U swings with the motion of the radius rod in a horizontal direction about the point occupied by T while the arc of the circle through which it moves is described by the radius $U\ T$. The arc of this circle will very rarely pass through the positions of U such as U_{ix}, U'_9 U_{viii}, U_8, etc. that have been previously determined. Since the slip of the link block may, sometimes, be diminished thereby, the motion will work inaccurately with the result that the point of cut-off will not be equalized on the two sides of the piston. In order that these defects may be made as light as possible, the locations of U that have already been found should be retained, which lie near the neutral point of U, as well as U_{ix}, U_{viii}, etc., for the forward gear and U_9, U_8, etc., for the backward gear of the engine. This to be conditional on the hangers so swinging that the position of U moves from U_{ix}, U_{viii} not to U'_9 and U'_8 but to U_9 and U_8.

By connecting the positions of U_{ix} and U_9, thus given, with the corresponding positions of G, the positions of the link block F, as controlled by the aforesaid motion of the hanger, will be given for the closing point of the valve at the front and rear sides of the piston. The link block is not moved from F_{ix} to F'_9 but to F_9. The difference between these two distances from E is the amount of slip of the link block.

From the position of F_9 for the forward gear of the engine it is evident that, since F_9 lies upon the arc of a circle struck from G as a center, the lap-and-lead lever has reached its position corresponding to a cut-off of 90 per cent, but the link has not yet reached its 9 position, for F_9 lies between the link positions 8 and 9, hence the link will close the port earlier on the left hand end of the cylinder, and before the piston has completed 0.9 of its stroke. The result will be that there will be an unequal steam admission for the right and left hand sides of the piston. From the position of the link block at closure, which controls the principal movement of the valve, and when the closure takes place at F_9, we find that this occurs at approximately from 0.6 to 0.7 of the stroke between 8 and 9, with the result that we will have a steam admission of from 86 to 87 per cent. of the stroke on the left hand side of the piston and of the proper 90 per cent on the right.

Under the guidance of the hanger and the point G, the link block, in the action of the mechanism, moves from F_{ix} to F_9, and the path traversed will be approximately a straight line, because G does not move horizontally. The position of the link block for the several positions of the link is given by the intersection of these lines of motion with the arc of the center line of the link. If, then, for any point of cut-off, arcs of circles are struck with the position of the link block as a center for each of the positions of the link, using the length of the radius rod as a radius, the point G must lie on the arc so described. We may consider, further, that if the link, with its block, has reached the position $I\ X$, the point J of the lap-and-lead lever has also reached its point $I\ X$, so that, with these positions given, the correct position of the lap-and-lead lever can be drawn; for, as H moves in a straight line, which is the center line of the valve stem, G must be at the proper distance from H and at the same time, on the arc of the circle struck from the position $I\ X$ of the link block with a radius equal to the length of the radius rod and with J in its $I\ X$ position. Now, since the point G moves, the point J does not describe the arc of a circle, but will simply be on such a circle at the two ends

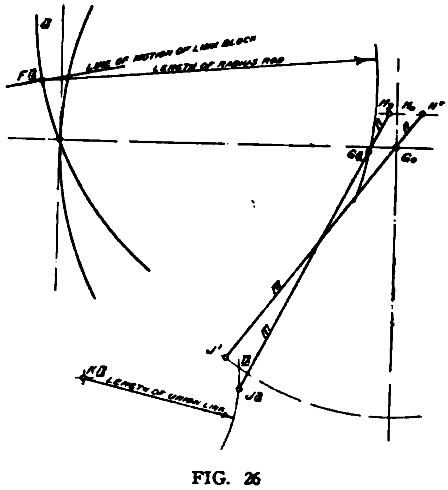


FIG. 26

of its motion at J and J'. The other positions of J will lie above or below this arc, but must always lie on the arc of a circle, drawn with a radius, equal to the length of the union bar $J\ K$, from the corresponding position of the end of the crosshead arm K as shown in Fig. 26.

After plotting all of the positions of the lap-and-lead lever in the same way for all positions of the link and the block and for a single method of operation of the engine, we will obtain the extreme distance of the points reached by H to the right or left of H_o, the corresponding travel of the valve for the point of cut-off used, and the amount of port opening from d and d' to the right and left.

The plotting of the positions of the lap-and-lead lever can best be done with a paper template on which are marked the total length of the lap-and-lead lever and the location of the point *G*. By moving this paper template about so that the upper end *H* is upon the center line of the valve stem (Fig. 26.) and the point *J* lies upon the arc of the circles struck from *K*, *K*, etc., its correct position will be obtained when *G* lies on the arc of the circle struck with the length of the radius rod as a radius, from the corresponding position of the link block.

Ordinarily, in practice, only the latest desired point of cut-off for forward gear is analyzed, since the inequality in the motion of the valve to the right and left is greatest under those conditions. In this case the use of the paper template is very convenient and perfectly satisfactory, yet should it be desired to analyze the motion of the valve for all points of cut-off and for both the forward and backward motion of the engine, the resultant plotting of the positions of the lap-and-lead lever so many times on the drawing would result in an exceedingly complicated mass of lines. To avoid this the universal apparatus shown in Fig. 27 may be used,

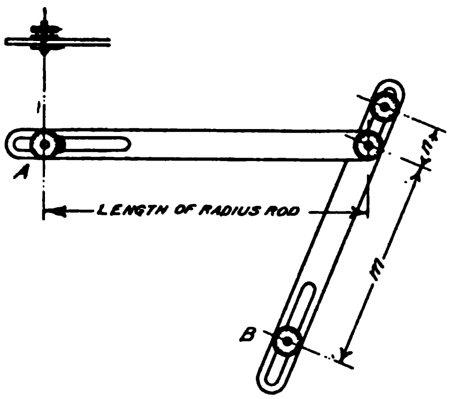


FIG. 27

since it is readily adapted to each piece of work and can be changed so as to have the proper dimensions for all types of engines. It is so adjusted that the length of the radius rod as well as that of the two parts, *m* and *n*, of the lap-and-lead lever, are correctly given, and the position of the valve will be idicated by putting the center *A* on any desired position of the link block and then adjusting the center *B* so that it rests upon the arc of one of the circles struck from *K* — *K'*, etc., a thing that is quickly done. If the controlling influence of the point of suspension *U* of the radius rod is to be determined also, it will be necessary to add a center to be used accordingly.

When all of the motions of the valve, for the gear that has been plotted, have been determined, they can then be transferred to a Zeuner or Meier-Reuleaux valve diagram, whereon the given steam phases in the cylinder can be brought together in a single drawing. If the motion of the valve is analyzed for but one point of cut-off the drawing, thus made, will be available in the future.

With it the designer has before him a clear picture of the working of the valve motion, and he has developed an ideal movement of the valve, that is to say, one of perfect symmetry, so that from the values given in the valve motion diagram he can equalize and adjust the values of the working conditions.

The following data will be contained in these diagrams relative to the forward and backward movement of the engine as well as for the left and right hand sides of the piston:

Steam Admission per cent	Expansion in inches & per cent		Compression in inches & per cent		Linear Lead	Maximum Port Opening in inches	Slip of Link Block in inches
	Beginning	End	Beginning	End			

sure of from 18 lbs. to 25 lbs. per sq. in. From the latter it is usually customary to take the amount of steam admission of the high-pressure cylinder and that of the corresponding admission to the low-pressure cylinder, and calculate the lengths of the lifting shaft arm *S T* and the hanger *T U*. The above relationship of steam admissions is fixed by the length of the lifting shaft arm so found. After these things have been determined, it will be necessary to start afresh, and examine critically both valve motions, that is for the right and left hand sides of the engine; a proceeding, which up to this point in the development

The better these tables or diagrams agree the better will be the action of the valve motion. Naturally additional defects will be introduced by the execution of the design in the shops. Therefore each valve gearing should be carefully watched in its erection, and each type should be tested and checked in operation.

On each drawing of a valve motion diagram there should also be given, besides the complete drawing of the valve and the valve seat, the diameter of the cylinder, and the maximum desired amount of steam admission as well as a steam diagram of the machine taken at the mean point of cut-off in the cylinder.

If the engine is designed to work as a compound different points of cut-off should be provided for the high and low-pressure cylinders.

In order that this may be done and that with but one reverse lever in the cab, it is necessary that greater dimensions should be given to the lifting shaft arm *S T* and the radius rod hanger *T U* on the low-pressure side than upon the high-pressure side and that both should be keyed to the shaft *S*. It is to be noted, however, that the mid gear position should be reached on both sides at once, because if this did not occur the amount of steam admission to the low-pressure cylinder would be greater for one direction of running than it would be to the high-pressure cylinder; while, for running in the opposite direction it would be less.

The corresponding steam admission of the high and low-pressure cylinders will be found if we assume in the drawing of the steam diagram of the high-pressure cylinder, that there is a clearance space of from 6 to 10 per cent and from the final pressure, due to which, from 3 lbs. to 6 lbs. per sq. in. must be taken because of the drop of pressure in the receiver, and with the pressure thus delivered the steam diagram for the low-pressure cylinder can be drawn on the basis of a clearance space of from 8 to 12 per cent and a final pres-

of the valve gear, has not usually been done.

A further difference in the valve gearing for the two sides of the engine will be found in the valve, because the steam port in the low-pressure cylinder will be longer than that in high. The width of the ports in the two cylinders is the same.

With the application of compound working the ratios of steam admission in the two cylinders can be indicated on the drawing of the valve motion diagram.

PART IV

Valve Setting

When the crank is on the dead point or at the end of its throw, the valve must have opened the steam port on the same end of the cylinder as that corresponding to the position of the crank by an amount equal to the linear lead. With the Allen ported valve this is $\frac{V_e}{2}$

In the cabs of all locomotives there is a graduated quadrant on which the points of steam admission should be marked, so that it is only necessary for the driver to place the reverse lever *N X* (Fig. 1) at the proper notch or the pointer of the screw reverse to the correct index, by turning the handwheel, in order to secure a corresponding degree of steam admission in the cylinders. Again by setting the lever in front or back of the neutral or mid gear position, he can change the direction of running to forward or backward.

The division of the quadrant is rarely laid out by designer but is obtained after the valve motion has been set up in the shops. To do it the crosshead should be set at the two ends of the stroke of the piston and marks made at one end of the crosshead on the guides so that the total length of the stroke will be indicated, and this distance should be divided into ten equal parts; each one of these will, therefore, represent one-tenth of stroke of the piston. If it is desired to admit steam for the full length of the stroke of the piston, then the mark at the end of the stroke is to be used. Suppose, now, that the steam admission is to be such that the valve closes at 90 per cent of the stroke. It is evident that the edge of the crosshead against which the mark on the guides was made, must be at the 9/10 part as so marked, while the valve must have just closed the port and the edges of the valve and the port be in line with each other. When the crosshead has been set, take the reverse lever and move it until the proper position is reached by the valve. Then a mark can be made on the quadrant for the notch to indicate the proper position of the reverse lever, or on the screw for its location in order to obtain a steam admission of 90 per cent in the cylinders. In the same manner a correct division of the quadrant can be made for all points of cut-off or rates of steam admission for forward and backward gears of the engine.

In order to verify the movement of the valve in both directions, for each distinct point of cut-off as well as the port opening on both sides; the piston should be placed at the end of its stroke, and the corresponding position of the outer edge of the valvestem crosshead marked on its guide and then when the motion has been set for any predetermined cut-off the engine may be turned and the motion of the valvestem crosshead followed with a pencil. Then, when the position at the end of the travel has been obtained, the length of the motion of the valve stem crosshead, increased by the amount of linear lead will be the amount of port opening effected by the valve on one side. When this determination has been made for all points of cut-off on one side, the crosshead should be moved to the other end of its stroke and the position of the other edge of the valve stem crosshead marked, from which a determination of the valve movements for the other side and port can be made. By bringing these values together in a table or diagram the designer may be able to equalize them and the better they can be made to agree the better will be the operation of the valve gearing.

It must be noted, however, that, in the case of the Trick or Allen ported valve, the port opening cannot be obtained without further information. First the motion of the valve must be determined. This consists of the mark made on the guides

and $e + \frac{V_{\bullet}}{2}$

A model can then best be used to duplicate the motion and the port opening obtained therefrom.

In order to ascertain the actual slip of the link block, as it exists in practice, it is only necessary to follow the movement of the block in the link, with a pencil, for all points of cut-off for forward and backward gear as the engine is turned, from which it will be readily determined.

To make an observation as to the exact position of the valve when it is closing the port is a small matter in the case of flat valves as it is merely necessary to remove the cover of the steam chest. But, in the case of piston valves, especially of those having an inside steam admission, it is very difficult unless special arrangements have been made, either to properly set the valve or to follow its motion. In order to meet this difficulty, a straightedge II (Fig. 28) should be fastened with screws to the front steam chest cover. The valve seat is to be accurately drawn on this straightedge, so that the opening of the port when the valve is in the position of effecting the linear lead can be measured to the fractions of an inch. The straightedge II is fitted with a groove in which a second straightedge I can move back and forth, and this is fastened directly to

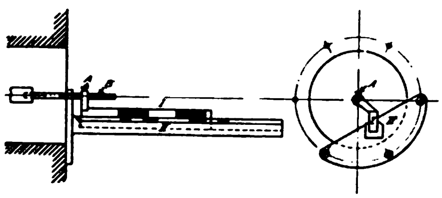


FIG. 28

the valve or to an extension of the valve stem, and on it there are drawn the exact dimensions of the valve itself. Then, when the crank and piston of the engine are brought to the end of their stroke and the valve is so set that its outer edge has opened the port by the amount of the linear lead, the straightedge I is to be adjusted by means of the thumb screws *A* on the stem *B* so that its position on the straightedge II is in exact accordance with that of the valve; that is to say so that the steam port on the proper side of the straightedge II has been opened by the amount of the linear lead. Then every movement and position of the valve will be directly and clearly shown by the straightedge. The graduation of the quadrant as well as the determination of the movement of the valve in both directions is then readily effected by means of this apparatus.

The final adjustment of the valve motion is effected by a test of the locomotive and applying indicators to both cylinders, whereby the harmony of action of the two sides of the engine can be observed.

New York Central Starts Work on the "Castleton Cut-Off" Improvement

Construction work will commence at once on the Castleton bridge and "cut-off" improvement of the New York Central Railroad under plans providing for rapid work on a scale that will bring it into operation within two years. The bridge, connecting railway, yards, etc., call for an ultimate expenditure of approximately $20,000,000.

The new bridge, located about twelve miles south of Albany, N. Y., will be the second high-level structure to span the Hudson River, and larger than its single predecessor at Poughkeepsie, N. Y. Extending from it will be three tangents of double-track railway, aggregating twenty miles, creating shorter and level connections between the main line of the New York Central and its two important branches, the Boston & Albany and the West Shore Railroad.

The beneficial results forecasted by the railroad operating officials and engineers include the practical doubling of New York Central freight tonnage capacity, a great increase in passenger-carrying capacity and a possible reduction of average time in transit of freight between the North Atlantic seaports and the Middle West of from two to five days. The new connection will provide easy flow for a vast amount of through freight traffic of New England and New York now passing through the Albany gateway, where conditions restrict rail facilities, causing uneconomical operation and in times of heavy business serious congestion and delays.

The new bridge will be in two spans, as originally designed, of truss type and stone and steel construction. It will carry two tracks, but be adaptable to expansion to hold four tracks if desired. It will have an under-clearance of 138 feet above high-water level, which is three feet more than that of the Poughkeepsie bridge or the big suspension bridges across the East River at New York City. The tracks will be 150 feet above the water line. The masonry and steel work will weigh about twice that of the Poughkeepsie bridge, which is supported by five piers in the river bed. The Castleton structure, including the viaduct approaches, will be one mile long, from abutment to abutment. The two central spans over the navigable channels will be 600 and 400 feet long, respectively. The viaducts will contain one hundred concrete towers, supporting 25-foot rectangular steel framework.

Railway Electrification in Canada

Electrification of railways was discussed recently in the House of Commons in Ottawa, Canada. The assertion was made by Mr. Deslauriers, member for St. Mary's that the cost of the motor power for an electric locomotive is as 88 to 200 compared with that for a steam locomotive, and that the maintenance costs are as 8 to 18.

The question will be further discussed.

Hearing Before the Interstate Commerce Commission on Power Brakes

The hearing called by the Interstate Commerce Commission on Power Brakes, the questionnaire on and notice of which appeared in the April issue of RAILWAY AND LOCOMOTIVE ENGINEERING was opened on May 17, in the building of the commission at Washington. The examiners were F. E. Mullen and W. P. Borland. The appearances of record were Messrs. Edgar C. Clark, Wilbur Lea Roe and F. E. Brown of Washington, and M. C. Hamilton of New York in behalf of the Automatic Straight Air Brake Co. of New York. Paul Synnesvedt of Philadelphia in behalf of the Westinghouse Air Brake Co., Charles C. Paulding of New York, in behalf of the New York Central Lines and the American Railway Association; Alfred P. Thom and Alfred P. Thom, Jr., of Washington, in behalf of the American Railway Association and Scott R. Hayes in behalf of the New York Air Brake Co.

The opening statement in behalf of the Automatic Straight Air Brake Co. was made by Mr. Edgar E. Clark who called attention to the requirements of the original Safety Appliance Act that all trains shall be equipped with a power brake which will permit the engineer to control the speed of the train from the cab, and then to the changed conditions of train operation as they exist to-day in comparison with similar conditions at the time of the enactment of the law. He claimed that the efficiency of the brakes had not kept pace with the changed conditions.

The first witness called on in behalf of the Automatic Straight Air Brake Co. were connected with the Westinghouse Air Brake Co. From these witnesses admissions of various kinds were obtained as to the shortcomings of the Westinghouse brake, most of which were based upon prior publications of officers or employes of that company. The testimony swung about the freight brake, though the passenger brakes were dragged into the discussion. The principal point conceded was that an emergency application was unavailable after a service application with the Westinghouse freight brake.

These witnesses were followed by others connected with the Automatic Straight Air Brake Co., by whom it was testified that the brakes of that company worked in harmony with those of the Westinghouse Company and that the operation of the latter was even benefited by them. The matter of the effect of the brakes on wheels was gone into with considerable elaboration, and considerable data, drawn from the reports of the railroads to the Interstate Commerce Commission was introduced to show the damage to property and the expense incurred by the railroads due to faulty brake applications.

Cross examination attempted to break down this testimony.

After the case of the Automatic Straight Westinghouse Air Brake Co. placed some of their officers and employes on the stand who testified to the efforts that had been made by that company to constantly improve its product and keep up with the demands of the times. The development of the various forms of triple valves were enlarged upon and some indication given of the reasons for that development. It was contended by these witnesses that the Automatic Straight Air Brake would not meet the requirements of the specifications of the American Railway Association promulgated in 1918 and that it would not harmonize with the Westinghouse brakes. A statement was read into the record setting forth the attitude of the Westinghouse Company as to new inventions in the air brake art. It showed that every development had been very carefully followed, and that every move in the development of the Automatic Straight Air Brake had been followed and reports thereon rendered by officers and employes of the Westinghouse Company all of which had been adverse.

These witnesses maintained that on the basis of observed wheel temperatures of trains in which there were Automatic Straight Air Brakes, these brakes were not doing their share of the work and could not be made to do so.

This testimony was vigorously assailed on the cross-examination of the witnesses and, in some cases, successfully.

The attitude assumed by the two parties was that the Westinghouse brake was and was not efficient and satisfactory, and capable of meeting the demands of the traffic of the present time, and that the Automatic Straight Air Brake would and would not harmonize in its operation with the Westinghouse brake, and that it had and had not failed to fulfill the claims made for it.

After the completion of the case for the two brake companies the hearing was adjourned until early in July.

Railway Refrigerator Cars

Interesting notes on refrigerator cars were presented at a joint meeting of the Metropolitan Section of the American Society of Engineers and the Railroad Division of the Mechanical Engineers, and the members of other engineering societies at the Engineering Building, 29 West 39th Street, New York City, on May 16, by W. H. Winterrowd, Chief Mechanical Engineer of the Canadian Pacific. The author of the paper showed a close study of the subject and illustrated the matter with drawings and diagrams of the various systems in use. As is well known the prevailing method of obtaining refrigeration is by means of naturally-circulated air, cooled by contact with ice, or ice and salt, placed in suitable receptacles called bunkers located at each end assisted and made most efficient by means of containers so constructed that the relatively warm air must pass over the top of them to reach the ice, or ice containers, the air becoming chilled, and therefore heavier, sinks towards the floor and reaches the body of the car by passing through a space beneath the bulkheads. These insulated partitions also assist in protecting the lading nearest the ice containers. Without bulkheads, and when salt is used with the ice to hasten and increase refrigeration, that part of the lading nearest the ice frequently freezes, an undesirable and disastrous occurrence with some commodities. At the same time that portion of the load near the center and top of the car may remain at too high a temperature, an equally undesirable condition.

As a further aid to circulation, particularly in cars where the lading is piled or stacked, a slatted wooden structure known as a floor rack is of very great value. These racks, on the top of which the lading may be placed, consist of longitudinal runners 3 or 4 ins. high, with cross slats fastened to the top of them. They are hinged to the side walls of the car and are divided in the middle so that they can be turned up to make the floor accessible. These racks permit the cold air which flows beneath the bulkhead to circulate freely toward the center of the car and up through the lading.

As Mr. Winterrowd stated a very great improvement has been made in refrigerator-car construction and design, particularly within the last few years, but there is also evident indication that the field of investigation in connection with cars of this type is still a most fertile one. Some fairly recent cars indicate that the subject of refrigeration in transit is not appreciated in some quarters as it should be. Efficient refrigeration is most important, because cars that can be kept in continuous service with a minimum cost of maintenance and which are sufficiently efficient to protect the lading in transit mean increased income to the railways.

Railway Extensions in Canada

The sum of $1,890,000 has been appropriated by the Legislature of Alberta for extension of railways in the northern part of the Province. The railway bills include $410,000 for a 15-mile extension of the Edmonton, Dunvegan, and British Columbia Railway west from Grand Prairie; $475,000 for a 13-mile extension of the Central Canada Northwest Railway from Peace River to Waterhole; $265,000 for an 11-mile extension of the Lacombe and Northwestern Railway to the north; and an issue of $740,000 for the Alberta and Great Waterways Railways; of which $255,000 is to repay the general fund of

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Railroad Labor Board Aims at Establishing Stable Foundations

As was expected the United States Labor Board has been occupied in deliberations in another nation-wide railroad wage adjustment, and hearing testimony in regard to a ten per cent reduction demanded by the railroads. After two years' activities under most trying circumstances, the Labor Board has performed a vast amount of work which in the very nature of things could not please everybody. The leveling up of wages made by the government during the war period was unavoidable. There was no time to discriminate between the costs of living in the different localities, and the variations in this regard were not so marked at that time as they have been since and nothing better than a fair average could be taken to base a necessary increase of remuneration, which, of course, added to costs in certain localities. The deductions in wages which became inevitable were not looked upon as a final settlement in the important question of arriving at a degree of stability, and the work in the hands of the Labor Board at the present time should form a more or less stable foundation for future wage adjustment to fit a peace time industry operating under normal conditions.

One thing seems to be universally admitted, that in the pre-war days the average railroad man was not paid a rate commensurate with the importance of his work, nor in a ratio with that of other industries. This was particularly true not only in the maintenance of way departments, but among the skilled mechanics in repair shops. There had been no increase in wages to speak of since the civil war period, and while it is true that railroad work generally is of a more steady and reliable kind than that of the building and some manufacturing industries, it should not be forgotten that during the fluctuations in transportation incident to variations in freight traffic, it was invariably the shop men and others of the lower paid railroad men that were the first to feel the effect of a reduced railroad income, and suspensions, shortened hours, and occasional reductions on wages were not uncommon. The result was that many of the best men sought work elsewhere, leaving the unskilled and inexperienced, thereby adding to the cares of the foremen the necessity of training men to do work that frequently was not as well done as it should have been, and leaving much that was not done at all to wait for a more convenient season.

Hence the old rates of wages should not be considered in any deliberations of the Labor Board, or if considered at all should be looked upon as utterly inadequate, and in a kindlier spirit it might be considered a justification towards liberality and if it should appear that certain classes have been overpaid for a short period, it would take a long period of such conditions, if they do exist to make up for the deficiencies of the past.

As to the variable costs of living in the various localities it may be relied upon that the Labor Board will before rendering any decision give this matter due consideration, and it may result in a series of wage decisions following the groupings used in issuing rules decisions. In any event in view of the growing sense that comes from experience, let us hope that we are approaching settled conditions in the days that are to be.

The Taxation of Motor Trucks and Railroads

The Public Utilities Commission of Colorado has delivered an important decision which will form a precedent in similar cases by other state utilities' commissions, in regard to comparatively free motor traffic on public highways. The case furnishes a parallel to the universal disadvantage to which the railroads are placed in the matter of taxation in the various states through which transportation is carried on. The Denver & Rio Grande Western Railroad runs parallel through two counties where there are sixty-eight motor trucks operating as public carriers. The owners of the trucks paid into the state treasury $819 per year for the use of the state and county highways. They had not contributed directly to the construction of the highways. The railroad not only built its own roadway, but paid in one year $38,023 in taxes for the public roads which they do not use at all, and in addition other taxes making the total in these two counties paid by the railroad company $153,896. A portion of the decision of the Commission claims that "Public convenience and necessity, by which must be understood the convenience and necessity of the people at large as contradistinguished from the convenience and necessity of a very small number of persons who seek to derive a profit from the farmers' and home owners' investment in roads, never contemplated that the truck driver should destroy that, to the cost of construction of which he contributed little or nothing, or that he should reap where he has not sown. When the taxing laws of this state are so amended that the truck driver operating over state highways shall contribute his due proportion to the cost of construction and maintenance of our highways, then, and only then, can this Commission regard his use, under proper conditions and restrictions, of a great and tremendously expensive public facility as of equal dignity and equal benefit to the people with the moderate use thereof by the ordinary tax payer."

The President Calls Up Railway Heads

Nineteen of the leading railway executives were called to go and consult with the President. This may seem at first sight to imply a doubt as to the reliability of the reports of the Interstate Commerce Commission and the United States Labor Board, but it should not be so construed, at least, until we see the result of the conference. That the President means well there can be no doubt. That the railway executives will tell him all they know, if there is time, we may rest assured. That some good may come of it we cherish a fond hope. We are confident it will be something more than a visit of Cherokee Indians who are pleased to see their photographs in the company of the Great Father, then go home thinking their own thoughts. Perhaps the President has something up his sleeve that will lower rates and increase receipts, something that will allay discontent and bring back the tender grace of a day that is dead. The executives have not secured the promised six per cent yet, if it was promised at all, or merely set up like the ideal that eludes and ever has eluded the seeker after the unattainable. We await the result, not forgetting the beatitude "Blessed are they who pect little for they shall not be disappointed."

At the meeting which was held at the White House on May 20, it is reported that the President "voiced the unanimous desire of the railroad executives to make the fullest contribution possible to restore and maintain prosperity." The executives voted to name a committee to recommend what action would be taken. Secretary Hoover's suggestions embraced cutting freight on coal, steel, farm products, minerals, and other heavy-priced basic raw materials. It also involves a policy of letting freights on high-grade, high-priced finished materials remain at approximately their present levels, and probably leaving passenger rates untouched.

One subject frequently mentioned in advance of the White House dinner, that of railroad wage levels, now under re-examination before the Railroad Labor Board, apparently did not come up for discussion. No mention of it was made in the statement, although questions of new equipment purchases and other "problems of railroad management" were referred to specifically.

Interstate Commerce Commission Orders a Reduction in Freight Rates

While the President and nineteen railroad executives were discussing the advisability of making reductions in railroad freight rates on certain commodities, and a committee of the railroad executives was appointed to consider and report on the matter with a view to effect reductions, it appears that coincidentally the Interstate Commerce Commission was preparing an order for a sweeping reduction in freight rates and which are to be effective on July 1. The Commission also announced that railroad rates in the future would be based on a return of 5¾ per cent on the aggregate value of the lines, as compared with 6 per cent under the Esch-Cummins law The provision of this law recently expired, and the Commission was empowered to fix a new rate of return.

At first glance the action of the Commission seems to be premature. It is a bold experiment but we are not without hope that it may be successful, as all indications point to a rapid revival of industrial activity. Our hopes have been slow in realization before and we have not had time to forget that since the general increase in freight rates, effective on August 26, 1920, the railroads of the United States have realized a return upon their tentative valuation of 3.35 per cent, according to reports filed with the Interstate Commerce Commission up to April 1, 1922. During these 19 months the net operating income has totaled $995,087,379, which is $784,582,123 short of a 6 per cent return. To have earned 6 per cent the railroads should have had a net operating income amounting to $1,779,669,502. In these 19 months the railroads as a whole have on only one occasion earned above 5 per cent and that was in March last, when it was 5.83 per cent.

During the year 1921 their net operating income for the 12 months' period was at the rate of 3.26 per cent on their tentative valuation, while during the first quarter in 1922 it has been at the rate of 4.51 per cent.

The reductions which will pass into effect next month will reduce the 40 per cent increase allowed in the Eastern district in August, 1920, to 26 per cent. In the Western district where 35 per cent increase was allowed, the reduction will cut this to 21½ per cent. In the Southern and Mountain Pacifics the previous rate increase of 25 per cent will be reduced to 12½ per cent, while in the Interterritorial districts where the rate increases averaged 33⅓ per cent, this will be cut to 20 per cent.

International Railway Congress

After a lapse of twelve years the International Railway Congress assembled in Rome, Italy, in the latter part of April. It will be recalled that it was intended that a meeting would have been held in Berlin in 1915, but as it is well known it was not convenient to get to Berlin at that time. During the twenty-five years of the existence of the Congress, although held at irregular intervals, the sessions have been well attended by well-selected delegations, and able discussions have been held on vital subjects pertaining to railroad development. At first glance it might seem that there is little to learn by an accomplished American railroad man visiting Europe. Their ways are not as our ways. Their miniature equipment is frequently spoken of with something approaching derision by the average American who may not understand that in compact countries with dense populations a greater frequency of trains is better adapted to the needs of the people, even if the equipment is limited in power and accommodation, because of the easy possibility of a greater number of trains being run. In fact with the exception of Russia the railroad traffic in Europe might be not improperly compared with the suburban traffic of our Eastern States. In regard to unqualified opinions of the economic advantages of a train of enormous capacity passing over the long, thinly populated regions of the United States and Canada once in twenty-four hours the foreigner knows little and cares less. Their means and methods suit them and ours suit us, and while we cheerfully admit that the whole science of transportation has been learned from Europe, we are very apt to think that we have made marked improvements upon it. whereas they may be merely changes entirely arising from the exigincies of the varying situations.

At any rate in a kindly, fraternal spirit of learning from each other the International Railway Congress has been established and in this spirit, no doubt, it will be carried on. There is certainly great need of master minds, if there be such in existence, to devote their attention to the economic side of railroading. It is not much to our credit that after nearly a century in which the steam engine has done the great bulk of the world's work especially in transportation every railroad, either State owned or private owned, should be on the brink of bankruptcy, with a ceaseless battle between capital and labor, with equipment in a lamentable condition, and with a large portion of the time, which ought to be devoted to wise legislation calculated to maintain and develop the resources of the various countries and increase the material welfare of the people, taken up with acrimonious debates that lead next to nowhere.

We are not without hope that out of the International Railway Congress some good may come. The echoes that have come to us so far are similar to the radio electric noises that amuse and interest the young and idle—brass bands,—addresses of welcome, — set speeches, — labored essays, that leave the hearers about as wise as they were, with the blessed consolation that silence after all is golden.

It may be added that the number of members and the mileage represented at the congresses rose from 131 and 31,000 at the Brussels Congress in 1885, to 420 and 373,000 at Berne in 1910, and the association now comprises 260 administrations representing something like 250,000 miles of line.

The Mechanical Conventions

The stresses of the war period and the unsettled conditions arising from it rendered it necessary to forego holding the railway mechanical conventions with that degree of regularity which had characterized the meetings for many years. Out of this misfortune, however, has come a closer association of what may properly be called the allied mechanical associations, and the meeting this month will mark a new era in the history of these associations.

It would be difficult indeed to overestimate the value of the work accomplished through the educational agency of these associations. The marvelous development of the modern high-powered steam locomotives owes much of its present day supremacy to the spirit of enterprise and encouragement created at the meetings of the best and the brightest of the leading spirits engaged in the construction and repair of the locomotive and other appliances. These meetings have no parallel in any other country, and hence the advanced position occupied in the transportation industry in America, and all that is needed is a complete return of normal conditions so that the good work may be continued under favorable conditions, and those who occupy positions of responsibility in relation to motive power and rolling stock with their multitudinous and ever-expanding accessories may be afforded an opportunity of meeting with those similarly occupied and exchange views calculated to further development in the great and good work in which they are engaged.

The railway companies are well aware of this, and while they are not all in a position to send as many of their leading men as they would wish, it is already evident that even with the limitation of conditions not yet quite settled, there will be the largest assembly of the most accomplished railroad men engaged in the mechanical departments that have hitherto met together, including those engaged in the manufacture of the products essential to the work in question.

To this end it is particularly gratifying to know that the manufacturers of railway supplies are taking full advantage of the opportunity afforded them, and coincidentally with the largest assembly of railway mechanical experts there will be the largest and widest variety in point of display of railway appliances hitherto exhibited. The place chosen for the display, as is well known, affords unsurpassed facilities, which have been enlarged for the occasion, while the committees in charge are composed of men graced by a spirit of unselfish activity and polished by experience.

In the July issue of Railway and Locomotive Engineering we will present a fitting reflex of the proceedings as well as a description of the salient features of the exhibits.

As already announced, the convention, which will be known as the third annual meeting of Division V—Mechanical—of the American Railway Association, will be held at Atlantic City, N. J., during the week June 14-21, inclusive. The program as arranged, embracing reports of committees, standing and special, and such other business as may be brought up, will be as follows:

June 14.—Opening exercises; association business; reports of committees, including Nominations, Safety Appliances and Scheduling of Equipment through Repair Shops.

June 15.—Reports on Prices for Labor and Material, Arbitration, Tank Cars, Loading Rules, Train Lighting and Equipment.

June 16.—Reports on Car Construction, Couplers and Draft Gears, Brake Shoes and Brake Beam Equipment, Train Brake and Signal Equipment, and Car Wheels.

June 19.—Reports on the Manual, Specifications and Tests for Materials, and Locomotive Headlights and Classification Lamps. Election of officers.

June 20.—Reports on Locomotive Construction, Feed Water Heaters, and Modernization of Stationary Boiler Plants.

June 21.—Report on the Design and Maintenance of Locomotive Boilers; topical discussion. Closing exercises.

Standing and special reports will be printed and distributed to the members in advance, and discussions will be in order on the presentation of each report. No reports will be received from the committees on "Autogenous and Electric Welding"; "Design, Maintenance and Operation of Electric Rolling Stock"; "Engine Terminals, Design and Operation"; Lateral Motion on Locomotives"; "Mechanical Stokers"; "Standard Blocking for Cradles of Car Dumping Machines"; "Train Resistance and Tonnage Rating"; and "Car Shop Layouts."

Applying a New Fire-box

In discussing shop output, W. E. Symons, an eminent railway engineering authority, states that he found in looking over the matter some years ago that in the event of a locomotive in need of a new fire-box the difference in the time of overhauling an engine requiring a new fire-box was so much greater than the time required for general overhauling where there was not a new fire-box applied that the company lost a great deal of the annual earning value of the engine on account of extra delay due to fire-box. I adopted the plan of applying what is called a back end to a locomotive boiler when we had ten or more engines of one class. When an engine came in requiring a new fire box, which is a heavy job (consuming ordinarily fifteen days more than one that did not require a new fire-box). I simply cut off the back end of the boiler at the throat sheet and applied a back end in this manner and had the engine in service in fifteen days less time than would otherwise be the case. I would send this back end that had been removed to the boiler shop for what is called "stock work" and while the engine was out on the road earning money for the company its old back end was in the boiler shop receiving a new fire-box, and this back end in turn could then be applied to the next engine of that class requiring a new fire-box. By this plan each engine so treated would render about fifteen days more service.

Metallic Packing

D. J. Smith states in the *English Mechanic*, "that for rods having a reciprocating movement such as piston or valve rods, I used two forms of packing, sometimes in combination. The first and most satisfactory consisted of woven asbestos and brass wire impregnated with graphite. This was woven square in section and then pressed into rings with beveled joints. This will stand any ordinary superheat, cannot blow out, and lasts almost indefinitely. It will not score the rods, and can be used in the ordinary stuffing boxes. The other packing consisted of bronze bushes turned inside the size of rod and outside about 1-16 in. smaller than the inside diameter of stuffing-box. The ends of bushes were coned, one end male, the other female. The first and last bushes only had one end coned. The bore of the bushes was grooved with shallow rings about ⅛ in. wide and 1-32 in. deep, the "lands" between the grooves being about ⅛ in. wide. The bushes were then split diagonally with a fine hack-saw and put on rods; in the case of rods where they could not be put on ends the bushes were cut in two, also diagonally, the cut on each bush running the opposite way to the other, the coned ends holding them together. Such a gland needs to be quite four diameters long, which is the chief objection to it. The space between the bushes and stuffing-boxes was filled with flake graphite.

The Walschaerts Valve Gear

The series of articles on the Walschaerts valve gear and which are concluded this month have already called forth many warm commendations from engineering experts capable of estimating the merit of the work as a valuable contribution to the railway literature of our time. Although at first glance apparently complex in detail, the facts emphasized are of the highest value particularly to the mechanical or constructing engineer. In order to maintain its highest efficiency as a means of admitting and cutting off the supply of steam to the cylinders, the various central movable points of the gear must be laid out with a degree of exactitude that approaches perfection. If this is not done the working mechanic, no matter how expert he may be, can never wholly rectify the error. In fact error besets error. Even if some skilful adjustment may be made to rectify some seemingly unimportant defect, a thorough examination will show that a multiplied error is created at some other baffling point. With the original design carefully planned and finely executed the valve-setter has little to do. In the inevitable wear of parts slight alterations in the eccentric and a radius bar may to some extent remedy growing defects but new bushings and refitted bearings are more reliable and more economical in the long run. We commend the work of the accomplished Russian engineer to all whose duty calls them in any way either in the construction or adjustment of the Walschaerts valve gear.

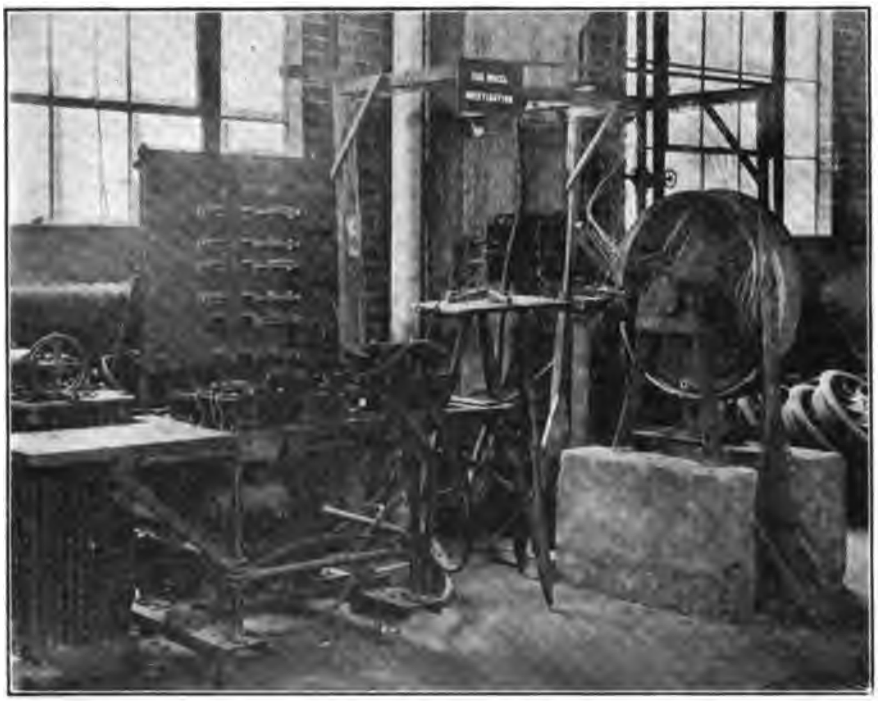
Thermal Stresses in Chilled Iron Car Wheels*

By G. K. Burgess and R. W. Woodward

About six years ago the Bureau of Standards at Washington undertook the investigation of the stresses developed in chilled iron car wheels by heat. The method of heating used was an attempt to produce effects similar to that encountered through long application of brakes on heavy grades.

Chilled-iron wheels have given general satisfaction, even under the present existing conditions of greater speeds and increased stresses due to the use of heavier wheel loads. With the advent of more severe operating conditions there are frequently cases of improper usage in which the car wheels are subjected to conditions much more severe than the service for which they are designed. Through such conditions it is found that occasional failures of chilled-iron wheels occur at the foot of long, steep grades as found in mountainous regions. This particular type of failure is caused by prolonged brake application at high speed and the absence of cooling stations. The effect of long-continued application of the brakes is to heat the tread of the wheel to high temperatures, while the central portion or hub of the wheel remains relatively cool. At points intermediate between the tread and hub the temperature decreases from that of the tread to that of the hub. The rate of decrease, in general, is not uniform and varies at different positions within a wheel. These variations in temperature as caused by brake application induce stress and strain of varying amount within the wheel.

The magnitude of these stresses and strains depends on the rate of heating the tread of the wheel, which in turn is dependent on the brake-shoe pressure, speed of train, kind of shoe, and time applied. When the difference in temperature between the tread and hub becomes sufficiently large, the wheels will crack and occasionally break in parts, with the possibility of derailing the car and wrecking the train. One of the large railroad systems found that in a period of seven months approximately one-fifth of their wheel failures were due to the effects of brake application. As stated above, this type of wheel failure usually occurs through improper usage, and investigation generally reveals either excessive speed with brakes heavily applied when descending long grades, improperly maintained braking equipment, whereby one car does more than its share in retarding the train, or the absence of cooling stations, whereby the train may be stopped and the temperatures allowed to equalize. Although the number of failures of chilled-iron car wheels is relatively small, yet they are of sufficient importance to warrant investigating the strains and stresses that are developed under various operating conditions with a view toward improving the design and harmonizing operating conditions with design. For these reasons it was decided after consultation with representatives of the Association of Manufacturers of Chilled-Iron Car Wheels to conduct at the Bureau of Standards an investigation of the thermal stresses in chilled-iron car wheels.



ARRANGEMENT OF APPARATUS FOR MAKING THERMAL TESTS OF CAR WHEELS

Innumerable problems present themselves in connection with the subject of strain or stress due to brake application; as, for instance, the effect of speed and shoe pressure and length of brake application in producing thermal strain. Accordingly, this investigation has been restricted to the problem of determining the manner in which the thermal stresses build up in wheels and chiefly to determine the relative ability of the various weights of chilled-iron wheels to withstand the effects produced by temperature gradient within the wheel.

Fifty wheels made by three manufacturers were used in these tests. Three types of wheels were used: the Washburn or M. C. B.; the arch plate and single plate. Of these 28 wheels were subjected to the thermal test at the Bureau of Standards. These were given the serial numbers of from 1 to 28 and had the following characteristics:

DESCRIPTION OF WHEELS TESTED AT BUREAU OF STANDARDS

Type	Wheel number	Manufacturer	Weight, pounds
M. C. B.*	1	A	625
Do	2	A	625
Do	3	A	700
Do	4	A	700
Do	5	A	725
Do	6	A	725
Arch plate	7	B	625
Do	8	B	625
Do	9	B	700
Do	10	B	700
Do	11	B	775
Do	12	B	775
Do	13	B	850
Do	14	B	850
M. C. B	15	C	625
Do	16	C	625
Arch plate	17	C	650
Do	18	C	650
M. C. B	19	C	700
Do	20	C	700
Do	21	C	725
Do	22	C	725
Single plate	23	C	750
Do	24	C	750
Arch plate	25	C	775
Do	26	C	775
Do	27	C	850
Do	28	C	850

*Present standard wheels adopted by Master Car Builders' Association are 650, 700, 725, 750, and 850 pound weights of arch-plate type.

*Abstract of paper prepared for the Bureau

METHOD OF PROCEDURE FOR THERMAL STRESS TESTS

In the special thermal stress tests the wheel was mounted on a hollow water-cooled 6-inch axle. The axle in turn rested upon cast-iron and concrete supports, such that the bottom of the wheel was 2 feet 8 inches above the floor. A soft-steel resistor 3½ inches in width and one-fourth inch in thickness was placed on the tread of the wheel, but insulated from it by a thin sheet of perforated asbestos, and an alternating current of 1000 to 1500 amperes at 15 to 30 volts from a 30-kva transformer was passed through the resistor. As the wheel was in an upright position and remained stationary throughout the test, it was readily possible to take such observations as necessary. The front illustration shows the arrangement of this apparatus. It was found possible to bring the resistor itself to a red heat within 5 to 10 minutes. Undue radiation of heat into the air was prevented by the use of asbestos covering. The tread of the wheel attained a maximum temperature of approximately 716° F. in each experimental run.

In order to interpret the results of these tests, it was necessary to determine satisfactorily the distribution of temperature in the wheel from tread to hub. Copper-constantan thermocouples were used—seven couples along a vertical radius at approximately 2-inch intervals and seven others similarly located along the horizontal radius. Readings were taken along both radii for the purpose of obtaining duplicate results. Two other thermocouples were inserted into the treads of the wheel. Thus, four couples, one at the gap in the resistor, were placed at equidistant points in the tread of the wheel and assurance given that uniformity of tread temperature was attained. The 16 copper-constantan thermocouples can be seen in the illustration extending from the wheel to overhead supports and then down to the potentiometer on the transformer table.

A 2-inch Berry strain gage was used for measuring the deformation, six sets of readings being taken at 1-inch intervals on both the vertical and horizontal radii. It will be observed that these readings were taken over a considerable area, this being the only manner of satisfactorily determining the location of the point of maximum stress.

It was only necessary to take a survey of the stresses on the plate side of the wheel (outside as mounted on axle), since preliminary measurements had shown that the stresses on the bracket side of the wheel were of a compressive nature and of relatively small magnitude.

The rate of heat input in these tests was considerably more severe than that found in normal operating service. From the tables that were developed it was calculated that 630,000 foot-pounds of energy are destroyed per minute by the brake on each wheel of a 100,000-pound car in maintaining a constant velocity under the following operating conditions: Descending a 1 per cent grade at 1 mile per minute, or 60 miles per hour; 2 per cent grade at 1 mile per 2.68 minutes, or 22 miles per hour; 3 per cent grade at 1 mile per 4.37 minutes, or 13 miles per hour; 4 per cent cent grade at 1 mile per 6.03 minutes, or 10 miles per hour.

However, the actual test conditions were more severe than these figures indicate on account of the difference in the heat dissipation in the two cases. In these tests the resistor completely encircled the wheel and was thermally insulated to drive the heat into the wheel. Under these conditions a larger percentage of the energy supplied to the resistor entered the wheel than would be the case when the same wheel is subjected to brake application, as occurs in service, due to the fact that part of the energy destroyed by friction between the shoe and wheel goes to heating the brake shoe, and thence by radiation to the air, and, further, the shoe only bears on a small part of the circumference, thus allowing the heat in the uncovered part of the tread to radiate directly into the air instead of entering the wheel.

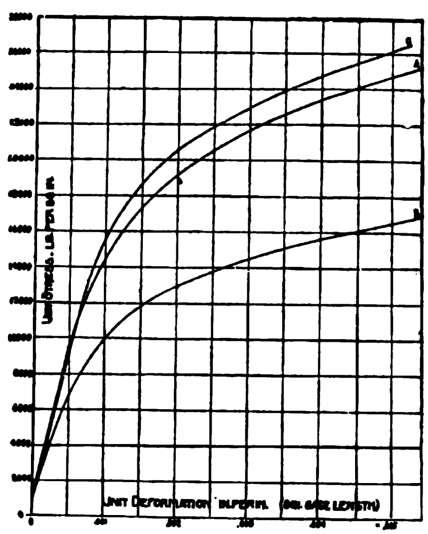
In the Bureau tests the treads of the lightest wheels reached a temperature of 716° F. in about 75 minutes, while it required from 100 to 105 minutes for the heaviest wheels to reach the same temperature. Readings were taken of the temperature, strain, and power input at regular intervals, a strain gage reading of the cold wheel being also taken before the test was started. When the desired tread temperature was reached, the power was shut off and the asbestos covering on the resistor was removed to permit more rapid dissipation of the heat.

It was necessary to make a number of auxiliary tests to supplement and interpret the results of the special thermal tests. These consisted of the determination of the coefficient of expansion, stress-strain curves, chemical analyses and metallographic examination.

The composite coefficient of expansion for the three manufacturers as obtained by careful tests is shown by the following table:

Temperature rise (Fahr.)	Aver. total expansion, in inches per inch calculated by equations, of three manufacturers
90	0.00055
180	.00113
270	.00175
360	.00241
450	.00311
540	.00384

Preliminary runs on some of the wheels had shown the circumferential stresses to be practically negligible. In order to determine the physical properties of the metal of the wheels several specimens were cut out from the wheels from each foundry. For the purpose of computing the stress values in the heated wheels the modulus of elasticity is required, but since cast iron has no such constant modulus when tested in tension the stress-strain curve was determined up to as near rupture as possible and then extrapolated to rupture by the data obtained for the elongation and ultimate strength. Such curves, each the mean of all tests on iron from a given manufacturer, are shown in the illustration of the composite strain curves.



COMPOSITE STRESS — STRAIN CURVES OBTAINED FROM TENSILE TESTS ON SAMPLES OF WHEELS OF THE THREE MANUFACTURERS

The modulus as thus determined was for

Manufacturer	A	17,300,000
"	B	15,400,000
"	C	18,400,000

In the matter of chemical composition of the wheel the analyses showed the ranges of the various elements in the 28 test wheels to be as follows:

	Per Cent.
Total carbon	3.14 -3.70
Graphitic carbon	2.49 -3.06
Combined carbon	0.31 -0.77
Manganese	0.52 -0.77
Silicon	0.54 -0.87
Phosphorus	0.28 -0.41
Sulphur	0.109-0.185

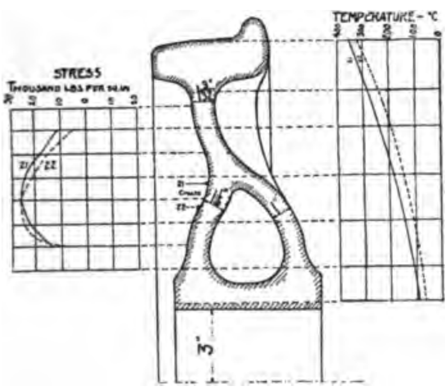
Since the wheels which were tested at the place of manufacture were supposed to be representative of the wheels tested at the Bureau of Standards, and since the former passed the requirements of the American Railway Association specifications, it seems safe to say that apparently satisfactory wheels may be made in which the composition covers the ranges given. It may be stated, further, that by proper control of manufacturing conditions, such as molding, pouring, annealing, etc., the ranges given above can no doubt be enlarged upon.

These statements, however, should not be construed to mean that it is necessary to confine the various elements within the above ranges, because chemical composition is only one of the factors that assist in the production of good wheels.

It was found in the tests that an unexpectedly large number of the wheels developed cracks in the plates. These cracks were circumferential in nature and were all approximately at the same distance from the center of the wheel, namely, 9 inches.

WHEELS FAILING UNDER THERMAL TESTS SHOWING CRACKS

Of the 28 wheels 16, or 57 per cent, developed cracks in the plates. Some of the cracks were barely perceptible to the unaided eye even at the time that the maximum temperature gradient between tread and hub existed and were of very short length, while others developed comparatively early in the test and almost completely encircled the wheel. These larger cracks opened up to about one-sixteenth



CROSS SECTION AND STRESS AND TEMPERATURE GRADIENTS FOR WHEELS OF THE 725 POUND M. C. B. TYPE

of an inch and were, of course, readily apparent. The illustrations shown are typical examples of the cracked wheels. The cracks themselves were marked with white chalk in order to make their location easily visible in the photograph.

The stresses in the 725-lb. wheel furnished by the manufacturer C, is shown in the engraving, and they are of the same general character as in the other wheels tested. In the single-plate wheel, as shown, the stress distribution is decidedly different than it is in the other types. The single-plate type of wheel is a special experimental design and is not used by any railroad.

In order to have the stresses in equilibrium, there must necessarily be tensile stresses near the rim on the opposite or inside of the wheel. No measurements were made to determine the stresses on the inside.

The highest maximum stress measured was 28,400 pounds per square inch, while the lowest stress at which failure occurred was 14,000 pounds per square inch. It is possible that the latter wheel, No. 18, had an internal flaw which accelerated the failure. The maximum stresses observed are in nearly all cases very close to the ultimate strength of the cast iron of which the wheel is composed. Thus, for manufacturer C the stresses are in the neighborhood of 26,000 pounds per square inch, and this material was shown to have a tensile strength of 27,000 pounds per square inch. The wheels from foundry B usually showed stresses around 17,000 pounds per square inch, while the tensile strength was about 19,000 pounds per square inch.

A typical curve showing the manner in which the temperatures build up with time at different positions in the wheel is given for the 700-pound arch-plate wheel No. 3. Couple No. 1, which was nearest the tread, attained a maximum temperature of 651° F. after 95 minutes, and couple No. 7, which was nearest the hub, indicated a temperature of 297° F. This wheel, however, cracked 65 minutes after the start of the test, at which time the temperatures were 554° F. and 196° F. for couples Nos. 1 and 7, respectively. It is evident that these temperature gradients were sufficient to develop stresses in the plate of the wheel reaching the ultimate strength of the iron.

The table classifies the wheels in the order of the temperature of the tread at the time of failure or at the maximum temperature in case cracking did not occur. There is also given the circular length of the crack in degrees, the time at which this crack occurred, energy supplied to the wheel by the electric heater, and the maximum stress resulting from this energy. It will be noticed that those wheels which failed comparatively early with low values of applied energy had very long

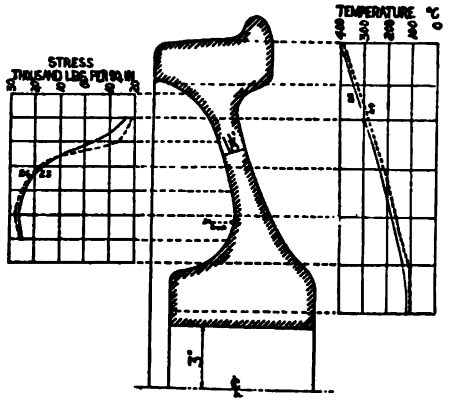
CONDITION OF WHEELS AT END OF HEATING PERIOD OR AT TIME OF CRACKING

Type of wheel	Wheel number	Approximate circumferential length of crack in degrees	Temperature of couple No. 1 (nearest thread), °F.	Temperature difference between couples Nos. 1 and 7 °F.	Maximum stress in pounds per square inch—Estimated amount
625-lb. M. C. B....	1	None	671	478	27,600
	2	None	658	471	23,300
	15	145	500	469	25,900
	16	340	419	340	24,700
625-lb. arch plate...	7	190	597	441	20,200
	8	220	437	309	19,900
650-lb. arch plate...	17	120	469	376	26,700
	18	350	345	289	14,000
700-lb. arch plate...	3	35	586	421	23,300
	4	75	633	473	24,500
	9	None	666	478	17,400
	10	15	613	415	17,100
	19	130	482	358	26,000
	20	130	577	505	26,500
725-lb. M. C. B....	5	None	676	500	24,800
	6	None	671	460	23,800
	21	120	590	417	26,400
	22	210	545	403	26,900
750-lb. single plate..	23	None	727	509	26,900
	24	10	676	468	28,400
775-lb. arch plate...	11	None	680	437	16,800
	12	None	666	405	17,100
	25	None	673	442	23,500
	26	40	577	396	24,800
850-lb. arch plate...	13	None	682	406	17,700
	14	None	649	435	18,300
	27	10	592	437	23,400
	28	None	660	464	24,800

cracks, sometimes nearly encircling the wheel; also, as would be expected, the lighter-weight wheels fail with smaller application of energy than the heavier wheels.

To show the relative ability of different weights of the arch-plate type wheel to withstand the effects of temperature gradients, a special table was also prepared.

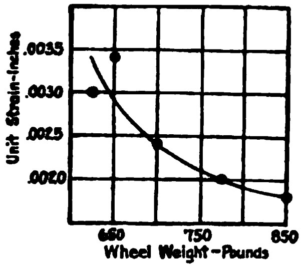
In it are given the unit strains due to internal stress 40 minutes after the start of the tests. The unit strains at that time were averaged as shown for each of the types tested. Then, by using the average unit strain as found in the 625-pound M. C. B. type of wheel as a basis for comparison, the relative average strains at the end of 40 minutes of heating are given in the table. It is evident that the 850-pound M. C. B. (arch plate) was best able, while the 750-pound single plate was least able



CROSS SECTION AND STRESS AND TEMPERATURE GRADIENTS FOR WHEELS OF THE 750 POUND SINGLE PLATE TYPE

to withstand the special Bureau thermal test. In the case of the single-plate wheel this does not necessarily indicate that this type would be least satisfactory in service, as was indicated above. By plotting the average unit strain against the weight of wheel adapted for the arch-plate pattern the effect of the additional weight becomes apparent. Since only two 625-pound and two 650-pound arch-plate wheels were tested and each of these types were furnished by different foundries, the averages given for them should be given less weight than the remaining three weights, namely, 700, 775 and 850 pounds. Taken from the curves developed the relative strains for the arch-plate type of wheel are as follows:

625 pound	100
650 "	86
700 "	69
775 "	57
850 "	51



RELATION OF STRAIN TO WEIGHT FOR ARCH—PLATE WHEELS OF VARIOUS WEIGHTS

There is also a further indication that a certain amount of metal does more good when added to the lighter weight than it does when added to the heavier weight wheels. In addition, it will be noticed, that at 850 pounds the curve is rapidly approaching the horizontal. This indicates that if the weight were still further increased a weight would be reached at which additional metal would have little effect toward enabling the wheel to withstand brake application.

Preliminary tests show that the stress in a tangential direction on the outer face and also the stress in both the radial and tangential direction on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M. C. B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. This seems a desirable condition in that it then lies in the region where it is counteracted by the strains due to forcing the wheel onto its axle.

The tests also lead one to believe that the operating conditions to which wheels are subjected may be as important a factor in the safety of the wheel as are the problems arising in their manufacture.

By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels. It seems conceivable, however, that a wheel may be made where increased weight will not aid the wheel to withstand brake application. Such weight, however, is beyond the weights in use today.

The Railway Chief Clerk—His Problems, Duties and Required Qualifications*

By H. A. Balkwill, Car Accountant, Grand Trunk Railway System, Montreal, Canada

The modern railway is of so complex a character and the chief clerk is such an important part of the organization that we cannot hope to deal fully with our subject in the time alloted to us. We are aware that in claiming such an important position for the chief clerk, a very prominent railway man some years ago declared the position illogical, mainly on the ground that no man can sign another man's name without a "dishonest violation of the fundamental laws of matter." It is respectfully submitted, however, that the position of the chief clerk, not only before, but since this statement was made, has proved its worth, and granting his place in the modern railway organization, there can be no doubt in respect to his responsibilities. This problem will, of course, like responsibilities, be governed by the size of the staff over which he has control, as well as the nature of the peculiar duties of the office with which he is connected. We will endeavor to show that the qualifications necessary for a successful chief clerk are those which all of us must possess to some degree if we are to play our part in life with any resultant credit.

It is, of course, a fundamental truth that no man can serve two masters. The modern chief clerk in a large railway office, however, successfully upholding his chief to the benefit of the company by demonstrating to his fellow employees that his selections for the various tasks are in line with justice and the legitimate demands of their employer, has as closely approached this impossible task as can well be expected of any man and has thereby solved one of the most, if not the most, important problems confronting him. The problem we refer to is that of securing an organization, for it is a fundamental that team work will give results greatly in excess of uncontrolled individual effort. As the ability of each employee differs in degree, it is absolutely necessary that they be assigned to the various tasks, so as to become an efficient whole, thereby securing the maximum of service for the company. The wise employee will admit the truth of this statement, as an unorganized staff or a staff not properly organized will require a large number of employees with a possible decreased output and it does not necessarily follow under such conditions that the company alone will be the loser. The problems generally confronting the chief clerk in some of the more important railway offices are as varied as the ramifications of the road itself, and if he is successfully to measure up to his responsibilities, he should have a general knowledge of matters affecting every ac-

*Read before the Canadian Railway Club in Montreal at a recent meeting.

tivity of his railway as well as the work of his own particular office. The majority of employees are conscientious, not merely time servers, but, being human, dislike and resent apparent injustice. A successful chief clerk will, therefore, see that his fellow employes receive justice, with courteous treatment, for courtesy will ever bring large dividends in the dealings of every day life. We can all possibly recall men eminently just, but so harsh in manmer as to largely counteract the justness of their actions. I have endeavored to stress the important facts confronting the chief clerk, that he must secure for his company efficient as well as cheerful service, by wise selection, firm and courteous bearing, so that both he and his fellow employees will be dividend producing advertisers for their road, instead of being merely 8-hour day clerks. A disgruntled employee is not a profitable investment during office hours, and may by his "knocking" both at home and in society become a positive liability.

If the duties of a chief clerk bring him in touch with the public, his problems as well as his responsibilities are necessarily increased, as the particular problem then confronting him is to satisfactorily meet the demand of those whose knowledge of the difficulties concerning railway operation must of necessity be limited, and while a great majority of the public are fair and broad-minded, still there is always a considerable portion to whom the one and only important matter before the railway is their particular case, and no allowance will be made for any failure to measure up to the standard set up by them. In fact cannot we railway men recall a similar attitude of mind towards commercial houses when to us they have most inexcusably failed in service.

The wise chief clerk will also always bear in mind the telephone is probably the most important point of contact with the public, and will carefully mark the manner in which the public is approached by this avenue. Even an unwise answer over the phone will leave a feeling of irritation and may result in the shipper listening to the wiles of the other road's solicitor. Of course there is as much human nature in the public as in railway employees and occasionally the employee is hard put to it to control his temper. In such an event he should be trained to turn the customer over to the chief clerk, whose larger experience will generally win the day. Do not let us forget that while a soft answer will turn away wrath, a wise answer in the first instance will obviate the necessity for the soft answer later on.

No endeavor has been made to draw a sharp distinction between the responsibilities, the problems and the qualifications of a chief clerk, as it is somewhat difficult to separate them into their component parts and our purpose will be equally served if we do not attempt to draw too sharp a distinction. If, therefore, we are prepared to admit the responsibility attaching to the position, it logically follows that the problems add to the responsibilities, and the responsibilities are because of the duties confronting the occupant of the office.

The heads of some offices are of necessity absent from headquarters a considerable portion of each month; the chief clerk then becomes in the full sense of the term the "assistant" and must shape his actions so that the best interests of the company as laid down by his head will be fully served. This emphasizes the necessity for practical knowledge of all of the details of the work coming under his supervision, so that urgent and unexpected demands for special information, or statistics, in which time is a vital essential, can be fully complied with.

Of course, chief clerks being only human we sometimes find that the possessor of the title has magnified the importance of his position and has assumed responsibilities out of all proportion to their real value; then is the unfortunate caller overawed by the magnificent presence and regal manner and if he does not feel that his business demands an interview with the head, he frequently leaves that particular office fighting mad with a desire to get even with the cause of his irritation. If, however, the caller finds it necessary to see the head of the department, he draws his first assured breath only on being admitted to the private office, feeling that he has come in contact with the fallible human being.

On the other hand we have the timid chief clerk, a man afraid to shoulder responsibility and apparently unable to reach a decision even in matters of every day detail. Such a one is greatly bothered by a request for a prompt decision, and usually asks that the matter be submitted in writing, so that careful consideration may be given to it. Of course, such a chief clerk has his value to the pulp and paper industry, as many a file of correspondence is started on its innocent way to assume large proportions simply as the result of the timid chief clerk. Again we have the offhand chief clerk, the bright, snappy, optimistic fellow to whom all things are possible and who will promise practically everything requested, but whose promises must of necessity fall short on many occasions. It is a source of satisfaction, however, to note that such varieties of chief clerks are becoming rare, necessarily so, as modern business has no room and cannot afford time for self glorification, undue timidity or reckless optimism.

As against the foregoing, let us recall with pleasure the competent chief clerk encountered in so many railway offices, whose quiet manner, supported by an intelligent grasp of the subject, leaves you with a feeling of respect, not only for the chief clerk as a man, but for the office of the road he represents.

In considering the qualifications required by the really successful chief clerk, we could, of course, sum it up in the one word, efficiency. This word has, however, been overworked and does not completely define the qualifications considered necessary and it will, therefore, doubtless prove profitable to consider the matter in more detail. A certain railway man of this continent, in an endeavor to bring himself prominently before the railway public, has stated he possesses the qualifications of being "viciously ambitious and yet cautious and determined." Without ambition, advancement cannot, of course, be achieved, but we fail to comprehend why a man should claim viciousness as a virtue necessary to advancement. Viciousness must necessarily be a handicap even to the "cautious and determined" man. We would strongly advise my ideal chief clerk to purge such a poison out of his system without delay. Would not the better motto be "Ambition controlled by fairness and aided by determination."

As the ideal chief clerk I would picture a man mentally alert, with a broad understanding of humanity, whose heart is kept in proper control by his reason. In such a person we will expect to find, and will find enthusiasm, for enthusiastic leadership will turn many an apparent defeat into victory. With it the morale of the staff will be raised to a high level, and will be consistently maintained, resulting in more efficient service. In fact we would place enthusiasm properly controlled close to the top of the qualifications required by the successful chief clerk. We have, however referred previously to the necessity of the chief clerk securing cheerful as well as efficient service. This of necessity involves a systematic arrangement of the work, but system must not become a fetish, otherwise the results will not be those hoped for. These two qualifications, viz., enthusiasm and system, necessarily imply the faculty to plan. If, therefore, we are prepared to admit that enthusiastic leadership and systematic arrangement of the office are essentials to the career of a successful chief clerk, it necessarily follows that the possessor of these two important attributes must likewise possess the power of seeing, to a certain extent, into the future, and be able to plan for today, so that tomorrow's changes may be taken care of without serious derangement of the main plan of the organization. Thus enthusiastic leadership, aided by judicious system, strengthened by foresight, will go far towards success, and the office so blessed with a chief clerk possessing these attributes will rank high in the organization of any road. In fact a staff of average ability, under such conditions, will give better results than one depending rather on the outstanding abilities of the few, hindered more or less by the unintelligent efforts of the many.

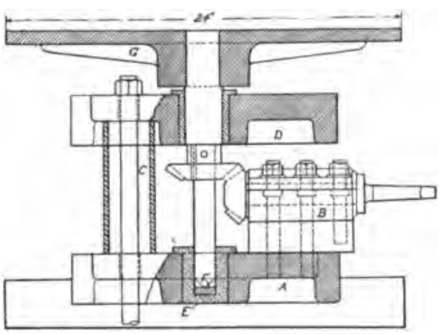
New and Improved Shop Devices for Railroad Work

Dry Pipe Grinding Apparatus—Clamp for Babbitting Compound Cross Heads—Air Motor Rack—Tools for Finishing Cylinder Cocks

Dry Pipe Grinding Apparatus

The grinding in of the dry pipe head is usually a hand job and one that takes more time and hard labor than looks well on the time sheet. There is a simple device in use in the Peru, Ind., shops of the Chesapeake & Ohio of Indiana, whereby an air or electric motor is made to do the work. A vertical cross-section of the device is shown in the accompanying engraving.

In this there is a cast iron base *A* set upon and bolted to a concrete foundation. This base is faced off on its upper surface to take the shaft bearings *B* and the separators *C* on which the ring *D* for the upper bearing rests. A brass step bushing *E* is inserted in the hole in the base, which serves the double purpose of a seat for step of the vertical shaft and a bearing for the same. The end of the shaft is coned and is stepped in a center in a hardened steel bearing *F*. The upper end of the shaft carries the grinding table *G* which is 24 ins. in diameter. It is faced off on its upper surface to receive the tee to be ground. The plate is ¾ in. thick, strengthened by ribs to the hub as shown. The ring *D* is for the sole purpose of carrying the bushing which serves as an upper bearing for the main shaft. The separators *C* are of steel tubing, 8



DRY PIPE GRINDING APPARATUS

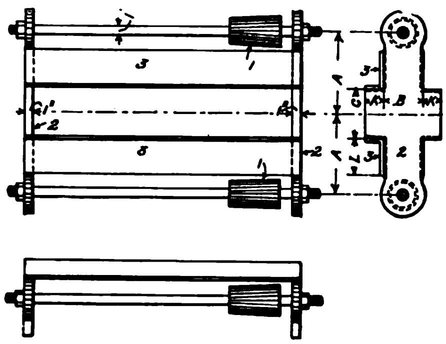
ins. long and the two pieces, *A* and *D*, are tied together by 1 in. bolts.

A miter gear is pinned to the vertical shaft just below the upper bearing and serves as a shoulder to prevent any lifting of the shaft out of its step. The mate to the miter gear on the vertical meshes with one on a horizontal shaft running in the bearing *B*, and terminating in a No. 3 Morse taper shank having a taper of .602 in. per foot. This horizontal shaft is 1¼ ins. in diameter.

In operating the device the tee to be ground is bolted to the upper face of the revolving table *G* and the dry pipe is suspended above it by a chain hoist attached to a jib crane. The work done is rapid and, of course, accurate.

Clamp for Babbitting Compound Crossheads

At one time the Erie Railroad had a number of four-cylinder compound locomotives in use, and a clamp was designed



CLAMP FOR BABBITTING COMPOUND CROSS HEADS

for holding them while the bearings were being babbitted. The general design of the device is so flexible that it is here presented as a suggestion for such modifications as may be necessary in order to adapt it to other types of crossheads.

It consists of two templates (2) made of plates 1" thick and having the contour or outline of a cross section of the guides of the engine against which the babbitted bearings of the crosshead come in contact, and with holes for the 1" clamping bolts which are spaced at the same distance apart as the two piston rods. In the forming of the template the dimensions that are indicated by the letters from *A* to *L*, are varied to suit the dimensions of each engine.

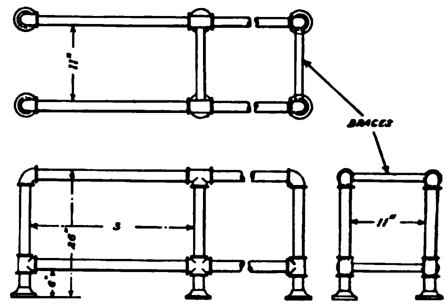
The clamping bolts are finished and 36 ins. long and have the coned plugs (1) sliding over them. The templates are also finished on the edges representing the guide outline and on the inner faces that bear against the crosshead and the conical plugs when babbitting is being done.

To use the device the right hand template and the plugs are removed from the bolts and the latter run through the piston rod holes. The plugs, which are turned to fit the taper of these holes, are then put into them; the right hand template is put in place and the nuts on the clamping bolts tightened until the crosshead is held tightly between the left hand template and the plugs. The angle pieces (3) are then set upon the templates and clamped in place, when the babbitt is poured. These angles are, of course, finished and one set is sufficient for all classes of crossheads. The dotted lines along the dimensions indicated by *C, B, K, L*, etc., indicate the outlines of the paces of the crosshead when it is in place.

Air Motor Rack

Instead of strewing the portable air or electric motors over the floor or on shelves it is well to give them proper supports and a suitable abiding place. Such a place is suggested by the accompanying engraving of a rack that is in satisfactory use. Its construction is so clearly shown that it needs little explanation.

It is made of 1 in. pipe and fittings, with the exception of the cross braces which are of ½ in. pipe. It is easily made and can be of any desired length. The only recommended dimension is the distance between the vertical supports, which should not be much more than 3



AIR MOTOR RACK

ft. in order to avoid a sagging of the horizontal lengths upon which the motors rest.

Tools for Finishing Cylinder Cocks

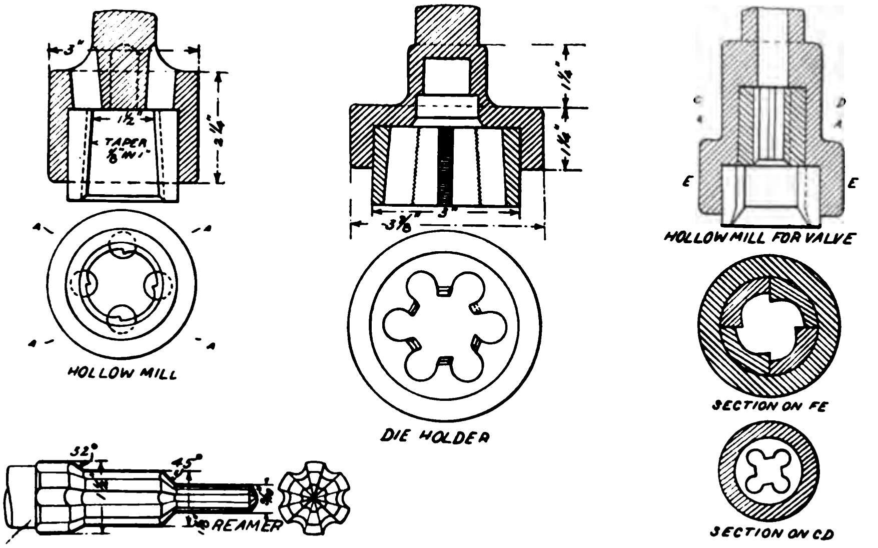
To finish cylinder cocks on an ordinary brass finishing lathe is a slow job as compared with the closing of the work on a turret lathe with a proper equipment of tools and holders. In the case under consideration the sue of the tools shown in the accompanying engraving cut the cost of the work down from 25 cents to 7 cents. For the shell of the cock there are three tools: one for turning the shank, a second for threading it for screwing into the cylinder and a third for seaming out and finishing the interior with the valve seats.

The first is the hollow mill. The holder has a shank made to fit the turret and is countersunk to receive the reamer, which is held in place by four ⅜-in. headless screws indicated at *A*. The interior cutting edges of the mill have a taper of ⅛-in. in 1 in. and when this is run down over the shank of the revolving shell of the cock the shank is finished for threading by the dies in the die holder. The die holder is of similar construction to the holder for the hollow mill, and will also take a 1¾-in. die. This finishes the shank of the cock.

The shell is finished by the reamer, which will be held in a third holder in the turret, so that three rapid movements finish the shell.

The valve is first finished from a solid rod by the hollow mill made for that purpose and then cut off.

As has been already stated this has so simplified the work as compared with its performance on an ordinary high-speed lathe that the cost of production has been reduced to less than one-third.



TOOLS FOR FINISHING CYLINDER COCKS

The International Railway Fuel Association

The fourteenth annual convention of the International Railway Fuel Association was held in the Auditorium Hotel, Chicago, Ill., May 22-25, 1922. The attendance was unusually large, several of the leading railroads sending delegations of enginemen who have made excellent records in fuel saving during the year. President W. L. Robinson, superintendent of fuel and locomtive performance of the Baltimore & Ohio, in his opening address pointed out the distinctive character of the membership and the work on which they were engaged in promoting the best methods of the economical use of fuel in railroad service. To this end the association had been established, and the educational work already accomplished was the best guarantee of the need of going on in the good work in which they were engaged, keeping in view the constant aim to reduce fuel costs by means of an interchange of personal experiences to which the best and brightest minds engaged in the laudable work were contributing.

The number and variety of subjects treated of were the largest and most comprehensive hitherto attempted by the association, embracing the following: "Report of Standing Committee on Firing Practice,"—chairman of committee, M. A. Daly, General Fuel Supervisor, Northern Pacific; "Fuel Conservation from the Standpoint of a Division Superintendent," —S. U. Hooper, Superintendent, Baltimore & Ohio; "Fuel Conservation from the Standpoint of a Representative of Department Operating Coaling Stations,"—W. S. Burnet, Division Engineer, M. of W., C. C. C. & St. Louis.; "Locomotive Engineer,"—C. J. Barnett, Locomotive Engineer, Illinois Central; "The Effect of Tonnage Rating and Speed on Fuel Consumption,"—J. E. Davenport, Engineer of Dynamometer Tests, New York Central; "Locomotive Fuel—the Life Blood of Transportation,"—G. M. Basford, Consulting Engineer, Lima Locomotive Works; "Incentives for Promoting Fuel Economy—A Survey of existing and Proposed Practices,"—O. S. Beyer, Jr., Consulting Engineer; "Report of Standing Committee on Front Ends, Grates and Ash Pans,"—chairman of committee, Prof. E. C. Schmidt, Professor of Railway Engineering, University of Illinois; "Report of Standing Committee on Fuel Accounting," —chairman of committee, J. N. Clark, Chief Fuel Supervisor, Southern Pacific Lines—Pacific System; "Educational Work Along Fuel Economy Lines,"—D. C. Buell, Director, Railway Educational Bureau; "Idle Day Costs,"—E. S. Peabody, chairman of the Board, Peabody Coal Company; "Effect of Circulation on Locomotive Boiler Efficiency,"—F. G. Lister, Mechanical Engineer, El Paso & Southwestern; "The Various Items of Saving by Using a Better Quality of Coal,"—Earl Cobb, President Southwestern Coal Company; "Colloidal Fuel,"—Linden W. Bates, Mt. Lebanon, New York; "Assigned Cars for Railroad Fuel," —C. G. Hall, General Manager, Walter Bledson & Co.; "Report of Standing Committee on Storage Coal,"—chairman of committee, Prof. H. H. Stock, Professor of Mining Engineering, University of Illinois; "Locomotive Fuel as a Comparative Performance Unit for Different Railroads,"—Harrington Emerson, the Emerson Engineer; "Report of Standing Committee on Fuel Statistics,"—W. E. Dunham, chairman of committee, Assistant Superintendent, M. P. & M., Chicago & North Western; "The Government and the Coal Industry,"—T. H. Watkins, President, Pennsylvania Coal & Coke Corporation; "The Relation of Overdevelopment of the Bituminous Coal Industry to Transportation,"—C. E. Lesher, editor *Coal Age;* "Standard Form of Contract Covering Purchase of Railway Fuel,"—W. J. Tapp, Fuel Supervisor, Denver & Rio Grande Western.

It may be readily imagined that the presentation of the papers and the discussion arising from the same occupied lengthy sessions during the four days of the meeting. A brief abstract of the papers would not be doing justice to the important subjects or the masterly manner in which they were handled. We will reprint some of them in the near future, and doubtless the entire proceedings will be issued in a volume before the end of the year.

Coincident with the meeting a number of railway supply companies made interesting exhibits, among which was the type of exhaust steam injectors recently applied to five locomotives on the New York, Ontario & Western. Moving pictures furnished excellent illustrations in relation to the coal industry and economy. The election of officers resulted as follows: President, J. N. Clark, chief fuel supervisor, Southern Pacific; vice-presidents, P. E. Best, fuel engineer, Delaware & Hudson Company; M. A. Daly, general fuel supervisor, Northern Pacific, and J. W. Dodge, transportation inspector, Illinois Central. Secretary-treasurer, J. G. Crawford, Chicago, Burlington & Quincy; address, 702 East 51st St., Chicago, Ill.

Alternating Current

In alternating current systems the electricity does not always flow in the same direction, but instead it travels in one direction, and then reverses and travels in the opposite direction, this reversal taking place many times a second. The rate of speed at which the current reverses is called the frequency, and when 60 cycles is mentioned, it means that the current makes 60 complete reversals in one second.

We find an analogy for this reversing of the current in the swinging of a clock pendulum. We know that the speed of the hands depends upon the number of swings or reverses the pendulum makes in a definite period of time. The same principle holds true in nearly all types of alternating current motors.

Snap Shots—By the Wanderer

There was a time, which some of us can remember when the idea prevailed among manufacturers that a warm and comfortable shop in the winter tended to produce laziness and indifference among the workmen; while a heatless building built up energy and the men would work harder in order to keep warm. That notion has been pretty well exploded and in its place has come the one that cheerful, comfortable surroundings are good investments and pay satisfactory dividends.

Observation shows that human nature does not differ much in its fundamentals in the several walks in life. So if comfort is an aid to production in the shop, why not out of doors also?

Broken stone at the bottom, with a covering of cinders or a bed of cinders alone, makes a good foundation for a path, and one that dries quickly. It is probably for that reason that it is used so almost exclusively for railroad yards.

But, of all the disagreeable things to walk on, to stand on, to work on, the cinder bed and the cinder path is well in the lead. In summer it is so hot that the feet of its frequenters are blistered and burned, and in winter and summer it is unpleasant to walk upon. Nobody likes it. The point raised is whether men who must continually walk upon an uncomfortable path will walk as rapidly and work as well as they would if there were something pleasant beneath the feet. What is wanted is something that dries quickly, is soft to the foot, will not get overheated, will not get muddy, will work down to a smooth surface and will not require much attention to keep it in order.

Isn't it worth thinking about? It is the shop for hundreds of inspectors and yard men, and they will all bear testimony to the uncomfortableness of it.

The path between tracks is not wide enough to let two men walk abreast, so the footway may be very narrow. Here is a suggestion. Use the present cinder bed as a foundation and then along the center of the path sprinkle a thin layer of earth free from pebbles. Let the layer be just enough to fill in between the top strata of cinders but not deep enough or wide enough to hold water. This will quickly bed down to a smooth hard path, very elastic to the foot, free from a disagreeable tendency to get hot and a vast improvement on the crunching, sole wearing, sole burning black cinders that we are now accustomed to. And the man who has to walk eight or ten miles a day up and down between the tracks will appreciate the difference in his foot-feel at night. And if his foot-feel is better, there is every reason to argue from analogy that his foot pace will be faster. In any event, there is room for a big improvement over the present cinder path between the tracks.

And speaking of comfort, why not try and extend it to train crews? There was a time when the caboose at the rear of a freight train was the ideal place in which to travel. The trains were short, but long enough to be far enough away from the engine to avoid the smoke. Then, with the brakes gently set at the rear and the train stretched, the abnormal slack of the link-and-pin couplers caused no inconvenience by its running in or out, and a ride in the old cupola was one of ease and enjoyment.

Our first real introduction to slack was at the Burlington tests when Mr. Rhodes introduced us to the fifty-car train and its capabilities as a shock producer. Unfortunately his introduction did not also include a shock absorber. But the jars set up in those Burlington cabooses, and the long slips of the improvised slidometer to tell us how hard we had hit or been hit, have not let up to the present day. We all recognized that a trip in the caboose on one of those tests was an extra hazardous occupation, as the insurance men would say. But that was an event, an occasion for which we prepared ourselves; but now a caboose ride is a continuous performance, with all the variants from a delightful drift to stop to a genuine collision, with the common accompaniments of cracked skulls, broken bones and bruised flesh.

There is a theory that whatever is desirable can be attained. So a more comfortable, not to say a safer caboose is desirable and, if the premise be true, should be attainable. Where the trouble lies need not be discussed here, but if it were to be found it certainly ought to be removable. I have already suggested a remedy for one discomfort, the cinder path, and in order to leave an open field for other suggestors I modestly refrain from giving a remedy for this one. Probably, the reader will say, because I have none. Well! Perhaps he is right.

This is no argument for molly-coddling. No man who works a freight train can be molly-coddled to any great extent, unless he be, perchance, the man who makes up the last of the full crew, and is given an armchair and told to occupy it until he reaches his terminal. But, if slack runs in, in the meantime all suggestion of molly-coddling vanishes. Molly-coddling? Oh yes, there is a lot of it on a freight train run. The crew is molly-coddled into dragging a chain a half mile on a winter's night to connect two cars that parted company. Or the flagman is having a joyous picnic as he goes back with a flag in the midst of a thunder shower. And it is an occasion of hilarity to work over a hot box in the midst of a blizzard. While bucking a snow bank is a school boy's frolic, to see the arching clouds of frozen vapor fly before the speeding plow; unless the plow gets stalled. These are merely invigorating exercises, in which the body delights to play.

But, somehow, my recollection runs back to the time when I was a boy, and after a day's hard play with my sled or on my skates, and with the blood bounding through my body, as the resultant of the cold and exercise, somehow, I say, the warm house, and later the snug bed did seem very nice and comfortable and good. So I am inclined to think that if the men who have been out with a flag, or on the chain gang could come back to a comfortable and easy running caboose, free from the fear of incipient collisions, it would seem very good indeed. And the probability is that they could stand a whole lot of that sort of molly-coddling without experiencing any dangerous sort of deterioration in their morale or their alertness on the job.

Why shouldn't the safety first men take up this as propaganda? Isn't it really a case of the loss of a horse shoe nail being the immediate and direct cause of the loss of a nation? Doesn't the alertness of the flagman depend on his physical condition, and doesn't his physical condition depend on his physical comfort? So in an environment of physical discomfort his alertness falls below par, he doesn't "get back," and the more of a passenger train pilot pokes in beneath the train he was supposed to protect, but didn't; and safety is scattered to the four winds of heaven and distributed over the four adjacent tracks. Yes! It looks very much as though the safe operation of a passenger train over a division might well depend on the physical comfort of a couple of men in the caboose. It isn't at all a far cry.

Someone has said that there are very few fundamental principles governing the operation of natural laws. Why not make the same statement regarding the laws governing the actions of humans? Then apply the law of a comfortable shop as affecting the rate of production, all down the line, and if it does not land you as an advocate of an easy walk between tracks and a comfortably riding caboose, then my teaching of the logic of the case is sadly at fault.

OBITUARY

George D. Brooke

George D. Brooke, formerly superintendent of equipment and machinery of the Iowa Central & St. Paul, died last month at his home in Minneapolis. Among other notable engineering work Mr. Brooke was selected as assistant engineer in the Panama Canal Zone by Chief Engineer J. F. Wallace, and latterly acted in the same capacity under J. F. Stevens and General Goethals. Besides his arduous work as assistant chief engineer he had charge of field and shop work in all that pertained to motive power and machinery.

Edward A. Williams

Edward A. Williams, for many years associated with several of the leading railroads as mechanical superintendent, died at Glen Ridge, N. J., in the seventy-fifth year of his age. Mr. Williams served an apprenticeship in the machine shops of the Chicago, Milwaukee & St. Paul. He was promoted to various positions on some of the Western roads and was for a number of years mechanical superintendent of the Minneapolis, St. Paul and Sault Ste. Marie, with headquarters at Minneapolis. In 1901 he was appointed superintendent of rolling stock of the Canadian Pacific with headquarters at Montreal. In 1904 he was appointed assistant general manager of the Erie, and latterly general mechanical superintendent from which he retired in 1907.

Alfred W. Gibbs

Alfred W. Gibbs, chief mechanical engineer of the Pennsylvania, died on May 19, at Wayne, Pa., in the sixty-sixth year of his age. He graduated from the Stevens Institute of Technology in 1878, and served a special apprenticeship in the Altoona shops of the Pennsylvania. In 1881 he became a draughtsman for the Richmond & Danville, and was rapidly promoted to the position of master mechanic, and in 1890 was appointed superintendent of motive power of the Central of Georgia. Returning to the Richmond & Danville as master mechanic he was shortly afterwards appointed to a position in the engineering department of the Pennsylvania, and in 1902 was appointed superintendent of motive power of the Philadelphia, Wilmington & Baltimore, latterly a subsidiary of the Pennsylvania. In 1903 he was appointed general superintendent of motive power of the Pennsylvania, and in 1911 was appointed to the then newly created position of chief mechanical engineer, which position he occupied at the time of his death. Among other important work Mr. Gibbs superintended the series of tests incident to the selection of the design of the electric locomotives specially constructed for the electrification of the Pennsylvania railroad in the vicinity of New York and Philadelphia. He was an occasional contributor to the leading engineering and scientific journals, and was chairman of the advisory committee of the Locomotive Cyclopedia. He was prominently identified with many engineering societies, including the Mechanical Division of the American Railway Association, and was for many years a manager of the Franklin Institute of Philadelphia.

Canadian Railway Club

The annual meeting for the election of officers of the Canadian Railway Club was held at the Windsor Hotel, Montreal, on May 9. The attendance was large, and the election resulted as follows: President, G. M. Wilson, superintendent of motive power shops, Grand Trunk, Montreal; first vice-president, H. R. Taylor, assistant works manager, Angus Shops, Canadian Pacific; second vice-president, C. E. Brooks, mechanical superintendent, Canadian National, Toronto. The retiring president, Arthur Crompton was presented with a jeweled emblem as a souvenir of his term of office.

Annual Report of the Westinghouse Electric and Manufacturing Company

The annual report of the Westinghouse Electric Manufacturing Company shows that in spite of the adverse conditions of the past year, the sales amounted to $99,722,026.09 and the cost of sales $93,461,846, leaving a net manufacturing profit of $6,260,180.09. Other income and deductions on account of sundry indebtedness left a net income available for dividends and other purposes of $5,837,388.66. The company possesses an inventory of $55,000,000. This is the largest volume of business handled by the Company except during the war period. A substantial improvement is shown during the first three months of the present year. The report closing on March 31 shows that in addition to the very favorable indications for an increasing demand for the regular line of the Company's products, a large demand for radio telephone receiving apparatus has developed with a prospect of its continuance for an indefinite period. In this latter industry doubtless the competition will be keen, but the Company has acquired a substantial interest in the capital stock of the Radio Corporation of America, and the demand for Radio receiving apparatus has already reached large proportions by the establishment of Radio broadcasting stations at Newark, N. J., Chicago, Ill., Springfield, Mass., Pittsburgh, Pa., and further additions are expected to be made in various sections of the country.

United States Labor Board Orders a Cut from Pay of Rail Workers

A decision was reached by the Labor Board on May 27, directing a reduction of 13.2 per cent in the wages of railway maintenance of way of employees, effective July 1. The decision announced affects approximately 400,000 employes. It is reported that other Labor Board orders involving all other classes of railway labor excepting the train service and yard employes will be issued in time to become effective July 1 also. If their predictions are fulfilled the scale of wages will be put back approximately to where it was before the increase in May, 1920. The decision was concurred in by the three public members and the three railroad members of the board. The three labor members dissented on the ground that the pay now prescribed does not represent a living wage.

Average Wages of Railway Men

The railroads of the United States had 1,552,014 employes in January, to whom was paid $205,178,639, according to statistics just made public by the Interstate Commerce Commission.

This was a decrease of 85,137 employes, compared with the total for December, and 252,808 less than were reported for January last year.

In December last, the railroads had 1,637,151 employes, to whom were paid $214,921,396 in compensation.

The decrease in employes in January, compared with the preceding month, was principally due to a reduction in the maintenance forces.

The average earnings of all employes in January, according to the Commission, was $176, including overtime, while in December the Commission shows that the average was $172.

Railroad Expansion Limited Since 1914

The increase in both the freight and passenger business of the railways was larger in the seven years ending with 1920 than in the seven years ending with 1913, being in each period about 40 per cent.

In the seven years ending with 1913, however, the total locomotives owned by the railways increased 23½ per cent and their total tractive power increased 50 per cent, while in the seven years ending with 1920 the number of locomotives increased only 2.3 per cent and their total tractive power only 23 per cent.

In the seven years ending with 1913 the total freight cars in service increased 24 per cent and their total capacity 47 per cent, while in the seven years ending with 1920 the total freight cars in service increased only 2 per cent and their total capacity only 13½ per cent. The railway mileage of the country increased 30,000 miles in the seven years ending with 1913. It increased practically not at all in the seven years ending with 1920.

NEW PUBLICATIONS

Books, Bulletins, Catalogues, etc.

Railway Accidents in Canada

We are in receipt of published statistics showing a very gratifying decrease in the number of casualties on the Canadian railways. The total number of accidents reported during the year 1921 show 243 persons killed and 1928 injured. In 1920 there were 254 and 2,330, respectively. Of these 4 passengers killed and 240 injured is the record for 1921, out of over 51,000,000 people carried on the railways of Canada. During the year there were 91 employes killed and 1,344 injured in a total of 185,000 employes on the railways. One significant factor is the large number of motor accidents; over 50 per cent of the highway crossing accidents were motor accidents, while 80 per cent of those killed and about 70 per cent of those injured are found in the column of motor accidents. In some of these accidents automobiles were driven at a high speed into trains that were standing at the crossings! If the drivers had only the horse power of common sense that the motors have in force there would be fewer disasters.

Coal Washing Studies

The Bureau of Mines reports that field studies have been made in Pennsylvania regarding the preparation and particularly the weighing of both anthracite and bituminous coal. In addition special attention was given to two new coal cleaning processes now being tried out on anthracite, the Conklin-Elmore and the Chance processes. Methods for the utilization of culm were examined. In the bituminous fields, the use of tables and dewatering pits were studied.

Airco Cutting Tools

The Air Reduction Sales Company has issued a new catalogue leaflet describing its Airco "D" cutting tools. The various features in the design and construction of this improved apparatus are described. Tables are added giving the thickness of metals that can be cut, the pressures of oxygen and acetylene necessary, and the gas consumption per hour when using tips adapted to the cutting of steel, cast iron or rivets. The details of the cutting tools are finely illustrated. Copies of the leaflet may be had from the main office, 342 Madison avenue, New York, Airco District offices.

The Commonwealther

The Commonwealth Steel Company's publication for April-May has all the elegant freshness of a Spring pic-nic programme. The welfare of the employes seem to be nearer the hearts of the clever editors than the usual trumpeting of the superiority of manufacturers' products, which is so common in house organs. We note that one of the Commonwealth's well-chosen mottoes is—"Praising yourself to the skies is not going to get you there." Of course, the Commonwealthers' handiwork as expressed in passenger car trucks that have become standard on most of the leading railroads of the United States may be said to be beyond praise. Another excellent feature of the fine number is the serious attention bestowed on "Safety," which is accompanied with original safety bulletins.

Carborundum Is Starred in the Movies

A moving picture is abroad in the land showing how carborundum is produced at the temperature of 4,000° Fahr. In addition to filming the method of production no less than 58 industries have been utilized to obtain scenes illustrating carborundum on the job in its various uses. It is universally conceded to be the most comprehensive industrial picture ever filmed. It is being extensively exhibited. It will be used by the government in the campaign started by Secretary Hoover to use movies as a means of creating foreign markets for American products. Not only so, but those who cannot afford to go to Niagara Falls in a Pullman car can see the Falls in all their amazing colossal splendor as reproduced by the enterprising company, whose extensive works are located at Niagara Falls.

Texaco Gasoline

There are varieties in gasoline as in almost everything else. It may not be generally known that during the last ten years the consumption of Texaco gasoline has increased from 160,000 to 1,000,000 a day. The demand is so insistent as to compel a continuous and rapid increase in production and distribution. It is one of the numerous products of the Texas Company, 17 Battery place, New York City.

Chilled Car Wheels

Owing to the desirability of obtaining definite information concerning the magnitude and distribution of stresses in chilled car wheels and of determining the limits of these wheels as used today, and with a further view of improving the chilled iron wheel in order to meet future requirements, a co-operative investigation was entered into by the Association of Manufacturers of Chilled Car Wheels and the University of Illinois. Bulletin 129 of the Engineering Experiment Station of the University of Illinois presents the results of the first part of this investigation, that is, the results of tests made to determine strains produced within the wheel by mounting it on its axle, and by the application of wheel loads. The bulletin includes a discussion of the general problem of wheel loading, the determination of the physical properties of chilled car wheel irons, a description of the apparatus and methods used in the tests, and a summary of the conclusions to be drawn therefrom. Copies of Bulletin No. 129 may be had without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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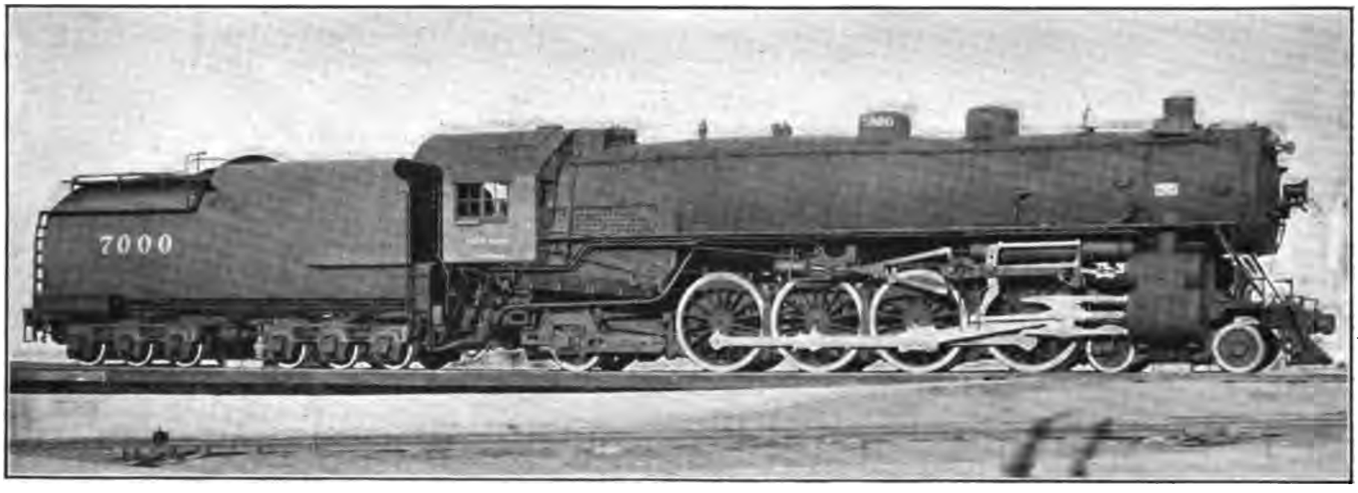
Powerful Mountain Type Passenger Locomotive for the Union Pacific Railroad

Lightness of Parts a Remarkable Feature in Construction

A fine example of the fact that the power of the modern locomotive may be increased without adding to the weight is shown in a recent addition to the motive power of the Union Pacific railroad, by the introduction of a Mountain type passenger locomotive built by the American Locomotive Company. The Mikado type locomotives which have been in service for several years over the mountainous districts where the heaviest grades occur, although doing excellent service have been found barely capable of maintaining the high speed essential to meet the schedule arrangements in the up grade, and while this has been compensated by extra rates of speed on the down grades the result has been detrimental both to maintenance way and the increased cost of locomotive repairs. Hence the management took into consideration the possibility of introducing the mountain type of locomotive as a more likely type to meet the require- erally known that there are grades west of Cheyenne in the Wyoming division of long distances running as high as 1.55 per cent on the westbound, and 1.14 per cent grades on the eastbound operation.

Over this region extending to nearly 484 miles, the distance between Cheyenne and Ogden an average speed of 37 miles per hour is maintained. In the busy season trains of thirteen and even fourteen all steel cars are necessary to meet the traffic. Six through passenger trains pass over this region daily. The only difficulty in introducing the mountain type of locomotive was in the recognized fact that the weight should not exceed 345,000 lbs., for while the railroad, as is well known, is double tracked and of the most substantial construction, the numerous bridges, viaducts and other structures are not calculated to meet the requirements of heavier motive power than the weight referred to.

thorough investigation solved the problem, and its solution has been largely owing to the marked improvement in recent years of the quality of material whereby it has become possible to lighten many of the parts of the locomotive and still retain a reliable quality essential to safety in point of performance. The result has been already demonstrated that the locomotive furnished by the builders and known as No. 7,000 has not been approached in point of design where boiler capacity in relation to weight is considered, and has only been made possible by a close comparison with other types where weights are known and by thorough tests of individual parts and material in order to ascertain what was possible as the looked for accomplishment, looking towards a general introduction of the mountain type of locomotive, if the success of the experiment should prove beyond controversy.



MOUNTAIN TYPE 4-8-2 PASSENGER LOCOMOTIVE FOR THE UNION PACIFIC RAILROAD
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

this particular locomotive are identical with those which have been in service on the Union Pacific, and are readily interchangeable. In regard to power it may be briefly stated that with cylinders measuring 29 in. by 28 in., the maximum cylinder horse power is, according to Cole's formula, 2,950, showing that this locomotive has a 98 per cent boiler, and showing a weight of 113.9 lbs. per cylinder horsepower, or 116.9 lbs. per boiler horsepower. The full significance of these figures, and a correct estimate of the full measure of the success attendant on this experiment is shown by a comparison with the Railroad Administration standard heavy mountain type locomotive from which designs following the adoption of the standard has not departed from to any extent until the present instance, and that of locomotive No. 50,000 which although differing in type, is now surpassed by locomotive No. 7,000. The following is a comparison of the three types of locomotives:

	Pacific Type Locomotive 50,000	U. S. R. A. Std. Heavy Mountain Type	Union Pacific Locomotive No. 7,000
Weight of locomotive	269,000	352,000	345,000
Maximum tractive effort	40.600	57,900	54,838
Weight for tractive effort found	6.62	6.08	6.29
Maximum cylinder horsepower	2,437	2,824	3,030
Maximum boiler horse power	2,235	2,900	2,950
Per cent h.p. to cylinder h.p.	92.0	102.6	98.0
Weight per boiler h.p.	119.6	121.4	116.9

As already noted the use of the best available material has made the results possible, and in this regard the extensive use of carbon-vanadium steel wherever it was found advantageous to use this alloy in eliminating weight, as for example the main and side rods are annealed carbon-vanadium steel, as are also the crank pins, the driving and trailing axles and pistons. The weight of the reciprocating parts are —piston head, finished,—505 lbs., piston rod—334 lbs., main rod—864 lbs., cross-head, with shoes—640 lbs.

The locomotive is furnished with a Duplex stoker, which operating in a grate area of 84 sq. ft. provides a reliable steaming capacity. The fuel is of the high-grade semi-bituminous variety averaging 12,000 B. T. U. and is free from any tendency to clinker formation. The mechanical department also after considerable investigation decided in applying the Young type of valve gear, and are convinced that it has the quality of increasing the capacity of this locomotive on hard pulls either on level runs or steep grades, as the long travel of the valve gives the opportunity of a sustained piston pressure, the valves applied to No. 7,000 have a diameter of 14 ins., and a travel of 9 ins.

As an illustration of the finer details of the lessening of the weight of parts, the sand boxes are made of pressed steel, and when filled with sand are less in weight than the empty cast iron boxes of the same capacity. The same material is used in the care of the stack extension and other details, and in some instances modes of construction are changed as in the case of the ash pan which is made of straight sheets flanged at the ends, thus avoiding the use of angle irons.

Among the attachments may be noted the Pyle National headlight; Franklin adjustable driving box wedges; Nathan non-lifting injectors; Ohio flange lubricators, and Vissering sanders; Hunt-Spiller gun iron cylinder and valve bushings, cross-head shoes and piston rings; Paxton-Mitchell rod packing; and the Tate flexible staybolts with welded sleeves and reduced body bolts. Okadee fittings are also applied including the blow-off valves, cylinder cocks, feed pipe strainers and smoke hinges.

Other devices of a novel kind also make their appearance on this locomotive; including a low-water alarm device the invention of C. E. Fuller, superintendent of motive power, Union Pacific railroad. This device has already passed the experimental stage and is in successful operation on several locomotives on the road. A. H. Fettes, mechanical engineer of the road has a device also which renders the operation of a drifting valve with a degree of efficiency which leaves nothing further to be desired.

The general dimensions of the Mountain type locomotive No. 7,000 are as follows:

Tractive effort	54,838 lb.
Cylinders, diameter and stroke	29 in.—28 in.
Driving wheels, diameter	73 in.
Factor of adhesion	4.19
Weight on driving wheels	230,000 lb.
Weight on engine truck	59,000 lb.
Weight on trailer	56,000 lb.
Weight of locomotive	345,000 lb.
Weight of locomotive and tender	582,800 lb.
Coal capacity of tender	20 tons
Water capacity of tender	12,000 gal.
Wheel base, driving	19 ft. 6 in.
Wheel base, locomotive	41 ft. 3 in.
Wheel base, locomotive and tender	79 ft. 11½ in.
Boiler pressure	200 lb.
Boiler diameter	84 in.
Firebox, length and width	126 in. by 96 in.
Tubes, number and diameter	239—2¼ in
Flues, number and diameter	48—5½ in.
Length of tubes and flues	22 ft.
Length and dia. of combustion chamber	40 in.—60 in.
Super-heating surface	1,242 sq. ft.
Evaporating surface, firebox and combustion chamber	382 sq. ft
Evaporating surface, total	4,974 sq. ft.
Grate area	84 sq. ft.

Semi-Annual Meeting of the Electrical Engineers

After a lapse of two years the Electrical Engineers mustered in larger numbers than they had ever done before to what is expected to be a resumption of their regular semi-annual meetings. The Hotel Dennis, Atlantic City, N. J., was their headquarters, and on June 19 the meeting was called to order by E. S. M. MacNab, first vice-president, in the absence of the president, L. C. Bensel. Mr. MacNab briefly sketched the progress of their work

material the records showed 460 locomotives, 1195 passenger cars, and 77,053 freight cars.

E. A. Lundy, of the RAILWAY ELECTRICAL ENGINEER, referred strongly to the need of collecting authentic data to establish reliable records of what has been done on the various railroads. E. Wanamaker, of the Rock Island Lines, pointed out that railroad operation generally depended on electrical equipment much more than was generally known. J. A. Andreucetti, of the Chicago & Northwestern, and L. D. Moore, of the Missouri Pacific, presented data on the rapid increase in electrical equipment in the West and the benefits on point of economy resulting therefrom.

Special committees reported on "Motor Specifications;" "Illumination;" "Electric Welding;" "Stationary Power Plants;" "Electric Repair Shop Facilities and Equipment;" "Power Trucks and Tractors;" "Train Lighting;" and "Locomotive Headlights and Classification Lamps." The subject of automatic Train Control was also discussed at considerable length; and B. F. Collins, of the General Electric Company, concluded the interesting proceedings by the presentation of a very able paper on "Electric Heating," which was highly appreciated by the members.

Analysis of Railroad Accidents in 1921

A careful analysis of railroad train accidents occuring in the United States during 1921 shows that 538 persons were killed. In train service accidents 5,229 were killed, making a total of 5,587 railroad fatalities. This was a decrease of 14 per cent from the number killed by the railroads in 1920, of the 5,587 fatalities, only 205 were to passengers, and 1,096 to employes. It is notable that almost 40 per cent of the employes were not on duty.

The only classes of accidents that increased in 1921 were those to trespassers, of whom 2,481 were killed and 3,071 injured, which means 14.5 per cent more deaths than in 1920, and 29.7 per cent more persons injured, in face of the fact that accidents to all other classes specified in the statistics of the I. C. C. showed a decrease of from 10.5 per cent for passengers to 48 per cent for trainmen on duty.

Austro-Hungarian Railway Agreements

The railway agreements concluded between Hungary and Austria in January last have been ratified by both governments and now come into effect. One agreement deals with the question of railway connection between the two countries. The other agreement regulates traffic through the Sopron (Ohrenburg) district and provides that persons traveling through Hungarian territory in closed cars shall be exempt from exhibition of passports and from customs examination

Convention of the American Railway Association Division V—Mechanical

Reports of Committees and Election of Officers

On June 14, 1922, the third annual convention of the members of the American Railway Association—Division V—Mechanical, assembled in the Greek Temple of Young's Pier, Atlantic City, N. J., N. J. Tollerton, general mechanical superintendent of the Chicago, Rock Island & Pacific, chairman of Division V, presiding. A warm welcome was tendered to the members by Hon. Edwin F. Bader, mayor of Atlantic City, after which Chairman Tollerton delivered an eloquent and comprehensive address, in which he emphasized the fact that one of the most important questions before them, was that of harmony and cooperation. Closer association between the executives, local or subordinate supervisory officers and the employes is steadily becoming more firmly established, and its fulfillment will undoubtedly have far reaching effect. This is being accomplished, first, by right general policies, including proper interest in the welfare of the employes, and, second, the most careful selection and education of supervisory officers to carry out and continue these policies. I have abounding faith in the capabilities of the officers of the American railroad organization, and also in the rank and file of employes, to solve these problems to the entire satisfaction of themselves and our real employer, the American public.

We have had many serious obstacles to overcome in the past and there is gratification in the knowledge that some of the troubles, which were felt at the time to be practically insurmountable have been overcome and in a general way have started a healthful reaction for the ultimate benefit of the railroads.

Mr. Tollerton earnestly recommended that some arrangement be promulgated by the American Railway Association for cooperative tests of railway appliances. This would involve the advisability of establishing some central system for joint investigation, so that tests which would require heavy expenditures could be carried on at the expense of the association and would make available to all railroads, at a minimum expense, information and data as to devices which promise economy in maintenance and operation. Procedure of this kind would be of great benefit, but care should be exercised to see that it would not have the effect of destroying initiative on the part of individual roads who are in position to originate or advance the development of economical designs and appliances.

In regard to economies, we should be very careful not to apply or think of this term as merely a reduction in expenses, if they are of such a nature that the ultimate expenditures may suffer an increase in consequence thereof. My observation has been that, invariably, operating expenses of a railroad are affected adversely by the ratio of maintenance of equipment expenditures. Sufficient expenditures for proper maintenance of equipment make economical transportation costs. Injudicious savings in maintenance result in actual loss through the increase in transportation costs and the heavier later costs for deferred maintenance.

It is readily to be understood that, unless equipment is properly maintained, locomotives kept in condition to give maximum hauling capacity with minimum fuel consumption, and freight cars in condition to give a maximum period of service with the lowest consistent time held on repair tracks, we cannot hope for economical operation on the part of the transportation department.

Locomotive fuel, representing nearly 35 per cent of the cost of train operation, is in itself a question of major importance in the entire transportation problem and, due to its volume in proportion to the total expense, is naturally an item of greatest opportunity for effecting economies. Having this in mind, I would commend for your special consideration that fuel saving devices should have most careful study and development.

After reviewing the excellent work that was being accomplished by the various committees, the chairman referred to the question of why the European railroads are electrifying, and stated that the Swiss and Indian railways, and to a lesser extent the French railways, are engaged in making and carrying out plans for the electrification of certain of their lines. Some criticism has appeared in publications of wide circulation to the effect that our railways are not progressing as rapidly in the use of electricity for traction as these European railways. The visitor to Europe is especially impressed by the difference between some important conditions in some of the countries of Europe and in the United States. The Italian railways have been paying upward of $25 a ton, measured in American money, for coal. The average price paid by the Paris-Lyons-Mediterranean of France in 1920 was 266 francs, or at the present rate of exchange, about $26. Even in 1921 its coal cost it, at the present rate of exchange about $18 a ton. The cost of coal to the Swiss railways is also extremely high. The average cost of coal to the railways of the United States in February, 1922, including freight charges for its transportation, was only $3.56 a ton. You will see, therefore, that, at the minimum estimate, coal costs the railways of Southern Europe on the average five times as much as it does those of the United States. On the other hand, these countries, especially Switzerland and Italy, have large supplies of natural water power, while in many parts of the United States such power is not available. It follows that the savings in fuel cost to be made by electrification in some of these countries of continental Europe is much larger than in this country, and we should not allow this important fact to be overlooked in discussions of the subject. In closing, the chairman predicted that the organization had before it a very bright and productive future.

Report of General Committee

The opening part of the report of the general committee stated that in the period since the last annual meeting, meetings of the committee had been held on the following dates: July 21, 1920; October 20, 1920; March 30, 31, 1921; October 26, 27, 1921; March 14, 1922 and June 13, 1922.

The membership of the division at the present time includes 206 railroads, representing 379 memberships in the American Railway Association, and in addition thereto, 100 railroads, associate members of the American Railway Association. These railroads have appointed 788 representatives in the Mechanical Division. In addition there are 1,529 affiliated members and 126 life members in the division.

The last session of the division was held June 9-16, 1920. Since that time the general committee has taken action on several important subjects. This action is outlined in the following report and your approval is respectfully requested.

A mass of data in regard to letter ballots referring to interchange and loading rules, maximum loads and marking on freight cars, fuel conservation inspection of material and equipment, automatic train control, investigation of power brakes and power brake systems and other subjects. The result of the letter ballots had been already announced and the full report of the committee in regard to the various subjects submitted to consideration will be published with discussions thereon in the annual volume issued by the association.

Scheduling Equipment Through Repair Shops

This report considers the scheduling and routing of passenger and freight equipment under repairs. Very little has been done to promote systematic scheduling methods when repairing equipment. One road in Canada has this work highly perfected and claims are made for a considerable increase in output with decreased costs due to its adoption. At least one road in the United States has recently introduced scheduling and routing practices in their passenger car repair shops and indications point to an increase in understanding and appreciation of methods widely used in contract shops and which are equally applicable to railroad shops.

In general the plans outlined for scheduling and routing locomotives (report of this committee for June, 1920), are employed for cars, passenger and freight. These classes of equipment will be considered separately and scheduling systems recommended in some detail. Passenger cars, like locomotives, are treated as units, but freight cars, by reason of the large number of repairs and speed of delivery, do not conform to passenger car methods. Groups of cars are scheduled as a unit and "days" of time are further subdivided into "hours," morning and afternoon. Gang work is recommended for passenger car repairs, but not to the extent suggested for freight repairs.

Separate master schedules should be prepared for coaches, mail, baggage, express, combination, dining, parlor and sleeping cars. These schedules should be further subdivided for wood or steel construction. All master schedules should show exterior, interior and paint work separately, also work in all other participating departments, such as the tin and pipe shop, electrical department, air brake shop, etc. Any convenient combination of figures and letters may be used to designate particular schedules. For example, a "1-A-2" repair schedule would indicate a class 1 heavy exterior repair, class A heavy paint repair and a class 2 medium interior repair.

Freight Equipment

The committee suggested that only heavy repairs should be considered in any discussion of freight car schedule. Such repairs require 20 man-hours and over. Separate master schedules should be prepared for flat, coal, box and refrigerator cars, these to be subdivided for wood or steel construction. The above separation may be varied to some extent when cars are repaired under a group system with specialized shifting gangs.

It is not possible at this stage of development to define arbitrary rules for scheduling freight equipment. Shop tracks and buildings are lacking in uniformity and a majority of shops and tracks are not at present so arranged that practices giving excellent results in one shop will work equally well in another. In general it may be definitely stated that some easily understood and workable system can be adapted to any shop, large or small, which turns out heavy repairs. It is generally conceded that individual cars should not be scheduled, the cost would be prohibitive even if thought advisable, but groups of cars of the same type and class of repairs may be scheduled successfully. Close attention should be paid to segregation of incoming cars if best results are to obtain. The stripping operation is important and should be given careful study.

Constructive information pertaining to freight car scheduling is very meagre, but one large shop has perfected the following plan: Incoming cars are switched to three or four parallel tracks, having regard for the type of car and nature of repairs required.

By this method it is possible to schedule 10 or 15 cars in a group on one track as a unit. The time for each gang may be predetermined and stated on a master schedule. This schedule, with hours, dates and duties inserted, should hang in a conspicuous position near the head of each working track where foremen and inspectors may check the progress of the work.

Safety Appliance

No advance report was made or printed by the Committee on Safety Appliances, the condition in general being the same as it was in June, 1920. At that time the latest figures obtainable showed 60,170 cars to be equipped. No later figures have been obtained, and it is presumed that all of these cars in service have been equipped by this time. No condition has arisen in the last two years which has made necessary any special work for the Committee on Safety Appliances and therefore no action has been taken.

Report on Prices for Labor and Materials and Report of the Arbitration Committee

From the reports presented it appeared that there had been few revisions in the prices for materials made by the committee this year. Some slight reductions had been made in the labor rates. No changes were made in the time allowance for air brake repairs. In regard to settlement prices for destroyed cars $100 was allowed for cast steel wheels and $125 for rolled steel wheels. Further revisions may be made if prices decline before the revised code comes into operation.

The Arbitration Committee reported that no less than 1,200 cases had been acted upon, and a copy of the decisions was made on the report. They refer largely to what may be called a strict interpretation of the rules, and very few changes were submitted or recommended.

Report on Tank Cars

The Committee reported that they had endeavored to secure improvements in safety valves, dome closing arrangements, heater coils, and the bottom outlet.

A safety valve was developed at Altoona in which the contour of the seat, valve and huddling chamber followed very closely the design of a valve submitted by one of the manufacturers of locomotive safety valves which had been previously tested. Some modifications were also made in the form of the wings of the valve disk to reduce the restriction of the discharge area, and the spring was made with six coils instead of five as in the standard design. The test of this valve indicates that the question of discharge capacity at the popping pressure has been satisfactorily solved, as practically full discharge is obtained at the initial pop. This is important in that while the tanks are required to be designed for a bursting strength of 300 lb. per sq. in., this strength does not hold good when the tanks are heated to high temperatures by external fire.

Following this test the valve manufacturing concern has prepared three experimental valves along the same lines and they are now at Altoona for test. It is hopel that these valves will show also a great improvement in the matter of tightness up to the popping pressure. Until the results of these tests are available the Committee is not prepared to make its recommendations as to changes in standard design.

In regard to bottom outlet valves there had been 28 different designs considered of which 17 are modifications of the present plunger type, 9 of the plug type, 1 a sliding disk and 1 a rotating disk. Four designs were recommended for further trial, 13 for further trial with the understanding that the design must first be changed, and 9 were eliminated from further consideration, one has not yet been tried. One was authorized for trial September 13, 1921, but trial has been suspended pending reports on tests of the lubricating device, which is a feature.

None of the designs we have studied can be considered to have solved the problem of leakage. The four designs in first group, however, show considerable improvement over the present type.

We believe that a valve will not be satisfactory or practical which requires two seats, the aid of gaskets, or a complication of levers and springs. The operating mechanism should be simple, strong and positive in action. Troubles due to sticking appear to be characteristic of valves of the plug and piston type.

The work of this sub-committee will be continued during the coming year.

Several designs looking towards dome closing improvements had been submitted and approved for trial to meet the requirements adopted last year that after July 1, 1922, the dome cover for class IV cars, if external shall be secured by bolts; or if internal by yoke and screw.

In regard to heater pipes, the committee recommends that the following requirements be made part of the tank car specifications:

1. Where heater pipes are installed not less than 2 in. extra heavy pipe and fittings shall be used. All piping shall be properly secured to permit the necessary expansion and contraction and so installed as to provide for self drainage.

2. Cast iron, malleable iron or cast steel return bends shall not be used. Return bends may be forged or made by bending the pipe and using threaded sleeve coupling, forged unions or welded joints. A minimum number of connections shall be used.

3. Single or multiple heater systems may be installed, but the latter is preferable.

4. The steam inlet preferably should be through the top of tank or through dome; the outlet may be either in the end or through the bottom of tank; but both shall be safeguarded by an approved form of cock, cap or plug. Where the discharge is through the bottom of tank, no part of pipe shall extend below bottom of underframe.

Where inlet or outlet pipes pass through the shell of tank, the opening shall be reinforced by suitable pads riveted on inside or outside. The pipe connection preferably shall be expanded or welded, or both, into pad. The outside connection shall not be an integral part of the heater, but it shall be secured to the pad by an approved design.

5. On new installations the heater pipes shall be tight at a hydraulic pressure of 200 lb. The same test shall be applied when the tank is retested.

6. Each compartment of a compartment-tank shall be treated as a separate tank and comply with the foregoing requirements.

7. Designs of heater systems shall be submitted to the American Railway Association for approval before application.

The committee in its 1921 report recommended that "the bottom outlet pipe when applied to tank cars having center sills shall not project below the bottom line of sills more than the threaded length necessary to permit the application and removal of the bottom outlet cap." The committee representing tank car users, and after discussion of the subject with representatives of the car builders recommends that Section 7 (c), Specifications for Classes I and II cars, be amended to read as follows:

Effective July 1, 1923, botton outlet valve castings when applied to cars having center sills shall be of such length that the extreme projection of outlet cap equipment shall not be below the bottom of the underframe more than specified in the following:

1. With cap and plug or combination cap and valve on 4-in. outlet—6 in.

2. With 6-in. outlet, 4-in. reducer, cap and plug or combination cap and valve—12 in.

NOTE—In no case shall extreme projection of bottom outlet equipment extend to within 16 in. above top of rail.

All outlet valve casting caps and attachments shall be secured to the car to prevent loss.

No nipples, valves or other attachments shall project below the bottom outlet cap except while car is being unloaded.

Report on Loading Rules

The committee has considered all suggestions for modifications of and additions to the Loading Rules presented by the members of the association as well as shippers and has held joint conferences with the latter to the end that the Loading Rules may be kept up to date and take care of any new methods of loading that may be presented. As a result of this procedure, the committee made a number of recommendations and submission to letter ballot for adoption as standard of the association. The recommendations were accompanied by illustrations showing improved methods of loading gasoline tractor engines on flat cars, loading wrought pipe on flat cars, loading pipe on gondola cars and flat cars, different methods being shown for pipe of various diameters from 24 ins. to and including 96 ins. diameter.

Report on Train Lighting and Equipment

The Committee's report embraced descriptions of the "Safety Car Heating and Lighting Company's Drive"; the "Gould Drive"; the "United States Light & Heat Corporation Drive," accompanied with records of tests on some of the equipments. Many marked improvements were referred to. In the matter of lighting the committee recommended reducing the number of lamps required for the greater part of car lighting service to four. The entire report embracing a large number of recommendations will be submitted to letter ballot.

Report on Car Construction

The Committee reported that the various refrigerator companies have either developed a brine retaining valve of their own or favor some particular type of valve. A canvass of brine valve application to refrigerator cars shows the cars of twelve railroads and car lines are either all equipped or will be, in all but one case, during the current year. The following rules are suggested for adoption as a standard of the association:

1. Operating rods shall be solid and not less than ⅝-in. in diameter.

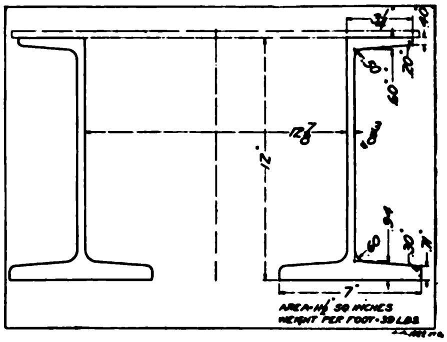
2. Operating lever at top shall be of wrought or malleable iron, with cross-sec-

3. Rubber seats shall be made of pure rubber, to resist the action of salt water.

4. Cast parts shall be of malleable iron, not less than ¼-in. thick.

5. All parts of brine valves shall be heavily galvanized or sherardized.

6. All surfaces adjacent to rubber or other seats in the valves shall be machined and free from fins, blow holes or other defects.



RECOMMENDED CENTER SILL SECTION FOR ADOPTION AS STANDARD

7. Valve operating mechanism shall be so constructed that valve must be closed before plug can be put in place.

8. Where possible, valves should be so arranged that weight of brine in tank will hold the valve closed.

9. The diameter of wearing pins and connecting bolts shall be not less than ½-in.

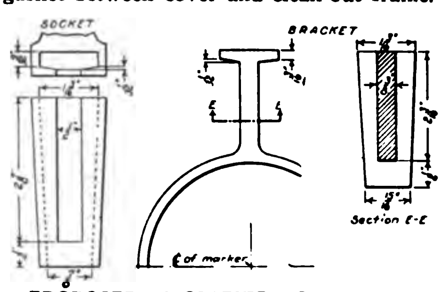
10. All nuts shall be held in place by cotter pins at end or by lock nut.

Rules for Clean-out or Hand-hole Castings

1. Cast parts shall be of malleable iron, not less than ¼-in. thick.

2. All parts of clean-out casting shall be heavily galvanized or sherardized.

3. Clean-out castings shall have a gasket between cover and clean-out frame.



PROPOSED MODIFIED STANDARD MARKER SOCKET AND NEW STANDARD BRACKET

4. The cover locking device should be simple in operation and easy to close.

Rules for Brine Tank

1. The tank shall be made of heavily galvanized iron, not less than 1/16-in. thick.

2. All joints shall be riveted and soldered.

3. Connection castings shall be made of heavily galvanized or sherardized malleable iron castings.

4. The brine tank shall be securely sup-

RULES FOR INSPECTION

1. See that rods, levers and other parts of the brine valves are connected, and that valves function properly.

2. Inspect the following parts for leaks: Clean-out castings, tanks, valves, and connections between tanks. All leaks shall be repaired before a car is loaded.

3. A card, reporting the brine tank equipment in serviceable condition, signed by the foreman in charge of the inspection, shall be filed before a car is loaded.

A number of recommendations were made by the Committee in regard to center sills, marker lamp socket brackets and holders, and also stated that meetings had been held with the committee on car design and engineering of the Car Manufacturers' Association of the United States, with a view to go further into the fundamentals of car construction, and the result had been the submission of several preliminary designs by the Manufacturers' Committee, which are now under advisement, and the committee hopes to be able to submit one or more complete designs next year.

The sub-committee on car trucks in conference with the Cast Steel Manufacturers' Committee, made considerable progress toward producing one or more designs of trucks, and it is expected that truck designs can be completed in the coming year, these designs to incorporate fixed conditions, facilitating interchangeability between details, singly or in groups, and so that preferred specialties can be substituted for standard detail construction.

REPORT ON COUPLERS AND DRAFT GEAR

The main body of the Committee's report referred to a number of recommendations concerning the Standard "D" Coupler Specifications and gages which were submitted for approval. Among other changes it was also recommended that 10 per cent of the complete couplers be weighed instead of all of the couplers as under the present ruling.

REPORT ON BRAKE SHOE AND BRAKE BEAM EQUIPMENT

It will be recalled that last year the Committee submitted as a progress report a tentative Standard Practice for the consideration of the members and requested their consideration and criticism. No criticisms or suggestions were offered. A further study of this subject emphasizes the importance of repaired brake beams meeting the capacity and other requirements of the standard specification. To handle this work most efficiently, properly organized central repair plants, provided with special equipment for assembling and testing, are recommended. The equipment, while special in character, is inexpensive and can be constructed largely of second-hand material, as suggested and illustrated in detail in last year's report.

In view of the desirability of a standard brake beam design and the progress being made in that direction, and also the demand for improvement in present practice in brake beam maintenance generally, the brake head strength feature has been deferred for action in connection with the standard beam.

A canvass of the situation developed that brake shoe keys conforming to the standard drawing and properly applied give little trouble. It is believed that an improvement can be made by lengthening the head from ½ in. to 1 in. and bending it over instead of upsetting it. This change is recommended for submission to letter ballot, as it involves a change in the standard drawing. It is further suggested that purchasers of brake shoe keys have such inspection made that will insure keys conforming to standard, and that railroads co-operate by having repair points use more care in maintaining better fitting keys, and when manufacturing their own keys to see that they comply with the standard.

The committee is not prepared at this time to submit a standard design of brake beam, and the subject will be continued.

On suggestion made by the chairman of the Mechanical Committee, Brake Beam Manufacturers' Institute, the committee recommends for letter ballot changing Section 14 of the Standard Specifications for Brake Beams to real:

The A. R. A. Nos. 1, 2, 2-plus, 3, 4, 5 or 6, as the case may be, shall be cast on the center strut with raised letters and figures not less than ⅝ in. high and ⅛ in. in relief, where they can be readily inspected when beam is in place on car.

REPORT ON TRAIN BRAKE AND SIGNAL EQUIPMENT

The committee reported that during the last year the subject of automatic hose connectors for freight and passenger equipment has been further considered by a sub-committee during the past year which reports in substance as follows:

One maker of automatic connectors reports having 15 locomotives, 12 passenger trains, 100 ore cars and 34 slag cars equipped with their automatic connector, and that tests are progressing favorably.

Another maker claims to have 5 passenger trains in Canada and one in the United States equipped with their type of connector and are working with certain railroad officials in the direction of developing a freight connector.

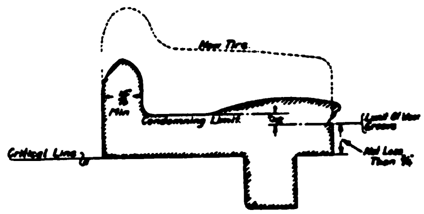
Further than this, the reports are in the general direction of development only.

It will be seen from the above that the trials in general now being made are in passenger service and the progress of development in automatic train connectors is not such as to put the committee in possession of information at this time that will enable it to make any definite recommendations on an acceptable design of connector for both passenger and freight service.

Attention has been called to the fact that in many cases where the stenciling is above the transverse center line of the auxiliary reservoir it frequently becomes illegible through drippings from the car. Experiments have been made on at least one large railroad by stenciling below the center line, which indicates an improvement.

We believe the practice of applying the stencil approximately one inch below the center line should be followed, which can be done without conflicting with the present requirements from the fact that the location for the stencil is not specifically indicated.

At the request of the Car Construction Committee, the Committees on Train Brake and Signal Equipment and Brake Shoe and Brake Beam Equipment have



Steel Tire
Recommended Practice.

CONDEMNING LIMIT DRAWING FOR STEEL TIRED WHEELS, RECOMMENDED FOR INSERTION IN THE INTERCHANGE RULES

held several joint meetings during the year in connection with the strength requirements of brake beams, and have submitted their recommendations to the Car Construction Committee on the proposed status of number two and two plus beams.

REPORT ON CAR WHEELS

At the last convention held in 1920 the contour of the back flange of steel and steel-tired wheels adopted in 1912 was withdrawn from the standards and the 1909 contour readopted as standard, with the 1912 contour the back of the flange of steel and steel-tired wheels was identical with that of cast-iron wheels between the base line and the top of flange. The 1909 contour reduced the width of the rim from 19/32 to 5½ in., and the backs of the flanges of steel and steel-tired wheels are not now identical with those of cast-iron wheels between the base line and a point approximately ½ in. above it. Because of this change, the committee recommended that the drawing of the maximum and minimum flange thickness gages for cast-iron, solid steel and steel-tired wheels be changed to show the height of the surface of ⅜ in. The proposed change will have no effect whatever as concerns cast-iron wheels. The committee made investigation of attempting to mate wheels of equal hardness, but it is their conclusion that the only practicable method of doing this is in the case of solid wrought carbon steel wheels to mate them within a .05 per cent carbon content range, and in the case of cast iron wheels to mate by tape sizes as already provided for in the recommended practice for mounting wheels. It is therefore recommended that the following section be added to Paragraph 8 of the Recommended Practice for Mounting Wheels:

> "In the case of new wrought steel wheels, those mounted on the same axle should not differ in the carbon content by more than .05 per cent."

The committee has under consideration certain revisions in the specifications for wrought steel wheels and cast-iron wheels. However, investigation has not yet progressed sufficiently that it is ready to submit recommendations at this time.

Locomotive Headlights and Classification Lamps

This committee at the 1920 convention was instructed to work jointly with manufacturers of headlight turbo generators and the Association of Railway Electrical Engineers in developing certain contour standard practices. The lack of uniformity in number as well as location of supports or feet on the various makes and types of turbo generators renders interchange difficult, and is detrimental to the best interests of manufacturers as well as objectionable to the railroads. The spacing recommended can be adapted to future designs without much difficulty, thus overcoming the present chaotic situation.

The recommendation for the location of the steam inlet may appear to allow the manufacturer more latitude than is desirable, but to fix a definite location appeared to be an unnecessary handicap in the freedom of design. With the variation in location of steam inlet from the longitudinal and transverse center line of bolt spacing and vertically above the base plate in increments of ½ in., any make of turbo generator can be applied without the necessity of changing the steam pipe from the boiler by using standard fittings and proper lengths of pipe nipples, standard lengths of which vary by ½ in. increments.

The restriction of turbo generator manufacturers to one size of ball bearing was likewise considered as unnecessarily hampering future development, and particularly with reference to the design of the shaft. Much of the ball bearing trouble that is being experienced can be attributed to (1) rotating parts out of balance; (2) shaft running near the critical speed, producing excessive vibration; (3) shaft loose in bearings, which, existing, rapidly increase; (4) shaft too small, which, when attachments thereto are out of balance, springs out of line to seek its balance, thus throwing bearings out of alignment; (5) faulty design of bearing housing, which permits dirt to work into bearings. This condition is aggravated creating a tendency to discharge air through all possible outside openings and draw in air near the center of the shaft, carrying dirt with it.

Shafts of larger diameter with a higher critical speed are less liable to distortion on account of parts out of balance, and with a range of the following three sizes of ball bearings (the principal dimensions being given in inches) which the ball bearing manufacturers agreed could be expected to give satisfactory results, a greater opportunity is afforded the designer to overcome the difficulties enumerated than would be the case if he were restricted to one size of bearing.

Bearing Number	Outside Diameter (Base of Housing)	Inside Diameter (Diam. of Shaft)	Width of Roll
306	2.8347	1.1811	.748
308	3.5433	1.5748	.9055
406	3.5433	1.1811	.9055

A method of overcoming the possibility of dirt working into bearings is a problem yet to be worked out by the designers of turbo generators, and in this connection the suggestion has been made that some form of air inlet near the center of the shaft be provided in such a way that the incoming air would not pass through the bearings; also that a pressed steel disc carried by the shaft running close to a pressed steel disc carried by the housing would soon fill with grease and form an effective dirt seal.

Experience has demonstrated that oil is best for lubrication. It should be as light as possible consistent with the conditions of heat under which it operates, but not so light that there will be excessive evaporation. The best results will be obtained if the oil is filtered and kept in a covered receptacle.

The bolt spacing for base of headlamp cases, while not one of the subjects originally referred to this committee, was considered advisable to standardize if possible, and it is believed that the recommended spacing can be readily adapted to all designs. Where a railroad's standard location for headlamp is on the top or near the top of smoke box, and the recommended bolt spacing will bring the top of the headlight casing above clearance limits, the transverse spacing of bolt holes can be changed to 14 in., but as there are so few railroads where this condition exists, it was not considered necessary to cover this addition in the recommendation, it being believed advisable to leave the matter to the railroads affected to arrange with the manufacturers.

In this committee's report to the 1920 convention, reference was made to headlight reflectors that were being developed which would not require as constant attention to keep clean as is the case with the silver-plated copper reflector. A large uranium glass with silvered backs and varying in diameter from 12 in. to 18 in., the size most commonly used being 14 in., have been conducted, there seems to be time to demonstrate the permanency of their reflecting value and the small expense required to keep clean.

From information received of tests that have been conducted, there seems to be no doubt that these reflectors, used in conjunction with lamps which have been adopted as standard, will produce ample illumination to meet the requirements of the Division of Locomotive Inspection of the Interstate Commerce Commission, but in the absence of what might be termed official tests, it is not considered advisable to present any recommendations at this time.

Consideration has been given to the advisability of using cab lamps of smaller dimensions, with the idea of reducing the size of lamp cases, and the lamp manufacturers are co-operating in an endeavor to produce a satisfactory 15-watt S-14, 33-volt lamp to be used in place of the present S-17 lamp, but the development has not advanced sufficiently to warrant other than mention. The S-14 lamp is approximately 11/16 in. shorter and ⅜-in. smaller in diameter than the S-17 lamp.

A number of new and commendable styles of headlamp cases have been developed by the manufacturers since the last convention, lightness of weight coupled with durability being the dominant features, although other noteworthy refinements have been accomplished. However, the committee has not thought it advisable to consider their standardization other than with respect to the bolt spacing of the base.

There will be found at the end of this report several recommendations for maintenance practice, and while the recommendations submitted at this time are few, it is hoped that the start that has been made will eventually result in the formulation of a set of maintenance regulations which will be of assistance to the railroads in obtaining best possible results from the electric lighting equipment on locomotives.

The committee recommends that the following be submitted to letter ballot as recommended practice for future designs, and to be added to recommended practices previously adopted:

1. Turbo generators to have three feet for support and attachment to base plate, thickness of feet at bolt hole to be ¾-in. and ribbed on sides to engage head of bolt to prevent turning; ribs to extend to body of generator to strengthen the feet, holes in feet to be 11/16-in. diameter for ⅝-in. bolts, bolts to enter from the top, with nuts on undersize of base plate. Bolt hole spacing to provide for one bolt at generator end on longitudinal center line of machine 5-in. from transverse center line and two holes at turbine end on op-

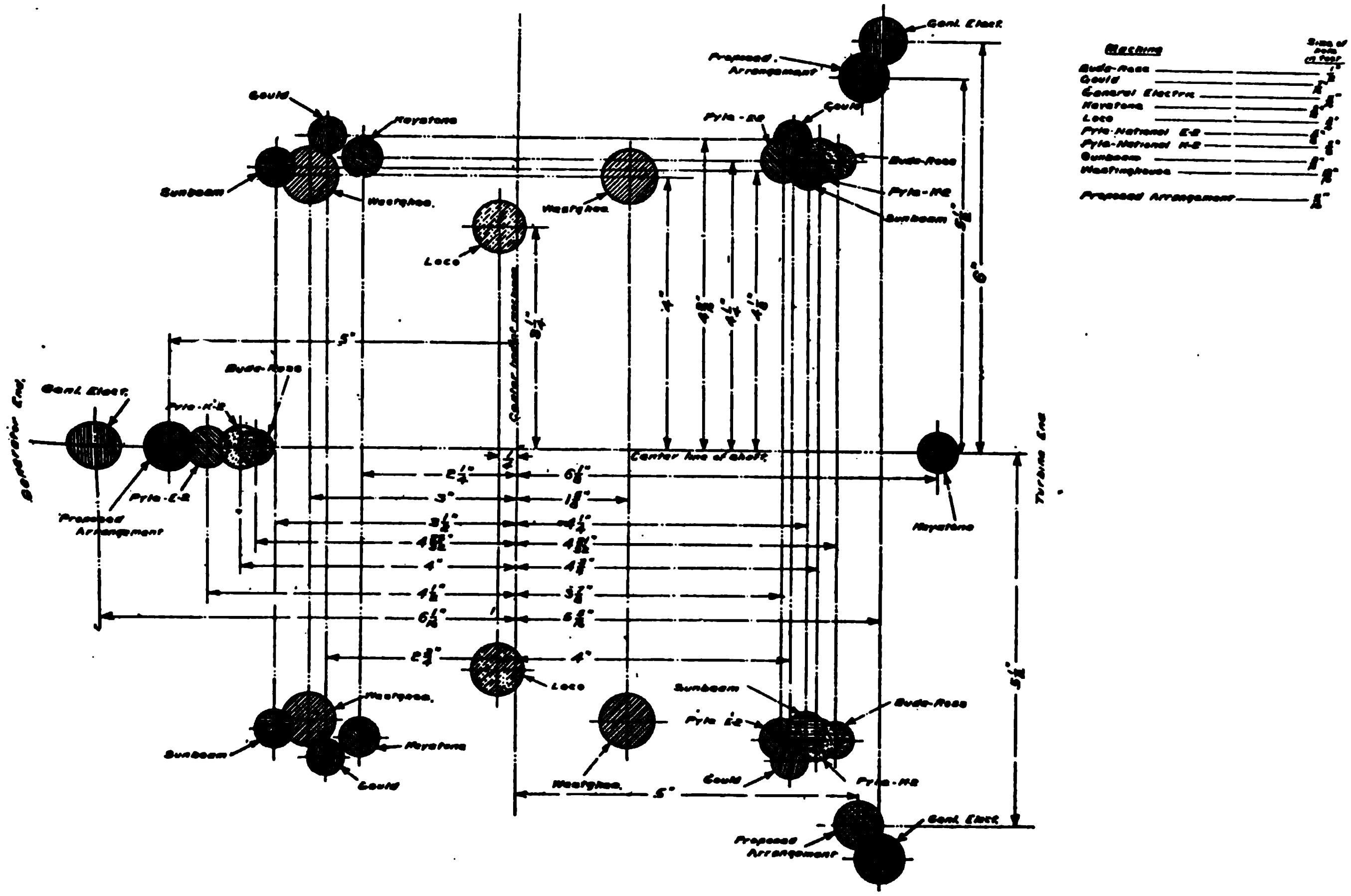
center line and 5-in. from transverse center line.

When clearance between foot and body of generator prevents entering bolt from top, foot may be slotted, but where it is necessary to slot all feet slot in foot at generator end should be parallel with longitudinal center line and slot in feet at turbine and parallel with transverse center line.

casings to be 12-in. by 12½-in., the center line of back holes to be not more than 5 in. ahead of rear of case, bolt holes to be 7/16-in. diameter for ⅜-in. bolts, general design of casing to permit bolts to be applied from top with nuts on underside of bracket.

8. Screw sizes smaller than Nos. 12-28 thread not to be used, heads to be either fillister or flat and material to be brass or

committees responsible for recommendations which have been adopted as Standard or Recommended Practice, your Committee on Manual has codified and published in one loose leaf volume the Standard and Recommended Practice of the Division; test and drawings. The adopted practices of the former American Railway Master Mechanics' and Master Car Builders' Associations have been care-



LOCATION OF SUPPORTS IN VARIOUS TYPES OF TURBO GENERATORS SHOWING PRESENT AND PROPOSED BOLT HOLE SPACINGS

2. Steam inlet of turbo generator to be for ½-in. iron pipe, exhaust outlet to be for 2-in. iron pipe and drain to be for ½-in. iron pipe.

3. The variation in location of steam inlet from longitudinal and transverse center lines of bolt spacing and the distance above the base plate to be in increments of ½-in. steam inlet to be on left side facing turbine end.

4. Ball bearings to be any of the following numbers, which also designate the size:

No. 306 No. 308 No. 406

5. Brushes to be 1-in. wide, ½-in. thick and not less than 1½-in. long.

6. Brush holders to be equipped with springs so designed that no adjustment is necessary or possible during the full life of brush and commutator, and to provide uniform pressure. during 1-in. wear of brush. Brush holders to be machined inside, set 3/32-in. from commutator and at an angle of 10 deg.

steel. For sizes larger than No. 12 use ¼-in., 5/16-in., ⅜-in., etc., bolt sizes, heads of ¼-in. and 5/16-in. bolts to be slotted to permit use of screw driver.

9. Lubrication for turbo generators to be oil.

The committee also recommends the following to be submitted to letter ballot as recommended practice for maintenance of turbo generators:

1. Oil for lubrication to be as light as possible consistent with the conditions of heat under which used, to be filtered before using and kept in a covered receptacle.

2. Oil reservoirs to be kept free from accumulation of grit and dirt.

3. Extensive repairs, and particularly repairs to rotating parts, to be done only at shops or designated points where adequate facilities are available.

Report of the Committee on the Manual

At the direction of the General Com-

fully checked and harmonized and together with the practices since adopted by the Mechanical Division, American Railway Association, are included in this volume.

This book is designated as the Manual of Standard and Recommended Practice, Mechanical Division, American Railway Association.

For ready reference this Manual is divided into twelve section under the following headings:

A—Specifications for Materials.

B—Gages and Testing Devices.

C—Car Construction—Fundamentals and Details.

D—Car Construction—Trucks and Truck Details.

E—Brakes and Brake Equipment.

F—Locomotive Wheels, Tires and Miscellaneous Locomotive Standards.

G—Safety Appliances for Cars and Locomotives.

H—Train Lighting, Headlights and

I—Rules for Fuel Economy on Locomotives.

J—Inspection and Testing of Locomotive Boilers and Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders.

K—Specifications for Tank Cars.

L—Miscellaneous Standards and Recommended Practice.

Each of the sections is provided with an index and in addition there is a complete detailed index to the entire Manual.

The Rules of Interchange and Loading Rules are not included in this Manual even though adopted as standards. They are published in separate handy form and are revised and supplemented so frequently it would not, in the opinion of your committee, be practicable to include them.

Circular No. D. V. 231, dated May 16, 1922, has been issued to the members advising as to prices, etc, for this Manual.

Specifications and Tests for Materials

The committee reported that sub-committees had been appointed and are now actively engaged in work on the subjects assigned as follows:

(a) Co-operation with the Rubber Association of America on the preparation of Specifications for Mechanical Rubber Goods.

(b) Specifications for Welding Wire.

(c) Specifications for Water Gage and Lubricator Glasses.

(d) Revision of present specifications for Galvanized Sheets.

(e) Revision of specifications for Structural Steel.

Subjects Referred to the Committee by the General Committee

(a) *Heat Treated Axles and Crank Pins. Has the process of heat-treatment decreased the number of failures to any appreciable extent?*

The committee felt that it did not have sufficient information among its members to satisfactorily answer this question and therefore requested the secretary of the association to circularize all members to secure the expression of opinion from those who have been using heat treated steel.

This circular was sent out and the original replies received have been tabulated in the following summary:

Total number of replies received, 77.

Number reporting no information, 52.

Of the remaining 25, four report that they consider heat treated axles and crank pins more satisfactory than untreated. Nine report that they are using heat treated material, but are doubtful as to the value of the heat treatment. Five report that they prefer annealed steel rather than the heat treated. Six report that their experience with heat treated material has been satisfactory. One road reports that they consider heat treated axles satisfactory, but are using annealed steel for

The committee has had representatives serving with the representatives of the American Society for Testing Materials on the Joint Committee on Specifications for Steel Castings for Railroads, which has been working for the past two years and which held a final meeting on March 21, 1922, and approved specifications for submission by each of the representatives to their parent bodies.

The committee also submitted exhibits containing revisions of numerous recommended practice specifications and new specifications, some of which are as follows:

Specifications for turpentine; oxide of iron plate; black paint; raw linseed oil; boiled linseed oil; red lead; mineral spirits; red lead and oil, and extended red lead paste paint.

The committee recommended that the above revisions referred to and new specifications be submitted to letter ballot of the association.

Proposed Standard Specifications for Carbon Steel Castings for Railroads

The Joint Committee on Steel Castings for Railroads held a meeting at Philadelphia on March 24, 1922, and submitted a comprehensive report in regard to the manufacture, chemical properties and tests; physical properties and tests; workmanship and finish; marking; inspection and rejection, and other details, all of which will be submitted to letter ballot.

Report on Locomotive Construction

The committee opened with a presentation of the main features of the Mallet locomotive but claimed that the railroads themselves can best determine what tractive effort to choose in simple operation dependent upon the design and weights on drivers of the locomotive.

In regard to broken frames of locomotives, the committee claimed, in but a few instances could it be ascribed to method of attaching boilers to frames. Usually locomotives remain in service several years before frame failures occur, and possibly there will then be an epidemic, indicating that time is an element. Investigation of failures on different classes of locomotives on one railroad indicated that the principal zone of failure was in the neighborhood of the main wheel, or ahead of the front pedestal, and little trouble occurred at the point where furnace is attached to the firebox.

If locomotives are designed with frames of proper strength to withstand stresses, little trouble should be experienced with broken frames, if a locomotive receive necessary running maintenance. Neglect of loose pedestal binders, loose wedges and worn rods, result in many frame failures.

Locomotives have been designed with insufficient frame crossties and crossties deficient in strength, or improperly lo-

together. When many of the older locomotives were designed, the art had not advanced to a sufficient degree to clearly understand the varied stresses set up in locomotive frames, and undoubtedly there is much yet to be learned in this respect.

The vertical loads due to the dead weight carried, as well as the vertical, longitudinal and lateral loads caused by the piston thrust, brake equipment, etc., produce strains that cannot be completely analyzed. This, therefore, requires that the frames be designed with very low stresses per unit of section, or very liberal sectional areas, to allow for these unknown forces. The frame, frame bracing and boiler when fastened together, should form a rigidly connected structure, and in whatever direction the thrusts may be applied, it must retain a fixed relation of one part to another.

The springs and spring equalizer rigging must provide the necessary flexibility and absorb the stresses which are imposed on the locomotive laterally, due principally to centrifugal forces on curves, and the reaction of the guiding effect of the engine truck, which is concentrated at the first frame pedestal as a fulcrum, with its resulting lateral bending stresses in the frame, between the pedestal and the cylinder. The longitudinal flexibility, due to brake application, is likewise absorbed in the spring rigging, as well as the vertical pressure due to the dynamic augment resulting from the driving wheel counterbalance.

The pressure due to the piston thrust produces vertical pressure on the guides. This guide construction must form a rigid framework in itself, as the fatal results from any flexibility in the working of these parts will be easily understood.

The bracing of the frames should be applied as closely as possible to the points of application of pressure in the various directions. It is most improper in designing frames simply to add metal to prevent breakage instead of designing to absorb the stresses in the proper manner. The adding of weight to the frames would serve practically no purpose in remedying frame breakages. On certain existing locomotives the addition of one or more waist sheets would have a beneficial effect. It must also be kept in mind that if a sliding bearer is used under the front and back of the furnace it should be provided with brass bearings. Otherwise it is liable to become corroded and stuck, in which case broken frames are apt to result. When the top waist sheet angle is riveted to the boiler, and also to the waist sheet plate, there have been many instances where it was most difficult to keep either bolts or rivets in the top or bottom of the waist sheet plates. This difficulty has been overcome by applying support that is flexible at the boiler, so made that the boiler merely rests upon a bearing, which is free

Extended piston rods have been tried out with more or less success on a large number of American roads as a means of reducing cylinder and piston wear. Any means employed for relieving the cylinder and piston from the weight, shock and consequent wear attendant upon a free piston, would seem to be a direct benefit. If it were always possible to preserve the alignment on both ends of the rod the extended piston rod would be beneficial in preventing cylinder wear and would also permit the use of cast steel, thereby resulting in some reduction in weight. On the other hand the extended rod itself results in considerable increase in weight, which seriously complicates the question of counter balancing.

Two general methods have been resorted to in treating the extended piston rod; one, the use of another metallic packing on the front cylinder head, while the other employs an extension sheath in which the piston rod is permitted to reciprocate the bronze or other suitable form of bearing at the inner end of this sheath to take the weight of the rod and piston. In the former case the upkeep of an extra metallic packing is a serious objection, while in the latter case the steam clearance is considerably increased and it is difficult to design a bushing of sufficient bearing to prevent rapid wear. The committee are convinced that there are diverse opinions as to the merits of extended piston ends, hence definite conclusions should be deferred and more investigation made on the subject.

Regarding solid bushed front end main rods, the builders state that several years ago quite a number of roads had locomotives equipped with solid front end main rod and bushing, but have since gone back to the use of keys and two-piece brass on account of the solid bushing not giving entirely satisfactory service.

With reference to the comparative merits of the Mikado and Consolidation types of locomotives, the first Mikado types were built by the Baldwin Locomotive Works in 1897 for the Nippon Railway of Japan; in 1902 a locomotive of similar type was built for the Bismarck, Washburn and Great Falls Railway in the United States.

The Mikado type locomotive permits the use of a long boiler with a wide and deep firebox, which is placed back of the driving wheels and over the trailing truck. This form of firebox is especially suitable for burning high volatile coal, as there is sufficient furnace volume for the combustion of the gases before they enter the tubes. Cases are on record where Mikado type locomotives have successfully burned fuel of a quality too poor for use in a Consolidation type engine of equivalent hauling capacity, but having smaller fireboxes. With a given weight on driving wheels and equal ratios of adhesion, a Mikado type locomotive will show no superiority as far as starting effort is concerned. As the speed increases, however, the tractive effort of the Mikado type will fall off less rapidly than that of the Consolidation, because of the greater boiler power of the former locomotive. On some roads the Mikado type locomotive has made an excellent combined passenger and freight locomotive, being used interchangeably for either service as occasion requires. The Mikado engine, on account of the wheel base arrangement, is somewhat easier on flange wear, and somewhat safer in high speed without danger of derailment. On Consolidation type locomotives having wide fireboxes, and comparatively large driving wheels, the depth of the furnace throat is necessarily restricted, making it difficult to apply a satisfactory design of brick arch. This difficulty is avoided in the Mikado type, as there is ample space between the grate and bottom row of flues for an arch with its supporting tubes. The necessity of placing a driving wheel under the firebox makes it practically impossible to apply a satisfactory ash pan to the Consolidation type, because the pocket over the driving wheel is so close to the underside of the grates.

The committee further reported that they had issued a questionnaire to sixteen railroads in regard to the relative advantages of non-lifting and lifting injectors. The advantages of the non-lifting injectors are reported as follows: Larger capacity for same size injector, injector pipes and connections; grades closer, giving a wider range for each size of injector; gives less trouble from restricted openings in the feed water supply pipe; located on the outside of the cab, thus relieving congested conditions inside; more reliable and dependable; application and maintenance cost less; more accessible for repairs and repairs can be made on the injector in place without disconnecting from the piping; will work with less water in tank, also operate with feed water at a considerably higher temperature.

The advantages of this type of injector are its greater liability to being knocked off by derailment, side swipe, etc., and the liability to freeze in extremely cold weather.

The advantages of the lifting injectors are stated as follows:

Mounted in cab where engineman can more easily see and observe its workings; if trouble occurs on the road it is easier for the engineer to remedy it; self contained and fewer parts to operate; easier operated and controlled.

Its disadvantages are: Less grading range than the non-lifter; more readily affected by restricted feed water opening and length of lift; must be taken down from pipe connections to repair the tubes; tubes coat up more rapidly than in the non-lifters; it is subject to failure from a leaky boiler check, worn steam nozzle or injectors become overheated they must be cooled off before they will operate.

It would appear from the replies received that: Little is known about the comparative efficiency of the two types of injectors with respect to steam consumption for a given quantity of water delivered; the cost of repairs and maintenance is less with the non-lifting injector; the non-lifting injector is more easily located and repaired; the non-lifting injector is generally considered preferable and is gaining in favor, particularly on large locomotives.

For the purpose of securing data on the subject of saturated steam drifting devices for superheater locomotives a questionnaire was prepared and sent to 16 railroads from which 14 replies have been received. It would appear from replies received that:

Automatic drifting valves on superheater locomotives are not generally being used; the common practice when drifting is to crack the throttle; the use of the manually controlled steam line from cab to valves and cylinders has not proven satisfactory; some roads are using home made devices for supplying air compressor exhaust steam to valves and cylinders with satisfactory results; a few roads are using automatic drifting valves with apparent success; a few roads are experimenting with various forms of automatic drifting valves; an automatic drifting valve is desirable if one can be found or developed which will operate successfully both at high and at low speeds, and be simple and rugged enough to be reliable and stand the service requirements without undue maintenance cost.

In order to determine modern practice of representative railroads in regard to tank syphons versus tank valves, a questionnaire was prepared and sent to 24 railroads, from which 16 replies have been received. Summarizing the data submitted by the various railroads, it appeared to the committee that the syphon is well adapted for use with lifting injectors, while the tank valve is more suitable for non-lifting injectors.

To the inquiry regarding the subject of tank hose versus metallic connections no replies were received from railroads and one voluntary report from a manufacturer. All of these roads but one, were large systems. Five roads had no experience whatever with metallic tank connections. One road reported trying out one in 1909 without success. Another road has tried one on a switch engine for three years with no cost for repairs beyond three or four gaskets and their application. The Erie has one connection applied to engine No. 2509. This has been in service for the last 18 months. The test is to cover a period of two years. One large system reported having had "a little experience" with metallic tank connections, adding "We are not extending it."

pears that metallic connections for steam, air and signal lines are almost universally used. All of the roads but one reported unanimously in this regard. None of the present devices are heartily endorsed so as to warrant your committee in making a recommendation.

The maintenance of tank hose amounts to very little if it is manufactured of first class material and properly applied. Tank hose suffers more from abuse than from use. It is put up wrong as often as it is put up right and is in many instances a badly neglected detail. If the hose connections are properly angled and the hose cut to proper lengths, the kinking will be reduced to the minimum and the maintenance likewise, as it is the kinking of this stiff wire-lined hose that destroys it. Standard diameters and lengths are easily maintained, but in the application the drawing cannot be adhered to literally for the length—it has to be adjusted for existing conditions. When engine and tender are coupled up the water hose should hang in such manner as to make one continuous easy curve from the point of the feed pipe connection on the engine to the tank well connection. Any other form is apt to kink the hose.

Your committee concludes that in the light of the information in hand we are not justified in discarding the hose. We feel assured that with a reasonable amount of attention to this detail the present maintenance may be considerably reduced.

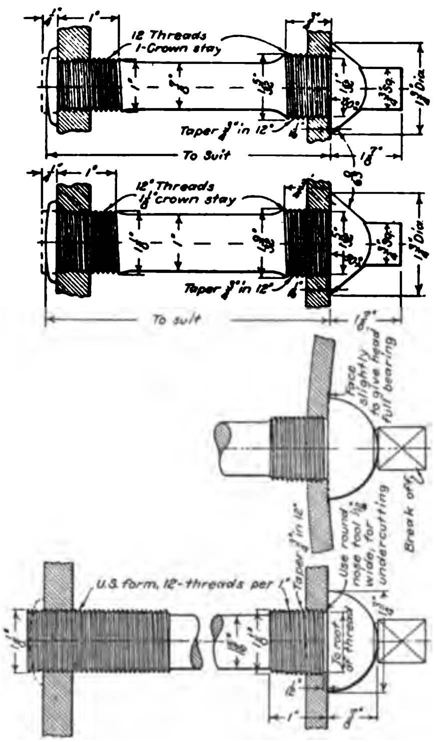
Feed Water Heater for Locomotives

The Committee's report showed that a number of the roads have made economy tests of the feed water heater in comparison with the injector; and some very excellent results have been obtained. The committee has no information as to how these tests were run and can not vouch for the accuracy of the results reported, but give them as information.

When the locomotive is standing or drifting the use of the heater is not recommended. Objection has been made to the application of feed water heaters on the ground that it would be impossible to prevent their use when there was no exhaust steam to heat the water and then cold water introduced into the boiler would have a bad effect on the flues and firebox.

The replies to the questionnaire indicate that there is no evidence that the use of the feed water heater has resulted in any damage to the boiler.

The use of exhaust steam from the auxiliaries, such as air pump, headlight generator and stoker may be advisable in order to maintain the temperature of the feed water when the locomotive is not working.



APPROVED FORM AND METHOD OF APPLYING STAYBOLTS IN LOCOMOTIVE BOILERS

Road No. 1—Closed Type	
Increased evaporation per pound of coal	15.3 per cent
Coal saving per 1,000 gross ton miles	12.3 per cent
Increase in over-all boiler, furnace and grate efficiency	14.3 per cent
Type of locomotive tested (cylinders 27 in. by 30 in., drivers 69 in., 200 lb. boiler pressure)	4-8-2
Road No. 2—Open Type	
Coal saving	12 per cent
Road No. 3—Closed Type	
Increased evaporation per pound of coal	24.1 per cent
Decrease in fuel consumption	10.5 per cent
Decrease in superheat	3.6 per cent
Road No. 4—Open Type	
Saving in coal per 1,000 ton miles	14.0 per cent
Increased boiler efficiency	16.1 per cent
Exhaust steam recovered from the cylinders, condensed and returned to the boiler	8.6 per cent
Decrease in superheat, deg. F.	21.7
Road No. 5—Closed Type	
Saving in coal per 1,000 ton miles	8.9 per cent
Road No. 6—Open Type	
Saving in fuel oil	12.5 per cent
Road No. 7—Closed Type	
Saving in coal per trip	12.5 per cent
Increased evaporation per pound of coal fired	16.0 per cent
Road No. 8—Closed Type	
Saving in fuel	13.0 per cent
Road No. 9—Closed Type	
Saving in fuel	16.5 per cent
Road No. 10—Closed Type	
Saving in fuel	14.0 per cent

Several roads express the opinion that any damage from the introduction of cold water to the boiler would be reduced by the use of a top head check.

Design and Maintenance of Locomotive Boilers

At present there are two general styles of locomotive boilers being applied to locomotives in this country, the Belpaire and the radial stay.

The radial stay type of boiler was preceded in use by the crown bar type. As the demand for larger boilers and higher pressure took place, the weight of bracing necessary to support the crown sheet became excessive, increasing the difficulty in washing out and keeping the crown clear of sediment, due to the obstruction of crown bars.

In the earlier style of radial type the crown sheets were so much arched that it was possible to apply only two center rows of radial stays with buttonheads to bear squarely against the under side of the crown sheet, and the angle of the stays was such that the heads of the outer rows would not bear squarely against the under side of the crown; the end through the outer shell was at such an angle that it was impossible to get a continuous full thread fit within the thickness of the shell sheet, resulting in leaky staybolts.

In the later designs of radial fireboxes the crown sheet was very much flattened, permitting the application of buttonhead stays to approximately the full width of the crown. In the first design of radial stay fireboxes, in order to get the number of flues to correspond with those used in equal size crown bar boilers, the crown was carried higher than in the crown bar boiler, resulting in restricted steam space. In flattening the crown sheet, the steam storage space was increased, but the firebox heating surface reduced as compared with the earlier designs.

In the Belpaire type, the outside and inside firebox sheets are arranged with the surfaces of sheets practically parallel, permitting the application of braces at right angles to the plate supported thus giving maximum fit for the threads of the stays or sleeves in the sheets and enabling the use of buttonhead stays through the full width of the crown.

With the Belpaire type, a given diameter of the boiler shell gives: (1) greater steam storage space, (2) greater steam disengaging surface, (3) greater firebox heating surface, (4) greater number of tubes, (5) all vertical stays of same length which results in less variation in expansion and contraction, less distortion of shell sheets, less breakage of bolts, and less number of staybolts to be kept in stock for repairs.

Since the history of boiler design shows that the firebox crowns have been shaped to provide for the application of buttonhead crown stays for the support of the crown sheets, the committee feels that this type of stay as illustrated should be adopted as recommended practice for other than oil-fired boilers.

Consideration should be given to provide protection for return bends of superheater units. No design other than the ordinary damper appears to have been developed or at least are not within the knowledge of this committee. In this connection protection to the superheater units could be obtained by locating the throttle between the superheater and the engine, and developments along this line should be considered.

Improvement should be made in the usual form of tapered screw washout plugs threaded directly in the shell of the boiler. It would be desirable to design a screw plug wherein the plug proper was not screwed directly into the shell of the boiler and the cap or plug should be so designed as to eliminate the possibility of crossing threads in screwing to place.

The report embraced a full description of the approved methods of boiler maintenance by the appliances that have come into use during the last four years,—the cutting out by the use of the gas cutting torch of defective parts, and autogenous welding for uniting parts.

Descriptions were also embodied in the report of approved methods of water treatment and closed an excellent and comprehensive report by pointing out the fact the cost of boiler maintenance can be very materially kept down, and the maximum efficiency of the boiler more nearly obtained by the consistent use of hot water washout and fill systems. In the use of hot water, in order to be effective for the loosening of scale and washing out mud from the interior of the boiler, it should be under a pressure of about 130 lb. per sq. in., and at a temperature of about 150 deg. F. This force and temperature will quite effectively remove scale and clean the boiler.

There are three general types of washout and fill systems in use.

1. The ejector type, in which washout water is slightly heated and placed under pressure by inecting steam into it through a suitably designed nozzle. This is the simplest and least expensive type, but appears to be the least desirable.

2. The pump and heater system, where the water is heated in an open or closed heater, distributed through a pipe line in the engine house and forced under a pressure of about 130 lb. into the locomotive through a hose and nozzle. This type is fairly effective and can be installed without violating any patent rights. For a medium sized terminal, such a system with two water tanks, one washout and one filling pump and two pipe lines into the engine house, will afford washout water at 150 deg. and filling water at 200 deg. F. at a small operating expense. Where exhaust steam is available for heating water, this type is an excellent one for a medium sized terminal.

3. The blow-back type, where the steam blown off the locomotive is utilized to heat the wash and filling water. Such systems which also provide for the automatic tempering of the water used in washing out and the use of a circulating line to keep the water always hot in the engine house lines, are protected by patents. This system is the most effective one, and provides washout water at all times of the proper temperature, and steam blown off from the locomotive instead of washing it.

The committee earnestly urges upon the management of the railroads the importance of installing hot water washout and fill systems, thereby effecting economies and efficiency with little expenditure of capital.

The session of the convention was largely attended and while the reports without exception were unanimously approved, the discussions arising from the presentation of the reports were of much interest as presenting illustrations of individual experience sustaining the findings of the committees. The total attendance was considerably larger than that of two years ago, there being 2,339 railroad men registered this year as against 2.024 two years ago.

Election of Officers

Chairman, James Coleman; vice-chairman, John Purcell; members of general committee, C. F. Giles, T. H. Goodnow, A. Kearney, J. T. Wallis, W. H. Winterwood, C. E. Chambers, and L. K. Silcox. To fill unexpired terms on general committee ending June, 1923; W. J. Tollerton and H. C. Oviatt.

A. R. A. Section VI—Purchases and Stores

Among the other sections of the American Railroad Association holding their meetings, Section VI., embracing Purchases and Stores, the members showed a praiseworthy activity in assembling coincidently at Atlantic City while the other conventions were in progress and contributing their quota of thought and activity in the important department of railroad transportation in which they are engaged. The chairman, H. B. Ray, called the meeting at an early hour on June 20, and after the appointment of committees introduced Elisha Lee, vice-president Eastern Region of the Pennsylvania, who showed a thorough mastery of the subject of organization generally and purchasing and stores particularly. The necessity of the department, he claimed, was three-fold; first, to minimize the amount of capital at risk in stores; second, to reduce the interest loss on the idle capital; third, to keep the company in a position to cope promptly with changes in markets or general business conditions without incurring serious loss.

"The Stores Department Book of Rules"; "The Classification of Material"; "The Distribution and Accounting for Supplies" and "Accounting" were all discussed by those in attendance.

On June 20 Mayor Edwin F. Bader welcomed members to the city and assured them of all the conventions that came to Atlantic City the railroad men were the best. Marion J. Wise, manager, Department of Material and Supplies, United States Railroad Administration, spoke on "Proper Organization in Service of Supply Real Basis for Successful Achievement;" and among shining truths claimed that the greatest handicap has been the lack of men who are primarily fitted for the work to which they are assigned and for which they are held responsible. "Material Accounting and Mechanical Facilities" were reported on by an active committee who recommended mechanical devices, such as adding machines, comptometers, typewriters, listing and tabulating machines, which was approved.

A report on "Reclamation of Material" embodied plans or reclamation of plants, and "Scrap Classification" was illuminated by plans already perfected on the Rock Island, and Kansas City Southern. "Supply Train Operation" furnished valuable suggestions for overcoming many difficulties in train operation and distribution of material equipment and other supplies.

The third session was notable in the discussion of "Office Organization"; "The Need of a Sinking Fund to Care for Losses in the Handling of Materials"; "Economies in the Stationery Store"; "Fuel Conservation," and other subjects.

Election of Officers

A nominating committee consisting of A. Bushnell, J. G. Stuart, O. Nelson and H. P. McQuilkin, placed in nomination the following members to the General Committee for 1923: Chairman, F. D. Reed, vice-president Chicago, Rock Island & Pacific; vice-chairman, U. K. Hall, supervisor of stores, Union Pacific; R. C. Vaughan, vice-president Canadian National Railways; R. J. Elliott, purchasing agent, Northern Pacific; H. H. Laughton, assistant to the vice-president of the Southern; W. G. Phelps, purchasing agent of the Pennsylvania; William Davidson, general storekeeper, Illinois Central; C. D. Young, general supervisor of stores of the Pennsylvania; J. G. W. Stewart, general storekeeper, Chicago, Burlington & Quincy, and J. F. Marshall, purchasing agent, Chicago & Alton.

29th Annual Convention of the Air Brake Association

Wastes in Air Brake Service and Standard Practices Discussed

The first day's proceedings of the 1922 Convention of the Air Brake Association opened in the Haddon Hall hotel, Atlantic City, N. J., on June 19. President L. P. Streeter, in the chair. The meeting was largely attended nearly 400 being present, and an added interest was attached to the meeting which marked the first time that the convention of air brake men has been held coincidently with that of the Mechanical Division of the American Railway Association. A happy address of welcome was delivered by the mayor, Hon. Edwin F. Bader.

In the course of an excellent opening address the president congratulated the members on the opportunity afforded of witnessing the extensive exhibits made by the railway supply men, which was without a parallel in the world, and was in itself of the highest educational advantage. The air brake men had a right to feel proud of their achievements, their organization was filling successfully a highly specialized field of work, and had earned the warmest commendations both from the Interstate Commerce Commission and from the Bureau of Safety. The triumphs of the association was the best guarantee of its future.

The report of the secretary and treasurer showed that the association was progressing in membership and funds.

Wastes on Air Brake Service

Professor S. W. Dudley, of Sheffield Scientific School, Yale University, presented a timely and instructive paper on the above subject from which we make some abstracts dealing directly with the important subject:

"The Great War has brought home to thoughtful people here the object lesson of the European nations, who are, and have been for years, face to face with the struggle for existence on what seems to us a hopelessly narrow margin between natural resources and national needs. Only recently have any of us become much impressed with the necessity for conserving our own vast natural resources. It has now become a common saying that some nations would live comfortably on what we, as a nation, waste.

An excellent example is the magnificent work accomplished by the Committee on Air Consumption of Locomotive Auxiliary Devices, under Mr. Weaver's able leadership. His reports, at this and the two preceding conventions, are full of original and practical information and sound recommendations. They deserve to be studied and acted upon. The railroads will benefit directly as the sources of loss and efficiency mentioned are attended to.

show the appreciation which this thorough investigation merits in no better way than by adopting its standards of performance and methods of testing as a part of their recommended or standard practices.

The conditions disclosed by the report of this committee certainly justify immediate and thorough action. Such action has already been taken on several railroads. Why should not the supervisor of air brakes have at least one man, possibly one at each terminal and division point, whose sole duty should be the finding and stopping of air leaks? He would be a busy man and might need several helpers, but would it not pay? A good live young fellow, interested in his job, would soon learn a lot about what should and could be done. Call him the air leakage inspector, if you choose. I believe the committee will back me up in saying that the results would astonish you.

Wastes in air brake service are by no means only those direct losses due to leaky or inoperative devices, or to materials or supplies actually lost or damaged. In a foreword to the Engineering Societies' Committee report, Mr. Hoover said some things which apply to the air brake service, as well as to the general industrial situation which he had particularly in mind: "We have probably the highest ingenuity and efficiency in the operation of our industries of any nation. Yet our industrial machine is far from perfect. The wastes of unemployment during depressions; from speculation and over production in booms; from labor turnover; from labor conflicts; from intermittent failure of transportation of supplies or fuel or power; from excessive seasonal operation; from lack of standardization; from loss in our process and of materials—all combine to represent a huge deduction from the goods and services that we might all enjoy if we could do a better job of it."

Time, energy, both human and mechanical; money, materials, and equipment must all be wisely directed and intelligently used. Many of our most serious losses arise from our failure to use the time and energies of past generations, as well as those of living men. Committees, rules and reports point the way but are powerless until translated into right action at the right time and place by the man on the job,—whether he be the general manager or the yard inspector.

Well, there are many causes, some evident and easy to cure, some not so evident and not so easy to overcome. Lack of vision, faulty management, ignorance, carelessness, lack of team work, inadequate or improper equipment or installation, lack

rials or tools, the wrong man on the job and (perhaps the most serious of all) not enough trained men to do the work.

I want you to read again Mr. Frank McManamy's address before our 1920 convention. Listen—"I have always felt that the air brake man was working under a rather strong handicap and that while he was a mighty good fellow, there were too few of him." With the additional work the air brake man has to perform outside of organizing his departments and looking after the brakes, and looking after men that handle brakes, he is able to give entirely too small a proportion of his time to the actual maintenance and operation of the brakes. It seems to me that we shall never get the air brake conditions which are desirable, and which are in fact necessary under modern methods of railroad operation, until we increase the air brake departments on practically all the railroads. We must have first, men to plan the reorganization. We must have, second, the facilities to permit the work to go forward. To get both of these we must have support from the higher officials of the railroads, because while it will cost them a little money at the start, it will pay. It will be one of the biggest dividend payers that they have on their railroads."

Make no mistake about this. This is not an air brake man trying to land a job or get an increase in salary. It is the deliberate practical judgment of a good business man, an executive of wide experience, accustomed to look for the facts wherever they may be found and to face them squarely when found. A little further on he says: "If the rules and recommendations of this Air Brake Association were being observed on all the railroads in the country, we would not need any federal laws relative to the condition of air brakes." This is a compliment and a challenge. Gentlemen, it lies in your power today, more than ever before, to make these rules and recommendations effective through co-operation with the proper agencies of the greater association with which you are now affiliated.

Perhaps you will be interested in knowing that the larger part of my professional experience has been in connection with railway mechanical engineering. While serving a special apprenticeship on the Santa Fe, I specialized somewhat in air brake work. At one time, I made a study of the waste of compressed air about the Cleburne shops. It was found that there was a very large waste occurring through leaky valves, improper hose connections, faulty air drills and by equipment while not using it, at noon hours and other times. Through correcting these things, a *lack of air supply* was converted into an *abundance* and a *low* pressure, brought about by leakage, was changed to a *sufficient* pressure. This made it unnecessary to *purchase additional* air compressors which had been contemplated. I am confident that this situation is duplicated in many of our railroad shops.

Without further mention by name, but with hearty thanks for their co-operation, I wish to quote or refer now to several suggestions received from active and influential members of this association (most of them members of the Manhattan Air Brake Club) as to concrete cases which illustrate clearly what we have been thinking about. Excessive leakage is, of course, an old and an ever present source of waste, delay and inadequate control.

First, therefore, a good suggestion regarding leakage:—I do not feel that you can lay too much stress on the necessity of railroads providing a departure yard suitably equipped with air brake charging lines with a view of eliminating excessive leakage and correcting irregularities that may exist when there is adequate time, rather than performing this work after the hauling locomotive is attached to the train when the time is limited. This does not only mean assisting the life of the compressor and accessories but goes a long way toward assisting proper and economical functioning of the air brake equipment.

Insecure pipe clamps, use of the human instead of the soap brush to locate leaks and carelessness about retainer pipes and unions are well known but altogether too common sources of leakage. These and other shortcomings of installation and inspection are of much more consequence on a locomotive than on a car, because "a locomotive failure is a train failure."

Do you know why this leakage is tolerated? As in most other cases, the answer has an economic flavor. It is because coal costs only $4.00 per ton.

They don't know what leakage is in Europe. One of your best known members told me of riding on a French railway locomotive during the war and being almost paralyzed to see the engineer calmly reach over and shut the throttle valve in the air compressor steam pipe shortly after leaving the station. There was about 80 lbs. pressure in the system and there it stayed until the brakes were used to make the next stop, when the pump throttle was opened up and the pressure restored. There *were* no leaks—they were not tolerated. Why? Because at that time coal was $64 per ton and the engineman received a bonus on every pound he could save. So it *can* be done.

We avoid the cost of a good tight pipe job, of close inspection and of competent repairing, but burn more coal. We need to do more than make rules about these things. We must have the right kind of men, enough of them and encourage them by giving them the tools, the materials and the proper places to do the work. No man can turn out a decent job with only a pipe wrench, a paint brush and a lack of proper material or conveniences.

The following describes conditions perhaps not entirely unfamiliar to some of you.

Probably the greatest handicap suffered, in my experience, was and is due to the extreme poor quality of the men that we are provided with for air brake work, it seeming to be understood that any kind of a man will answer the purpose, which of course results in a great loss of time and material, as well as safety. To illustrate:

While checking triple valve repairs not so long ago, it was found that paper wads had been used to fill the triple piston packing ring openings, which for the minute, permitted the valves to pass the test rack requirements and for the same purpose and in the same lot of valves, a very heavy grease had been used on the piston ring and cylinder.

Improper tools is another cause for a waste of time and material. While watching one of our men cleaning the brake equipment on a car recently, it was noted that he was using a hammer and chisel for removing nuts from the bolts. On inquiry it was found that he had but a 12-in. pipe wrench for the purpose and this could not be used due to lack of space.

At one time 26 steam heads for 9½-in. compressors were found hidden away in one of our shops instead of being repaired and used because it was much easier to apply new. Of course, these had been some time in collecting, but it illustrates the waste and nearly the same condition prevailed at the same shop in connection with slide valve feed valves for engineers' brake valves.

The saving in material and time which can be made possible by improvements in storerooms and repair yards would scarcely be credited. Here is a concrete case:

For several years we were unable to have the stores department handle second-hand material. When surplus air brake material was repaired, they refused to allow us to place it in stores for filling orders to outside points, claiming that this put the burden of cost on them. At the same time requisitions were not submitted to me for approval. About four years ago I made a check of extra material on the system and found about $35,000 worth of distributing valves, brake valves, feed valves, pump governors, cut-out cocks, etc., lying in engine houses, shops and repair tracks. This material was repaired and stored for less than $600, including labor. In this lot there were 30 distributing valves that only required a piston packing ring, or an application piston packing, feed valves that only required cleaning, governor bodies requiring reboring, new portions of governors that had been stripped to make repairs to second-hand material and triple valves. This was the direct result of drawing on the stores department for new material without returning the old parts for repairs. While we furnish enginehouse inspectors with material that requires no work except application to the locomotive or tender, they do not clean feed valves or distributing valves, but draw new ones on the stores department. We found that the shop repairmen and pipe fitters were ordering material that did not move from the stores department in many instances for eight to ten months. The pipe fitters were going to the stores department for new material when the old material would have served the purpose just as well. As evidence of this we found 1,200 ¾-in. cut-out cocks which were thrown in different places in the shops, all of which were made good by regrinding and placing them again in service.

After noting the difference of the men in regard to material, we checked all requisitions to prevent duplications of the above parts, and are satisfied that from our present system we are saving from $10,000 to $15,000 per year without in any manner diminishing the safety or efficiency of the service. We then checked all the storehouses on the system and found hundreds of parts of special retaining valves, feed valves, governors, etc., which we assembled and placed in stock for distribution. The result of this is we have not ordered any of these parts, including triple valves, for the past four years, and having a check of the number of whole parts on hand at the different points on the system, duplications can be made only through loss by accident.

At our main car shops where heavy repairs are made which require taking down the entire brake apparatus, we found that the amount of pipe work was so great and the distance from the pipe and cutting machine so far, that six men were required to do the work which four men could do equally well.

Where five foreign lines deliver to us, we found that the number of non-operating brakes were so great that it was necessary to add six men to the force, two on each eight-hour trick. In our fast freight trains we put in at least four to eight cylinder packings in each train. To save time we furnished pistons complete with packing leathers, so that when one was removed from the cylinder under the car, a complete piston was added and the work of re-applying the leather was done when there was no train work. The trains then departed with 100 per cent operative brakes, and nearly always on time. We have placed standard triple valve test racks at all terminals where air is supplied to repair track, 10 in number, and all cleaning of triple valve is done in the shops instead of on the car. A laborer carries the triples to and from the test racks to the cleaners. All triple valves are sent to one point for repairs.

Lack of material was always an excuse for not doing work properly and efficiently. I found on visiting the different stations that they were always short of certain material, and that requisitions were not promptly filled. We appointed one man whose sole duty is to visit all repair stations, note requisitions and see that no place suffers for want of material. This worked out perfectly as we find now that there are no delays in shipments of material, unless it is that for which we are waiting delivery from the manufacturer.

It is a noteworthy fact that foremen at shops, enginehouses and repair tracks never check up the work of air brake men. This is probably due to the fact that they were never interested in the work and know very little about it. We, therefore, depend upon the men to honestly perform their work, and to do this they must be furnished with the necessary devices and material. The proper location of locomotive and car air devices is essential, as an improper location of such devices means neglect on the part of the workmen.

In your own proceedings and in those of many of the railway clubs these truths have been emphasized over and over again. One of the most notable of these is a paper on "Freight Brake Maintenance" presented by F. B. Farmer before the Canadian Railway Club, April 1918. This paper should be studied and adopted as a standard text by every air brake instructor and inspector in the country.

The sole purpose of a railway is to save time. Therefore, the greatest possible waste is that of time. To operate the railways human energy and skill are necessary in the highest degree. Therefore, misdirected or unduly overloaded human energy is a source of avoidable waste. To permit human energy and skill to function effectively and efficiently, proper organization, policy and support must be provided. Therefore inadequate organization, lack of understanding and vision, and insufficient funds, materials and equipment cause lower efficiency, diminish effectiveness and result in far-reaching wastes. Expensive "economy" and wasteful "saving" must be guarded against. To paraphrase a well-known Arabian proverb:—

"He who wastes and *knows* that he wastes is a fool. Avoid him.

"He who wastes and *knows not* that he wastes is simple. Teach him.

"He who wastes not and *knows not* that he wastes not is asleep. Wake him.

"But he who wastes not and *knows* that he wastes not is a wise man. Follow

On June 20 the attendance was larger than on the previous day, showing an increased interest in the proceedings. Prof. Dudley's fine address evidently being much discussed and giving an excellent illustration of the calibre of the men called upon to address the meetings. F. W. Brazier, of the New York Central, complimented the members on the admirable work that had already been accomplished, and the interest and sacrifice which many members of the association show by attending the meetings at their own expense and loss of time was more than they should be expected to do if the importance of the meetings was better understood.

Air Operated Auxiliary Devices

A report on this subject was read by C. B. Miles, followed by R. E. Miller of the Westinghouse Air Brake Company, who accompanied his remarks by lantern slides of the diagrams and charts referred to in the report. It will be recalled by readers of Railway and Locomotive Engineering that a committee of the Air Brake Association presented an extensive report which was circulated by the Executive Committee of the Association last year furnishing detailed information of air consumption of various locomotive auxiliary devices other than those belonging to the air brake, such as air operated fire doors, reverse gears, bell ringers, cylinder cocks, coal pushers, sanders and water cocks; and recommending a code of tests for such devices and recording the same thereby obtaining a method of estimating the costs of the maintenance of the devices. The report occasioned considerable comment among railroad men at the time of its publication. The estimates showed the enormous waste occasioned by the lack of reliable and economical operation. The condition of the auxiliary devices were shown to be far below the standard which should be maintained. The report was of real value, and the examples and illustrations furnished by Mr. Miles and Mr. Miller emphasized the need of more serious attention to the lack of economy in the application and care of the fittings of these auxiliary devices.

U.-C. Brake

Another illustrated discourse was given by J. C. McCune, furnishing a fine analysis of the U.-C. Brake. The moving picture films were furnished by the Manhattan Air Brake Club and were warmly appreciated, particularly in illustrating minutely the working of the U-12 universal valve. Slides and moving pictures of gasoline engines, carburetors, refrigerating machines and other appliances were shown and described by P. O. Warren of the Picture Service Corporation, Chicago, and were warmly appreciated and approved as a valuable aid in educational work.

In the course of the afternoon Hon. Frank McManamy, manager of the de-

Railroad Administration was introduced and spoke eloquently of the importance of the air brake in railroad operations and recommended that the association should be held responsible for the standard rules in regard to the maintenance and operation of air brakes. He also urged that the air brake men should be more aggressive and persistent in seeing that their recommendations were carried into effect.

On June 21, the third and closing day of the session of the Air Brake Association the report on "Standard Practice" was submitted by H. A. Clark. It contained a large number of suggestions in regard to improvements on minor details particularly in regard to the various valves and the cleaning and repairing of the same. The insistence on standards in details, especially on material was of a kind that showed how thoroughly the members of the committee having the subject in hand had noted minute defects coming under their observation. The details of changes recommended will be published in the annual proceedings of the association.

F. M. Nellis, secretary of the association, reported that while heartily co-operating with American Railway Association, steps toward amalgamating with that association had been given up. It was evident that there was already a congestion of work in the association and some of the air brake men had been looking towards Chicago as a permanent place of meeting. This idea also had been abandoned, as it was deemed advisable to hold the annual conventions in different parts of the country, instead of selecting any special locality, however, inviting it may be.

Election of Officers

The election of officers resulted in unanimously adopting the report of the nominating committee, which included the following: President, Mark Purcell, Northern Pacific; first vice-president, George H. Wood, Atchison, Topeka & Santa Fe; second vice-president, Charles M. Kidd, Norfolk & Western; third vice-president, R. C. Burns, Pennsylvania; secretary, F. M. Nellis, Westinghouse Air Brake Company; treasurer, Otto Best, Nathan Manufacturing Company.

Air Brake Appliance Association

Among the leading members of the Air Brake Appliance Association who prepared special exhibits at Haddon Hall, in addition to the exhibits displayed by them in the more extensive spaces at Young's Pier were the Westinghouse Air Brake Company, Ashton Valve Company, Barco Manufacturing Company, Clark Company, Crane Company, Joseph Dixon Crucible Company, J. B. Ford Company, Johns-Manville, Inc., The Leslie Company, Harry A. Montgomery, New York & New Jersey Lubricating Company, and Pilot

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Mechanical and Allied Conventions

The conventions of the various railway associations have again brought prominently into notice the importance of the occasional interchanges of opinions among men engaged in the same occupation. This is in keeping with the progressive and enlightened spirit of the age in which we live, and differs from the older spirit, which has, happily, almost disappeared, when every man engaged in scientific research or mechanical employment particularly intricate, kept his own secrets, or admitted others only as necessity demanded. The desire and aim now seems to be to proclaim discoveries or improvements not for personal aims or emoluments, although that need not be altogether overlooked, but that the art or calling may be improved, and that the advance, if any, may be all along the line.

As is well known in the expanding realm of railway traffic, there still remains a mighty field in which mechanical ingenuity and scientific knowledge can be applied to increasing advantage, and not alone in the special domain of mechanical appliances, but in all the multitudinous details that facilitate the work of the transportation department, there is a constantly widening sphere calling for a quickening of action and improvement in means and methods.

The railroad conventions and meetings give opportunities for the interchange of thought on these and kindred subjects, and while it is true that periodical literature is rapidly taking the place of text-books that soon become antiquated, the current press having the advantage of maintaining a constant stream of information on every conceivable question, which can readily be reached by the humblest, there is besides and, perhaps, above all this a peculiarly vitalizing influence to be felt in the opportunities of getting into touch with the results of experience directly from the lips of those who are actively engaged in the intellectual and physical activity incident to railway work. The advantages to the individual members may be briefly summarized as aiding, by mental exercise, in strengthening the faculties of the mind in learning how seeming difficulties may be overcome, how troubles may be promptly met, how the elemental and increasing forces of nature may be better harnessed and more economically utilized; while social intercourse with active, intelligent, thoughtful men polishes the mind and engenders a kindlier courtesy in the complex relation of man to man.

These benefits have their corresponding reflex on the communities of which the members of these societies are a part. The lasting good that is to be gathered from the intercourse to which we have referred tends to improve the conditions of life and work wherever the example or authority of the members extends. The latest improvements in mechanism and in methods are brought into the path of wider use and fuller development. As iron sharpeneth iron, so the public mind is better educated in the growing benefits that come from a broader vision of the marvelous world of science, and then the thoughts that are gathered at the conventions of the mechanical and allied associations, like seeds sown in the furrowed earth, spring into full blossomed beauty that ripens into the rich harvest of improved practical utility.

The Connector

It is coming on close to being a full generation since the use of the automatic coupler for railway cars was made compulsory, and the number of those who can remember the holocaust of victims of the old link-and-pin arrangement, is perceptibly thinning. For years before the law went into effect the inventors of automatic couplers had been haunting the conventions of the Master Car Builders' Association with all sorts of gimcrack contraptions, mostly, to be sure, of no value whatever, and were receiving scant attention; and, be it said to the shame of the members of the association, almost no serious advice as to the requirements and what would be needed to meet them. Meanwhile the link-and-pin was working out its own damnation and public opinion was becoming thoroughly aroused in its demand that the maiming and killing be stopped. Yet in the fact of all this there were many railroad officers of high standing who opposed the adoption of the automatic coupler on the ground of its higher cost.

The law was, however, enacted in the face of opposition and its main requirement was that the coupling should be effected without necessitating that the men should go between the cars. This was accomplished and it is safe to say that there is not a railroad officer in the country who would go back to the link-and-pin.

Still there remains the necessity, brought about by a second law requiring the use of power brakes, that a man should go between the cars to make the hose connections. It is not a particularly hazardous piece of work and there are few accidents resulting therefrom. But it is not to be classified among the preferred class of vocations and it takes time. It is unobtrusive and it is not probable that any statistics can be produced that will arouse public sentiment to the point of making the demand for reform that the link-and-pin succeeded in doing.

The desirability of the scheme is acknowledged while its necessity is denied. It is on the basis of this desirability that a number of men have been engaged for several years in perfecting designs to meet the requirements of the case. Service tests have been in progress for a sufficient length of time to show that the devices will meet the demands that may be put upon them, and that they are commercially practicable.

In some ways our railroads seem to resemble the old Bourbon dynasty, in that they do not learn much by experience. They were compelled by law to adopt the air brake and the automatic coupler, and the automatic train control appears above the horizon as one of the possible universal compulsions of the near future: with the indications of the approach of the automatic connector as a close follower.

It would be hazardous to claim that the connector has been so perfectly developed that it will meet all the severities of the requirements of freight service in interchange traffic. But few things do reach perfection at a bound.

With this prospect ahead of them, it would seem to be the part of wisdom for railroad executives to cut loose from Bourbon traditions and take a lesson from the leaves of experience and prepare for the probable inevitable.

So instead of ignoring the issue, why

not look to what has been done and get ready.

The coupler is the natural point of attachment for the connector, and the designs now prominently to the front are arranged to be fastened to it. It is, therefore, suggested that it would be a matter of eventual economy for the railroads to adopt a form of lug to be cast to the bottom of the coupler head or shank, to which the connector designers should fasten their designs. This will not only greatly facilitate the introduction of the connector, but save money during the transition period.

The present hostility on the part of some interests is understandable, but why the railroads should deliberately ignore what seems sure to come is difficult to comprehend.

That the making up of trains and all switching movements are greatly facilitated by the automatic coupler there is no denying, and why not reason directly from analogy and concede that the same savings will be effected by an automatic connector.

Careful Crossing Campaign

The united effort that is being made by the railroad companies on their appeals to automobile associations, chambers of commerce, the national highway traffic associations and other agencies to join with them in a united movement having for its object the conservation of human life at highway grade crossings is already making itself felt in the lessened number of accidents occurring since the special campaign beginning on the first of last month was inaugurated. The absolute remedy would be the elimination of the grade crossings. This is being done as rapidly as possible but as it is utterly impossible to raise the means to accomplish this in a short time, it is laudable that a united effort should be continued not for a period of a few months but for all the year round.

We are one with those who hold that the automobilists themselves are to blame but the same may be said of all other weak-minded, mentally defective, unthinking individuals whose actions bring disaster upon themselves. We must learn to take human nature as it is. Motor drivers as a class should not be looked upon as wholly incorrigible. Even if the most heedless among them could be confined in public institutions for a while and debarred from such an occupation ever afterwards the effect would not be noticeable, as the young crop of embryo drivers seem to be more reckless than those who have survived some self-imposed catastrophe. The sobering effect of a collision is not soon forgotten.

There is a singular weakness in human nature that shows itself in taking chances where there is nothing to win. It would be just as useless to enquire what is gained by an automobile driver in rushing heedlessly over a railroad crossing as it would be to enquire of an ordinary pedestrian plunging out into the maelstrom of taxi cabs in a crowded crossing in a city avenue. By the time he gets half way across, generally, the current of the wave of traffic has ceased by order of the constantly recurring whistle blasts of the vigilant police, and the waiting rush of pedestrians are across the avenue almost as soon as the adventurous spirit who risked life and limb. What did he gain? Perhaps thirty seconds of time. What use did he make of the gain? Watch him. He is either rolling a cigarette or looking in at a shop window, or having his shoes polished or setting his watch in accordance with the time registered on some watchmaker's advertising clock, or reading a "movie" sign, or looking at a row of straw hats reduced from some figure to something lower. It is of no consequence. He has a hat already. What he needs is a new head, or that being out of the question, a new method of using the head he has. And yet there are said to be fifteen thousand killed in a year by taking the risk that he took. At this rate in four or five years there will be as many killed as there were of our gallant army helping to subdue the Huns.

Something less than half this number are killed in automobiles at railroad crossings, but the cause is the same—the idiotic impulse to move through space in the face of real danger, to accomplish next to nothing. If one is really in a desperate hurry, something of pressing importance, something commensurate with the chances taken, there might be a point to all this, but there is not one case of disaster of this kind in a thousand where there is any pressing call for haste.

We cannot change the dumb instincts of the lower animals. They need no change. They are, generally speaking, fixed and in their natural way unerring. Man is capable of developments. Education sets him thinking, and while there always will be a considerable number of people who make a poor use of education, the general result is beneficient in the development of those qualities that tend towards self-protection and general welfare. And so it is, that the railroad companies are engaged in a great and a good work in giving earnest attention in teaching people to protect themselves in the risks to life and limb incident to the operation of titanic forces essential to the constantly increasing work of transportation.

Colors for Traffic Signals to Be Standardized

A conference on the standardization of colors for traffic signals was recently held in New York under the auspices of the American Engineering Standards Committee, among others steam and electric railway interests were well represented. The conference agreed unanimously that there should be national uniformity in the use of colors for signals, and that the detailed technical work involved in bringing about such uniformity should be carried out by a thoroughly representative committee. This means that the day is not far off when red, green and yellow, when used as traffic signals, will each have its distinctive meaning which will be uniform all over the country.

Mr. A. H. Rudd, on behalf of the American Railway Association, presented a paper in which were summarized the general facts of the situation affecting the steam railroads, and suggested lines along which they would like to see standardization progress. While signal systems of different railroads differ in some respects, fundamentals are largely standardized. For the operation of trains these include: red for danger (stop); yellow for caution; and green for clear.

A paper by Mr. H. B. Flowers gave the experience of the American Electric Railway Association. The standard use for signals in electric railroad practice is: red for stop; yellow for proceed with caution; and green for proceed at schedule speed.

No final technical decisions were reached at the conference, these being left to be worked out in detail by a committee representing over 40 associations and about 30 manufacturers.

New Equipment Orders Largest in Many Years

Since the beginning of the year the railroads have placed orders for a total of 77,053 freight cars, 1,195 passenger cars and 460 locomotives. These purchases are larger than those in several years, and the orders for new freight cars are in excess of those placed in the first five months of any year since 1912. In the whole year of 1921 only 23,346 new freight cars were ordered for domestic use, and in 1920, 84,207, which number the orders of this year will soon exceed. In 1919 the total year's purchase of freight cars was 22,062, and in 1917, 79,367. In 1912 the total for the year was 234,078, and in 1916, 170,054 cars. Orders for 1922 to date are considerably ahead of those in 1916, as in the first five months in that year orders totaled only 49,551.

The total number of passenger cars ordered to date has been 1,195; in 1916 the orders placed in these months amounted to only 736 cars.

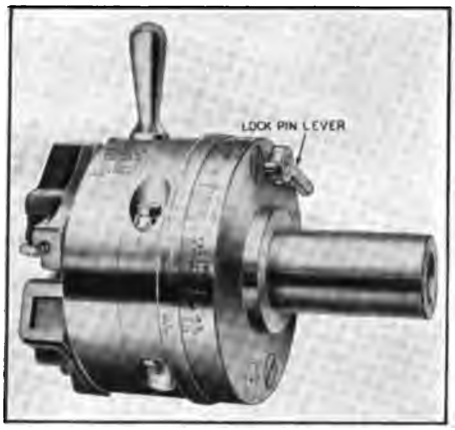
Orders for new locomotives have not been as numerous in comparison with other years as have those for other kinds of rolling stock. The 460 locomotives ordered since January 1 compare with 1,315 for the first five months in 1916, which year was the best since 1913.

Landis New Type Automatic Screw Cutting Machine

The Landis Machine Company have recently placed on the market a new type automatic screw cutting die head for application to turret lathes and hand screw machines. This die head is different in design from other heads of this type in that the chasers are supported on the face of the head. This permits of easy access to the chasers when it is necessary to remove them for grinding and changing from one size to another. It is made of steel and its sturdy construction insures a long life of hard service. The head is applicable to practically all makes of screw machines and turret lathes which have sufficient space to swing heads of these diameters. The head is opened automatically by retarding the forward motion of the carriage and is closed by hand.

It is locked by the engagement of two hardened cylindrical lock pins in hardened bushings. The roughing and finishing cuts are obtained on the 1¼ in., 2 in. and 3 in. heads by the movement of the lock pin lever. When cutting threads in one pass both lock pins are engaged. When cutting threads in two passes both lock pins are engaged during the first cut and for the second cut one lock pin is engaged. This is controlled by the lock pin lever.

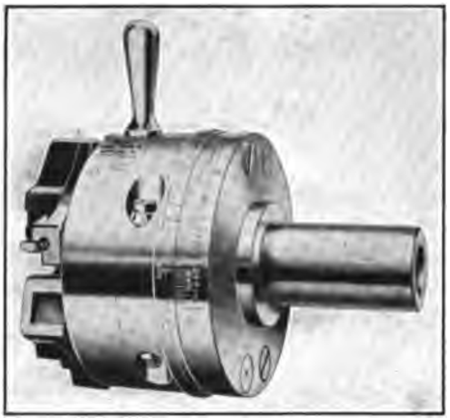
The head is adjusted to size by means of an adjusting screw, which engages the head body. Since the operating, adjusting and closing rings remain in a fixed position when the head is closed the rotat-



1¼ IN., 2 IN. AND 3 IN. AUTOMATIC HEAD

ing of the head body within these rings gives the diameters within the range of the head. It is graduated for all sizes of bolts, both right and left hand, and right hand pipe within its range. To adjust the 1¼ in., 2 in. and 3 in. heads for left hand threading, reverse the position of the lock pin lever in relation to its position for right hand threading.

The chaser holders and trunnions on the ⅝ in. and ⅞ in. automatic heads are integral. The one set of chaser holders furnished with the head will be suitable for threading bolts and pipe within its range. When pitches and diameters other than U. S., "V." S. I., Whitworth and Broggs standards are to be threaded, special chaser



⅝ IN. AND ⅞ IN. AUTOMATIC HEAD

holders with trunnions integral will be supplied.

The chaser holders and trunnions furnished with the 1¼ in., 2 in. and 3 in. automatic die heads are separate. Unless otherwise specified the die heads will be furnished with right hand bolt chaser holders for cutting U. S. standard diameters and pitches. If these heads will be required for threading pipe for cutting S. A. E. diameters and pitches, or diameters and pitches other than U. S., "V.," S. I., Whitworth and Briggs standards, the proper chaser holders will be supplied. This type of head employs the Landis long life chaser. These heads will be furnished with shanks to meet individual requirements.

Detroit River Bridge

Development of the plans for the Detroit-River bridge to connect Detroit, Mich., with Windsor, Ont., a project that has been under consideration for the last two years, has progressed so far that the outstanding features of the proposed structure are now made public. A span of 1,803 feet from center to center will be required with towers 330 feet in height from the base. The plan has been adopted to the requirement of construction in two stages, the highway deck to be built first and the railway deck to be added later. The towers will be of steel, consisting each of four posts in the vertical planes of four pair of cables. The breadth of the upper vehicular roadways and pathways are 28 feet for the roadways and 9 feet for the pathways. The two railways on the lower portion of the bridge have each a space of 36 feet in width, adapted for double tracks in each, with an intercostal space for bracing between the inner towers of 21 ft. 6 ins. Making the entire width of the structure 93 ft. 6 ins. Compared with other bridges in this country, the Brooklyn bridge has a span of 1,595 ft., width 86 ft., height of towers 272 ft. Williamsburg bridge span 1,600 ft., width 118 ft., height of towers 332 ft.

The unprecedented span length and the high load capacity necessary for the service to be carried made the design a difficult problem. The promoters have obtained the necessary authority from the United States Congress and the Dominion Parliament, through the granting of charters to a United States and Canadian company for the construction of the bridge, and these companies have been organized for joint action. Arrangements have also been made to sell the bonds and stock. In the meantime an advisory board of engineers has been formed, comprising G. H. Pegram, Prof. W. H. Burr, C. N. Monsarrat and Prof. C. R. Young. The drawings of the design and completed details have been prepared by C. E. Fowler, chief engineer, and D. B. Steinman, assistant to the chief engineer.

Automatic Train Control

On June 15 final orders were issued by the Interstate Commerce Commission to 49 of the principal railroads of the country to establish automatic train control devices on 5,000 miles of their lines before January 1, 1925. The commission declared that the art of automatically controlling trains had long since passed the experimental stage.

Last January the commission served notice on the railroads concerned that it intended to require the installation of automatic train control devices along stated portions of their lines unless managements could demonstrate that the policy was undesirable. A series of hearings were conducted, at which the roads entered some protests against compulsory installation, while manufacturers of devices, and also some railroad officials, presented evidence to show that the installations were feasible and necessary.

The commission in deciding the issue held that devices for stopping trains entirely or controlling them when they entered danger zones had been shown to be practicable and economic. An incidental estimate was made that equipping a single-track road and necessary rolling stock for automatic control under one type of device would cost approximately $1,500 a mile.

Some Recent Developments in Gasoline Driven Railway Passenger Cars*

Self-propelled railway cars, as is known, have been in use for a considerable number of years, but not to wide extent. In fact, one of the larger makers discontinued production during the period of the war, although the need for mechanically successful units is probably greater than ever before in the history of railroading. In consequence of this need, the subject has received an encouraging impetus recently and if there is progress along right lines, accomplishments should be very considerable and of early realization.

The gasoline engine, as a prime mover is attracting the widest attention from designers and users of equipment and it appears quite clear further development will be chiefly through its use, although light weight Diesel type machines may offer competition and also steam is not out of the running.

As in previous developments of self-propelled rail cars, two forms of transmission of power from the engine to the wheels, and axles are prominent. While gasoline-mechanical drive is at present in the fore-front, there is renewed interest and endeavor to revive the gas-electric system along new lines, embodying lighter construction and less power than formerly used.

Many railroad men have been extremely doubtful about the success of a single pair of wheels operating on rails at speeds necessary for passenger service. It can be stated, however, that the greatest success has resulted and over a sufficient period of time to demonstrate there is nothing to be feared in the trailing of a single pair of wheels under a car of this sort. It is not recommended, of course, that cars be operated at high speed in reverse motion, but even so, it has not come to notice that any difficulty has been experienced in backing six wheel rail cars; the usual backing movements being under speeds of 25 miles per hour.

Very casual investigation of the operation of six wheel rail cars shows low operating cost per mile. Cars built on two to three ton chassis have a gas consumption of eight to eleven miles per gallon and cars built on five ton chassis a consumption of from four to six miles. The consumption, of course, depends on atmospheric temperature, length of run, loading, grades and especially speed. Maintenance should not exceed five cents per mile on the smaller car or eight cents per mile, on the larger one, over a period of time. Other operating and maintenance costs depend on local conditions, particularly as to wages. One man is required for the mechanical operation of the car but whether he can handle the collection of tickets and the performance of such other duties, depends altogether on local conditions and each railroad man can figure that out for himself. First cost of a car of the smaller type is usually around $9,000, and of the larger car, around $16,000, depending on the refinements of construction of chassis and body, and particularly whether or not the body is built for severe or mild weather conditions.

From the standpoint of successful automotive rail equipment operation, it appears better to avoid the attachment of any draft gear, with its attendant operating devices, because of the weight necessitated for meeting existing requirements governing such appliances. A simple arrangement for permitting the towing in of a vehicle if it becomes disabled appears the most practicable arrangement at the present state of development.

The use of trailers on standard roads furthermore may raise questions in regard to the number of men required in the crew and thereby disrupt plans and estimates with respect of economies versus steam. Under many conditions, a train consisting of two or more cars with a seating capacity of perhaps sixty (60) people and with a small baggage compartment, would be unhandy to operate around terminals as compared with the same capacity in a single car, particularly if the single car operated in either direction.

This double end operation feature is certain to attract increasing interest and there are strong indications and in fact, assurances by some automotive manufacturers that successful double end control mechanism can be applied so that a single car can be operated with equal facility and speed in either direction and therefore be used in shuttle service in the same manner as a trolley car. Operating men can appreciate what this would mean in many terminals in comparison with operating any train, steam or otherwise, of more than one unit.

Any consideration of the expense of self-propelled cars should constantly carry with it the many factors involved, beginning with first cost of the vehicle and the attendant charges for interest on investment, taxes, insurance, depreciation, operation and maintenance. Equipment provided for a given service, therefore, should cost the minimum, from first to last. Anything provided at a greater cost than a reasonable minimum, of course, decreases the tangible benefits. One does not have to delve into this subject very far to discover that as one increases the size of vehicles with larger gas engines, etc., the margin of profit rapidly decreases. Also, the steam locomotives and cars now in use usually have little or no book value and comparative fixed charges on equipment may easily be to the disadvantage of gasoline propelled vehicles.

Some of the rail cars now in operation require only about 1½ to 2 brake horsepower per passenger seat provided. If one gets into heavier types of construction so that the weight runs up faster per additional unit of capacity, then the cost of construction and all of the charges down the line increase proportionately so that if one is not careful, an addition of as low as 25 or 30% in carrying capacity may increase the final cost from 75 to 100%.

So far as is known, no one has designed and constructed a modern gasoline engine, particularly for rail car operation. In consequence, although results have been generally satisfactory with 4-cylinder vehicles, it is very necessary in developing engines for the larger rail cars, where more cylinders are used that engineers thoroughly study and understand the conditions of rail car operation and adapt their designs to the requirements thereof. There must be smoother running with less noise and vibration in order to have the quietness desired. The six-cylinder type of engine, of course, would be far superior to the four. There must be design from a standpoint of sufficient ruggedness and reliability to enable meeting the schedule service of railroad operation without too much expense for current inspection and maintenance. The requirements on gasoline engines in rail car operation are usually more continuous and more severe than the operation of engines on highway vehicles. It is, therefore, necessary for instance, to arrange more generous cooling surfaces in the radiators than are provided in auto trucks. In order that there may not be delays from failure of auxiliaries, it is necessary to give attention to having dual facilities such as double ignition. Air brake system must be light, as quiet as possible, and of sufficient capacity and thoroughly reliable. The capacity should be sufficient for operating an air whistle for crossing and other signalling purposes.

It is better to drive on the front truck of the car than on the rear, especially if the baggage compartment is in the front of the car in order that the passenger compartment may be at the rear and away from the noise and odor of the engine.

*Abstract of a paper read at the May meeting of the New York Railroad Club, by W. L. Bean, Mechanical Assistant to the President of the New York, New Haven & Hartford Railroad Company.

One of the features of the gasoline mechanical drive system of rail cars requiring study, is the matter of engine speed versus car speed, not only from the standpoint of economy of gas engine operation regarding fuel and maintenance, but chiefly of vibration. Operation of the gasoline engine under favorable conditions on level track or down grades, where little power is required, should be at speeds which do not set up annoying vibrations in the car body. This can be overcome, in a measure, by having a gear ratio enabling the engine to produce sufficient power to operate the car, under such light power conditions at engine speeds below normal. The tendency is for operators of cars to exceed the normal engine speed under such favorable grade conditions, whereas if the gear ratio is such in direct drive that the car speed is high relative to the engine speed, the vibration is much less. It is realized that with a gear ratio of this sort it would be necessary to use one of the gear ratios, in the change speed box giving more torque than in direct drive when operating under unfavorable weather conditions or on ascending grades.

This is one feature in which the gas-electric design has the advantage; namely, that engine speed can be entirely independent of car speed.

The six-wheel design has demonstrated its ability to track well. Because of the unsymmetrical wheel arrangement and the absence of a swing bolster at one end, cars of this design operate exceedingly well with lack of lateral oscillation, even at speeds in excess of forty miles an hour, on track which is not the best.

Some designers of automotive rail cars have absolutely overlooked the necessity for keeping unsprung weights of trucks to an absolute minimum. Even in some cases where four-wheel trucks have been used, too much reliance has been placed on the four-wheel versus the two-wheel truck to give comfortable riding results and excess unsprung weight has operated adversely.

It is believed that in the last analysis it will be found advisable to have anti-friction bearings of a type which permits the pressing of wheels on to an axle as is usual in railroad practice. If wheels are pressed on axles, it becomes necessary to consider a design of gears which will permit application and removal of same without removing wheels from axles. Some arrangements now offered would require in the case of breakage of gear housing or the renewal of ring gear on the axle, to press off one of the wheels, which of course means applying a new wheel or else removing the axle or fitting a new one to both wheels.

The problem of heating cars of this type is considerable. In small cars, it is relatively easy to heat through the use of exhaust gases from the motor but in large cars, seating 50 or 60 people, especially if designed for double end operation, it is not an easy problem to solve, and it may be necessary to rely on a hot water or a hot air heater but the provision of electric current for the circulating of the air in the latter case is also not easily arranged in cars having mechanical transmissions. Of course, where exhaust gases can be conveyed through thin gauge steel tubes, heating is accomplished with minimum weight and occupation of space.

At speeds above twenty-five miles per hour, wind resistance absorbs a large part of the power produced by the engine. The unit pressure due to wind resistance increases as the square of the speed while the horsepower expended in driving the car against this pressure increases as the cube of the speed. Knowing the above laws, it would seem that by using the projected area of a car, the horsepower required to overcome wind resistance at various speeds could be easily calculated. This is not the case because the contour of the surface of the car displacing the air determines the resistance and thus the power.

The continued operation of steam trains to handle 30 or 40 passengers or less and small amounts of baggage, mail and express, is wasteful and therefore should be supplanted by more efficient equipment. Existing gasoline cars can handle the traffic offered on many light lines of road but occasional spurts requiring the seating of 60-75 people create a need for a larger car which need should be met. In many cases, the change from expensive steam locomotive to cheap gasoline car operation, hinges on the production of the larger capacity self-propelled vehicle. The small gasoline cars built on modified highway chassis are exceedingly satisfactory to the extent of their capacity. Surely American engineers can increase that capacity 50% to 75% with corresponding efficiency, reliability and economy of operation. If the carriers and manufacturers get together properly, the problem can be solved and without either party hazarding funds of such extent that they are worth considering in view of the benefits possible.

A Rolling Roll of Honor

Locomotive Engineers Honored on the Canadian Pacific

The naming of locomotives beginning with Stephenson's "Rocket" was a start in the right direction, but as the number of locomotives increased, the titles ran into absurdities. "The Iron Duke," was not so bad, but when the names of princes and lords and other parasites were emblazoned on the engine cab, where real work was being done, the nomenclature was caricature, of the coarsest kind. The names of what were known as big railroad men were not considered inappropriate, but the constant changes among them made the engines look like fugitives from justice who changed their names for some mysterious reason, The simple numerical appellation may be said to fill the bill, but if there is to be any naming at all the Canadian Pacific has struck a happy idea of honoring the engineers who have served the road faithfully for many years, or for exceptional meritorious service in the use of fuel by naming its engines after them.

JACK HARTNEY AT HIS JOB ON THE CANADIAN PACIFIC

The accompanying illustration shows an engine thus marked with the name of Jack Hartney, while Jack himself is shown seated in the cab enthroned in his post of duty. We have seen the names of many officials, especially of a political kind emblazoned on apparently easy chairs, while the expected occupants were—elsewhere. When one sees the name of a Canadian Pacific engineer, or the name of an engineer of any other road who has adopted this fashion, glittering on the engine cab it is a safe guess that that is "him" inside. Honors that are nobly won can never be justly considered cheap.

Effect of Circulation on Locomotive Boiler Efficiency*

By F. G. Lister, Mechanical Engineer, El Paso & Southwestern System

The benefits to be derived from positive circulation of water on heat transfer in steam boilers has in years past been quite neglected in steam boiler design, and only in these later years has the subject been given meritorious study. The desire to ascertain its real value to the efficiency of the boiler has led to no small amount of experimenting and many efforts have been made to create and improve it through various methods, the later and most satisfactory ones being to create more rapid and unrestricted circulation of the water so that more nearly uniform temperature throughout the boiler would result, and the effect of unequal expansion and contraction of all parts proportionately reduced and the durability of the boiler increased.

Circulation of the water in the boiler is its flow caused by its density differing in various parts of the boiler due, in part, to the difference in temperature and also to the formation of steam bubbles. The rate of the circulation depends upon the rate that the steam bubbles are formed from the heating surfaces and their unrestricted liberation and rising to the top forcing the colder or heavier water to settle to the bottom.

The theory of circulation described by George H. Babcock in "Steam" is too well known to require repetition. It is illustrated by the application of a flame to one leg of a "U" tube suspended from the bottom of a vessel filled with water, the heat from the flame setting up a positive circulation.

Positive circulation, in addition to mixing the hot and cold water together, materially increases the effectiveness of all of the heating surfaces by bringing the moving currents directly in contact with the radiant surfaces, thus adding to the ability of the water to take up heat. It also prevents in a large measure the accumulation of scale forming deposits in the boiler, and as such impurities are prevalent in most waters, and when the water is evaporated remain to incrust the surfaces of the boiler, circulation should without any question of doubt play a very important part in cleaning the boiler of them, as incrustation sometimes becomes quite serious, so much so that the transmission of heat through the metal is almost entirely prevented. Good circulation allows a hotter fire to be carried, which in turn boils away the water more rapidly, and at the same time reduces the liability to waste heat by what is technically known as priming.

An annoying condition in a locomotive boiler is the chemical action set up, especially in the belly of the shell, due no doubt to the very slow circulation or more likely lack of circulation of the water, which prevents the precipitated impurities from being carried out. Corrosion, which is a chemical action set up between the acids in the water and the metal, of course, varies quite materially, depending upon the composition of the metal in the sheets, and the nature of the acids in the water, but can to a great extent be overcome if the water can be kept moving.

In the earlier designs of locomotives the vertical type of boiler seemed to prevail. The value in those days of circulation of the water in the boiler was not particularly realized, the principal desire having been to create more steam by adding as much heating surface as possible. This heating surface was increased in various ways, most of which did not seem to prove very effective.

The horizontal type of boiler succeeded the vertical type about 1840, and closely following this time British builders began to make modifications in them in order to secure additional heating surface. Some of the modifications consisted in what was termed "mid-feathers," some of these "mid-feathers" being placed crosswise and others lengthwise of the firebox. Others hung down from the crown sheet in the shape of pockets or channels, the construction being similar in some respects to the Nicholson Thermic syphon of today, except that they had no connection with the tube sheet.

In the "Development of the Locomotive," by Angus Sinclair, he has brought to our attention numerous attempts to hasten water evaporation in the boiler by means of additional heating surfaces in both the boiler shell and the firebox and by more perfect and rapid combustion. These might be considered as primitive steps toward the later development of means to create more uniform and constant water temperatures in the boiler through proper circulation.

Tests conducted in 1920 by the Bureau of Locomotive Inspection, Interstate Commerce Commission, which terminated in the recommendation of the Chief Inspector that water columns equipped with water glasses and gauge cocks be applied to locomotives, revealed without any question of doubt that there is a very swift movement of the water up the sides and back of the firebox, emerging onto the crown sheet in fountain or geyser-like effect, so that a true register of the height of the water in the boiler could not be depended on where the water glass and gauge cocks were connected directly into the boiler.

The fact has for many years been recognized that the temperature of the water should be raised before it should come in contact with the water already in the boiler, and with this prevalent fact in mind many devices have been tried in an effort to put the water into the boiler at a high temperature in order that a uniform and constant thermal condition might be created in the boiler. On the "Hayes" 10-wheel engine built by the Baltimore & Ohio R. R. in 1853, the feed water entered the boiler by checks immediately in front of the back tube sheet, and was then conveyed by a pipe inside the boiler and discharged immediately back of the front tube sheet. This pipe seems to have been abandoned for an open trough, due to the accumulation of sediment in the closed pipe. Another device previously used consisted of water pockets placed over the boiler check openings between the shell and tubes, training the water upwards and discharging it into the boiler near the surface of the water. In 1903, Mr. M. H. Wickhorst, of the C., B. & Q. R. R., proposed a boiler check elbow extension consisting of a cast iron elbow screwed into the boiler check and turned upward, allowing the water to spray down through the steam.

Aside from the supposition that the water traveled from the front end of the boiler along the bottom of the barrel, down the back tube sheet and up the sides and back of the firebox, little additional attention appears to have been devoted to the study of the true principles governing the proper heating of the water in the locomotive boiler and the events which caused the water to circulate.

Only since the subject has been given systematic study has it been considered that positive means should be provided to keep the water constantly traveling through a "trodden path." Angus Sinclair in his "Development of the Locomotive Engine" says, in reference to forcing a boiler beyond its endurance: "The inability of the ordinary firebox to withstand the heat of the high combustion is due to the fact that natural circulation will not keep the heating surface covered with water as fast as it is evaporated." This same thought has, no doubt, occurred in the minds of a great many, and has possibly been the nucleus around which the various later

*Abstract of a paper presented before the Fourteenth Annual Meeting of the International Fuel Association held recently in Chicago.

methods and devices have been developed for stimulating better circulation.

The Thermic Syphon

Among the various innovations in locomotive boiler construction probably none has created more attention than the Thermic Syphon. Results of tests conducted during the last four years on a number of railroads demonstrate that this device has passed the experimental stage, and will probably be one of the standard fixtures in the locomotive of the future, as is the arch tube at the present time. They are in service now on twenty-seven railroads. As we are all more or less familiar with the design and construction of the Thermic Syphon a detailed description of it will not be necessary.

The first pair of syphons went into service on the Chicago, Milwaukee & St. Paul Railroad in June, 1918, and at the present time they are still in service apparently in approximately as good condition as when installed.

As with practically all new devices it had to pass through its experimental stage, but now it appears to have reached a final state of development. Located in the hottest part of the firebox, extending in triangular form from the crown sheet to the throat sheet, the additional radiant heating surface provided in the firebox must naturally increase the boiler efficiency proportionately, but the heating surface to be effective must be assisted by circulation of the water over same. The more rapid the circulation, the greater amount of heat will be transferred from the firebox and tubes to the water.

The water entering the boiler at the check being of a lower temperature than the water already in the boiler, falls to the bottom, and through the partial vacuum set up by the mixture of steam and water traveling up through the syphon, sucks this water into the intake channels located in the belly of the boiler, and connecting with the throat of the syphon at the throat sheet carries it up into the syphons. As the water in the syphon, which lies in the direct path of the hottest flames in the firebox, evaporates, steam bubbles rising to the surface, coupled with the difference in density of the water in the syphon and in the forward portion of the boiler, creates an upward movement of the water through the syphon, syphoning it through the intake channels from the front end of the boiler backward to the syphon and up over the crown sheet and forward to the front tube sheet again. Its temperature by this time should neutralize with the other water, the temperature depending on the number of heat units in the water, the velocity of flow, the rate at which steam is taken from the boiler, and new water injected into the boiler.

The fuel economy, the manufacturers say, resulting from the water passing through the intake channels, adds to the saving effected by the syphon itself, due to the fact that tube heating surface is constantly swept by this flow of water, which increases the heat transfer by assisting in disengagement of steam bubbles from the tubes and sheets, thus freeing the surfaces of all accumulations of steam and allowing a close contact at all times between the water and heated surface. In locomotives equipped with the syphon, the mud deposits collect in the rear water leg, where it can be easily washed out.

Results of tests of locomotives equipped with the Thermic Syphon conducted on several railroads indicate an increase of from 10% to 27% in the water evaporated per pound of coal, with a corresponding increase in gross ton miles. As in the arch tube installations the brick arch serves its important part with the Thermic Syphon in increasing the firebox temperatures and in making the firebox heating surfaces absorb more heat.

Harter Circulator Plate

The Harter Circulator Plate is one of the more recent developments for creating or inducing circulation in the locomotive boiler. It is the invention of Mr. Charles Harter, mechanical engineer of the Missouri Pacific Railroad. It consists of a curved plate extending horizontally from side to side of the barrel of the boiler between the tubes, reaching backward to within about 4 inches or 5 inches of the rear tube sheet and forward to within about 30 inches of the front tube sheet. Into the circulator plate are inserted a number of 2-inch tubes or pipes known as steam risers, which extend upward through the tubes and terminate close to the top of the boiler sheet. These tubes or pipes are provided for the purpose of carrying up into the steam space the steam generated below the plate.

The object of the circulator plate is to provide a definite circuit or path for the water from the sides and crown of the firebox forward over the plate, around the end and backward under the plate and around the firebox, from which the same course is repeated several times a minute. Its use, along with arch tubes, should increase its efficiency value very materially. It is stated by Mr. Harter that the impurities in the water are carried back into the water legs, where they can be washed out or blown out, and that the rapid travel of the water along the tubes and sheets retains a clean heating surface with a reduction in scale formation and the prevention of the adhesion of the steam to the metal.

From data furnished by him an engine of 50,000 to 60,000 tractive power equipped with the plate will raise steam to the required steam pressure in from 30 to 45 minutes less time than the same class of engine not so equipped, and that from a series of comparative tests conducted a saving of fuel consumption averaged 15%.

Feed Water Heater

While considering means for assisting circulation it should be worth while to consider the feed water heater. In addition to the saving of fuel accomplished by the use of exhaust steam for heating the water before entering the boiler the steaming capacity of the boiler is increased, due to the fact that the heating surfaces are relieved of some of their work when the feed water has received some of its heat before it enters the boiler. The boiler is able to generate more steam with the same heating surfaces and with the same amount of heat transmitted through them when assisted by the pre-heated feed water and at no expense to the boiler.

Washout and Refilling System

While possibly not considered as directly responsible for assisting in the circulation of water in the locomotive boiler, there is no other one apparatus that does more to make circulation easier and more effective than the locomotive washing and refilling system which is now quite universally used.

Its particular advantage (aside from the time and fuel saved in washing the boiler and getting up steam again) is in the even temperatures maintained in the boiler.

The longer it takes to fire an engine up the harder it is on the boiler. The washout and refilling system not only protects the boiler against undue strains caused by rapid change of temperature, but on account of supplying water to the boiler at close to boiling point the pressure is quickly raised.

A difficulty that must be overcome in rapid circulation in bad water localities, where water is not treated before or after it enters the boiler, is the foaming caused by the rapid movement of the water, thereby carrying the impurities along and holding them in suspension, not allowing them an opportunity to precipitate and be deposited at the mud ring, where they may be easily blown out.

It may be difficult for a locomotive to make a round trip under such conditions without the necessity of changing the water in the boiler at each terminal.

Circulation holds an important place in the safety of the boiler in preventing unequal strains due to the expansion and contraction. It should also prevent the crown sheet from becoming overheated in case the water level should drop below it. Most explosions of locomotive boilers are the result of strains set up by unequal expansion.

The advantages to be derived from proper circulation may briefly be summed up as follows:

A cleaner boiler, which means higher heat transfer and more water evaporation per pound of fuel, which is conducive to fuel economy or a higher boiler horsepower; elimination of pitting, and elimination of strains due to unnecessary expansion and contraction; a lower maintenance cost and longer life.

International Railway Congress

Nearly One Thousand Leading Railway Men Meet in Rome, Italy

As previously noted the ninth congress of the International Railway Association was held in Rome, Italy, during the last two weeks in April. There were nearly 900 delegates present. The subjects discussed were divided into five sections, including: ways and works, locomotives and rolling stock, working, general, and light railways.

In regard to locomotives and rolling stock, the conclusions reached were as follows:

SUPERHEATED STEAM.

(*a*) Superheating is universally adopted in the construction of locomotives for passenger and freight trains. It has not yet been exclusively applied to suburban traffic, but the results given in these services have been satisfactory, especially when the smoke box dampers, which cuts off superheating when the regulator is closed, are removed.

(*b*) The application of superheat to saturated steam engines may be advantageously done when these are in the shops for repairs, especially to powerful engines of recent types.

(*c*) Owing to the superheat, the use of two cylinder single expansion and superheater locomotives has increased. For powerful engines the preferences of the railways are divided between two-cylinder single expansion with superheater, the four-cylinder compound with superheater and the three or four cylinder single expansion with superheater designs.

(*d*) The fuel economy obtained by the application of superheat to the single expansion engines may be estimated on the average, in ordinary working conditions, to be about 10 to 20 per cent. This economy, however, is very variable, according to the work done and the condition in which the parts are kept, and it is necessary to be more particular in this upkeep than with saturated steam engines.

(*e*) The special arrangements adopted originally for the valves and pistons of superheat engines have a tendency to become more uniform and simpler and more like those used on saturated steam locomotives. On new locomotives piston valves are exclusively used for the high pressure cylinder and packings with sliding joints and outside cooling for rods [illegible] the cylinder relief valves has also been increased. These are the only special arrangements, the necessity for which has been universally recognised.

The same tendency towards simplification is apparent in the instructions given to the drivers.

(*f*) Some administrations use at the same time both inlet air valves and bypass. The usefulness of this double action does not appear to be yet completely established.

(*g*) Corliss and similar type valves and the uniflow arrangement have made no progress.

FEED WATER HEATING.

Some railways have introduced feed water exhaust steam injectors on a large scale.

The results which have been obtained justify the extension of the use of these devices.

VARIOUS DEVICES.

(*a*) The trial of water tube boilers in competition with those of ordinary type has made no progress. Those made up-to-date have not enabled any definite conclusions to be arrived at. Even in the most favorable cases the advantages found or anticipated in coal consumption or cost of maintenance appear to be small.

(*b*) There is an advantage in washing out boilers with hot water, particularly when it is necessary that they should be stopped for as short a time as possible. These washing out plants with auxiliary boiler and fixed water and steam piping allowing the recuperation of the steam and water for locomotives are used to advantage in certain particular cases, especially where the cost of water is very high, but their price and complication seem to be against their extensive use on systems where the engines have fixed bookings.

(*c*) Brick arches improve combustion, and their use has become general.

TRUCKS OR BOGIES, AXLES AND SPRINGS.

On this subject there was much diversity of opinion, but the methods mainly adopted to facilitate easy running on curves are:

For the guiding members to have bogies, pony trucks or Bissel bogies.

For the middle axles, tire flanges to be reduced in thickness.

For the back axles, to have bogies, pony trucks, or axles with side play.

Sliding axles, especially when fitted in front of a locomotive that generally travels in one direction, should be fitted with a sensitive centering arrangement, which may be either spring or gravity controlled, but the latter method appears simpler, and more certain in its action. Whether there should be an initial effort to overcome or not is open to question, but probably the majority favor the opinion that there should be.

Bissel bogies are not used sufficiently universally to enable conclusions to be formed about them, but Bissel trucks would doubtlessly benefit by being simplified, and the length of the tail piece should be fixed so that the axle is normal to the track or curves.

For suspension, on the drivers and coupled wheels, laminated springs of moderate flexibility are perhaps the best, as the friction between the plates has a braking action which reduces the amplitude and duration of the vibrations and oscillations.

Side compensating levers are especially advantageous on poor track or sinuous lines. They should have sufficient points of suspension to reduce rolling oscillation. On good track they are probably not worth the extra expense and trouble entailed in their provision and upkeep.

Balance weights for balancing the reciprocating parts of the motion should be as light as possible, so as to diminish shock to the road.

LIQUID FUEL ON LOCOMOTIVES.

There are no mechanical difficulties in the adoption and use of liquid fuel for locomotives. The question of cost both of the fuel and maintenance makes its use, however, prohibitive, except in certain localities, and these are so restricted that the subject is not recommended for discussion by a further session of the Congress.

The question of the use of liquid fuel in conjunction with internal-combustion engines on locomotives, is, however, one of more general interest, and might with advantage be considered.

Shop Kinks in Use on the Chesapeake & Ohio

The Chesapeake & Ohio R. R. has recently adopted a method of marking material, kept in store for repairs, that bids fair to effect a considerable saving in labor and the time of procuring the necessary supplies required in the shop and roundhouse.

The usual storehouse and wharf has had all of the requisites of order and neatness and for the man who knows the general layout and the names of all of the multifarious castings and forgings that are located there, there would be no great difficulty in picking out what he was sent for. But for the man who is a stranger to the layout and a little shaky as to the names of the parts, a good deal of time would be lost in searching for what was wanted and the chances of bringing in the wrong article would be more than negligible.

In order to remedy these difficulties and facilitate the selection of what is wanted, a system of numbering has been adopted. Each piece in the form of casting, forging or assembled parts is given a number and this number is stencilled on each one of the castings, forgings or assembled parts. They are then arranged through the yard or on the wharf serially so that a glance at the number on any part will indicate the direction to take to go to the part desired.

Then instead of telling the laborer to go and get a steel casting for the cross-head of an Fl locomotive, he is simply told to go and get casting No. so-and-so. It thus becomes possible for any new hand or a man totally ignorant of locomotive or car parts to go directly to the storage bins or platforms and get what he has been sent for and that without delay, mistake or the asking of questions.

The handling of heavy timbers or planks on the bed of the machines on which they are to be worked or shaped is not always an easy matter especially where the timber is to be pushed over the table and against a powerful rip saw. The frictional resistance to the movement of the work can be greatly lessened by the use of a little coarse sawdust. It is only necessary to sprinkle a handful or two of this material over the surface of the table before the timber is lifted upon it, and the small particles will become rollers beneath the work and make it possible to move it about with very much less effort than would be required were it to rest directly on the table without the interposition of these improvised rollers. They will act in essentially the same manner as a handful of small shot would do, but a handful of fine shot is not always available in a planing mill while the sawdust can be had for the picking up of the same.

The washout plugs on the shell and water leg of a locomotive boiler are always the source of more or less annoyance because of leakage and this leakage is caused to a great extent by the thinness of the plates into which they are screwed, which, up to recent times, has been an irremediable difficulty. That time is now of the past and the American Locomotive Co. and some others are now welding a flange, or rather building a flange up about the outside of the hole in the sheet and this flange is reamed out to the same diameter as that of the hole and the combination is then tapped at the same time and in this way any desired length of thread for the plug can be obtained. This method adds something to the cost of the fitting of the plug but will save it in the freedom from annoyance that it gives and the greater security insured to the holding power of the plug. The beauty of the scheme is that its application does not depend upon making it to a new boiler or firebox, because it can be applied at any time to an old sheet that is giving trouble by leaking. In making repairs of that kind, however, it will of course, be necessary to build the new metal in over and fill up the old threads and then ream out the whole hole anew, so that a fresh clean thread can be cut.

There is an engineering maxim that has been attributed to Gen. Hickenloper, who was Sherman's chief or engineers on the famous March to the Sea, that it was always possible to find something that would *do*. It would often be very far from that which was desirable or best, but it could be made to *do*. That is do the work. It is not probable that many if any reader will ever find himself in a position making it necessary to take advantage of this kink and it is offered solely as an example of what can be accomplished with a kink if one knows how.

The place was away from a source of supply and in the woods where a boiler was in use. It became necessary to tap a half-inch pipe into the boiler and though the pipe was there there were no taps and no drills, but there was the length of pipe and a set of pipe dies. There was no forge but there were hammers, a cold chisel, a file or two, some old wire, a pipe wrench, a discarded pair of shoes, the remnants of an old and discarded stove and a wornout wheel for the saw carriage. Not exactly the supplies that would be chosen for the work in hand.

The first thing done was to make a tap. A thread was cut on a piece of pipe and it was cut off to a length of about five inches. The threads were then filed into the form of a tap by cutting the usual grooves. The old stove was carefully cut into small plates so that these pieces could be laid together to form a small box with an inside capacity a little larger than the size of the nipple that had been cut. The pieces were bound together with the wire and nipple placed therein and packed all about with the bits of leather cut from the old shoes, and the casehardening box, thus improvised, was put in the firebox of the boiler and kept at a red heat until it was thought that the casehardening of the nipple had been completed. Meanwhile the cold chisel had been hammered into a cape chisel using the hub of the old wheel as an anvil.

With this cape chisel a hole was cut in the boiler after the casehardening of the nipple had been completed, and that hole was filed to an approximation to roundness. It was a Sunday morning when this last piece of work was started and a failure to accomplish the task meant the disablement of the boiler, for it would be useless with a hole big enough to take a half-inch pipe cut in the sides. To say that the casehardened tap was used gingerly and babied as no tap had ever been babied before, is to put it mildly. But by the most careful manipulation, and constant backing out to clear the chips and clean the hole it was, at last, driven through and a full thread cut in the plate.

When the pipe was screwed in and the boiler filled there was a small leak as was to have been expected, but a little judicious calking stopped that, and the job was complete, to the great mental relief of the man who had assumed the responsibility for the work. It was just another exemplification of the adage that it is always possible to find something that will *do*.

Japanese Railway Buys New Equipment

The Westinghouse Electric and Manufacturing Company announces that it has received an order for motor car and sub-station equipment from the Chichibu Railways which operate in the vicinity of Tokio, Japan. A large part of this new equipment will be a duplicate of the large order shipped from the Westinghouse Company's plant at East Pittsburgh to the Chichibu Railway during the past year. The original equipment on its initial operation over the 1200-volt direct current lines of the Imperial Government Railways with which the Chichibu Railway connects, drew many commendable remarks from the electrical engineers and railway operators of Japan and there is no doubt that the appreciation of these men for great possibilities in railroad electrification has led them to increase the original equipment.

Notes on Domestic Railroads

Locomotives

The Central New England has placed an order for 20 switching locomotives of the 0-8-0 type with the American Locomotive Company.

The Atlantic Coast Line is having 80 Pacific type locomotives built by the Baldwin Locomotive Works.

The Patagonian Railway has ordered 25 Mikado type locomotives from the Baldwin Locomotive Works.

The Chicago & Northwestern has ordered 20 Mikado type locomotives, 20 six-wheel switching locomotives and 10 Pacific type locomotives from the American Locomotive Company.

The Lehigh Valley, with a view to modernize its limited equipment, is having general repairs made and superheaters installed on 14 ten-wheel locomotives in the Dunkirk shops of the American Locomotive Company.

The Western Maryland is having 20 locomotives, including Pacific, Mallet and Consolidation types, repaired at the shops of the Baldwin Locomotive Works.

The Akron, Canton & Youngstown has also ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Brownell Improvement Company, Chicago, has ordered two 4-wheel locomotives from the Baldwin Locomotive Company.

Passenger Cars

The Atlantic Coast Line has ordered 120 express cars and 10 coaches from the Bethlehem Shipbuilding Corporation. The construction is in progress at the Harlan plant.

The New York, Chicago & St. Louis has placed an order with the Pullman Company for five steel coaches and two baggage cars.

The Chesapeake & Ohio has placed orders with the Pressed Steel Car Company for 22 undivided coaches, 8 divided coaches, 8 combination passenger and baggage, 5 express with automobile doors, and 20 straight express cars.

The Southern has ordered 40 steel passenger coaches, 10 steel combination passenger and baggage cars and 25 steel baggage express cars from the Pullman Company, and 25 steel postal cars from the American Car & Foundry Company.

The Interborough Rapid Transit Company has ordered 100 new cars from the Pullman Company with an option on additional orders.

Freight Cars.

The Baltimore & Ohio Railroad Company has placed orders for 1,000 steel hopper cars and 1,000 steel gondola cars with the Pressed Steel Car Company, to be built at their plants in the Pittsburgh district, also 1,000 steel hopper cars, coke cars to be built by the Standard Steel Company at the Curtis Bay plant, Baltimore, Md., and the Cambria Steel Company 1,000 70-ton steel 46-foot drop-end gondolas to be built at Johnstown, Pa.

The Atchison, Topeka & Santa Fe has ordered 2,000 box cars, 1,000 of which are being built by the Pullman Company, 500 by the American Car & Foundry Company, and 500 by the Standard Steel Car Company.

The Roxana Petroleum Corporation, St. Louis, Mo., has ordered 25 insulated tank cars of 40-tons' capacity from the General American Tank Car Corporation. The cars will have a capacity of 8,000 gallons each.

The Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., has ordered 10 chlorine cars of 15-tons' capacity equipped with 40 ton trucks for the General American Tank Car Corporation.

The Chesapeake & Ohio has ordered 500 ventilated box cars of 40 tons' capacity from the Newport News Shipbuilding & Dry Dock Company.

The Seaboard Air Line has ordered 900 steel underframe ventilated box cars of 40 tons' capacity from the Pressed Steel Car Company, and 100 phosphate cars of 50 tons' capacity from the Magor Car Corporation.

The Illinois Central has awarded contracts for repairs to 2,600 box cars as follows: 800 to the Pullman Company; 1,300 to the Streator Car Company; and 500 to the Interstate Car Company.

The Atlantic Coast Line has purchased 700 box cars from the Standard Tank Car Company.

The Erie has awarded a contract for repairs to 1,000 box cars with the Standard Steel Car Company, and 500 box cars to be repaired by the Illinois Car Company.

The Pere Marquette has ordered 500 box cars from the Pressed Steel Car Company.

The Seaboard Air Line has ordered 900 steel underframe ventilated box cars of 40 tons capacity from the Pressed Steel Car Company, and 100 phosphate cars of 50 tons capacity from the Major Car Corporation.

The Tennessee Central has ordered 350 gondola cars from the Western Steel Car & Foundry Company.

The Missouri Kansas & Texas has ordered 200 refrigerator cars of 40 tons capacity from the General American Car Company.

The New York, Chicago & St. Louis has ordered 1,000 automobile box cars from the Illinois Car & Manufacturing Company.

The Wabash has orderd 2,050 composite gondola car bodies of 50 tons capacity from the General American Car Company, and 1,500 steel underframe automobile cars, 40 ft. in length and 40 tons capacity, 750 from the American Car & Foundry Company, and 750 from the Pullman Company.

Railroad Buildings and Tools

The Michigan Central has awarded a contract to the Roberts V. Schaefer Company, of Chicago, for the construction of a reinforced concrete, 500-ton capacity, automatic electric locomotive coaling and sanding plant to be built at Michigan City, Ind., costing approximately $48,000.

The Central Vermont has awarded a contract to the Roberts & Schaefer Company, of Chicago, for the construction of a duplicate coaling plant of 150 tons, frame construction at New London, Conn., also two "N. & W." type electric cinder handling plants, one at Burlington, Vt., and the other at White River, Vt.

The Chesapeake & Ohio has completed plans for the construction of an addition to its roundhouse at Peru, Ind., costing approximately $30,000; also the construction of a shop, store room and power house, and an addition to its roundhouse at Beach Creek, W. Va.

The Western Maryland has awarded a contract to M. A. Long & Company for the construction of a modern locomotive repair shop, 100 by 300 ft., at Baltimore, Md.

The Detroit United Railway has awarded a contract to the Otto Misch Company for the construction of a one-story repair shop, 126 by 285 ft., at Highland Park, costing approximately $65,000.

The Norfolk & Western and the Pennsylvania in joint connection with the proposed new engine terminal to be constructed at Hagerstown, Md., will also construct a large coaling station, a watering plant and other service structures for locomotives.

The Delaware & Hudson Company has awarded a contract to the Roberts & Schaefer Company of Chicago, for the construction of a 500-ton capacity, two-pocket, four-track automatic electric reinforced concrete locomotive coaling and sanding plant at South Junction, near Plattsburg, N. Y.

The Atchison, Topeka & Santa Fe will erect a new boiler and tank manufacturing plant at Albuquerque, N. M., to cost approximately $400,000.

The Chicago, Burlington & Quincy has completed plans for a new engine house, including shops, to be erected at Council Bluffs, Ia.,

Why Engines Fail, By Frank C. Pickard, Master Mechanic Delaware, Lackawanna & Western Railroad

To decrease engine failures the spotlight of publicity must be thrown on the causes just as on a feature on the entertainment stage. No failure should be dropped or closed until full responsibility has been placed, determining whether it was due to design, workmanship, inspection, defective materials, or failure to make repairs. It may be the highest official or the lowest who was responsible. Let everyone know his connection therewith thoroughly and take his share of responsibility. Look it squarely in the fact and call it by its correct name.

To attack the problem on any road or division take the performance for the previous year and make an analysis by divisions or units of the shop and enginehouse organizations to properly place the responsibility; i. e.: Steaming; Boilers; Machinery; Inspection; Enginemen.

After this is done you will be in a position to attack the problem, thus one item that is causing the greatest delay and the largest number of failures will be revealed. You will be able to say to any one of these department heads, engine or shop operations, "Your end of the game is not up to the standard. There must be an improvement. What are we to do to bring this about?" Determine and act quickly.

Next analyze your boiler troubles further and classify those giving most trouble; i. e.: Flues; Flue sheets; Side sheets; Mud rings; Bursted flues; Staybolts and crownbolts; Cracks in sheets; Grates and grate shaking devices.

Machinery is probably the next feature in line of importance and can be classified as follows: Axles; Cylinders and parts; Crossheads and piston rods; Motion work; Springs and equalizers; Wheels and boxes; Stoker and coal conveyors; Bearings running hot. After you have determined and placed a percentage to this itemized list, then you are in a position to attack your weakest point.

At the end of each month I suggest a statement as follows for each operating division or for each railroad:

STATEMENT OF ENGINE PERFORMANCE
MONTH OF..........

ENGINE FAILURES AFTER DISPATCHED FROM ROUNDHOUSE

Roundhouse:—

A	2 Passenger	D	4 Freight	N
B	1 Passenger	N	2 Freight	D
C	3 Passenger	D	6 Freight	N

Note: D for days. N for nights.

Constructive rivalry will build up a neat little competitive race to see who can dispatch the largest number of engines per failure.

A good record must be made of engineers and their performance with engines in their charge that fail. There is a weak spot in every locomotive, only some enginemen find it sooner than others. At the end of each year call in 25 to 35 of the men who have had the highest number of failures and you will be surprised to see the results. The time of your road foremen of engines can be applied most effectively with this knowledge in hand. Statement formerly mentioned shows failures that probably could have been avoided by the enginemen and you should hold your road foreman and his assistant responsible for them.

Take a failure on an outbound engine involving failure to perform because of improper report or failure to report correctly such details as valve, cylinder packing, etc. Charge these to Mr. Road Foreman of Engines and he will soon line up his men to see that they are careful in their operating and in detailed reports of work to be done so as to improve the service and bring about a better performance. The road foreman has a broad field and can assist very materially in better engine service. He must learn early to see that his men make good instead of making excuses for them.

The engineer's work report controls, to a certain degree, the work as applied to all engines. His reports should be intelligent and his road foreman should check these from time to time to see that they are reported in the best, most concise, and intelligent way. Inspection is probably as important a function as any in combating engine failures.

For each operating division there should be one general inspector who is held directly responsible for all engines in his territory being within the requirements of the Federal, State, and company's requirements and who must further see that they are in the best serviceable condition possible.

He should be clothed with the proper authority and backing. His word should be final when he orders that an engine be not permitted to run. This should be final. Try this. The first few months you will be asked to let some engine make another trip, but sit tight and the people will soon learn his word is law. When a failure occurs that inspection could have prevented, issue a circular letter to all inspectors calling their attention to the fact, stating frankly that the responsibility has been placed in this particular case with John Smith. Inspectors who locate trouble and an organization intelligently directed, will stop more engine delays than any factor of which I know.

Design and its relation to engine failures is another important factor. By reference to exhibit "E" you will see that rods form about 25 per cent of all machinery failures. I call this fact to attention, as design plays an important part. Lost motion is one of the principal causes. A design is available to combat this. A large number of rods do not have enough metal in the cross-section at pin and knuckle holes.

By the use of proper alloy steel these parts can be lightened in weight so the stresses set up by their own inertia can be reduced. Piston rods and motion work pins can be improved by placing so as to show all nuts and cotter keys outside within view of inspector and enginemen. Piston rods and pins should be designed with liberal fillets. Avoid square corners in as many places as possible all through the machine in frames, cylinders, spring work, pedestal jaws, axles, etc. This is true in boiler design. Avoid sharp turns. Think of the old dished patch that takes care of expansion.

When a locomotive is being designed figure that it is going to be necessary to take it apart. This has its relation to performance. "The let it go another trip idea" will fly up with trouble where it is hard to get at. Driving and engine truck springs often require replacing. Do not hide them so wheels will have to be dropped to do the work. It is very difficult to set jacks. Provision should be made for suitable jacking space both front and back.

Design for the greatest possible horsepower per 100 pounds dead weight and for the greatest drawbar horsepower per pound of coal. The original cost is more, but a year after the engine goes into service it will prove that the policy will pay. Good designed engine trucks in cast steel will eliminate bolts and nuts and thus relieve the responsibility for failures. Use forgings and cast steel, eliminate cast iron and malleable iron on locomotives.

Steam failures have many contributing causes that can be controlled. Did it ever strike you that ability to handle coal was a large contributing factor? Five or six engines all receive coal from the same car and only one fails for steam. Clean flues, especially those with the superheater units call for constant and zealous effort to keep them clean. Superheat units cause a number of failures, fastenings to the headers usually cause the trouble, as well as the joints of return bends.

The size of the exhaust nozzle can be used as a thermometer for controlling steam failures. The tendency in the past has been to choke it down when the engine fails for steam. Stop, think it over. There is some underlying cause. If you do not locate it you will probably have two or three small defects which later will cause a complete failure. I advocate that the master machanic on his division should be the only one authorized to change the diamter of a nozzle. There are more poor excuses than poor coal.

Hot bearings, as per exhibit "B," six and seventy-one one-hundredths per cent; this is another factor. The number depends on constant care and supervision, as there are so many contributing causes, such as weight, alignment of equalizers, springs, quality of metal, etc. Why there should be 30 per cent engine truck box failures I cannot determine. The surface speed is only a fraction in comparison with that of the driving axle. It seems there is need of some new method of lubricating engine truck and trailer axle bearings.

Shopping engines based on a stipulated amount of mileage is expensive. Engines should be shopped when necessary and the record of mileage between shopping kept for comparison. Metals have different wearing qualities. This causes lost motion and the primary cause for damage. When this occurs the expense will be twice as much when you do shop for correction. In other words, a stitch in time saves nine.

Conducive to good engine performance you must have first class facilities, competent inspectors, and all repairs must be permanent (note, *permanent* repairs). The working force must be properly housed with warm and clean surroundings. If these are not available the management should be impressed with this necessity in order to bring about quick turning and good mileage. Instead of engines making 1,800 miles per month they should be, and now are in some places, making 5,000 miles in freight service and 10,000 or more in passenger service. Why let a $65,000 investment lie around? Keep it going. Get the money out of the investment. A few modern locomotives with good terminal facilities are like intensified agriculture. In the former you get more per dollar, in the latter more per acre.

Providing good cinder pits, coal docks, turntables, enginehouses with machine tools, is good business policy. Talk of them, show what they mean and if you can prove your case you will get them. Proper assignment of locomotives to the service for which they are most suitable and where they can move through the greatest part or all of the division with maximum tonnage is another important matter. When an engine is not so assigned a loss due to running light of tonnage on parts of the division is encountered and must be guarded against.

Assignment of engine on account of machinery conditions as between modernized power and old power that has not been modernized is an important condition to consider, therefore, the matter is one to be handled by one who knows mechanically.

The data submitted is summarized in exhibits A, B, C, D, E and F.

Exhibit "A" is the general chart divided into five separate heads showing why engines fail. Then each of these items is still further analyzed as per exhibit "B," under the caption of Hot Bearings.

Exhibit "C," Steam. This shows in detail where delay of sufficient amount was lost to contribute an engine failure.

Exhibit "D" is purely the boiler failures and classified under seven heads.

Exhibit "E." This is the machinery table and shows the major failures divided into 35 separate classifications. Particular attention is required to failures due to rods. This points to the necessity for care to setting up wedges and it tells us to build new and to equip present power with means for automatically taking up this lost motion.

Exhibit "F" represents one and thirty-six one-hundredths per cent. It is sufficient to point out some details that can and may be bettered.

I do believe if these charts are given careful consideration present engine delays may be vastly reduced and if failures are critically, that is constructively followed, that all advantages of modern and up-to-date equipment may be utilized. I mean that if we follow up engine failures with a view of preventing them with all the power at our command, a better locomotive will result and those in service can be more economically operated from a cost basis. We will be able to get more mileage per day, per month, per year and at a less total cost and ultimately by looking the problem squarely in the face it will reflect a better service to the advantage of the mechanical department and a better operation generally.

ANALYSIS OF ENGINE FAILURES

Master Exhibit "A"

Classification	No. of Failures	Percentage
Hot Bearings	109	6.71
Not Steaming	393	24.19
Boilers	181	11.14
Machinery	919	56.60
Miscellaneous	22	1.36
Totals	1,624	100.00

Exhibit "B"—Hot Bearings

Classification	No. of Failures	Percentage
Driving Box	23	21.11
Eccentrics	10	9.17
Pin and Valve Gear	15	13.76
Truck Boxes	39	35.78
Tender Boxes	13	11.93
Other Bearings	9	8.25
Totals	109	100.00

Exhibit "C"—Not Steaming

Classification	No. of Failures	Percentage
Cleaning Fire	29	7.38
Flues Coated	3	.76
Inferior Coal	83	21.12
Superheater Units	32	8.14
New and Incompetent Firemen	39	9.92
Stoppage of Flues	3	.76
Valves Blowing	2	.51
Stokers	31	7.89
Other Causes	171	43.52
Totals	393	100.00

Exhibit "D"—Boilers

Classification	No. of Failures	Percentage
Flues	48	26.52
Grates	25	13.81
Steam Pipe	9	4.96
Valves	1	.55
Bursted Flues	33	18.24
Firebox	3	1.66
Other Causes	62	34.26
Totals	181	100.00

Exhibit "E"—Machinery

Classification	No. of Failures	Percentage
Air Pump	26	2.83
Axles	16	1.74
Air Pipe	46	5.02
Air Hose	7	.76
Bolts	23	2.50
Cylinder Heads	101	10.99
Cross Heads	15	1.63
Draw Arrangements	7	.76
Draw Bars	5	.54
Eccentric Straps or Bolts	26	2.83
Electric Lights	5	.54
Equalizers and Bolts	5	.54
Guides or Blocks	31	3.37
Injectors	9	.98
Link Hangers	4	.44
Lubricators	8	.88
Loose Tires	12	1.30
Pins or Keys	36	3.92
Other Brake Arrangements	9	.98
Rocker Arms	11	1.20
Rods	225	24.48
Spring Hangers	76	8.27
Steam Chests	7	.76
Springs	14	1.52
Tires or Flanges	22	2.39
Valve Yoke or Stem	8	.87
Valves	81	8.81
Wheels	4	.44
Stokers	26	2.83
Lost Bolts, Nuts, Pins or Keys	15	1.63
Loose Bolts, Nuts, Pins or Keys	9	.98
Other Breakages	26	2.83
Steam Pipe	4	.44
Totals for Machinery	919	100.00

Exhibit "F"—Miscellaneous

Classification	No. of Failures	Percentage
Engines Unable to Handle Train	22	100.00
Total	22	100.00

Items of Personal Interest

C. Seager has been appointed general round house foreman of the Chicago and Alton at Bloomington, Ill.

J. J. McGowan has been appointed round house foreman of the Chicago and Alton at Brighton Park, Illinois.

Louis R. Ernest, has been appointed master mechanic of the Soo Line, with headquarters at Minneapolis, Minn.

W. A. Buchanan has been appointed superintendent of foundries of the New York Central, with offices at Frankfort, N. Y.

Franklin G. Robbins has been elected vice-president and regional manager of the Chicago & Erie, succeeding A. E. Wallace, resigned.

C. A. Brailbier has been appointed supervisor of work equipment of the Atchison, Topeka & Santa Fe, succeeding William Barnes, deceased.

Robert S. Parsons, general manager of the Erie, has been elected vice-president, and will have charge of operations, with headquarters in New York.

B. W. Griffith has been appointed general storekeeper of the Michigan Central with headquarters at Detroit, Mich., succeeding G. T. Dunn, resigned.

A. H. Laret has been appointed assistant to the vice-president and chief purchasing officer of the St. Louis-San Francisco, with headquarters at St. Louis, Mo.

Harry Wannamaker, formerly with the New York Central, has been appointed superintendent of motive power of the Boston & Albany, with headquarters at Boston.

S. B. Riley has been appointed superintendent of motive power of the Western Maryland, with headquarters at Hagerstown, Md., succeeding G. F. Wieseckel, resigned.

J. P. Roquemore, acting superintendent of motive power of the International & Great Northern, has been appointed superintendent of motive power with offices at Palestine, Tex.

C. R. Painter has been appointed assistant to the general purchasing agent of the New York, New Haven & Hartford with headquarters at New Haven, Conn., succeeding B. L. Northam, resigned.

W. P. Dittoe, purchasing agent of the New York, Chicago & St. Louis, has been appointed purchasing agent of the Lake Erie & Western, a subsidiary of the Nickel Plate Road, with headquarters at Cleveland, Ohio.

C. Simpson, master mechanic of the ...n, with headquarters at Bristol, Va., has been transferred to a similar position at Knoxville, Tenn., and M. D. Stewart has been appointed to succeed Mr. Simpson at Bristol.

J. F. Lord, superintendent of safety and fire prevention of the Chicago Great Western, has been appointed assistant to the general manager, and the title of superintendent of safety and fire prevention has been abolished.

M. L. Zyder, roundhouse foreman of the Indian Harbor Belt, has been promoted to assistant master mechanic, with office at Gibson, Ind., succeeding A. B. Fromm, who has been appointed master mechanic, succeeding C. B. Nelson.

Harry B. Snyder of the foreign branch of the Baldwin Locomotive Works, having recently returned to New York, has accepted an appointment as assistant to the president of the Pilliod Company, 30 Church street, New York City.

W. McMarter, purchasing agent of the Indiana Harbor Belt, has been appointed purchasing agent also of the Chicago River & Indiana, and the Chicago Junction, with headquarters at Chicago, succeeding in the latter position S. Salter.

R. M. Nelson, assistant to the director of purchases and stores of the Chesapeake & Ohio, has been promoted to purchasing agent, with offices at Richmond, Va., and A. W. Hix has been appointed assistant to the director of purchases and stores.

Harry M. Way, formerly in the office of the superintendent of motive power of the Pennsylvania, has been appointed manager of the Chicago district of the Pittsburg Testing Laboratory of the Pennsylvania, with offices at 1560 Monadnock Block, Chicago.

G. L. Flint has been appointed road foreman of engines on the Portland division of the Southern Pacific, with headquarters at Portland, Ore., and G. H. Kilbron has been appointed to a similar position on the Portland division with headquarters at Roseburg, Ore.

W. B. Murray, chief engineer of the Miller Train Central Corporation, with headquarters at Danville, Ill., has been elected vice-president of the corporation, in addition to his present office. Mr. Murray has had considerable experience on the mechanical and engineering departments of railroads, and also as a consulting engineer.

John F. Schurch formerly associated with the Railway Materials Company of Chicago, and latterly vice-president of the T. H. Symington Company has been elected a vice-president of Manning, Maxwell & Moore, and has taken charge of the then western sales, with headquarters at the company's Chicago office, 27-29 North Jefferson street, Chicago.

Elred Byron Hall, principal assistant superintendent of motive power and machinery of the Chicago & North Western, has been promoted to superintendent of motive power and machinery, succeeding H. T. Bentley promoted. Mr. Hall entered the company's service over thirty years ago, and has had a wide experience chiefly in the mechanical and engineering departments.

Elliott E. Nash, vice-president and general manager of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has resigned to accept the position of western representative of the American Locomotive Company, with headquarters at Chicago, Ill. Mr. Nash has had an extensive experience, particularly in the operating departments of the leading western railroads. During the war period he was assistant to the federal manager in the Iowa territory.

A. E. Wallace, manager of the Chicago region of the Erie, with headquarters at Chicago, has been appointed general manager of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn., succeeding G. R. Huntington. Mr. Wallace is a graduate of Harvard University, and entered railway service on the Great Northern in 1902, and has had a wide experience on the leading railroads in the middle west particularly in the operating departments.

R. B. Milden has been appointed general manager of the Stoker department of the Westinghouse Electric Company, succeeding G. A. Sacchi, now manager of sales with Edgar Woodrow, manager of the contract division of the Stoker department. F. C. Wickling has now charge of the Pittsburgh district office, and Norman Stewart is manager of the Minneapolis office, and S. R. Shave has been appointed manager of the price section of the Power and Railway departments at East Pittsburgh, Pa.

Obituary

Joseph Maycock

Joseph Maycock, for many years connected with the Erie railroad and latterly as railway representative for Pratt & Lambert, Buffalo, N. Y., died in Buffalo on June 15, in the eightieth year of his age. Mr. Maycock became distinguished as the most accomplished decorator of locomotives and passenger coaches in America. In his early days his decorations were most elaborate—scrolls, floral designs and scenes being painted by him in great variety. He also originated finishing systems for many railroads. He had given up active work for several years but still held his connection with the well-known varnish company at the time of his death.

W. C. Arp

W. C. Arp, retired superintendent of motive power of the Pennsylvania railroad, died at Terre Haute, Ind., on June 16. Mr. Arp had been on the retired pension list since 1918, after completing a continuous period of service on the Pennsylvania of 48 years.

William C. Edes

William C. Edes, formerly chief engineer of the Alaska Railroad Commission died on a train near Merced, Cal., on May 25, in the sixty-sixth year of his age. Mr. Edes was a graduate of the Massachusetts Institute of Technology, and entered railway service in the engineering department of the Southern Pacific. He had an extensive experience in railroad surveying and construction in the West, and was appointed chairman and chief engineer of the Alaskan Engineering Commission in 1914. Since 1919 he had been engaged in private engineering consulting work.

Society of Railway Club Secretaries

On June 15 the members of the above society held their annual meeting in Atlantic City, N. J., and after the transaction of routine business the following were elected officers for next year: Chairman, W. A. Booth, Canadian Railway Club, Montreal; vice-chairman, Bruce V. Crandall, Western Railway Club, Chicago; secretary-treasurer, Harry D. Vought, New York Railroad Club, New York.

Signal Appliance Association

The Signal Appliance Association held its annual meeting at Spring Lake, N. J., on June 16, coincidently with the meeting of the Signal Section of the American Railway Association. The Signal Appliance Association elected officers for the ensuing year as follows: Chairman, G. A. Blackmar, of the Union Switch & Signal Company; vice-chairman, E. A. Condit, Jr., Rail Joint Company; secretary, F. W. Edmunds, Sunbean Electric Company, New York.

Chief Interchange Car Inspectors' and Car Foremen's Association

The annual convention of the above association will be held in Chicago, Ill., beginning on Tuesday, August 22, and continuing for three days. The executive committees are assured of a large meeting of members, and are perfecting details, which will be issued during July.

The Railway Supply Manufacturers' Association

After the disappointment attendant on the canceling of last year's proposed exhibit at the expected meetings of the Mechanical Associations, it was not generally hoped for that the Supply Manufacturers' Association's exhibits would approach in magnitude the splendid exhibitions of railway supplies that have marked the many occasions on which they put forth their best efforts. To the surprise of everybody familiar with the past history of the Mechanical Associations, and who had the good fortune to be present this year, the unanimous opinion was that the exhibition of finished railroad supplies both in magnitude of members and improvements in detail surpassed anything ever before attempted on such occasions. To say that the exhibition was without a parallel in the world is no great boast, as there is no other country, or for that matter, combination or league of nations that could present such an exhibit of railway material as is possible in America when the manufacturers set their minds to it.

It is gratifying to know that the combination of meetings made the occasion worthy of the efforts of the supply men and all this in face of the fact that the promised wave of prosperity is not yet upon us with that swelling momentum of activity which is hoped for, but is as assured as that day follows night. The exhibition of finished products essential to the mechanical necessities of railroad transportation is the best proof that the manufacturers are ready. In spite of the blighting aftermath of the business paralysis following the great war, the master minds in the intellectual realm of mechanical invention have not been idle. The bow-string of their spirits is not slack, and all that is needed is a fuller and freer measure of transportation under conditions that are reasonable, and with the restless spirit of labor tranquillized into mutual harmony with those who are endeavoring to earn a limited interest in return for the capital invested.

In keeping with the exhibits the officers and members of the committees were polished to perfection. John F. Schurch, elected president in 1920, is the right man for the place. As for the secretary-treasurer John D. Conway, long experience has made the multiplex duties calling for phenomenal activity a matter of relaxation to him. He slumbers not nor sleeps. Work seems to strengthen him, and it is thrust upon him with a volume and velocity that to an ordinary mortal would leave nothing further to be desired.

So perfect in ways and means has the association become that they have divided the country into seven districts. These are managed by seven committees, all men of wide experience, as follows:

First district (New England states and Canada) one member: George W. Denyven, George W. Denyven & Co., Boston, Mass.

Second district (New York and New Jersey) three members: Charles W. Beaver, Yale & Towne Manufacturing Company, New York; W. K. Krepps, Crucible Steel Company of America, New York; and H. G. Thompson, American Radio & Research Corporation, Medford Hillside, Mass.

Third district (Pennsylvania) two members: W. H. S. Bateman, The Parkersburg Iron Company and the Champion River Company, Philadelphia, Pa.; and John M. Gillespie, Lockart Iron & Steel Company, Pittsburgh, Pa.

Fourth district (Ohio), Indiana and Michigan) two members: George A. Cooper, Frost Railway Supply Company, Detroit, Mich.; and Edward M. Savercool, S. F. Bowser & Co., Inc., San Francisco, Calif.

Fifth district (Illinois) two members: L. B. Sherman, *Railway Age*, Chicago; and L. S. Wright, National Malleable Castings Company, Chicago.

Sixth district (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Kentucky and Tennessee) one member: George L. Morton, Galena-Signal Oil Company, Atlanta, Ga.

Seventh district (states west of Mississippi River, including Louisiana, Minnesota and Wisconsin) one member: S. H. Campbell, Western Railway Equipment Company, St. Louis, Mo.

There is also an Exhibit Committee that had charge of all arrangements in connection with the exhibits, consisting of five members of which Charles W. Beaver is chairman, and John M. Gillespie, H. G. Thompson, Edward M. Savercool and L. B. Sherman associate members.

Steam Locomotives

Domestic exports of steam locomotives from the United States by countries during April, 1922:

Countries	Number	Dollars
Spain	1	24,500
Canada-Quebec & Ontario	5	32,039
Honduras	4	33,222
Cuba	1	22,500
Brazil	2	52,830
Ecuador	1	9,300
Venezuela	1	13,000
China	1	10,263
Total	16	197,654

Commerce Commission's Report

Like its predecessors the annual report on railroads has to do only with steam roads. Of 1,108 roads reported on, 631 were under private operation and 477 under Federal operation during 1919. The switching and terminal companies are not fully reported, including 301 companies of this kind with 2,017.3 miles of main track operated, that is, tracks kept clear for the passage of trains, and 1,749.81 miles of main track owned. The total mileage operated and reported on is 263,707.40, the largest in point of mileage by States are those of Texas with 16,112.72; Illinois, 12,122.95, and Pennsylvania, 11,658.14. The details in regard to equipment, income and expenses are thoroughly classified and complete in detail, and the volume will take its place as a reliable reference of the details of an eventful year in involved railroad control.

NEW PUBLICATIONS

Books, Bulletins, Catalogues, Etc.

THE LEAD STORAGE BATTERY, by H. G. Brown. Published by the Locomotive Publishing Company, 3 Amen Corner, London, England. 162 pages, cloth, illustrated.

This is the work of an accomplished engineer who has acquired a complete mastery of his subject, and writes in a clear and interesting style. As is generally known the function performed by a storage cell is the conversion of electrical into chemical energy during the operation known as charging, and the reverse when discharging. Storage batteries are well adapted for light vehicles, and there is every likelihood of a more extensive use being made of them in competing successfully with steam and petrol. Portable cells, voltage regulation, peak loads, battery economies, capacity tests, repairs and removals, care and treatment, varieties in systems, regulator switches, boosters, the formation and structure of plates, and other multitudinous details are thoroughly described and finely illustrated in this work.

Electrolysis as Related to Railroad Electrification

A new illustrated publication, Reprint 118, has just been issued by the Westinghouse Electric & Manufacturing Company, embracing an article by Professor Chas. F. Scott on the subject "The Question of Inductive Interference and Electrolysis as Related to Railroad Electrification." The publication reviews briefly the causes of inductive interference and the remedial measures which have been applied citing definite experiences with alternating single-phase installations. The conclusion drawn is that power transmission circuits with solidly grounded neutral may be expected to produce telephone disturbances of the same kind and of even greater intensity than those caused by electric railways.

From the experience gained on several roads under different conditions considerable contributions have been made to the solution of the problem. Determination of the cause to be taken should be made before installation, and should be such as to involve the least cost for proper rendering of both services. The article is highly instructive and finely illustrated.

Tate Flexible Stay-Bolts.

As is well known nearly every railroad of any size in the United States uses the Tate bolt. The Flannery Bolt Company has shown a restless spirit of enterprise in the improvement of the device, and above other marked improvements the welded sleeve was developed during the war period and has been improved and simplified until it is universally accepted as a marked improvement over the threaded type of sleeve. An illustrated pamphlet has been issued by the company showing the gradual perfection of the welded sleeve, which was not accomplished in a day. A perusal of the pamphlet, copies of which may be had on application to the main office at Pittsburgh, Pa., will show railroad men why the perfected device is taking the place of many standards hitherto in use because it is stronger, it will not leak, it does not require the care in application that the threaded sleeve requires, and one type is suitable for replacing present threaded sleeves for rigid bolts.

Lubrication

The Texas Company's publication devoted to the selection and use of lubricants in its May issue devotes twelve pages to "the superheated locomotive—its lubrication." In this comprehensive article the subject is treated in a masterly way emphasising the fact that with superheaters that will deliver a superheat of 250 deg. Fahr., when operating at maximum capacity, only cylinder oil capable of withstanding such temperatures should be used,—an oil that has sufficient film strength to prevent the opposing metals from coming in direct contact with one another and at the same time avoid frictional resistance to the movement of the piston. Co-operation between the railroad company and the oil company's lubricating engineers in regard to conditions that influence the economical and efficient use of oils is advisable. This is convincingly shown in the article referred to besides much valuable information in regard to lubricating devices, packing, amount of feed, drifting, and other details all leading towards the successful and economical lubrication of superheated locomotives.

Idle Cars Decrease

There were 480,266 idle cars on the railroads of the United States on May 31, a reduction of 24,436 from the previous week, according to reports received by the car service division of the American Railway Association. Of the total 305,198 were surplus cars in good repair in excess of current freight requirements, while the remaining 175,068 were freight cars in need of repairs in excess of the normal number unfit for service.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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New and Interesting Mikado Type Locomotive Built at the Lima Locomotive Works for the Michigan Central

Introducing Radical Changes in Details Resulting in a High Standard of Efficiency and Economy

Another interesting and important development in locomotive construction looking towards efficiency and economy has made its appearance in a new Mikado 2-8-2 type of engine on the Michigan Central. Its construction at the Lima Locomotive Works, Lima, Ohio, was not heralded by any promising announcement, but on the contrary seems to have been carefully concealed until its unique appearance and noteworthy performance stamped it at once as a genuinely valuable contribution to the inventive ingenuity of the accomplished engineers of our time. The new locomotive was planned and constructed under the personal direction of President A. H. Smith of the New York Central Lines, whose long and wide experience in railroad construction and mechanical appliances stamps him as among the leading railroad men in America.

As is well known the marked improvement in material previous to the world war period furnished opportunities towards lightening many of the working parts of the modern heavy, high-powered locomotives, and some real progress in this direction had been made. The war with its paralyzing influence left little or no opportunity for any real progress. There was enough to do to keep the wheels revolving, although a questionable attempt was made at a so-called standardization of locomotive construction, simple enough as far as the general classification of wheel arrangement is concerned, but paralyzing in organic changes however laudable they might be in design and construction.

Not only so but the repressive and restrictive acts of the multitudinous commissions, together with strangely illiberal congressional enactments left little in the way of encouragement in the vitalizing realm of experiment among those whose mental equipment and training deserved, and always will deserve, generous treatment. To these corrosive causes were added appalling labor troubles, and many enterprises full of promise lay like a corpse on the dissecting table. There are intellectual attributes in humanity however, that cannot be altogether stifled, and none are more vital than the engineering inventive faculty in the atmosphere of American enterprise.

Coming to the accomplishment under consideration, the new locomotive, as shown in our illustrations, in general appearance presents striking departures from the familiar features of the ordinary locomotive, and in numerous details of its design and construction it is just as different from any predecessor as its appearance indicates. The weight of the locomotive, exclusive of tender is 334,000 lbs. The tender which has a capacity of 10,000 gallons of water and 16 tons of coal, weighs 199,700 lbs. The boiler carries 200 lbs. of steam. The main cylinders are 28 inches in diameter, with 30 inches stroke. The diameter of the driving wheels is 63 inches. A tractive effort of 74,500 lbs. is obtainable. Of this amount of force 11,000 lbs. are delivered by the "booster." The remaining 63,500 lbs.

MIKADO 2-8-2 TYPE LOCOMOTIVE NO. 8000, OF THE MICHIGAN CENTRAL, SAID TO BE THE MOST POWERFUL OF ITS WEIGHT AND ON THE LEFT, ENGINE NO. 8977, FORMERLY 248, STILL RUNNING AFTER A SERVICE OF FORTY YEARS

are obtained from the forward cylinders.

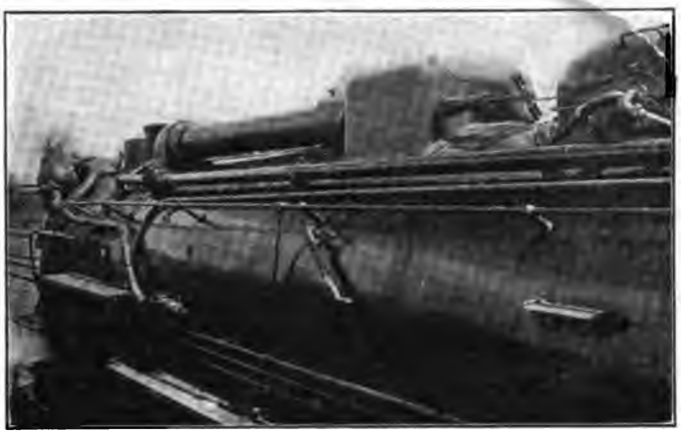
Among the departures from standard railway practice is the feature of superheating the steam before it reaches the main throttle, the steam passing through the steam dome into the dry pipe and thence to the superheater units, the dry pipe which is outside of the boiler being connected at the forward end direct to the superheater. For the first time also in the history of American railroading superheated steam is used to operate the air pump, feed-water pump, "booster" engine and headlight turbo-generator. Instead of the ordinary injector a feed-water pump takes the water from the tender and forces it through a heater, the heat for which being obtained from the exhaust steam, the condensate of which is returned to the tender through a filter, which eliminates any oil which may have been carried over from the cylinders into the exhaust steam.

and practice and calculated to get the steam to the cylinders from the throttle in the most direct way possible.

Careful attention has been given to the application of devices to facilitate handling the locomotive by enginemen, the special equipment consisting of power reverse gear, mechanical stoker of the Elvin type, and an automatic grate-shaking device which shortens the time the engine must spend over ash pits. The interior arrangement of the cab is such that the engineer and fireman perform the necessary duties in connection with the operation of the engine with a minimum of movement from their positions on either side of the cab, the physical effort of each being of the most easy kind. Even the blowing of the whistle is pneumatically operated, an air valve being located near the side of the cab and immediately in front of the engineer. As is customary on the Michigan Central, the engine is

what the structures and road-bed safely could carry continuously, and the new locomotive known as "No. 8000," was well within the specifications, although there was no established precedent to follow on the construction.

In the preliminary tests and subsequent regular daily service hauling heavy trains between Detroit and Toledo the locomotive more than met the highest expectations. The initial test comprised the hauling of 100 heavily laden coal cars and later easily negotiated a train of 140 cars containing more than 9,000 tons of coal, indicating a capacity of more than 150 cars, making a load in excess of 12,000 tons. Designed and built to expedite the movement of heavy fast freight trains, such as refrigerator trains intrusted with perishables, it has at once stamped itself as admirably adapted to the service, and more than meeting the expectations of those who witnessed its



CLOSE-UP VIEW OF LOCOMOTIVE NO. 8000, MICHIGAN CENTRAL, SHOWING NEW POSITIONS OF MANY BOILER PARTS, GIVING GREATER ACCESSIBILITY

VIEW OF LOCOMOTIVE NO. 8000, SHOWING STEAM TURRET ON TOP OF BOILER IMMEDIATELY IN FRONT OF CAB

The feed-water heater is located at the front of the engine, above the headlight and near the top of the tank so as to give the condensate pipe sufficient inclination to return the condensed water to the filter on the rear of the tender. The feed-water pump is mounted immediately back of the left side of the smoke box on the boiler.

It is worthy of note that before the steam leaves the dome it is passed through a separator which collects any water that may be carried in the steam, the water being automatically returned to the boiler, which, together with the taking of steam from the highest possible point of the boiler, insures absolutely dry steam of unusually high temperature. From the superheated steam passages in the header, the superheated steam is conveyed to the throttle, the location of which is in what might be termed a throttle box, which is on the top of the smoke-box, and immediately forward of the smoke stack, another unusual departure from existing designs

equipped with a water scoop which eliminates stops and consequent delays when the water tank needs refilling.

Among other improvements is a double refractory brick arch in the firebox of a new type designed to so aid combustion as to give the very maximum of heat units from the coal. A new type of precision power gear, which after repeated tests is claimed to be absolutely unvarying in its operation, has also been introduced for the first time. Even the bell ringer, like the whistle, is started by touching a button. Even the "booster," already referred to, is of the latest type C-1. This appliance, as is well known, is rapidly coming into favor and as an aid in starting and in grades its merits places it among the leading improvements in locomotive practice.

Previous to construction of this locomotive the bridge engineers of the Michigan Central set a maximum weight for the new locomotive that was based on the most exacting tests showing

performances. Among those who had the opportunity of observing the trials of force and speed, it was the unanimous opinion that locomotive 8000 is the last word in efficiency and economy in freight service. The official data show that with an increase in weight of less than two per cent as compared with the heaviest Mikados in service on the Michigan Central the new locomotive shows an increase of nearly eight per cent in tractive power, derived from the forward cylinders, and an increase of over twenty-six per cent when the locomotive "booster" is applied.

Briefly the principal merit marks claimed embrace the statement that for its weight, it will deliver more power than any locomotive in the world. That it will exert more tractive effort per ton of coal consumed than any locomotive ever built. That it will prove a locomotive easier to operate and repair than its predecessors, thus making for quick turn-arounds and safety.

These may seem bold claims, but the

constructors and railway officials are assured of their proofs, and it is expected that an opportunity will be afforded at an early date to make dynamometer tests and results minutely determined. Meanwhile the originality, the apparent reasonableness of the advantages involved, the boldness of the departures from general practice, together with the results of the tests so far recorded, make the introduction of this locomotive a notable event in railroad engineering. We are already convinced that the engine possesses more merit than many other innovations that have appeared in our time and are now little heard of, and hope to publish a detailed report of its actual performance in an early issue of Railway and Locomotive Engineering.

VIEW OF LOCOMOTIVE NO. 8000, MICHIGAN CENTRAL, SHOWING FEED-WATER HEATER LOCATION IN FRONT OF THROTTLE AND STACK

It may be added that the general dimensions of the leading parts are as follows:

Engine wheel base 37 feet.
Driving wheel base 16 feet 6 inches.
Engine and tender 71 feet 6½ inches.
Total length 82 feet coupler to coupler.
Engine height 15 feet 4½ inches from top of rail.
Engine width 10 feet 4 inches at cylinders.
Cylinder 28" x 30".
Steam pressure 200 lbs. per sq. in.
Diameter of drivers 63 ins.
Main driving journals 11½" x 14".
1-2-4 driving journals 11" x 13".
Engine truck wheel journal 6½" x 12".
Trailer truck wheel journal 9" x 14".
Driving wheel centers diameter 56".
Engine truck wheel centers diameter 33".
Weight of engine 334,000 lbs.
Maximum tractive effort including "booster" 74,500 lbs.

The tender weighs 199,700 lbs., and has a capacity of 16 tons of fuel and 10,000 gallons of water.

Oscillation of Locomotives Running at High Speed

At the summer meeting of the Institute of Mechanical Engineers in Paris, Sir Vincent Raven, an eminent English engineering authority, among other interesting statements, alluded to the fact that the question as to the most satisfacory mechanical arrangement of an express passenger locomotive for the British railways must be considered in reference to the discussion which has been occupying the attention of railway engineers for some time now, in regard to the possibility of oscillations or nosing of locomotives when running at high speeds. Experience in the United States with various designs of locomotives has, we are assured, proved that an electric locomotive cannot be expected to travel satisfactorily at such speeds as 70 to 75 miles per hour, if the wheel arrangement is symmetrical. This, of course, is an important point if one bears in mind that one of the advantages of electric working is that there is no necessity for turning the locomotive at the end of each journey. This is only possible if the locomotive can run equally well in both directions. For such speeds as we are considering it might be quite satisfactory to run a 4-6-2 locomotive with the bogie leading, but not with the bogie trailing, and therefore it is desirable that in whichever direction the locomotive runs there should be a bogie leading. Engineers in the United States advocate a construction which, while not symmetrical, does provide for a bogie at each end of the locomotive. For this purpose they recommend one or other of the various designs which are based on the articulation of two locomotives back to back.

The difficulties experienced in the United States, however, have not been borne out by the results of running symmetrical locomotives on British and Continental railways. In view of this, it is evident that there must be some cause which gives rise to violent oscillations on symmetrical electric locomotives when running in the United States which are absent when symmetrical steam locomotives are run in Europe. It may be argued that although the wheel arrangement of the steam locomotives mentioned is strictly symmetrical, the distribution of the weight in the superstructure of the steam locomotive is unsymmetrical. It is not considered, however, that this can make any substantial difference in the behavior of the locomotive. There is no doubt a good deal yet to be learned about the behavior of electric locomotives of a symmetrical arrangement when running at high speeds, but one possible cause of the trouble experienced in the United States and from which the European railways seem to be free, may be that on practically all the railways in the United States the rail joints are staggered, whereas on the British railways, and, it is understood, on the French railways also, the rail-joints are opposite to each other. This staggering of the joints in the United States must set up a periodic disturbing force both horizontal and vertical. The frequency of this disturbance will depend entirely upon the speed at which the locomotive travels. If the design of the locomotive is such that its own natural frequency corresponds to the frequency of this disturbance at a fairly high speed, then the oscillations set up will tend to become violent. With rail-joints opposite each other, as they are on the British and French railways, the same periodic disturbing force cannot be set up, and any oscillation of the locomotive which may arise from any local cause would tend to die out immediately after it has started. The whole question, however, is one of considerable difficulty, but the author expressed the hope that after extended trials of the 4-6-4 locomotive on the North Eastern Railway he would be in a position to express a more definite opinion in regard to the subject.

It is important, however, the types should be as few as possible from an economic point of view, and he considered it possible to confine these within five separate designs.

Railroad Strike Situation

Important Decision Made by the Railroad Executives—Expected Settlement Postponed

It would be impossible to follow the details of the conflict between the railroad executives and coal mine owners on the one hand, and the striking railroad employes and coal miners on the other. We have endeavored so far to present a fair and unbiased reflex of the attitudes of the contestants in the gigantic controversy, and had fervently hoped to have seen the end of it by the first of August. There has been much anxiety in official circles at Washington. Yet, in general, the people display little excitement. There is a serene confidence that everything will be settled in due time. This hopefulness of the people may be a reflex of the old American belief in our lucky star. We feel that we have always managed to get through our labor crises in the past, and that somehow we shall be able to emerge happily from this one. It is the complacent theory, so comfortable, but which may not always be justified, that Providence especially looks after idiots, drunken men and the United States. The mass of the people, however, can give resons for the faith that is in them. They believe, first of all, in the Government. With all its defects and weaknesses, it can be trusted upon to rise to the needs of a national emergency. It has latent and unwritten powers which can be utilized under the supreme law of the safety of the public. Furthermore, the people have a firm belief in the good sense of the men on both sides of the controversy. They do not expect either to go to extremities. This is the kind of confidence bred in Americans by long experience, and they are not to be easily shaken out of it now. Hope almost always creates from its own wreck the thing it contemplates.

Passing over the clamor of recriminations during July much was hoped for by the calling of the railroad executives together on the first of August. President Harding had obtained intimation from both sides that settlement might be achieved if certain compromises were made. It was learned from official sources that a settlement plan drawn up in Washington was about as follows:

1. The shopmen to return to work at once.

2. The Railroad Labor Board to grant a rehearing on the wage scale reductions and other working conditions which brought on the strike.

3. The railroads to agree to abide by the orders of the Labor Board prohibiting railroads from having repair work done in private shops.

4. Seniority to be restored only in part to the strikers, the men who walked out to receive rights inferior to those of the men who stayed on the job, but superior to those of the strike breakers.

This latter proposition for settlement of the seniority question is one that was said to be sponsored by a member of the Labor Board, and constituted the only doubtful point of the four mentioned. That it would be accepted by the shopmen was considered doubtful, the general opinion that the men would consider returning only if restored to the privilege of seniority, and it was equally well known that some of the railroads had promised permanent employment to their strike breakers. The significance of such a promise is that the one big privilege which seniority gives is employment. If a shop crew is being cut down, the last man hired is the first man fired. Hence, if the railroads take back the strikers with unimpaired seniority, and have room for no more than were employed before the strike, the strike breakers are going to lose their jobs.

Another suggestion understood to have been made by the President was that the men should return to work under the Labor Board's rules, waiving seniority rights for the time being, and leave the question of seniority, along with all the other questions involved, for settlement by the board. He is believed to have pointed out to the shopmen's chiefs that, should the men do such a thing, the generosity of their move would be so appreciated by the public and the Administration that the Labor Board would be almost certain to uphold their point of view in settling the seniority dispute.

It was explained that the question of seniority is not before the board at this time because the board takes the position that it is qualified to deal only with the roads and their employes. Which is to say, that strikers are not employes. But the moment they return to work and one of them, for example, is denied his seniority privileges, the question would be a legitimate subject for judgment by the board.

At the meeting of the Railway Executives' Association, held in New York City on the first of August, the official propositions submitted by President Harding were as follows:

First—Railway managers and workmen are to agree to recognize the validity of all decisions of the Railroad Labor Board and to faithfully carry out such decisions as contemplated by the law.

Second—The carriers will withdraw all lawsuits growing out of the strike, and Railroad Labor Board decisions which have been involved in the strike may be taken, in the exercise of recognized rights by either party, to the Railroad Labor Board for rehearsing.

Third—All employes now on strike to be returned to work and to their former positions with seniority and other rights unimpaired. The representatives of the carriers and the representatives of the organizations especially agree that there will be no discrimination by either party against the employees who did or did not strike.

Referring to the system of contracting work to manufacturing establishments in order to maintain needed repairs, the President pointed out that he "had not specifically stated it in the terms of settlement, but, of course, the abandonment of the contract system, in accordance with the decision of the Board, is to be expected on the part of all railroads. It is wholly unthinkable that the Railroad Labor Board can be made a useful agency of the Government in maintaining industrial peace in the railway service unless employees and workers are both prompt and unquestioning in the acceptance of its decisions."

The Railway Executives' Association, by a vote of 265 to 2, refused to agree to the President's plan for ending the railroad men's strike, sending him a qualified acceptance of planks calling for agreement to abide by all decisions of the United States Railroad Labor Board and the calling off of all litigation growing out of the strike, but refusing point blank to the third and main proposal, that they allow all strikers to return without any loss of seniority.

"Striking former employes," said the reply of the executives, "cannot be given preference to employes at present in the service without doing violence to every principle of right and justice involved in this matter and without the grossest breach of faith on the part of the railroads to the men at present in their service. Under these circumstances it becomes apparent that the railroads cannot consider any settlement of the present strike that does not provide protection in their present employment both to the loyal employes who remained in the service and to the new employes entering it."

Reports from Chicago where the strike leaders have been gathering in anticipation of action on the President's plan, were to the effect that the strikers would accept it, leaving it up to the President to take such other steps as he might deem best to bring the executives into line.

It may be added that the vote taken by the Railway Executives, and already stated, was taken after Herbert Hoover, speaking for the Administration, had urged full acceptance of the President's plan, on the ground that the full recognition of the United States Labor Board is the real issue in the strike, compared to which the seniority issue, important to the railroads, is of minor consequence. Coupled with this was the declaration that the President feels that maintenance of the integrity of the Labor Board transcends in importance all other issues, and a plea that the executives assist the Administration in disposing of one of the many vexatious problems confronting it.

The railroad executives agreed entirely with the President's statement that it is wholly unthinkable that the Railroad Labor Board can be made a useful agency of the Government in maintaining industrial peace in the railway service unless employers and workers are both prompt and unquestioning in their acceptance of its decision. The executives claim that "many men in the service refused to join the strike, and in so doing were assured of the seniority rights accruing to them and of the permanence of their positions. In some lines it is claimed that 50 per cent or more refused to join the strike. To these old loyal employes have been added thousands of new men who were employed and could be secured only upon a definite promise that their services would be retained regardless of the settlement of the strike, with all the rights appertaining to such employment, including that of seniority under the working rules and regulations previously approved by the Railroad Labor Board.

In view of the above the executives insist that the striking former employes cannot be given preference to employes at present in the service, without doing violence to every principle of right and justice involved in this matter and without the grossest breach of faith on the part of the railroads to the men at present in their service. Under these circumstances, it becomes apparent that the railroads cannot consider any settlement of the present strike which does not provide protection in their present employment both to the loyal employes who remained in the service and to the new employes entering it.

The willingness of the Railway Executives to accept two of the propositions submitted by the President was considered as a distinct step forward by the Administration. It was indicated, however, that even if a settlement is reached all around and the railroad workers also agree to abide by the decisions of the Railroad Labor Board in the future, legislation doubtless will be sought strengthening the hands of the board by giving it power to enforce its rulings against both the carriers and their employes.

One suggestion made in an authoritative quarter was that future wage decisions of the board should be on a regional rather than a national basis.

It was pointed out that wage scales in United States Navy Yards and Arsenals are based on the average wages paid for similar work in a number of manufacturing plants in the vicinity of the yard or arsenal and no attempt is made to fix a national wage scale for Government plants. It is felt that the same rule could be applied with profit on the railroads.

It is generally believed that the Government does not contemplate taking any further action in the dispute, at least until the breakdown of some particular railroad becomes evident. Acceptance of the striking shopmen of the President's proposals does not materially change the situation in view of the unanimous rejection of the terms by the rail executives. As already stated the employes, during the first week in August agree to return to work with the understanding that they have unimpaired seniority restored. The railroads flatly refuse to re-employ them on this basis.

Unless the railroads change their attitude and surrender on the question of seniority the Administration feels the strike is exactly where it was on July 1 when the shopmen walked out.

Either some entirely new basis for a compromise must be worked out and resubmitted or, as the President himself has intimated, the railroads and the shopmen will be allowed to "fight it out."

Among other reports not fully confirmed was one to the effect that the Administration's next move in the shopmen's strike would be to invite the strikers to return to work and then appeal to the Railroad Labor Board for a decision upon the seniority question. It was reasoned that since both strikers and executives have accepted the first of the President's proposals —that the judgments of the Labor Board must be obeyed by both sides—this gives opportunity for arbitration of the seniority issue. In labor quarters this report was received with interest and some favor. The obvious difficulty with this course of action is in the attitude of the executives who have assured employes taken on during the strike that their positions are permanent.

The only definite assurance is that the Railroad Labor Board has adopted a resolution to begin the hearing of wage and rule disputes involving certain classes of railway men on August 28. The Board's action is in line with promises previously made when the union's strike plans were formulated early in July. Labor board members pointed out that the Board made no concession in granting a rehearing of cases which resulted in slashing the pay on July 1, as any organziation was privileged to ask for reconsideration on the ground that living prices had advanced since the decision was rendered. The principal rule involved concerns overtime.

Cases involving forty-three roads have now been submitted to the Board, these railroads waiving their right to a thirty-day notice before submissions of the cases. Other roads are said to have pursued a similar policy.

Senator Cummins on the Railroad Law

Senator Cummins, who has had many conferences with the President on the Railroad Law of which he was part author, says he is convinced that the committee hearings, which will be designed to secure all possible aid in drafting a new formula on railroad wages, would begin soon, but not so soon as to interfere with the present strike negotiations. The committee chairman did not believe it possible that the amendatory legislation could be disposed of soon enough to be a factor in the present strike, his thought being that corrective legislation would prevent future trouble.

"The men undoubtedly are entitled to a guarantee of a living wage, inasmuch as the Transportation act attempts to define wage standards," said Senator Cummins. "I do not mean a nation-wide, standardized wage, but the law should be so amended as to guarantee a living wage, under a better formula of law than in the present Transportation act, which will be capable of better administration by the Railroad Labor Board."

Later, according to Senator Cummins, who is a co-author of the present law, must come legislation to make the board's decisions enforceable.

"They are binding now, on both sides, but not enforceable," said Senator Cummins. "I think we must have an amendment which will make them enforceable, by providing penalties against conspiracy among railway workers and also fines and imprisonment penalties against railway officials for violating the board's orders."

The latter legislation, Senator Cummins said, should not be injected now into the present strike.

An Authority on Labor Questions

Baron Shaw, one of the six members of the British Lords of Appeal, who is attending the San Francisco convention of the American Bar Association, and who is perhaps the highest authority on labor disputes in Great Britain, being chairman of the commission that settled the British dock strike, one of the most serious that has taken place in England, states that he was not sufficiently well acquainted on the coal and railroad strikes in America to venture an opinion, but he was a confirmed advocate of judicial arbitration, meaning an investigation in which both sides participated, with the power of cross-examination together with an impartial chairman, and where capital and labor hear each other. In the dock strike this was the method followed, and as a result the scandal of casual labor was done away with by a system of registration, and a minimum wage of sixteen shillings a day was fixed, on a sliding scale with respect to the cost of living.

Six-Wheel Truck for 120-Ton Capacity Coal Car for the Norfolk & Western Railway

Details of Unusual Features in Design and Construction

The June issue of RAILWAY AND LOCOMOTIVE ENGINEERING contained an article descriptive of the body of a 120-ton coal car built for the Norfolk & Western Railroad.

SIX-WHEELED TRUCK FOR NORFOLK & WESTERN RY.

The truck used is of the six-wheeled type of novel construction. In the ordinary six-wheeled truck the center of the equalizer springs lies at one third the distance from the center of the outside axle to that of the middle axle, in order to obtain a uniform distribution of the weight between the three axles. The appearance of this truck is deceitful in this respect because the center of the springs lies midway between the two axles. It is, in this, that the main peculiarity of the truck lies.

This peculiarity may, perhaps, be best illustrated by the use of a diagrammatic drawing.

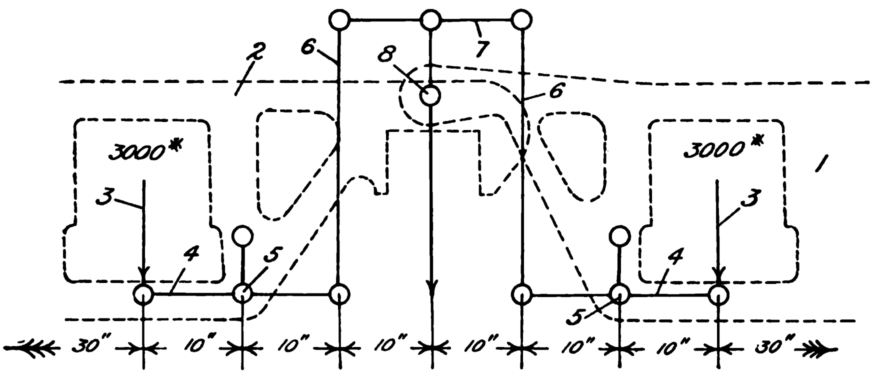


DIAGRAM OF LOAD TRANSFERENCE OF NORFOLK & WESTERN RY. TRUCK

The outer ends of the two side frames (1 and 2) rest on the axle boxes in the usual manner and are pivoted together at their inner ends where they rest on the center box. In the diagram it is assumed that the total wheel base is 120 in. and that the load is applied at a point (3) midway between the inner and outer axles. This load, as it is applied through the springs, does not rest directly on the side frames but on the outer end of an equalizing lever (4). This equalizing lever rests upon and is pivoted to the frame at (5) so that the inner end of the lever exerts an upward thrust through the column (6) against the end of the lever (7). This lever (7) is pivoted on the same pin (8) by which the two frames (1) are connected.

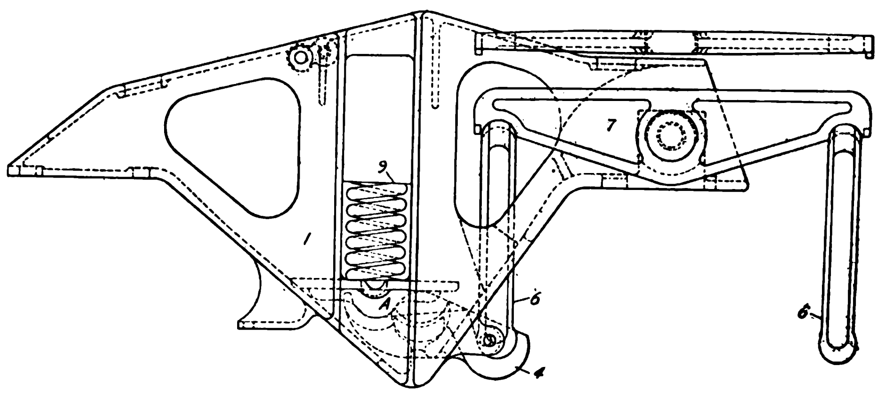
Following the distribution of the load there is first the direct loading let us say of 3,000 lbs. at (3) on the end of the lever (4). As this lever is one of two equal arms the downward thrust at (5) on the side frame is equal to 6,000 lbs. and the upward thrust on (6) is 3,000 lbs. to balance that at (3). As a similar upward thrust is given to each end of the lever (7) the result is to tend to lift the pin (5) and the two truck frames by the combined amount of this thrust and thus relieve the weight on the center box by that amount. With the downward pull at (5) equal to 6,000 lbs. and with the pivotal point (5) located one-third the distance from the center axle to the outer one, this distribution would naturally put 4,000 lbs. on the center axle and 2,000 lbs. on the outer. But the upward thrust on the column (6) relieves the center box of 3,000 lbs. of its load, leaving 1,000 lbs. to be carried by the journal box, or one-third the load put by the bolster and springs on the end of the lever (4).

In short the effect is the same as though the original weight was imposed by the springs on the pin (5) at a distance of 20 in. from the center axle or one-third the distance between the two.

The special drawing shows how this is worked out in practice.

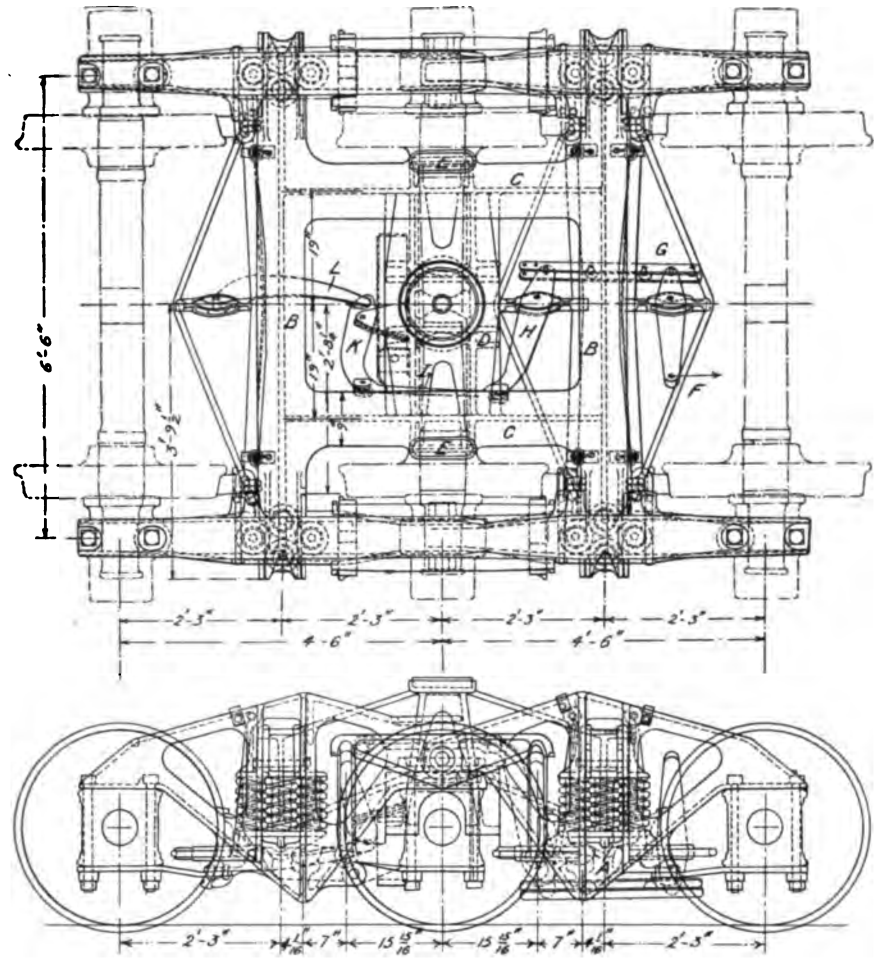
This is an assembly of the details for one-half of the side of the truck. In it the distance between the wheel centers is 4 ft. 6 in. or 9 ft. 0 in. for the total wheel base. The center of the springs is midway between the two axles and the pivotal point of the bottom equalizer (4) is 4 1/16 in. inside of this. The arms of this equalizer are 4 1/16 in. and 7 in. long, respectively. This makes each arm of the top equalizer 10 13/16 in. long.

With this ratio of equalizer arms and according to the analysis of the diagram of construction, the downward thrust on the frames is about 4,741 lbs. for each



ASSEMBLY OF DETAILS FOR LOAD TRANSFERENCE, NORFOLK & WESTERN RY. TRUCK

3,000 lbs. of load on the springs and short end of the bottom equalizer. The distance of the pivotal point on the frame



SIDE ELEVATION AND PLAN OF NORFOLK & WESTERN RY. SIX-WHEELED TRUCK

from the inner and outer axles is 22 15/16 in. and 31 1/16 in., respectively, or on a ratio of about .425 to .575 of the distance between the axles.

According to this ratio about 2,726 lbs. will rest upon the center axle and 2,015 lbs. on the outer axle. But the upward thrust on the inner end of the bottom equalizer is 1,741 lbs., which must be subtracted from the load that would normally be put on the center axle, leaving 985 lbs. which, with the 985 lbs. coming from the other half of the truck puts a total load of 1,970 lbs. on the center axle, and 2,015 lbs. on each of the outer axles, for each 6,000 lbs. (3,000 lbs. on a side) total load on the bolster.

All these working parts of the truck are of steel castings and the specifications require that the bearing parts shall be cast smooth so that no finishing will be required.

With the exception of this peculiarity the truck is similar to other six-wheeled trucks. In addition to the side frames and leverages described the bolster is one of the principal features of the truck. It is a steel casting. In plan it has two

by the longitudinal pieces *C C* on which the side bearings *E E* are cast. These two pieces are, in turn, united by a cross bar *D* on which the center plate is cast. The openings between *C, D,* and *B* afford access to and play for the brake levers. The sections are partly *U* and partly *I*-shaped, the cross pieces *B* being of the latter form and all are stiffened by necessary ribs and brackets.

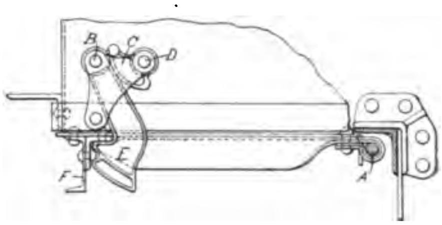
In the brake rigging the ordinary single shoe brake is used without a dead lever. The pull is applied to the end of the first lever at *F* in the direction of the arrow. This lever is pivoted to the brake beam of one of the outside wheels and its back thrust is communicated to the brake lever *H* of the central pair of wheels through the thrust rod *G*. The upper end of this lever is connected by the tension rod *I* to the upper end of the last lever *K* which is pivoted to the bolster and, by means of the thrust rod *L* puts a brakeshoe pressure against the third pair of wheels.

In connection with the car under which these trucks are to be used a description of which was published in our June issue, the latch used in holding the doors is worthy of notice.

The drop doors are plain traps turn-

fened by an angle at the swinging end. This angle, projecting beyond the edge of the door, serves as a bearing to catch the lip of the latch. The latch is pivoted at *B* and is held in the locking position by the cam *C* which is pivoted at *D* and is held by the same triangular bracket as the latch.

The latch has a double catch or lip. The main one that is shown in the engraving as holding the door in place comes well beneath and when crowded into place by the cam holds very securely. But that this lip should catch, necessitates that the door should be fully closed. As it may be difficult to swing the door up to closed position the small supplementary lip *E* is placed on the face of the latch just below the main lip. Then as the doors are swung up they catch on this lip and are held nearly closed. In order to close doors that are not easily lifted up to the shut position a hole is



DROP DOOR LATCH, NORFOLK & WESTERN R. R. 120-TON CAR

drilled at *F* in each door angle, and a bar put through one, as that to the left, makes it possible to use one door angle as a fulcrum with which to pry the other door up and shut. This done the bar is reversed for use on the other door.

As to how much farther we are to go in the matter of high capacity cars for bulk freight it would be hazardous to predict. But as things stand now this is the latest design to be produced.

Louisville and Nashville Veterans Honored

Service medals have been awarded to the employes of the Louisville & Nashville Railroad at a meeting held in Nashville, Tenn., recently. The medals in their material and design distinguish the length of service of the employe running from 15 to 25 years, from 25 to 35, from 35 to 45 and over 45 years. The total awards included 292 employes.

Electric Locomotive for Japan

The English Electric Company has received an order from the Imperial Government Railways of Japan for 34 electric locomotives intended for those portions of the Japanese main line railways which are expected to be in operation by the end of next year. The cost of the electric locomotives is said to approximate $2,500,-000.

Report on Locomotive Boiler Explosions

By A. G. Pack, Chief, Bureau of Locomotive Inspection, Washington, D. C.

Tables compiled by the Bureau of Locomotive Inspection show that boiler explosions have been the most prolific source of serious and fatal injuries. The primary cause of a boiler explosion is because some part of the vessel is too weak to withstand the pressure to which it is subjected, and the cause of this weakness is sometimes hard to determine. The violence which follows boiler explosions is accounted for by well-established physical laws. When shell sheets rupture or crown sheets fail and the boiler pressure is suddenly reduced to atmospheric, a tremendous amount of heat energy stored in the water in instantly released and causes a large part of the water to suddenly flash into steam, while the volume of the steam expands many times. The capacity of the boiler is then wholly inadequate to accommodate the increased volume of steam so suddenly generated, nor will the rupture permit it to escape fast enough to avoid a tremendous reaction. As a result of this reaction, we have the appalling explosions which are from time to time so forcibly brought to our attention.

The force of a boiler explosion is in proportion to the size and suddenness of the initial rupture and the temperature and volume of the water in the boiler at the time of the rupture. The average modern boiler has a capacity of approximately 500 cubic feet of water below the crown sheet and has a steam space of about 150 cubic feet. If such a boiler with 200 pounds' pressure ruptures from any cause, so as to suddenly reduce the pressure to that of the atmosphere, the release energy will amount to approximately 700,000,000 foot-pounds and if the explosion took place in two seconds approximately 690,000 horsepower would be developed.

This gives some idea of the force which accompanies many boiler failures, with their serious and fatal results, and supplies the reason for the violence which in many cases is sufficient to hurl the entire boiler several hundred feet or tear it into fragments, scattering them in every direction.

All New Locomotives Constructed with Water Column as Recommended

One of the most perplexing problems which has presented itself while operating the modern locomotive is that of securing a correct indication of the height of water over the crown sheet under all conditions of service.

In my last annual report was included a report covering tests made to determine the action of water in the boiler on the water indicating appliances with respect to their correct registration. These tests es-

in the boiler do not correctly indicate the general water level while steam is rapidly escaping from the boiler, and in order to secure a proper appliance it was recommended that a water column to which three gauge cocks and one water glass were attached be applied.

As far as we have been able to determine, practically all new locomotives constructed since that report was rendered have had water columns applied. On old locomotives the application has not progressed rapidly, probably due to the difficulty in obtaining necessary appropriations. The necessity for such appliances, however, is practically unquestioned, and some roads are proceeding with the application in a very satisfactory way. It is hoped that in the near future this important appliance will be applied on all locomotives, so that enginemen may have accurate knowledge of the general water level in the boiler under all conditions of service.

Transcribed reports showing defects found on all locomotives ordered out of service and those found approaching violations of the law and rules were furnished the chief operating officers of the carriers monthly, so that they might be fully informed of the condition of their locomotive as disclosed by our inspectors.

During the year 209 applications were filed for extension of time for the removal of flues, as provided in rule 10. Investigation showed that in 25 of these cases the condition of the locomotives was such that no extension could properly be granted; 22 were in such condition that the full extension requested could not be granted, but an extension for a shorter period within the limits of safety were allowed; 25 extensions were granted after defects disclosed by our investigation had been repaired; 88 applications were withdrawn for various reasons; and the remaining 99 were granted for the full period requested.

As provided in rule 54, there were filed 2,791 specification cards and 9,785 alteration reports. These have been carefully checked to determine whether the boilers represented were so constructed as to safely withstand the pressure to which they were being subjected and that the stresses given in the specifications and alteration reports had been correctly calculated.

On July 1, 1920, the rules became effective requiring each locomotive used in road service between sunset and sunrise to be equipped with a headlight which will enable the enginemen to see in a clear atmosphere a dark object as large as a man 800 feet ahead of the locomotive and that yard locomotives have one light on the front and one on the rear that will enable the

comotive. These requirements have been given close attention and have been fully complied with so far as it has been brought to attention of the chief inspector. The lighting equipment with which locomotives are now equipped seems to be meeting with the universal approval of officials and employes required to operate and maintain them.

During the year the inspectors of this bureau, at the direction of the commission, spent 962 days on special work, in connection with the transportation act of 1920 and the Interstate Commerce Act, other than the duties required by the locomotive inspection law.

The law provides that whenever any district inspector shall in the performance of his duty find any locomotive or apparatus pertaining thereto not conforming to the requirements of the law or the rules and regulations established and approved he shall notify the carrier in writing that the locomotive is not in serviceable condition, and thereafter shall not be used until in serviceable condition: Provided, that a carrier, when notified by an inspector in writing that the locomotive is not in serviceable condition because of defects set out and described in said notice, may appeal to the chief inspector to have the locomotive re-examined. The carrier, being dissatisfied with the decision of the chief inspector, may appeal to the Interstate Commerce Commission.

Under this provision of the law not a single formal appeal has been taken from the decision of any inspector during the fiscal year. This demonstrates that wisdom and good judgment have been exercised by our inspectors in the performance of their duties.

Locomotive Boiler Horsepower

Experiments conducted under supervision of D. F. Crawford, while general superintendent of motive power of the Pennsylvania Railroad, indicate that to obtain from locomotives the average power required from them it is necessary to consume fuel at the rate of 100 lbs. of coal per square foot of grate per hour, and to obtain the maximum power required it is necessary to consume 150 lbs. and at times an excess of that amount per square foot of grate per hour. To obtain the power necessary to perform the work demanded, a boiler which from its heating surface would be rated at 320 horsepower is frequently forced to develop over 1,500 boiler horsepower. Other boilers rated at 400 horsepower have developed as high as

The Properties of Chilled Iron Car Wheels

With Illustration of Testing Machine, Location of Gage Lines, Diagrams of Pressures, and Corresponding Unit Pressures

For some time past the laboratory of the University of Illinois has been engaged in an investigation as to the physical properties of chilled car wheels directing attention, at first, more particularly to the internal stresses set up in the metal by mounting and loading. The results of this investigation have been published by the University in its Bulletin No. K9, under the authorship of the engineers in charge of the work, Messrs. J. M. Snodgrass and F. H. Gulchner.

Owing to the desirability of obtaining definite information concerning the magnitude and distribution of stresses in chilled car wheels and of determining the limitations of these wheels as used today, and with a further view of improving the chilled iron wheel in order to meet future requirements, a cooperative agreement was entered into by the Association of Manufacturers of Chilled Car Wheels and the University of Illinois. The agreement provided that the University should conduct a research as to

(1) the strains caused by mounting the wheel on its axle;

(2) the strains caused by the static or wheel loads;

(3) the ultimate breaking strength of flanges, and strains caused by flange pressure;

(4) the strains, due to temperature gradients in the wheel, caused by brake application;

(5) incidental problems related to the above.

The present bulletin gives the results of a series of strain-gage tests in connection with the items (1) and (2) just mentioned. The strain within the wheel caused by forcing it on an axle was first determined for two 33-in. 725-lb. M. C. B. wheels. The same pair of mounted wheels was then subjected to static loads ranging from 20,000 to 200,000 lbs. per wheel, and the resulting strains noted. The loading effect was produced by applying the load to the axle by means of a testing machine, and allowing the wheels to transmit it to a pair of rails the conditions being similar to those found in service. Similar tests were then carried out with a pair of 33 in. 740 lbs. arch plate wheels and a pair of 725 lbs. M. C. B. wheels.

General Statement Concerning Wheel Loading.—A car wheel in service is subjected to conditions which produce stress within the wheel. These stress-producing conditions may exist in a great variety of combinations, and give rise to stresses of a more or less complex nature. The principal causes of stress in a car wheel are:

(1) manufacturing processes, which may cause initial stresses;

(2) forcing the wheel on the axle, or mounting;

(3) the proportion of the car loading supported by one wheel;

(4) the lateral pressure on the wheel flanges produced by rounding curves, by wind, or by the unevenness of the track;

(5) non-uniform temperatures in the wheel caused by brake application;

(6) centrifugal force, when the speed is high.

600,000-LB. TESTING MACHINE WITH PAIR OF WHEELS IN POSITION TO RECEIVE STATIC LOAD

Rotation, moreover, complicates the problem still further by introducing impact and repeated stresses.

Important initial stresses, if existent, can be traced to improper manufacture.

After being cast, the wheel is bored slightly smaller than its axle and forced upon it. In general, this mounting of the wheel on its axle produces compression in radial directions and tension in tangential directions throughout the entire wheel. The intensity of these stresses is greatest at the bore and decreases toward the tread until the intersection of the inner and outer plates is reached, at which point there may be a slight increase in magnitude, beyond which a decrease again occurs. At the rim or tread of the wheel these stresses become negligible.

On being placed in service, the wheel doubtless encounters conditions that produce an exceedingly complex stress distribution within it. As a consequence of the stresses set up by the static load, tensile and compressive stresses of varying intensity are set up in all parts of the wheel. The compressive stress produced by the static load is at a maximum on the radial line connecting the center of the wheel and the point where the rail is in contact with the wheel. No general statement can be made as to where the actual maximum stress occurs on this radial line.

The order in which additional stresses occur in the wheel is necessarily determined by the conditions under which the wheel is operating. Lateral pressure on the wheel flange when rounding a curve adds to or modifies stresses already existing in the wheel. Both the static load and flange thrust stresses may be considerably augmented by impact, as in the case when heavily loaded cars operate on imperfectly aligned track, or strike guard rails and crossings at high speed. The application of the brakes for purposes of car retardation generates heat that must be dissipated by the brake shoe and the wheel. Within the wheel this dissipation of heat produces unequal temperatures or gradients between different points, with resultant stresses. If not properly handled by operating men, long continued brake application, such as occurs in mountainous regions, may occasion abnormal stresses and be a source of trouble, with attendant possibilities of serious disaster. Centrifugal force or a hot journal may play a part in causing undue stress within a wheel. Due to rotation, moreover, all the stresses present, excepting initial stresses and those due to mounting, occur as repeated stresses, thereby still further complicating the general problem.

Of the more important means of producing internal stress in the wheel it may be generally stated, with the exceptions subsequently noted, that the mounting of the wheel and the static load tend to produce compressive stresses in a radial direction, which stresses may be wholly or partially relieved or even reversed by tensile stresses due to centrifugal force and brake application. On the outer face of the wheel the stresses due to flange thrust are cumulative with, while on the inner face they are opposed to, those caused by centrifugal force and brake application.

Throughout the tests an attempt was made to reproduce service conditions as far as laboratory facilities would permit, and the wheels used are assumed to be representative of their respective types.

In the evaluation of the stresses it is to be recognized that while the car wheel may be regarded as a series of curved plates in which the outer edge of one becomes the inner edge of the other there is no theory of curved plates by which it would be possible to predict the intensity or distribution of stresses in a car wheel by analytical methods. This makes it evident that the problem of car wheel stresses is an exceedingly complex one.

It is evident that the problem of the car wheel under load is one of compound stress; that is, stress in more than one direction. Throughout this report the term stress has been used to indicate the stress which would exist in the material under observation if subjected to either simple tension or simple compression, and, under these conditions, deformed to an extent equal to the measured strain.

In general, in discussions pertaining to the strength of materials it is customary to consider the matter in terms of stress. The fundamental data obtained in these tests were, however, strains or deformation measurements. Hence, to facilitate interpretation of the strain data in terms of stress, it became necessary to have a knowledge of the stress-strain relation of the metal used in car wheels. This relation was determined by applying a known load to the metal under test, and measuring the corresponding elongation or contraction; then, by calculation from the load and the deformation, were obtained the stress per unit area and the strain per unit of length, respectively.

Chemical analyses were also made and, in addition, hardness tests were made by both the Brinnell and scleroscope methods.

The preparation and methods of determination of the strains caused by mounting and static loads were as follows:

A pair of wheels was prepared with gage holes determining lines in both radial and tangential directions and on several radii. With the strain-gage, readings were taken on each of the gage-lines before mounting the wheels on the axle. The two wheels were then pressed upon the seats of a standard 5½-in. by 10-in. M. C. B. axle in a 600,000-lb Riehle testing machine. Autographic diagrams of the pressure during mounting were taken. After mounting, observations on each of the gage-lines were again made, and, as stated above, the differences, after proper corrections, between the latter readings and the initial readings are measures of the unit strains.

After the strains incident to mounting had been determined, the wheels were placed in the testing machine, as shown in the illustration, and subjected to various known static loads.

For each of the static loads thus applied a complete series of strain readings was taken. In this case the difference between the initial readings, the observations taken before mounting, and the observations at the load in question, is the total strain in the wheel caused by the combined effects of mounting and the static load. It will be noted that, except for the inversion of the wheel and rail, the apparatus arranged for the static tests loads the wheel in the same manner as in actual service.

In making the determination of the mounting and static stresses two pair of wheels were used: one a pair of 725 lbs. M. C. B. design and the other a pair of 740 lbs. arch plate wheels. There were natural differences in the details of the stresses set up, but so great a similarity in general results as to give a clear idea as to what may be roughly expected in any wheel.

Taking up the determination of the corresponding simple stresses as developed in the 725 lbs. M. C. B. wheel as developed by mounting and the static loads; the location of the gage-lines on these two wheels is shown in Fig. 11 and the gage-lines are designated as follows: the radial lines on which the gage-lines are located are lettered A to H, and these letters become the first figure in the designation; the relative position of the gage-line on the radius is next indicated by a numeral, which in turn is followed by either the letter R or T, signifying respectively a radial or tangential gage-line; thus $B4R$ denotes the gage-line or radial B, fourth from the tread and in a radial direction, and $B4T$ indicates the gage-line similarly located but in the tangential direction.

The pressures required to mount the wheels on the axle together with the fit allowance are shown in Fig. 2, while the equivalent simple stresses resulting, therefrom, for one of the wheels (No. 761,237) are given in Fig. 3.

Diagrams similar to Fig. 2 are regularly taken by both the manufacturers and railroads when mounting wheels. With wheels properly fitted, this curve will show a nearly uniform increase in the pressure required for forcing the wheel on the axle from the instant the axle enters the wheel up to its final position.

The wheel fit allowance on the wheel under consideration was 0.021 in. and the mounting pressure at a speed of 0.4 in. per minute was 61.5 tons; i. e., the allowance was 25 per cent greater than the manufacturers' maximum allowance, while the pressure required was 5 per cent less than might be recorded by commercial types of wheel presses, which, however, operate in some cases at much higher speeds.

From this and other mounting tests, it is apparent that the pressure required to mount a wheel is a function of the mounting speed. It is also probable that the magnitude of the mounting pressure is dependent on the alignment of the wheel bore and axle during mounting. As no spherical blocks were used in these tests when mounting the wheel—nor are they used on wheel presses—it is possible that the maximum recorded mounting pressures are higher than would be the case if perfect alignment between bore and axle existed. Hence it would appear that fit allowance might be a better criterion for mounting wheels than pressure where the mounting speed falls considerably outside the range of speeds customarily used in wheel shops, and in cases where poor alignment may occur. Under no circumstances, however, would it be advisable to discontinue the use of the final mounting pressure as a check against the placing of improperly fitted wheels in service.

In the case of wheel No. 671,237 the maximum tensile unit strain, due to

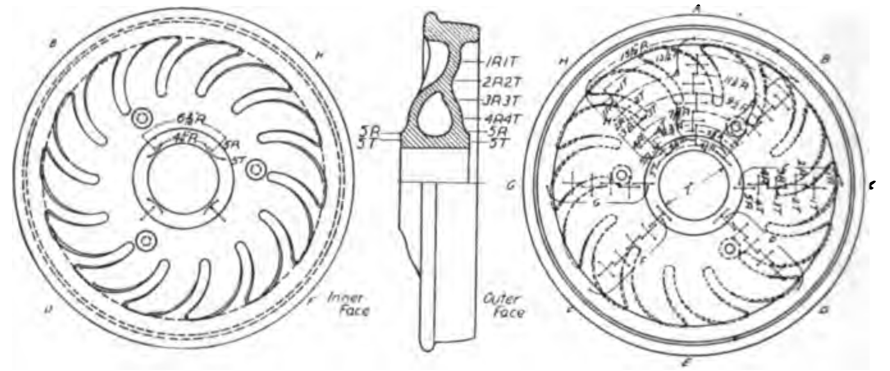


FIG. 1. LOCATION OF GAGE-LINES ON 33-IN. 725-LB. M. C. B. WHEEL NO. 671,237

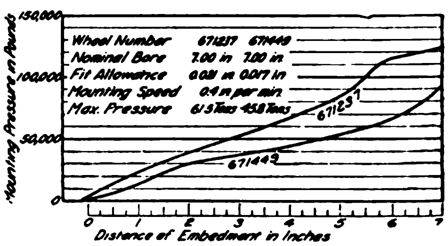
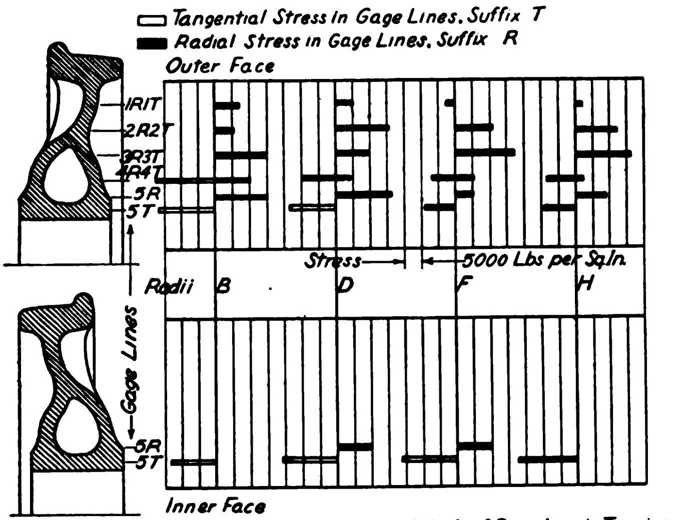


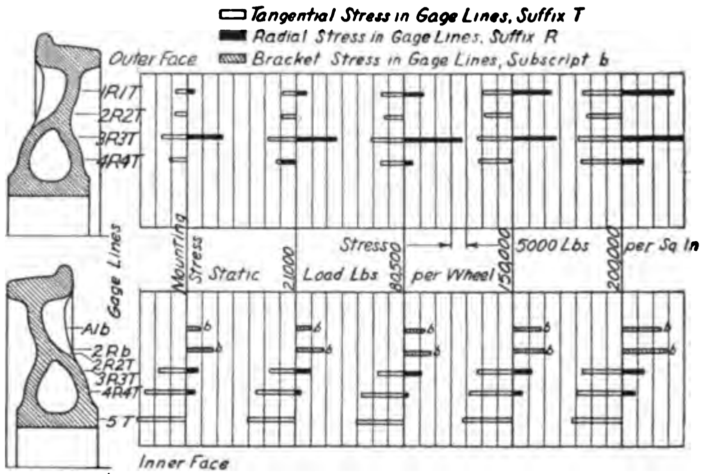
FIG. 2. AUTOGRAPHIC DIAGRAMS OF PRESSURES REQUIRED TO MOUNT TWO 33-IN. 725-LB. WHEELS ON AXLE

mounting (Fig. 3), was on gage-line $B4T$ on the B radial of the outer face. The magnitude of this strain was 0.00222 which corresponds to a simple tensile stress of 17,400 lb. per sq. in. Inspection of Fig. 1 shows that the measurement was taken in close proximity to a chaplet, and this may partially account for the large value. On the inner face the same value is nearly reached on gage-line $H5T$ where the strain was 0.00218, and the simple tensile stress corresponding thereto is 17,300 lb. per sq. in. With respect to the compressive strains the maximum was on the outer face on gage-line $F3R$ and equalled 0.00127, which corresponds to a simple compressive stress of 17,600 lb. per sq. in. This is in the region near the intersection of the inner and outer plates. A relatively short radius of curvature, 3 in., exists on a portion of this gage-line, so that curved plate action may partially account for the values found in this region.



Stress-To Right of Base Line is Compression, To Left of Base Line is Tension
Maximum Mounting Pressure - 61.5 Tons

FIG. 3. CORRESPONDING SIMPLE UNIT STRESSES IN 33-IN. 725-LB. M. C. B. WHEEL NO. 671,237 CAUSED BY MOUNTING ON AXLE.



Stress-To Right of Base Line is Compression, To Left of Base Line is Tension

FIG. 4. CORRESPONDING SIMPLE UNIT STRESSES IN 33-IN. 725-LB. M. C. B. WHEEL NO. 671,449 DUE TO COMBINED EFFECTS OF MOUNTING AND STATIC LOADS. LOADS APPLIED ON THE A RADIAL

After being mounted, the wheels were subjected to static loads up to 200,000 lb. per wheel, or about 10 times the load they would be subjected to in practice. The maximum stresses in wheels No. 671,449, which was the mate on the same axle with wheel No. 671,237 previously considered, caused by combined mounting and static loads, are shown in Fig. 4. In Fig. 4 are shown the corresponding simple stresses caused by superimposing the effects of the static loads, ranging from 21,000 to 200,000 lb., upon those due to forcing the wheel on the axle. To prevent the axle being bent, it was given additional support between the wheels for wheel loads above 40,000 lb. In the tests represented by Fig. 4 the load was supplied on the A radial gage-line, i. e., the several loads were transmitted from the axle along this radial gage-line to the rail. The strains along this radial gage-line were larger than the consequently, presentation of figures relating to the strains along the other radial gage-lines has been omitted from the discussion.

With respect to the radial gage-line along which the load is applied, the stresses due to a static load, when imposed upon those caused by mounting, are similar in kind to those of mounting, i. e., compressive on the radial and tensile on the tangential gage-lines. In ordinary practice the 33-in. 725-lb. wheel of this type may be subjected to a load not exceeding 20,125 lb. With a static load of 21,000 lb. the stresses are but slightly different from, and may be either greater or less than, those of mounting. This indicates that mounting is a much more important factor in producing stress than the maximum car load—neglecting impact and indirect effects—to which wheels are subjected in normal railroad service. With the static load equal to 200,000 lb. applied on the radial gage-line A, the maximum unit tensile strain due to the combined effects of mounting and load, was found to be on the tangential gage-line $A5T$ on the inner face of the wheel, and to be equal to 0.00185. This corresponding unit stress is 16,500 lb. per sq. in., or an increase of only 800 lb. per sq. in. above that caused by mounting alone. The maximum increase in tensile strain occurred on the tangential gage-line $G1T$ on the outer face when the 200,000 lb. load was applied along the G radial. For this loading, the increase in unit tensile stress on the several gage-lines over that due to mounting was as follows:

Gage-Line Outer Face	Increase in Tensile Stress per sq. in.
$G1T$	10,500 lb.
$G2T$	9,100 lb.
$G3T$	6,900 lb.
$G4T$	4,700 lb.

and $G4T$ nearest the hub, these figures indicate that the influence of the static load decreases as the distance from the rail becomes greater. As a whole the observations relating to stresses produced by the static loads indicate that the influence of these loads (as expressed by increase of the tensile stresses) decreases as the distance from the rail toward the axle increases, although occasional exceptions to this rule occur.

Slightly different conditions exist on the radial gage-lines with respect to magnitude and distribution of the stresses. On the radial gage-lines the stresses are compressive, and the variations over the G radial gage-line for the corresponding 200,000-lb. load were:

Gage-Line, Outer Face	Increase in Compressive Stress per sq. in.
$G1R$	15,000 lb.
$G2R$	13,300 lb.
$G3R$	13,800 lb.
$G4R$	7,400 lb.

Here again the maximum increase in stress occurs nearest the tread and the minimum increase nearest the bore. It will be recalled that, in mounting, the opposite condition was found; namely, that the greatest stress occurred at the bore and the least at the tread. It is further evident from the above figures that the variation in stress in the radial direction differs from that in the tangential direction in that the latter shows an almost uniform decrease in the intensity when traversing the section from $G1T$ to $G4T$, while in the former no such uniform decrease occurs. For the combined effect of mounting and the 200,000-lb. static load the maximum recorded compressive strain was on radial gage-line $G3R$, and amounted to 0.00267. The corresponding simple compressive stress is 25,600 lb. per sq. in., or 13,800 lb. greater than the stress produced

In summarizing, these tests would indicate that, directly, the wheel load of ordinary service does not materially alter the existent strains caused by mounting, although, indirectly, the wheel load is a factor in producing stress, due to the bearing it has on flange pressure, impact, etc. Load application results in increasing the compressive strains already existent in the wheel to a greater extent than it increases the tensile strains. It is further evident that in the absence of speed and track curvature, very heavy wheel loads may be sustained without greatly increasing the magnitude of the tensile stresses which were produced by mounting.

SUMMARY OF CONCLUSIONS

The results recorded in the previous pages may be summarized as follows:

(1) The tensile strength of the metal taken from different parts of the plates of three wheels ranged from 23,300 to 32,800 lb. per sq. in., and the modulus of elasticity ranged from 14 to 28 million lb. per sq. in. It is probable that these variations may be explained by variations in chemical composition of the several specimens, and variations in the treatment of the wheels after casting. Whatever be the reason, however, they suggest that a study of the metallurgy of wheel irons offers possibilities of improvement by which the higher values obtained in these tests might be consistently maintained or possibly exceeded.

(2) No distinct relation was apparent between the ultimate strength of wheel iron and either the Brinnell or the scleroscope hardness, nor could a constant relation be determined between the Brinnell and scleroscope results.

(3) In forcing the 625-lb. and 725-lb. M. C. B. or Washburn type of wheel on an axle the maximum tensile strain or stress is a tangential or "hoop" strain or stress occurring at the bore, and it may be on either the inner or the outer face of the wheel.

On the outer face of this type of wheel in a radial direction the strains or stresses are compressive. They are a maximum at the bore and, in traversing the section of the wheel from the bore toward the tread, they decrease up to a point where the radius equals the mean radius of the core, beyond which an increase occurs up to a point at or near the intersection of the inner and outer plates, after which a decrease again occurs.

On the inner face in a radial direction the strains or stresses are likewise compressive and a maximum at the bore. If a similar traverse be made across the section, these strains or stresses decrease up to a point where the radius equals the mean radius of the core; they are then of approximately uniform intensity up to a point whose radius is equal to the outer radius of the core; beyond this point they again decrease.

(4) In pressing the 740-lb. Arch Plate wheels on the axle, the maximum tensile strain or stress was a tangential strain or stress on the inner face and at the bore. In general the tensile stresses on either face of the wheel were a maximum at the bore and decreased toward the tread.

With respect to the strains or stresses in a radial direction on the outer face, no measurements were taken in close proximity to the bore, and accordingly nothing definite can be stated concerning their intensity in this region. However, the strain in a radial direction taken nearest to the bore was relatively small and was tension in one wheel and compression in the other. This fact may be due to bending action in conjunction with the thrust of mounting. As the tread was approached, the strains and hence the stresses became compressive and of increasing intensity, reaching a maximum at a point whose radius was equal to the mean radius of the core, beyond which they again decreased.

On the inner face over the region investigated, the strains or stresses in the radial direction were compressive, reaching the maximum nearest the bore and decreasing to a minimum at a point whose radius was equal to the mean radius of the core, after which they again increased.

(5) In the regions of the chaplets and core holes, pressing the wheel on the axle causes tensile strains in a tangential direction which are of lesser intensity than, but approach in magnitude to, those at the bore.

(6) The stresses and strains in the brackets which are produced in a radial direction by mounting are relatively insignificant.

(7) The strains caused by mounting the wheels on the axles, when mounting alone is considered, are greatest in the hub near the axles. These strains, although apparently high in the case of the greatest values recorded, are steady and not repeated as in the case with the majority of strains produced in service. Moreover, these highest strains extend through a comparatively thin layer of metal near the axle, and this strained layer is backed by other layers of less strained metal.

(8) In general the static load is transmitted from hub to rail, mainly through the outer plate, while the smaller portion of the load goes through the inner plate. This effect is more pronounced in the 740-lb. Arch Plate than in the 725-lb. M. C. B. type of wheel. This division of the load seems desirable in that the inner plate may be considered as affording reserve capacity for the purpose of absorbing the effect of side thrust on the flange when rounding curves.

(9) Pressing the wheel on the axle is much more effective in producing stress or strain within the wheel than the normal static load, and it therefore follows that the addition of the normal static load does not greatly add to or otherwise modify the more important of the existent strains caused by mounting.

(10) Abnormally heavy loads, in the absence of impact side thrust, etc., may be sustained by wheels without increasing the normal strains, already existent, to such an extent as to seriously stress the wheel.

(11) The maximum strains reported, caused by the combined effects of mounting and static load, appear large when expressed in terms of the stress that would exist if the material were subjected to simple tension or simple compression. As previously stated, these strains are produced in the main by the mounting load, and the more important strains are those of tension, which in general are greatest near the bore of the wheel. The character of the strains and the backing of the material most strained in less strained material, probably makes possible without injury to the material greater strains or deformation than would be allowable in the case of material not so supported and subjected to simple tensile stress. As previously stated the problem is one of compound stress, and the method used is computing the stresses reported is thought to give the highest value for that that could be expected under such conditions. Any error in estimating, from the stress value determined in this way where elastic failure might take place, would be upon the side of safety. In this connection it should also be remembered that the stresses reported are those produced by two forms of wheel loading only, and that the strains and stresses resulting from these two forms of loading (mounting and static) may be materially modified by additional stress-producing factors to which wheels are subjected in service.

American Couplers in the British Colonies

It is gratifying to observe that mechanical appliances of American invention and manufacture are being rapidly adopted in railroad transportation in India and other British colonies. Among others the McConway and Torley recommended by E. E. Lucy, chief mechanical engineer of the New South Government railways, and which is being installed on the cars of the company, and is also being applied to the cars of the Bombay, Baroda and Central India railway, and have been in service for some time on the Bombay Rack Bay section. As is well known the McConway and Torley company was the original manufacturers of the M. C. B. type of coupler and has manufactured and put into service many different designs of such couplers, following the evolution in railway equipment and requirements, embodying in the improved designs of coupler from time to time as they have seen desirable, new features and functions to keep them strictly up to date with service requirements and with the requirements of the Safety Appliance laws.

Mechanical Firing of Locomotives*

Mechanical firing on locomotives, like hand-firing, is subject to careless and extravagant practices. Correct supervision is as necessary here as in hand-firing. The successful and economical performance of a stoker depends, first, upon the proper condition of its parts, and, second, on proper operation, granting, of course, that the locomotive may be in proper condition. The things that constitute proper firebox conditions on hand-fired locomotives similarly apply to stoker-fired locomotives. It should be understood that a mechanical stoker is in no sense automatic. For economy in firing locomotives which are equipped with mechanical stokers, the committee recommends the following practices:

Before a fire is built in a locomotive, the distributing features of the stoker should be inspected and known to be in proper condition. The fire should be free from clinkers and banks when the locomotive is delivered to the engine crew. Before leaving the outgoing track the engine crew should see that the fire is clean and in good condition, the stoker parts are properly oiled, and that the stoker is working properly. The stoker should not be used in building up the fire, either by roundhouse force or engine crew. Build up the fire by using the hand shovel. Commence the operation of the stoker as soon after starting the train as conditions require. The fire should be maintained with the hand shovel when standing, drifting, or doing short switching. Use the shovel to hand fire spots in the firebed which may be "thin" or undersupplied by stoker. In that way, maintain a uniform distribution of coal over the entire grate surface. Every square foot of burning surface requires coal.

On the stoker-fired locomotives the throttle, reverse lever and injector should be operated with the same regard for economy as with hand-fired locomotives. Because of the "thinness" of the fire on stoker-fired locomotives greater care should be exercised when shaking the grates than is required on hand-fired locomotives. If practical, grates should be shaken only when the locomotive is not using steam. Attention should be given coal as it feeds into the conveyor removing any foreign material which would tend to clog or interfere with the operation of the stoker. Fuel should not be fed faster than it is consumed. Adjust the speed of the stoker to the requirements, and carry a higher level fire, reasonably thin. Frequently observe the condition of the fire to know that it is properly maintained. Best results are obtained by continuous stoker operation, care being taken not to crowd the fire. Avoid popping, stopping the stoker if necessary. See that the locomotive, the fire and the firing apparatus are properly adjusted to produce the minimum amount of smoke. When approaching grades the fire should be properly prepared, to meet the heavier demands. Do not wait until the train is on the grade before speeding up the stoker. Before beginning a descending grade or before taking on coal the conveyor slides should be closed. Overloading of tenders should be avoided. In case the stoker stops, due to clogging by foreign matter, the stoker throttle should be closed before any attempt is made to remove the obstruction. The fire should be maintained by hand until such time as opportunity may present to remove the obstruction. When approaching terminal, have all slide plates closed. This should be done at a sufficient distance so that without waste all coal may be worked out of conveyors. The engine crew should close all valves of stoker apparatus before leaving the locomotive. On arrival at terminal the engineer should report on regular work report, for correction, improper distribution or other stoker defects which may exist. A thorough inspection and test should be made of the stoker before locomotive is put in the roundhouse. Defects should be reported in customary manner.

To supervising officers who give attention to fuel, Firing Practice will always consist of two distinct things: first, the methods themselves for securing practical economy, and, second, the maintenance of those methods in practice. Proper methods have time and again been outlined in papers presented at these annual conventions. Those methods have been viewed from various angles; they and their applications have been detailed in extended discussions; they have been subjected to intimate analysis; we have seen pointed out the scientific basis underlying them, and we have seen demonstrated the reasons why those recommended methods of firing practice would deliver the most heat from the fuel burned. Proper methods are at hand. To develop in every-day routine the habitual use of those proper methods is the unending work of supervising officers. With the methods themselves as a guide we turn to persuade the individual. The problem now becomes one of warmer interest. It deals with human beings. From inflexible principles we turn to flexible persons. The supervisor's work is to inform, impress and improve. Intelligent and sympathetic application insures success.

Success brings attractive rewards: to the railroad, in reduced fuel expense; to the individual, in the satisfaction of work well done. The magnitude of the possible economies may be seen in two typical illustrations. Habitual clinkers and "banks" in a locomotive fire at terminals may usually indicate improper firing, or improper engine handling (if no mechanical defects exist.) Extreme cases, these, perhaps, but they seem to occur everywhere. A supervising officer may select one of these extreme cases and proceed to improve the performance. A fair improvement, if permanently effected, could easily save five per cent in coal consumption. Now, since a freight crew burns approximately $15,000 to $20,000 worth of coal a year, the five per cent improvement would amount to $750, or more per case improved. If a supervisor did nothing else but improve five habitual "bankers," this alone would save $3,750, a sum which would go some distance toward paying his salary. But, who would work on only five cases a year? This illustration is roughly selected, but shows that lack of supervision means waste while well directed supervision means saving.

Take a railroad with some 1,200 locomotives. If each locomotive pops off one time each day it means a waste of $42.80 a day (based on the prices the railroads pay for coal in the Northwest). But the cheerful thing about it is that a saving of $42.80 a day is accomplished when supervision reduces the number of poppings one time a day for each locomotive. This would figure out a saving of $15,000 a year. On this very question of reducing the popping of locomotives we understand that on certain railroads some admirable performances have been secured during the past year, and we may expect to hear of them in the discussions today, together with an account of the manner in which the interests of the engine crews were stimulated.

Again, consider the modern locomotive, with large grate area and good steaming qualities which will allow the maintaining of full steam pressure even in spite of holes in fire, which tend to increase cinder loss. Under these conditions, there is besides an approximate 25 per cent loss in the possible normal superheat temperature. This practice uncontrolled could waste hundreds of thousands of dollars a year on the railroads of the country. Properly directed supervision can save it. But it is not only the fireman who sometimes relaxes. Let us consider the engineer. Since the stoker is inanimate, an engineer may become indifferent and perhaps the fireman too, though he may smile at his escape from a firing abuse that is now borne by a machine instead of by his back although the expense of the abuse is borne by the railroad. With a locomotive equipped with a mechanical stoker the engineer may not now be able to overburden the fireman, he is still able to "punish" the engine and the coal pile.

*Abstract of a paper read before the members of the International Railway Fuel Association meeting, Chicago, Ill., May 22-25, 1922.

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The Railroad Labor Board and the Railroad Strike

It was a foregone conclusion among those at all familiar with arbitration proceedings that the Labor Board was not properly qualified to act as an untrammeled judicial body. Three men representing the Railway Executives and three representing the railway employes might as well have been left out of the Board. At first thought it may have been deemed well to have some men eminently experienced in railroad matters to sit on the Board. The value of their fund of information would seem to justify their presence, but the Board has suffered from too much information. They would have better filled the place of advocates presenting the side of the case to which they were by nomination and, apparently, by instinct, attached. It would be idle to analyze their decisions. They are clear to everybody. The press of the whole country is flooded with views equally biased for or against the decisions.

It seems a question as to how far apart capital and labor can drift from each other, forgetful of the fact that they are indissolubly united. On the one hand we see ... ard of living at something approaching a cost of several times more than any one ever dreamed of a few years ago, and on the other hand we hear of twenty-three cents an hour as sufficient in a day of eight hours, and all this wide disparity as if we were not common creatures susceptible of cold and heat with common wants and common needs. Surely there is some common ground upon which we can all stand. It seems to us that what we need is more of that quality known as common sense. We have previously referred to the system in vogue in many of the trades in Great Britain, where by mutual agreement the rate of wages is based on the cost of living, variations in the amount of remuneration for labor fluctuating in accordance with the fluctuations in the market price of the necessities of life. There is much in old world methods and observances for which we have little or no regard, but in this solution of the wage problem we feel that they are ahead of us, and probably what we are mostly in need of at present are statesmen gifted with vision. It has been said that these come in great emergencies. We certainly have need of them. Surely there is room for them.

In spite of all this our sympathies go out to the Labor Board. The repetitions they have to listen to would make a jazz band sound pleasant. The labored essays, the impassioned harangues, the exaggerated statements, the shamefaced allusions, the barefaced prevarications, the expected climaxes that are long delayed, the truth that "men may come and men may go, but I go on forever" seems to be the ruling passion of the clamorous claimants. If they get nothing else they get, or rather they take, good practice in the art of declamation.

Apparently, however, the Labor Board has learned to let all this vocal thunder go in at one ear and out at the other. At least six of the nine members are men, as we have already stated, who had their minds made up in advance, and might as well, in these summer days, go on a vacation, with their salaries running on, and come back rejuvenated with the soothing influences of a close communion with nature in her beauty and solitude, and having learned how sweet a thing golden silence is, unexpected flashes of wisdom might come to them that might point the way out of this weary wilderness.

Even the President is taking a hand in the Babel of voices. A garrulous galoot of a railroad flagman assured him of political partisanship in dealing with the railroad problem. To the flagman's pop-gun of a telegram, the President replied in a thunderous salvo of sonorous sentimental artillery that would have done credit to a national Fourth of July celebration in a Peace Jubilee of the People Triumphant.

Perhaps the most remarkable feature of the verbal battle with all its threatenings of coming calamity, is the undisturbed spirit of the American people. Perhaps it is the fact that transportation is still going on, the home fires and furnace fires are not yet quenched. Other threatened calamities have failed to appall them, and somehow it seems as if Hope that springs eternal in the human breast abides with them in the darkest hours, and they know that however robed in mystery the night may be, the morning cometh.

Having referred to the President there can be no harm in referring to the opinions of the Governor of New York, as long as his views are of an impartial character. He claims that labor and capital should arrange their relations by agreement or contract, leaving nothing for government to do. He holds that capital should take the lead in the establishment of industrial relations on the basis of mutual interest between the parties. The employer who lives too much in the past is as obstructive and wrong as the worker who lives too far in the future. Progress is necessary, since conditions are changing so fast. The choice is between capital leading reform, or the workers relying on revolution. But revolution is treachery to free government, and it is at this point that industrial disputes become a matter of government intervention. As the President stated, there can be no government unless its mandates are accepted by the citizenship. But many eminent authorities claim that the rejection of the mandates of government is characteristic of the present strikes above all others in our history.

There is a common agreement among the people that the selfishness of both capital and labor are injurious to both. Capital should be, and can afford to be, broad minded. Labor should beware of the growth of a radical element that is said to create unrest. Working men who do not work, however intellectually superior to their fellows they may be, should not allow their organizing capabilities to run into the dangerous realm of setting up a government within a government. This is not so particularly marked in the railroad strikes as it is in the coal strike. The railroad men are clever debaters. The miners will debate nothing. They simply demand, but as we have stated before there are too many employed in coal mining and when the coal pile is piled too high, they must needs take a rest, and the long-suffering public has to pay for the extended holidays of the miners. The only kindly thought that the miners seem to have or had is, that they did not start their holidays in the beginning of winter. Perhaps, like the rest of us, they preferred to take their holiday in summer. At any rate the winter of our discontent is upon us, and something will have to be done and that swiftly.

The attitude taken by all interested in the struggle during July need not be taken as a likelihood of an increase in antagonism in the future. Although the Railway Executives refused to adopt all of the suggestions submitted by the President on the first of August, some real progress toward a settlement is made, and it should be borne in mind that on whatever grounds the settlement may be made, the Labor Board can be appealed to at any time and hearings and even rehearings will become to the members of the board, if they continue in office, a matter of easiness.

Railway Electrification

It is interesting to observe the repeated efforts that are made by the advocates of railway electrification on economic grounds, and those who maintain that present methods under steam traction are equally efficient. An engineering contemporary recently attempted to define the fuel consumption basis, this being one of the principal grounds for the alleged "extravagant" claims made on behalf of electrification. The application is to proposals for super-power electrification schemes for American railways, and to an estimate that by electric operation no less than 57.6 per cent could be saved per unit of work done. It is pointed out, however, that while an equivalent coal rate of 3.18 pounds per kilowatt hour is claimed as the output of the electric locomotive, the coal consumption of the steam locomotive is assumed to be 7.5 pounds per kilowatt hour, a figure which is much too high, even for relatively out-of-date locomotives operating under unfavorable conditions.

It is suggested that if the method used in computing equivalent coal consumption under electric operation is applied to the steam locomotive, the result is quite different. Our contemporary suggests that 4.14 pounds per kilowatt hour, after allowing for standby losses, firing up, etc., would be a more equitable figure, though this would reduce the estimated saving due to electrification to 23 per cent. The whole question is admittedly a complicated one, for in addition to uncertain bases of comparison, the steam locomotive has to carry out a great deal of miscellaneous work, some of which, at least, is hardly likely to be given to the electric locomotive. It would appear, in fact, that while electrification has much to commend it where traffic is suited to its characteristics, it will require the traffic to be adapted to it to a degree which does not apply in the case of the steam locomotive, though it is the miscellaneous and incidental duties and the share taken in work for which electric traction would hardly be suggested that lower its standard of average performance.

This part of the question depends on whether the traffic as a whole or on particular sections can be adapted and reorganized so as to enable the full value of electrification to be realized, rather than direct comparison between the unit performance of individual electric

locomotives. Naturally, electrical engineers emphasize the direct fuel economies which they can realize; but the practical efficiency of the modern steam locomotive must also be given due weight, and it will not help either school of thought to advance extravagant claims or to depreciate those of the opposite party. So much for fuel economies, but what is even more important in many cases is the remarkable saving which results from the lower cost of maintenance and repairs, about a quarter to one-third of steam costs, and also the very much larger number of hours per day and per year during which the electric locomotive can be in service. In certain cases, those economies far outweigh the fuel economies.

A Discovery in Cracked Steel Sheets

This may not be exactly a shop kink, but it bears a close resemblance to it in that it is a caution as to something that should not be done.

There was a complaint that a certain well-known brand of firebox steel would not bear the work of flanging, but would invariably crack. The cracked sheets were replaced, and the new ones were no better. Things were so bad that there was every probability that the railroad, where these things were occurring, would discontinue the use of that brand of steel. An expert was sent on to the ground to investigate and show how the flanging should be done. The fire was all that could be desired. It was made of old planking taken from a torn-up machine shop floor, and the fuel was dry and free burning, but the expert also cracked the sheets.

About two thousand miles away a master mechanic accidentally found that a coupon cut from a steel plate cracked when it was heated for bending in a brazing furnace. He tried sprinkling some brass chips on a piece of steel that he heated in an ordinary forge and then bent. The steel cracked, when it was bent. He happened to tell the incident to a representative of the steel maker, who knew of the cracked sheets.

Immediately the inference was drawn that the old machine shop flooring was impregnated with brass filings and chips, and a test was made. A coupon was heated in the fire made of the flooring, and, when it was bent, it cracked. Another coupon, cut from the same sheet, was heated in another fire whose fuel was known to be free from brass, and it did not crack, when bent. It seemed a complete demonstration and the use of the flooring in the flanging furnace was discontinued and with that discontinuance, the cracking of the sheets stopped. On the basis of this the advice is given that the smith should make sure that there is no wandering brass linger-ing about the flanging fire.

Rail Motor Bus on Northern Pacific

A rail motor car will be placed in operation this month on the Fargo and Southwestern branch of the Northern Pacific Railway, to run between Fargo and Lisbon, North Dakota, according to an announcement made by A. B. Smith, passenger traffic manager.

"The Northern Pacific has been experimenting for some time with a motor car on its subsidiary line, the Gilmore and Pittsburgh and more recently on the S. P. & S.," said Mr. Smith, "but this will be the first car of this sort to run on Northern Pacific rails. If its performance is satisfactory it is not unlikely that this kind of service will be extended to other branch lines."

The car, which was built by the International Motor Truck Company, embodies the latest features in design and construction, and provides all the comforts of the modern passenger coach. It has a seating capacity of 40 passengers, is equipped with air brakes and can develop a speed of 45 miles an hour. It will be used between Fargo and Lisbon to supplement the steam train schedule, running at hours to permit its patrons in towns along the line to make the trip to Fargo and return at convenient hours and no doubt will add considerably to the amount of local passenger traffic.

Committee on Automatic Train Control Announces Its Plans

The American Railway Association has issued a circular directing the attention of member roads to a communication sent on July 1 to the 49 railroads named in the order of the Interstate Commerce Commission relative to the installation of automatic train control. The communication follows:

"In regard to I. C. C. Order No. 13413, in the matter of automatic train control devices decided June 13, 1922:

"It appears unnecessary at this time for any further action to be taken by the carriers' committee (appointed at the time the tentative order was issued) or by the American Railway Association in connection with this order. The Joint Committee on Automatic Train Control will continue as heretofore to co-operate with the Commission and the member roads under the present instructions and along the lines which have been followed. The Joint Committee will make regular and, if necessary, special reports to the Association in order to inform the carriers of the progress of the committee's work.

"It follows that the action to be taken in connection with Order No. 13413 is a matter for the determination of the individual railroads named in the order.

"By direction of the President."

(Signed) J. E. FAIRBANKS,

Snap Shots — By the Wanderer

Human nature is a strange conglomeration, and no doubt "What fools these mortals be" echoes to and fro through the brain of most of us with great persistency. "England is inhabited by forty million people, mostly fools," said Carlyle. "All people are more or less crazy, except me and thee, Hester, and sometimes I think thou art not quite right," said Ebenezer. And if it is the wise man who takes advantage of these foibles, then there must be some very wise men in railroad circles.

Most people like to go. They bear a close resemblance to the negro whom I saw and heard at a Southern ticket office.

"Give me a ticket, boss."

"Where to?"

"Oh, I doan care, only jus' so far as dat money'l take me."

Or as a lady once said to me: "We've just come back from a perfectly delightful automobile trip. We went twelve hundred miles in a week."

"Where did you go?"

"Oh, almost everywhere, and some of the hotels were very good, indeed."

"That was nice, but where did you go?"

"Really, I didn't notice."

It is a beautiful trip that, through the Long Channel to the north of Georgian Bay. The steamer winds in and out among the mass of islands that are like those of the upper St. Lawrence, except that they are, as yet, unspoiled by the cottages (?) of civilization. The air is a tonic that makes one forget the stimulus that prohibition prohibits. The sky and water are crystal clear, and the tourists flock through there by the hundreds. "Every prospect pleases and only man is fool." Yet of all the hundreds that take the trip about nine out of ten spend the major portion of their time in the cabin playing cards.

And how does this apply? Well, let us be specific. The passenger agents of the Erie and Lackawanna advertise their lines as great scenic routes and the Pennsylvania sets forth the beauties of the Juniata and the glories of the Horse Shoe Curve, and the public rises to the bait and goes that way. But once in the cars the interest in scenery vanishes and is wholly centered on a short story magazine, the first call for dinner in the dining car or a box of candy, and the railroad men know it.

So except for an observation platform at the rear they make no provision to facilitate the seeing of sights. And the observation platform is more of an attractive scenic effect itself than a pleasant place to occupy. Dust and cinders flock thither with even greater persistency than the tourist, and the last state of those men and women is worse than their first.

The railroad men also know that attractive cars and easy seats are traffic scenic beauties of the route, and got the public coming, they proceed to provide ease and beauty in the interior of the cars. So they have cut out the low, narrow window and put in its place one a little broader and somewhat higher. This cuts down the space between the top of the window and the spring of the roof, and the car has a light, graceful appearance that is most attractive. But the ordinary man likes an open window in summer when the scenic advertisement catches him. So he raises the window and finds that it is so high, and the lift, left available by the car construction, so low that when the window is wide open, the bottom rail comes right on his eye-line and a comfortable view of the scenery is impossible, while the space above is too narrow for a decent rack, and he stores his satchel somewhere in the seat space and twists his legs and feet about it for the whole journey. But the scenic and palatial car advertisements have hooked the sucker and the end and aim of the business propaganda has been accomplished.

But the other tourists travel in parlor cars if they journey by day. The luxury of these cars is all that the car designer can supply. There are great wide windows, with broad posts to carry the roofs and screens to prevent the intrusion of dust or cinder. There are hooks and parcel racks for hats and reticules and almost room enough to put a satchel in between the seat and the wall. The interior, as one enters an empty car, is certainly attractive and what more can be asked. But the fly in the ointment from a scenic viewpoint brings a little disappointment. Of course a real open window to let in the fresh and vulgar air is not a matter to be thought of in a parlor car. And the great broad windows with alternating narrow ones, do not lend themselves readily to uniform and desired seat spacing. So the seats and windows are like two lovers out of step, and the average scenic lover in the seat will find his natural view to consist mostly of a window post that does not quite obstruct his whole view, but is, nevertheless, a very efficient substitute for total eclipsilization.

Or he may be lucky (?) and draw a seat at the very center of a broad stretch of plate glass. But the tiny drop door ventilators in the clere story are not sufficient to furnish air for the twenty-four exclusives and so the broad stretch of plate glass is raised a few inches and the opening beneath is closed by a screen Rapture! Again the window rail comes exactly in the eye-line, and the screen—well of that more anon.

Then next in the order of luck (?) is the man who draws a seat set squarely beside an alternating narrow window. This is enough above the eye-line so that by stooping down and taking sight he can see a distant hilltop, and this extra large opening is protected by a screen.

It may be that when these screens are new, the great outside may be seen through them. I don't really suppose that they are made dirty, but rather that they acquire dirtiness, and do it quickly; for certainly, for things that are supposedly to be looked through, they are the champion obstructors to vision. So the tourist who pays his extra fare, to say nothing of the surcharge, for the privilege of a seat's exclusive use, finds himself almost as well cut off from a view of the outside world as though immured in a dungeon cell. He is not only cut off from *some* of dust and cinders that stray into the less exclusive cars, but also from the light and air that is their share. And the occupants busy themselves with their stories of the man who wins the best of girls by saving her from herself or some villain's snare, and swing along hot and perspiring and quite oblivious to the passing scenery.

And now for one last case. A certain western road has bought some really beautiful and luxurious chair cars for the man who has a ticket without a surcharge. The windows are broad and attractive and between each two is a twenty-four inch window post. The seats are amply spaced with plenty of room for suitcases away from the feet of those who occupy them. And the window and seat spacing so accurately harmonize that each alternate seat comes directly flush with the center of the window post. And he who sits therein has a fine view of polished mahogany for his whole journey, with a mere diagonal glimpse of the outside through the next window. Was there ever such a farce in car design?

Oh, my canny railroad friends, how well you know "what fools these mortals be." They really care not one weak whiff for all the scenic beauties of your route, but simply like to say they've been there, with their great unseeing eyes. They sweat and swelter in your parlor car because—well, the good Lord may know but he has not revealed his secret unto me. They rise to the hook of your advertisements and then sink into obliviousness as they slip through the hole or door in your receptacle. But in the last analysis would it not be well to just remember this? There are some of us who like to look and see. To whom the great wide world is as an open book. Who joy in all that Nature holds, and who resent the eye-line window rail, the dirty screen, the miscroscopic parcel rack, the close and choking air of pseudo exclusiveness and who would sing the praises of your scenic route into the very skies if you would but arrange to let us

Improved Shop Devices for Railroad Work

Dies for Making Socket Grate Levers—Devices for Forging Train Chain Hooks—Knuckle Tool Holder for Slotter

Dies for Making Socket Grate Levers

Socket levers for shaking grates have always been troublesome to make because of the necessity of making a fairly close fit on the stem and of cutting cost to the minimum on a comparatively rough piece of work.

The dies and forms shown herewith illustrate a device for doing this work on a bolt header, and doing it so expeditiously that the cost of making the levers has

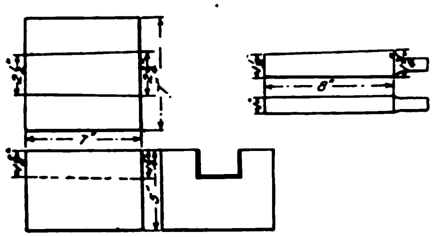


FIG. 1 FIG. 2

been cut to one third of that of doing the work by hand.

The method of using the device is to first cut the iron of which the socket is to be made to the proper length and bend it in the bending form shown in Fig. 1. This is done under a steam hammer by using the mandrel shown in Fig. 2. The bending folds the metal over the top and gives approximately the proper outlines to the outside and inside of the socket.

The socket thus roughed out is put in the die Fig. 3 on the bolt header. This die

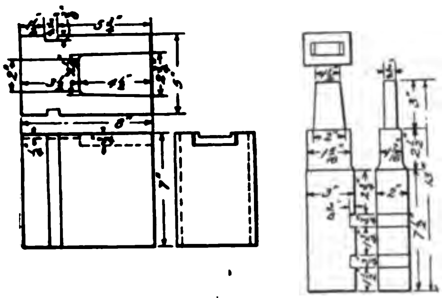


FIG. 3 FIG. 4

is made in two halves one right and one left. The plunger Fig. 4 in the working head is then driven into the socket forcing it out to fill the die and forming the inside to the exact shape required.

The handle is then inserted in the socket thus formed and the two brought to a welding heat when they are finished in the die with a single blow of the hammer.

Device for Forging Train Chain Hooks

The variety of appliances that have been devised for the use of compressed air in railroad shops is without number and here is one more to be added to the list.

In this case it is the adaptation of an air cylinder to the forging of train chain

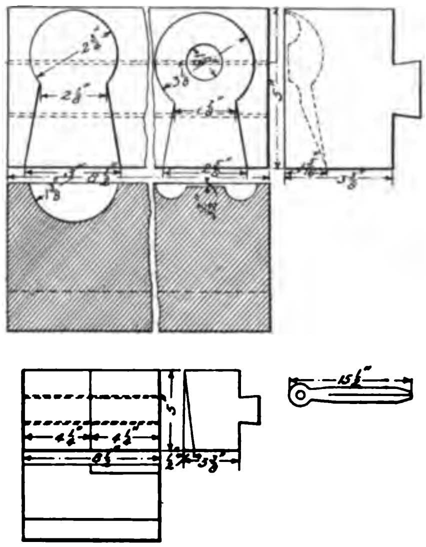


FIG. 5
DIES FOR SHAPING TRAIN CHAIN HOOKS

hooks. It is a horizontal machine with a wooden frame, at one end of which there is an air cylinder with an inside diameter of 10 in. and a total length of 34 in. From this about 4 in. is to be taken for the thickness of the piston, leaving a stroke of about 30 in.

The air supply is brought to the cylinder through the pipe *A* and then led off to the ends by means of the tee and the pipes as shown. In each of these pipes there is a three-way cock *B* by which the air can be admitted to the end of the cyl-

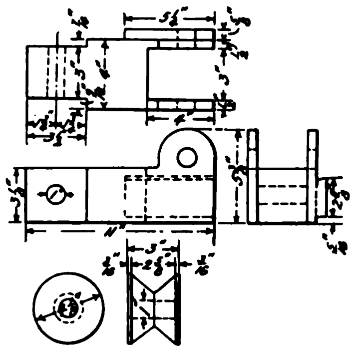


FIG. 6F

inder or exhausted through the pipes *C*.

The piston rod is fastened to a crosshead *D* which is extended by the U-

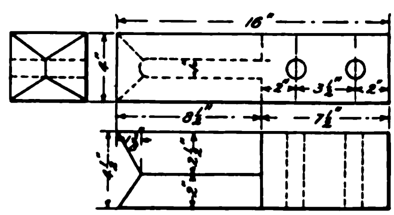
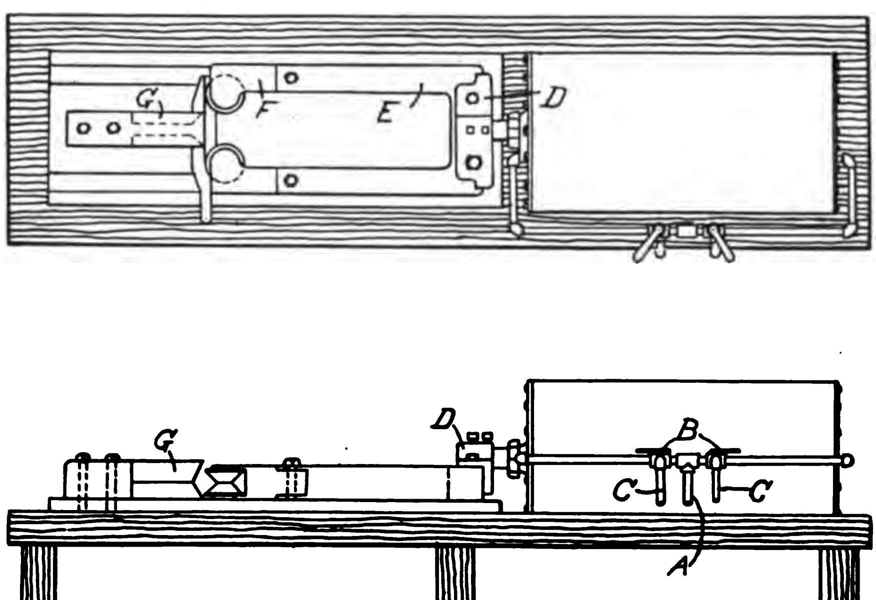


FIG. 7G

shaped piece *E*, to each leg of which the roller holder *F* is attached.

Before being bent the hook is formed under the steam hammer by the use of the



DEVICE FOR FORGING TRAIN CHAIN HOOKS

dies shown in Fig. 5. The hooks are made from 2 in. square iron cut to lengths of 12¼ in. This square section is not changed, by the shaping under the steam hammer, the eye and point being the only parts formed leaving the hook in the shape shown in the small piece 15½ in. long shown at the right of Fig. 5. The point is formed by the special die at the bottom of **Fig. 5.**

The anvil for the forging machine is the part marked *G* in the assembled drawing and also shown in detail in Fig. 7 *G*.

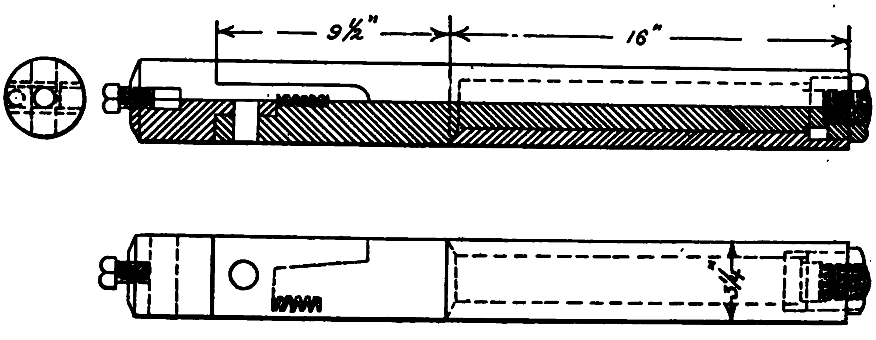
The forming of the hook is a very simple process after it has had the eye forged on. The piston in the air cylinder is drawn back to the right, and the straight forged bar of Fig. 5 is laid across the anvil *G*. Air is then admitted to the right hand end of the cylinder and the rollers coming in contact with the ends of the hook carry them to the left and bend the piece to the proper shape about the anvil block.

Knuckle Tool Holder for Slotter

The tool holder shown herewith is arranged so that the tool can be turned to any angle that it may be desired for cutting purposes after it has been placed in the slotter. This can be done without loosening the clamps or deranging the setting of the tool in any way.

The main stem of the holder is shown in cross section and is enclosed in a sleeve which is held in the bar of the slotter in the same manner as the ordinary tool. The main stem fits closely in this sleeve with an easy bearing fit so that it can be turned. It is held in place by the nut and washers shown at the top. The stem also has a tapered bearing against the bottom of the sleeve so that when it is drawn up tight with the nut it cannot move.

The outside of the sleeve has a diameter of 3¼ in. and that of the lower portion of the stem is the same. The inside diameter of the sleeve is 1 15/16 in.



DETAILS OF KNUCKLE TOOL HOLDER FOR SLOTTER

The knuckle or tool holder itself is pivoted as shown near the bottom of the main stem and has an L-shaped bearing against it. This lower part carries the slot for the cutting tool. In the tool illustrated, this slot measures ⅞ in. wide by 1 1/16 in. deep. The tool is set so that it projects from the side elevation at the right of the engraving towards the sectioned part.

The holder is pivoted on a 1 in. pin and has a bearing against the side of the stem 3¾ in. high when at work, while the horizontal bearing against which the spring presses is drawn away from its seat.

As the slotter bar rises from its work the drag of the tool turns the knuckle until the spring is compressed enough to permit the horizontal portion to seat and thus relieve the pressure against the side of the tool.

As soon as the tool is clear of the work, the spring forces the knuckle into the working position again and it is ready to start the cut without any jar.

The cutting tool is held in the knuckle by the set screw at the bottom.

A Locomotive That Lived

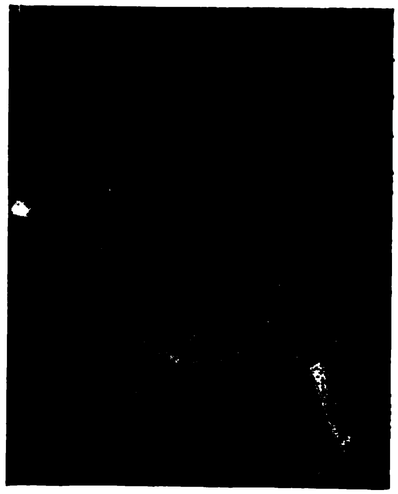
Like Kipling's Dimbula, "The Ship That Found Herself," the Louisville and Nashville locomotive No. 230 was almost human. It had a personality known to engineers and firemen as surely as enemies know each other's whims and bad points. For No. 230 was a bad one. It killed passengers in an extraordinary number of accidents, smashed things right and left and seemed always to be slyly on guard against leading the ordinary useful life of a passenger locomotive. Even its end was characteristic. It scorned old age in the railroad yard or in the machine shop and chose suicide, which it effected neatly by blowing off a cylinder head and stabbing itself with its driving beam.

This incorrigible was called "The Killer." Probably the crews assigned to it were convinced of its malignant power to live up to its name and its insane determination to "get" each one of them sooner or later. Sailors give certain ships like the old "Texas" that fought at Santiago a bad name, and the ships acquire individuality with their reputations.

Psychologically what the engineers of "The Killer" thought of their engine reacted on them as something actually thought by that inhuman organism of steel. The bell itself may have sounded defiant to them or the whistle hoarse with emotion. Machines with this kind of soul are a common problem. Even the disinterested cannot consider them without a hesitation of doubt; there seems to be no limit to the power of mechanical things, compared to the too definite limits of man's control over himself.

Gier Steel Loading Blocks

A number of car manufacturers have adopted a new method of fastening down automobiles for shipment by rail from factory to dealer. By using Gier Steel Loading Blocks, instead of the wooden equipment formerly employed for this



GIER LOADING BLOCK IN SERVICE ON AUTOMOBILE

service these manufacturers have reduced loading and unloading time and costs considerably, and at the same time have made their cars even more secure from possible damage while in transit. Gier Blocks are returned by the distributor or dealer and used over and over again indefinitely.

The Gier Blocks are 10½ inches high and stamped from No. 10 gauge, blue annealed, pickled, oiled and limed stock. They weigh 10 pounds each and can be nested and returned to the factory by the car dealer in bundles of four or more by fourth class rating.

Tabulated figures show that the steel blocks earn their cost in five trips.

Domestic Exports of Steam Locomotives, from the United States, by Countries, During May, 1922

Countries	Steam locomotives Number	Dollars
Canada-Quebec & Ontario...	1	2,803
Honduras	2	24,922
Mexico	5	39,723
Brazil	21	206,107
New Zealand	1	4,612
Total	30	278,167

Automatic Train Control in Great Britain

The *Railway Engineer*, of London, England, states that in October, 1920, a departmental committee was appointed to consider the question, and it was not only within recent years that the possibilities of train control have even been mentioned by the inspecting officers. Cab signals were, for many years, a subject continually brought by inventors to the notice of railway companies and the Board of Trade, but they have never met with encouragement at the hands of the inspecting officers who, however, frequently asked for mechanical fog-signalling. Not until the Slough disaster of June, 1900, was the subject mentioned, and then it was in relation to automatic train control. Sir Arthur Yorke reported on that accident, and if his views were shared by his colleagues it is no wonder that automatic control was only once afterwards mentioned in an accident report until the Ais-Gill collision of September 2, 1913. The exception was Sir Arthur Yorke's report on the Shrewsbury derailment of October 15, 1907, and there cab-signals and control were mentioned in very non-committal terms. But in neither the Grantham derailment of September 19, 1906, nor that at Goswick on August 28, 1907, due to a similar course, was any such remedy suggested as a means to avoid the evil results of drivers passing signals at "danger." When we come to Colonel Pringle's report on the Ais-Gill collision we find it said that "the mechanism (of cab-signalling) is very ingenious and highly complicated," and that "it cannot be said that the method has as yet been proved to be efficient to the extent of meeting adequately the very complicated requirements of traffic on English railways." The train stop on the underground railways was then mentioned, and it was remarked that "the arrangement is very suitable for an omnibus service at moderate speeds, especially where all trains are fitted with the continuous brake, but there are difficulties when other conditions prevail, as on steam-worked railways." It was, however, a device which railway companies should unite in experimenting with more fully.

Train control then began to come into its own so far as the Board of Trade was concerned. There were other accidents that year (1913) due to drivers passing signals at "danger," and this fact and others led to a memorandum dated November, 1913, and initialled by the three then inspecting officers in which it was said: "As, however, these accidents continue it is most desirable that some further mechanism should be provided by means of which a driver will obtain an unmistakable indication that he is allowing his engine to pass a signal at 'danger,' and which will automatically control his engine when he does so." The subject was not until the Warminster collision of September 2, 1916, and then only casually, because Colonel Pringle said, "the subject, though one of great importance, has been overshadowed and necessarily put somewhat in the background . . . by the conduct of the war." On November 20 of the same year a Midland express ran past some signals at Oakley, near Bedford, which led to Colonel Pringle observing that it was a further illustration of the necessity for some form of automatic train control. The climax came with the serious collisions, both on December 19, 1916, at Wigan and Kirtlebridge. Colonel Druitt inquired into the former and Colonel Pringle into the latter. Both made the same recommendation but the actual words of the latter officer were, "I can suggest no other safeguard in analogous circumstances than the adoption of a system of automatic control of trains whereby the continuous brake is applied when an engineman passes a fixed signal at 'danger.' This case has features which strengthen my opinion that any such system should include provision for a full brake application at an actual stop signal and preclude the possibility of a driver releasing the brake until after the train has come to a standstill." Since then other reports in particular that on the Selby collision of October, 30, 1919, have repeated this recommendation, but it was probably the Lostock Junction collision of July 17, 1920, and one on the same day at Eglinton Street, Glasgow, that brought the matter to a head and led to the appointment of the present committee.

On the Committee's report itself we need not say anything, as it shows itself to be a sound, practical and, withal, a reasonable document. We would, however, in the little space remaining to us, point out that the railway companies, in this matter, have moved faster than the inspecting officers. For 16 years the Great Western has had a system which is now installed on 200 track-miles with about 100 engines fitted. The North Eastern has 75 per cent of its engines fitted with a system which was introduced 15 years ago, and is installed on the main and relief lines between York and Newcastle. The Midland commenced to test such apparatus 15 years ago, when one of the Great Western type was put down, which is still in useful service, and at the outbreak of war that company had made good progress with the Railophone. Of recent years the Great Central has used the "Reliostop," having 20 engines fitted therewith, and the Great Eastern has the S.Y.X. in regular use, but to a limited extent. Having had a lead given them by an indication as to what is desired and is acceptable, no doubt most of the companies will now make some progress in this matter as soon as the sug- upon standard track and engine equipment.

As the result of their general investigation, the Committee found that there is a prima facie case for automatic train control, as the only means for obtaining greater security against the class of train accident, which in general, results from failure on the part of enginemen.

Electrification on Foreign Railways
India

Appropriations approaching $15,000,000 have been made, according to Commerce reports, towards the electrification of several short lines in India, among other what is known as the Harbor Branch of the Great Indian Peninsula Railway, which is about seven miles in length, terminating in Bombay. Another branch extends to 14 miles, also in the vicinity of Bombay. In addition to these about 40 miles of the Bombay, Baroda & Central India is also included. The work is estimated to be finished in five years.

Switzerland

There is every indication that the electrification of the Swiss railways is proceeding with a degree of rapidity that is the best proof that the government is convinced of the economical gain that will be made. Considerable reductions have been made in the prices of materials, electric locomotives formerly costing $175,000 can now be purchased below $100,000; and the Swiss Federal Council has issued the second electrification loan amounting to $28,000,000.

Brazil

The funds necessary for the contemplated electrification work on the Central Railway of Brazil have been guaranteed by the government securing a loan on the New York market of $25,0000,000. The improvements contracted for are on the State railways.

Russian Railroad Transportation

Official reports that in spite of much hindrance the worthy efforts of the American Relief Administration, whose huge shipments of corn and other food stuffs into the famine districts taxed the capacity of the roads for months, has all but completed its grain shipments and from now on will be confining its traffic chiefly to the child-feeding commodities, and medical supplies. From 50 cars sent out in August, 1921, by the American Relief Administration the number had risen in March to 8,585, and although the opening up of navigation on the Volga and its tributaries decreased the rail shipments, permitting to date the movement of some 46,000 metric tons of grain by water, rail shipments have continued heavy, amounting to 5,710 cars in April and 7,846 cars in

New Feeding Arrangement of the Elvin Mechanical Stoker

In the development of the Elvin stoker a change has been recently made in the method of feeding the coal from the tender forward to the crusher. A reference to the illustrated article on the Elvin Mechanical Stoker, published in *Railway & Locomotive Engineering* for October, 1921, will show that, at that time, the conveyor, for feeding the coal forward to the crusher, had a reciprocating motion with a variable travel of about 4 in. maximum.

In the latest design, as shown in the accompanying photographs, this reciprocating motion of the conveyor has been changed to an intermittent feed of the chain belt type.

The surface of the belt is composed of four link belt chains with feeding bars projecting upward. This whole belt has an intermittent forward movement on its upper surface, it being possible to vary the length of the forward step from ⅛ in. to 1⅜ in.

The mechanism by which this is accomplished is shown in the half side view. In this the square telescoping shaft *A* receives a continuous rotary motion from the engine shaft on the locomotive and this motion is carried backward and communicated to the shaft *B* to whose outer end the beveled gear *C* is keyed. A pair of frame, give the same continuous rotary motion to the shaft *D* and the eccentric *E* which is keyed to it.

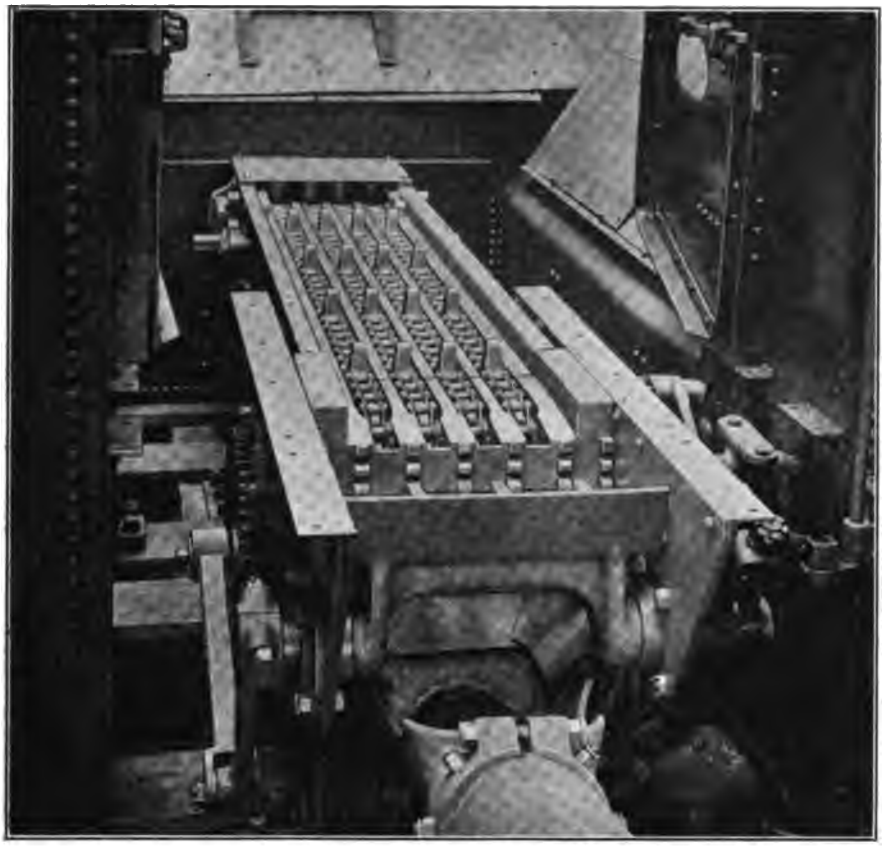
Above the eccentric *E* will be noted the eccentric rod *G* which has at its lower end a free moving roller, the rod being connected at its upper end to a lever operating the dog of the feed ratchet, both of which are contained in the ratchet casing *K*.

Under ordinary working conditions the weight of the eccentric rod and roller would cause the latter to rest upon the eccentric at all times and rise and fall throughout the whole throw of the eccentric for each revolution. Such a condition will give the maximum travel to the ratchet and, with it, a corresponding motion to the conveyor.

In order to lessen the throw of the ratchet dog a wiper *L* is attached to it, which turns with the dog about the ratchet shaft *M*.

Just above this wiper there is a bar *N* which may be moved to and fro in its guide by connections that are manipulated from the engine deck. As this bar *N* is pushed back it strikes the surface of the wiper farther and farther up on its surface until, when it is given its full backward movement, it strikes the wiper at 1 and, holding it down, prevents its turning at all, and thus holds the eccentric and rod at the upper end of their throw and, by preventing them from following down on the eccentric, cuts off all up and down motion and so stops the conveyor. As the bar *N* is moved out the wiper can rise more and more and thus gradually increases the intermittent forward step of the conveyor.

By means of this arrangement the back drag of the feeding bars on the link belt through the coal is avoided, and there is only the forward push of the coal towards the crusher to be provided. At the same time the amount of coal fed to the crusher can be regulated to a nicety by the variation in the forward steps that can be given to the conveyor.



TOP VIEW OF CHAIN BELT CONVEYOR FOR ELVIN MECHANICAL STOKER

SIDE VIEW OF OPERATING MECHANISM OF CONVEYOR FEED OF ELVIN

Improved Condition of Palestine Railway System

Local communications have been greatly improved within the past year, and today Palestine enjoys probably the best railway, telephone and telegraph, and mail service in the Near East.

An efficient railway system in Palestine is a heritage of the war. In their military operations the British built the line from Kantara on the Suez Canal to a point near Gaza, connecting there with the old pre-war narrow-gauge system. The gauge was broadened and an extension built into Haifa. The system, now 500 kilometers in length, connects with the Egyptian State railways at Kantara and with the Syrian railways in the north.

The motive power and rolling stock is in first-class condition. American locomotives built in 1918 for the British War Department are used, having evidently been turned over to the Palestine railways. A few mountain saddle-tank type locomotives built in Leeds, England, have been added recently. A number of new passenger coaches from England, together with international sleeping cars afford good accommodations to travelers. Daily passenger and mail service are proving beneficial to business.

Austrian Railway Electrification

It is reported that the main gallery, 1 mile 1,418 yards long, of the Spullersee electrical works on the Austrian Federal Railways, has just been pierced. These works are to supply the power for the Austrian Federal Railways between the Austro-Swiss frontier station of Buchs and Lindau as far as Innsbruck.

The boring work was done from both sides, and the boring parties met at 1,104 yards, and met exactly. The work in some parts was apparently much interfered with by huge water bursts, and the best waterproof suits or overalls could not withstand the pressure of the water as it gushed forth out of the clefts in the rocks. At the place where the two boring gangs met a memorial tablet is erected commemorating the workmen who perished on January 5, 1922, through an avalanche. The boring gangs were not expected to meet for about another two months, and it is now expected that the work of electrifying this stretch of line will be finished sooner than was anticipated.

Hydroelectric Resources in Spain

Important new Spanish hydroelectric installations are contemplated. The resources in this direction in actual exploitation early in 1922 are estimated at from 500,000 to 600,000 horse power. This is said to be only about one-tenth of the potential energy possible of development. A marked increase in railway and electric light and

Government Has Power to Operate

The Cabinet agreed that the government had ample power to keep the transportation lines of the country in operation, but it was held that the rail strike had not yet developed to the extent where interstate commerce was being seriously interfered with.

Should the strike spread so that the movement of the mails and transportation generally was at a standstill the President is known to feel that the government seizure and operation of the carriers could be hastily put into effect.

The view of the President is that he does not think it would abridge the liberties of any American to draft the citizenship of the country in order to meet any crisis, such as a general tie-up of the transportation lines. He joins with his Cabinet, however, in believing that the railroad situation is not likely to make this step necessary.

Much of the Cabinet meeting was devoted to the hearing by the President of reports from his aids as to the latest developments in the situation.

Secretary of War Weeks and Attorney-General Daugherty reported as to plans for the use of Federal troops and United States marshals to guard the railroad shops and rights of way. The former laid especial stress on the situation in Texas, where the Inspector General of the 8th Army Corps, whose 18,000 troops are being held in readiness for service, was sent earlier in the day to survey the situation at Denison, where several disorders have occurred at the Missouri, Kansas & Texas shops.

Ten Years of Strikes

In the decade ending at midnight on Dec. 31 next it is estimated that the number of strikes and lockouts that disturbed industrial America for that period will have exceeded more than 26,000 or 1,000 more than took place in the quarter of a century from 1881 to 1906, inclusive. These industrial disturbances, which have meant suffering and hardship not only for the participants but also for the public, have involved millions of men and women. The loss in wages, if available, would total a staggering sum, and the price paid by industry, if it could be measured in dollars would approximate the war debt of a first class power.

Statistics on file in the Department of Labor in Washington show that between Jan. 1, 1913, and Dec. 31, last, the number of strikes and lockouts was about 23,100 and by the end of the year the number will have passed 26,000. For the years under consideration the Bureau of Labor has a record by months, industries and localities. The records for the period of 1906 to 1912, inclusive, are not available.

tury period of 1881 to 1905, inclusive, will be used, the official records for those twenty-five years being fairly complete.

In the twenty-five years prior to and including 1906 the total number of strikes and lockouts was 25,353 and the number of persons involved about 6,715,000. These totals lose significance when compared with the record of the last ten years, with a total which by the end of this year is expected to exceed 26,000. The number of persons involved probably will be in the neighborhood of 18,000,000.

Of the more than 23,000 strikes in the nine-year period that ended Dec. 31, last, more than 14,000 were in seven States—New York, Pennsylvania, Massachusetts, Illinois, Ohio, New Jersey and Connecticut. Before the new year the total for these seven industrial commonwealths is expected to be well beyond the 15,000 mark.

More than 60 per cent. of all the strikes of the last ten years have taken place in the States that lie north of the Ohio and east of the Mississippi, about 10 per cent. of them in territory to the south of the Ohio and east of the Mississippi and the rest in the West.

The table that follows, which covers the 1914-1922 period, shows the number of strikes and a conservative estimate of the number of persons. The figures for 1922 are to a certain extent speculative, contingent on what happens in the five remaining months of the present year:

Years	Number strikes	Persons involved
1914	1,204	400,000
1915	1,420	700,000
1916	3,681	2,000,000
1917	4,324	2,000,000
1918	3,248	2,200,000
1919	3,452	4,000,000
1920	3,193	2,200,000
1921	2,164	2,000,000
1922	3,000	3,000,000
Totals	25,696	18,500,000

How Coal Strike Is Affecting Tonnage

The loadings of revenue freight as reported weekly by the American Railway Association have been increasing steadily since the first of the year. For the week ending June 24 car loadings of all commodities totaled 877,856 cars. This number included only 96,960 cars loaded with coal and is about 58,000 cars below the weekly average of coal loadings for the months of June and July, 1921.

If the normal autumn movement of coal alone were added to present car loadings a total of about 997,856 cars would be the total weekly movement of all commodities. This figure would be but 21,000 cars less than the record movement in American railroad history, which occurred in the

Westinghouse Electric Company Ships Equipment for French Railroad Electrification

Within a few weeks of the departure of the record-breaking shipment of apparatus for the Chilean Railroad Electrification, another enormous train-load of electric railroad apparatus left the East Pittsburgh plant of the Westinghouse Electric & Manufacturing Company this month for France.

The shipment consisting of transformers and lightning arresters was part of an order from the French Midi Railways which totaled well over a million dollars. The amount of the apparatus in the shipment, which weighed approximately eight hundred tons, can be estimated by the fact that 32 railroad cars were required to transport it. The material went by the Pennsylvania Railroad to New York, and shipped from there to Bordeaux.

The order was of more than ordinary interest, because it covered material for the first system outside of the United States to adopt 150,000 volts for its main transmission.

The lines of the Midi Railways are mostly located in the South of France north of the Pyrenees. As far back as 1906 the management of the Railways commenced an exhaustive study of the electrification of this part of their system, having in mind the utilization of the water power available on the northern slopes of the Pyrenees. By 1914 four sections had been electrified with single phase current at 12,000 volts and 16.67 cycles, but all work was stopped at the outbreak of the war.

The French early in the war lost practically all their coal fields to the Germans. This more than anything emphasized the necessity of developing the water power resources of the country and electrifying the railroads wherever it could be economically done. Thus on the cessation of hostilities one of the first acts of the government was to send a technical commission abroad to study existing railway systems.

The commission, after visiting Switzerland, Italy and America, recommended that 1,500 volts, direct current, be adopted as the standard for the electrification of all French railroads, and the Midi Railways Company, in conformity with this decision, immediately resumed the work interrupted by the war on this new basis. The sections already electrified at 12,000 volts will be changed to 1,500 volts, direct current, so as to have a uniform system throughout.

The power will be generated in six stations or groups of stations capable of developing a total of 362,000 horsepower, the stations being put up progressively as the different sections are electrified. The head tion with the lowest head to a maximum of 2,500 ft. Power is generated at 8,000 volts and 50 cycles, and is distributed to the railway sub-stations over a 60,000 volt three-phase distribution system, distant points of the distribution system being connected by 150,000 volt transmission lines.

The railway sub-stations, which are located along the railroad at intervals of 12 to 18 miles, are connected directly to the 60,000 volt distribution system. They all contain rotary converters with the exception of a few in which mercury arc rectifiers will be used.

The equipment for the generator stations, the distribution system, the railway sub-stations and the locomotives will be built in France. The work entrusted to the Westinghouse Company comprises a large part of the 150,000 volt transmission system, including the transformers, synchronous phase-modifiers for the voltage control, and the relay protective gear.

ELECTRIC LOCOMOTIVE HAULING A TRAIN LOAD OF AMERICAN-MADE ELECTRICAL EQUIPMENT FOR FRENCH MIDI RAILWAYS

For the initial development three generating stations will be utilized. The 150,000 volt lines will connect these with the distant cities of Pau, Dax and Bordeaux to the west and Toulouse to the east. At the generating stations 20,000 kv-a. banks made up of Westinghouse single phase two-winding transformers will raise the voltage from 60,000 to 150,000 volts. At the sub-stations near these cities the transmission system connects again with transformer banks of 20,000 kv-a. made up of Westinghouse single phase three-winding transformers, lowering the voltage from 150,000 to 60,000 volts. These transformers have a third winding of 6,600 volts for feeding Westinghouse synchronous phase modifiers.

These machines are intended to automatically keep constant the voltage at the sub-station irrespective of the load. Owing to the length of the lines and the high voltage of the transmission they are designed to cover a wide range of reactive kv-a. At Bordeaux, there will be two-phase modifiers each of 15,000 kv-a. capacity and 7,500 kv-a. lagging capacity. At Dax and Toulouse there will be in each two machines of 8,000 kv-a. leading and 4,000 kv-a. lagging capacity. All these phase-modifiers are equipped with the Westinghouse patent automatic voltage regulator designed to cause the machine to give the right amount of reactive kv-a. leading or lagging required to keep the line voltage constant.

The Westinghouse Company in conjunction with the engineers of the Midi Railways worked out a complete scheme of relay protection embracing the generator, distribution and transmission. The generators and transformers are individually potected differentially, that is, they are automatically taken off the line in case of internal trouble.

The transmission and distribution are so laid out that the supply to the railway sub-station is assured. The lines are therefore for the most part in duplicate, except where sections are fed from both sides. Where the transmission lines are in duplicate they are equipped with balanced line protection by means of the recently developed Westinghouse directional relay which does not require potential transformers. The whole relay scheme is so laid out that in case of trouble in any section of line or piece of apparatus the part in trouble is isolated without interrupting the supply to the rest of the system.

The whole order, of which this shipment forms a part, covered twenty-five single-phase transformers of 6,667 kv-a., two synchronous phase-modifiers of 15,000 kv-a., four of 8,000 kv-a., thirteen 150,000 volt lightning arresters and a large number of relays and current transformers.

Railway Mileage

There are 740,000 miles of railways in the world, of which 266,000 are in the United States, 220,000 in Europe, 70,000 in Asia, 60,000 in South America, 30,000 in

Railroad Equipment Notes

Locomotives

The Chicago & Eastern Illinois has ordered 10 Mikado type locomotives from the American Locomotive Company.

The Lehigh Valley has ordered 5 Mikado type locomotives from the Baldwin Locomotive Works.

The Nashville, Chattanooga & St. Louis has ordered 3 Mountain type locomotives from the Baldwin Locomotive Works.

The Chicago & Eastern Illinois has ordered 6 Pacific type locomotives from the Lima Locomotive Works.

The International Harvester Company is reported to have ordered 2 six-wheel switching locomotives from the Baldwin Locomotive Works.

The New York Central is having 50 locomotives repaired at the shops of the Baldwin Locomotive Works.

The Erie has made a contract running for six months to have 20 locomotives each month repaired at the American Locomotive Company's Cooke Works.

The Baltimore & Ohio has ordered 35 Mikado type locomotives from the Baldwin Locomotive Works. Contract has also been made for the repair of 25 locomotives at the Baldwin shops.

The New York Central has ordered 100 locomotive boosters from the Franklin Railway Supply Company.

The Southern Pacific has ordered 55 locomotive boosters from the Franklin Railway Supply Company.

The New York, Chicago & St. Louis has ordered 14 locomotives from the Lima Locomotive Works.

The Southern has ordered 15 Mikado type locomotives from the American Locomotive Company.

The Norfolk Southern has ordered 5 Consolidation type locomotives from the Baldwin Locomotive Works.

The Central New England has ordered 20 switching engines from the American Locomotive Company.

The Lehigh Valley is having 6 consolidation type locomotives and 9 switching locomotives repaired at the shops of the Baldwin Locomotive Works, and 5 Consolidation type and 10 switching locomotives repaired at the shops of the American Locomotive Company.

The Boston and Maine is reported to be considering the ordering of 2 mallet type locomotives, and 22 switching locomotives.

The Illinois Central has ordered 25 Santa Fe type locomotives from the Lima Locomotive Works, 25 Mikado type locomotives from the American Locomotive Company, and 15 switching locomotives from the Baldwin Locomotive Works.

The New York, New Haven & Hartford is reported to have contracted for the repairs to 30 locomotives by the Baldwin Locomotive Works.

The Philadelphia & Reading is said to have ordered 25 locomotives from the Baldwin Locomotive Works.

The Delaware, Lackawanna & Western has ordered 25 Mikado type locomotives and 5 Pacific type locomotives from the American Locomotive Company.

The Southern has ordered 6 switching locomotives of the 0-8-0 type from the Baldwin Locomotive Works.

The latest reports also add that the New York Central has issued an order for 150 locomotives of the same type as the Michigan Central locomotive No. 8,000. The extent of the order and the promptness with which it has been decided on is the best proof of the assurance that the design and performances of the new locomotive, which is described elsewhere in our pages, is all that it is claimed to be, and that its new features will rapidly be adopted in the construction of locomotives generally and high-powered freight engines particularly.

Freight Cars

The Northern Pacific is ordering one thousand 50-ton box cars of the finest construction obtainable. Forty-ton cars are standard in this type. Two hundred and fifty stock cars of 80,000 pound capacity, 250 convertible all-service cars, 250 gondolas and 70 express refrigerator cars are included in the new orders. The refrigerators will be built on passenger-car standards so they can handle Western fruit on fast schedules.

The Erie has awarded contracts for repairs to 5,000 box cars as follows: 1,000 to the Standard Steel Car Company; 1,000 to the Buffalo Steel Car Company; 1,000 to the Youngstown Steel Car Company; 1,000 to the Illinois Car & Equipment Company; 500 to the Western Steel Car & Foundry Company, and 500 to the Illinois Car Company.

The New York, Chicago & St. Louis has awarded a contract to the Illinois Car & Equipment Company for repairs to 1,000 box cars.

The Tennessee Central has placed an order with the Western Steel Car & Foundry Company for 350 gondola cars.

The Alabama & Vicksburg has ordered 25 all-steel automatic air dump cars of 40 tons' capacity from the Kilbourne & Jacobs Manufacturing Company.

The Western Pacific has ordered 2,000 refrigerator cars from the American Car & Foundry Company.

The Northern Refrigerator Car Company has ordered 500 refrigerator cars from the Pullman Company.

The Southern Pacific has ordered 40 all-steel automatic air dump cars of 40 tons' capacity from the Kilbourne & Jacobs Manufacturing Company. These cars are furnished with an improved apron attachment.

The New York, New Haven & Hartford has awarded a contract for rebuilding 6,000 bad-order freight cars to the Keith Car & Manufacturing Company, Sagamore, Mass.

The Detroit Edison Company has ordered 5 gondola cars from the Pressed Steel Car Company.

The Northern Pacific has ordered 250 gondola cars from the General American Car Company.

The United Verde Copper Company has ordered 24 ore cars from the Pressed Steel Car Company.

The Norfolk & Western has ordered 500 hopper cars from the American Car & Foundry Company, 1,000 from the Pressed Steel Car Company, and 500 from the Standard Steel Car Company.

The Chicago Great Western has awarded contracts for the repair of 200 cars to the Pullman Company; 154 cars to the Sheffield Car & Equipment Company, and 173 cars to the Siems Stembel Company.

The Argentina State Railways have placed an order with the Standard Steel Company for 100 ballast cars.

The Central Vermont has made a contract with the American Car & Foundry Company for the repair of 200 steel gondola cars, 400 steel underframe box cars, and 100 wooden underframe box cars.

The Nashville, Chattanooga & St. Louis has ordered 500 40-ton single sheathed box cars, 250 40-ton double sheathed box cars, 150 40-ton stock cars and 100 50-ton flat cars from the American Car & Foundry Company.

The Baltimore & Ohio has ordered 1,000 steel coke cars from the Baltimore Car & Foundry Company; 1,000 box cars from the American Car & Foundry Company; 1,000 composite gondola cars from the Pullman Company; 1,000 box cars from the Pressed Steel Car Company; 500 box cars from the Hamilton Car Company; 500 hopper cars from the Youngstown Steel Car Company; 500 box cars from the Illinois Car & Manufacturing Company; and 500 gondola cars from the General American Car Company.

The Buffalo Creek & Cauley has ordered 300 steel hopper coal cars of 55 tons' capacity from the American Car & Foundry Company.

The Missouri Pacific are having repairs made on 1,250 cars by the American Car & Foundry Company, 1,000 cars by the Sheffield Car & Equipment Company, and 250 cars by the Mount Vernon Car Manufacturing Company.

The Philadelphia & Reading has ordered 500 gondola cars of 70 tons' capacity from the Pressed Steel Car Company, and 500 from the Standard Steel Car Company.

The Pittsburgh & West Virginia has ordered 1,000 hopper cars of 35 tons' capacity from the Cambria Steel Company.

The Illinois Central has ordered 1,000 gondola cars from the Pullman Company, 500 from the American Car & Foundry Company, 500 from the Mt. Vernon Car Manufacturing Company, 500 from the Beltendorf Company and 500 from the Western Steel Car & Foundry Company.

Passenger Cars

The St. Louis-San Francisco has ordered 6 steel chair cars and 8 steel coaches from the American Car & Foundry Company.

The Missouri, Kansas & Texas has ordered 30 steel passenger coaches from the American Car & Foundry Company.

The Atlantic Coast Line has issued contracts for 30 passenger cars, 20 of which are reported to be combination baggage and express cars.

The Boston & Maine is reported to be making enquiries for the purchase of 65 steel passenger cars, 20 steel smoking cars, 8 steel combination baggage and smoking cars, 5 steel mail and baggage cars, and 25 milk cars.

The Nashville, Chattanooga & St. Louis is said to be in the market for 15 passenger equipment cars.

The Northern Pacific is reported to be in the market for 70 additional express refrigerator cars, to be used in its fast passenger train service.

The Maryland & Pennsylvania has ordered 2 passenger motor cars and 2 trailers from the Russel Company, Kenosha, Wis.

The Pittsburgh & West Virginia is said to be inquiring for 2, 60-ft. steel baggage and mail cars, 1, 70-ft. steel passenger, baggage and mail.

Railroad Buildings and Tools

The Wabash will equip a water filling station for locomotives at Glencoe, Ont., and lay a three-mile pipe line and install electrically operated pumping equipment.

The Chicago, Burlington & Quincy is requesting bids for the construction of a five-stall roundhouse at Council Bluffs, Iowa, and a combination freight and passenger station at West Frankfort, Ill.

The Chesapeake & Ohio has awarded a contract to Joseph E. Nelson & Sons of Chicago for the construction of terminal facilities at Peach Creek, W. Va., and improvements to its roundhouse at Peru, Ind. The contract involves about $475,000.

The Chicago, Rock Island & Pacific has awarded a contract to Joseph E. Nelson & Sons, of Chicago, for the construction of a water softening plant at Council Bluffs, Iowa.

The Denver & Rio Grande has begun to rebuild the portion of its power house at the West Denver railroad shops recently destroyed by fire.

The Chicago & North Western has awarded a contract to G. W. Gindle, of Chicago, for the construction of a 12-stall engine house at Ashland, Wis.

The Minneapolis, St. Paul & Sault Ste. Marie will shortly begin the rebuilding of its sixteen-stall roundhouse at Gladstone, Mich., which was recently destroyed by fire.

The Detroit United Railway has completed plans for the construction of a one-story car-shop, 125 ft. by 285 ft.

The Long Island has ordered a 150-ton overhead traveling crane from the Whiting Corporation for its Morris Park shops. The railway company is preparing an extensive list of new shop tools and purposes issuing orders for the same at an early date.

The Erie has awarded a contract for an extension to its locomotive repair shops at Hornell, N. Y., to the Bates & Rogers Construction Company.

The Wabash has awarded a contract for the construction of a reclamation plant at Decatur, Ill., to C. W. Gindle, Chicago.

The Western Maryland has awarded a contract for the erection of a Mallet locomotive repair shop, measuring 100 ft. by 300 ft., at Port Covington, Baltimore, Md., to M. A. Long Company, Baltimore.

The Atchison, Topeka & Santa Fe has completed plans for the construction of a new boiler and tank shop at Albuquerque, N. M., also boiler working plant at Amarillo, Texas, and Winoka.

The Louisiana & Arkansas has completed plans for the construction of locomotive repair shops at Stamps, Ark. The plans call for a main building 286 ft. by 129 ft., a blacksmith shop 60 ft. by 8 ft., a power house 68 ft. by 72 ft., and an office building 36 ft. by 60 ft. The principal buildings will have structural steel frames and brick construction.

The Missouri, Kansas & Texas is said to have awarded a contract for the grading and concrete work in connection with the construction of locomotive repair shops at Waco, Tex.

The Northern Pacific has prepared plans for the construction of a new passenger station and power plant at Glendive, Mont., a scrap reclamation plant at Brainerd, Minn., a boiler making plant at Forsythe, Mont., an oxyacetylene plant at South Tacoma, Wash., and new storerooms at Jamestown, N. D., Butte, Mont., and Tacoma, Wash.

Increased Activity in Repair and Construction of Locomotives and Cars

It is reported that since the beginning of the railway shop union strike on July 1, 205 locomotives and 14,827 cars have been repaired under contract with outside establishments. Orders for general repairs to 220 locomotives and 7,600 cars are said to have been contracted for during the last two weeks in July. During July the reports to hand show that 235 new locomotives and 10,946 new cars have been ordered. The number of inquiries for new rolling stock are also increasing rapidly, particularly in the prospective large demand for cars.

The Railways of Italy

Italy, with an area of 110,660 square miles and an estimated population of 36,740,000, has approximately 20,000 kilometers of railways (exclusive of railroads in territory acquired since the war), capitalized at about 7 billion lire. Of the total mileage, 80 per cent is owned and operated by the State, the remaining 4,000 kilometers being operated by private companies. The most important private lines are the Veneta, capitalized at 24 million lire and operating 772 kilometers of track, and the Milan Northern, representing an investment of 23 million lire and operating 259 kilometers of track.

Of the State-owned lines, perhaps the most important is the Southern, organized in 1862 with a capital of 100 million lire. This company at first operated railways only in southern Italy, but in 1885 its scope was extended to include all lines between the Apennines and the sea. Another large system is the Mediterranean, formed in 1885 with a capital of 180 million lire and operating the lines between the Apennines and the Mediterranean. Since purchased by the Government in 1905, this system has been active in the construction of lines in Basilicata and Calabria. The State also owns the Sicilian lines, which were incorporated in 1885 with a capital of 25 million lire.

Few additions were made to the rolling stock during the war. After armistice the equipment of State railways was increased by the addition of rolling stock belonging to the railways operated in former Austrian territory and by the State's purchase of Sardinian railways. But there has been no marked increase in new rolling stock. The bulk of rolling stock is in poor condition. During the fiscal year 1920-21, 17 per cent of the locomotives and cars were in repair shops, as compared with 10 per cent in the pre-war period. The cost of maintenance for State railways is estimated at 320 million lire per year, although it is believed that this figure may be exceeded during the 1921-22 fiscal year, on account of the poor condition of rolling stock.

Germany Building Rolling Stock

It is reported that in locomotive and car construction Germany has already made up all her losses during the war, including the 5,000 locomotives and 150,000 cars delivered to France.

Letter to a Retired Engineer from a Veteran in the Service

Dear Bill: Thare makin grate improovmints on the Midlan sence you wur raytired. Bigger ingines and thranes and shtokers on some of thim, I mane the ingines, and awl the firesmen hav to do is roll wan now and thin, mostly now, and awl the ingineer has to do is make the time. Some times he kin make it and more times he cant, but whin he cant he kin blame it onto the shtoker, ye see, and thats aisy, fer it cant talk back like a firesman thats layin down on the job, er like the fule superviser whin ya blame it on tha cole, er like the mastther mekanic whin ye blame it on tha valve motion, er like the conduckther whin ye blame it on the brakes stickin, er the like.

It aint offen, Bill, that an ingineer has a cinch like that. Its surer, too, than blamin it on the wind. I no wan day I came in tin minutes late and reported a side wind wur the cause, and back cum a not sayin my excuse wur N. G., fer Dick Kiker made up tin minutes the day before wid the same wind, ony he had a hed wind and thats worse, sez the note. So you kin see Bill thares no way whin you are dealin wid thim kinds av offishels, but take yer medicin the same as if ya liked it, and its comin to ya, whin it aint.

But Bill the gratest thing heer now is the Boosther. Dya no what it tis? Ye dont, I no. Well, itsa Boosther awl right, and when makin the time here wiathout any trubbel like we useta hav. Im runnin wan o thim ould nineteen be twintyfore tin wheelers wud a six fot wheel, and ye no thay cuddent pull a Plimmeth Rock of a sitten av eggs athout takin the schlack.

But not a wurrd o lie, Bill, were hawlin tin and ilivven cars, hivvy wans, on 11 and 6 now and were doin it so aisy Im almost ashamed to take pay for the wurrk, sence we hav tha Boosther.

I no yer not a good hand at undershtandin mekanics so I wont bother ye tellin how it operrates, only Ill say that whin ya get the hi ball frum the con, he hasta grap a handel rite away or ye leave him on the platform. Ye no tha way it useta be when ya got the hi sine, yed lay her down in the corner on two pipes of sand and pull her out to tha chane and she wud stand like a bawky horse.

Thin yed throw tha revarse leever back, and bump the thrane the same as a collision, thin jam her ahead agane, and after doin it two or three times, the con wud cum over ahed and tell ye to not be so dang ruff for the passengers wur kickin. So in yure mind yed tell him and tha passengers where they cud go if thayre in anny more hurry than yerself, and ye keep jerkin and backin and shlackin till ye got mad as tha divil and afther a while, like thayres an ind to everythin, ye do lave town.

But it aint that way anny more Bill.

Now, afore tha con gives the hi sine, he grabs on, or—as I sed beefore—hees left at the post, as the race horse min say, fer awl ya hav to do to cut the Boosther in is lift a latch tha same as raisin a damper, thin pull her out, and away you go, Bill, but so aisy that the con hafta wake up that passengers ta get thare fares, an not like it useta be here afore we had that Boosther whin wed be jackin and thrashin thryin ta start so the conducther wud hav to hold tha passenger down wid wan hand while he tuk his fare from him wud tha other. Thats no lie ayther, Bill, and well ya no it, fer ye had yure own thrubbles here.

Mannys that time whin I wur on frate, I useta see ya thryin ta start tin coaches with them same ingines an Id heer tha conducther say to tha passengers—be way of excuse fer puttin a crick in there backs er jerkin off thayre hats—our ingineer is a kind av a back number, fer he has an engine there that kin clime a tree, if he cud ony handle her rite. It useta cut me to heer that Bill, an I no I offen got the same deel meself.

But its tha ingineers turn at bat heer now, fer insted of him fixin up excuses fer poor time, its tha cons that hav to do that, now, fer if they ever stop ta shake hans wud some wan like thay useta afther givin us the hi ball, we kin lave thim every time if we wanta, and we wanta some times too, fer sum of thim hav it comin to thim, the way they useta nock us afore tha Boosther cum. Ye no ould Doc Jonson? Well ye mind the joolery he useta ware, and the white necktie, and the airs he useta put on, whin walkin down tha platform afore tha people, and him thinkin they wur all lookin and wondherin if he wur tha man that ownd tha rode and awl tha implyees, espeshelly tha engineers? Well tha other day I had wan of tha Boosther ingines and me bold Doc gave me wan of his sarkastic hi balls and wud that he stopped to take off his hat to sum jane on tha platform, but I had cut in tha Boosther and widend on her, and we wint outa town like a bat outa hell lavin Doc givin washout sines galore. But Bill, lissen here, I stopped and wint back and I sed to Doc, sez I, now this is tha first time this has happened to ye, an I wont repoort it, but if it iver happen agane, Id refuse to take ye out wud me.

What do ye think about that, Bill?

So ye kin see verry planely now what a grate change the Boosther have made heer, not only fer savin cole and masheenery and makin better time wid thranes, but it has also changed tha ingineer frum bein tha gote to bein tha bull moose of tha thrane sarvice. Thats goin sum Bill, and besides that its comin to us, sez you, and rite ya arre, me bucko. Hurray fer tha Boosther.

JASON KELLY.

The Railway Come-Back

Reports of May operations filed by the railways with the Interstate Commerce Commission bear out the indications in the securities markets that the lines are slowly but steadily "coming back."

The net return, 4.36 per cent, is yet below the figure fixed by the commission, 5¾ per cent. But despite the coal strike the operating income showed a considerable increase, while in the five months ending with May a fall in revenue of 3½ per cent was paralleled on the other side of the ledger by a reduction in expenses of 13½ per cent.

Meanwhile the census of idle freight cars, always a significant sign of the state of railway health, showed a decrease in unused cars of 13,178 in a week. Most of the surplus cars were in good condition, hence were out of use through no fault of railway management.

While railway stocks have not been as high as other industrials, they have made a steady advance in the last few weeks, despite the strike of shop workers. The investing public has of late exhibited a firm confidence in rail shares.

So the gradual escape from excessive costs and ruinous rates is under way. Not only the railways, but all interested in the return to sound economics that can come only through liquidation and deflation, are trusting that it will continue.

Reductions in Wages Since 1920

The Railroad Labor Board has made two general wage reductions since the general increase of May 1, 1920, and has also modified working rules and working conditions so as to somewhat reduce the payments for overtime and the like.

The wage increase of 1920 added $700,000,000 to the annual payroll of the carriers. About $360,000,000 per year was cut off the wage scale by the general wage reduction of July 1, 1921, and about $135,000,000 by the recent reductions (July 1, 1922) in the wages of shopmen, clerks, trackmen and various classes except train service employes.

The changes in working rules probably amount to from $30,000,000 to $50,000,000 per year. The total reductions thus amount to from $525,000,000 to $550,000,000, compared with the increase of $700,000,000 in 1920.

The Southern Valve Gear

Announcement has been made that the Pilliod Company, Swanton, Ohio, manufacturers of the Baker locomotive valve gear, has secured control of the Southern Valve Gear Company

Items of Personal Interest

Charles Hitchcock has been appointed erecting foreman of the Santa Fe, with office at Richmond, Cal.

J. E. Osmer has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Colo.

W. K. Smith has been appointed car foreman of the Rock Island shops at Chickasha, Okla., succeeding W. J. Logsdon, deceased.

W. S. Haines, master mechanic of the Erie at Dunmore, Pa., has been appointed assistant to the vice-president, in charge of operation, with office at New York.

G. H. Pinion has been appointed purchasing agent of the Trans-Mississippi Terminal, with headquarters at Dallas, Texas, succeeding L. M. Sullivan, deceased.

S. B. Riley has been appointed superintendent of motive power of the Western Maryland belt headquarters at Hagerstown, Md., succeeding G. E. Wieseckel, resigned.

P. Spence, locomotive foreman of the Canadian National at Winnipeg, Man., has been appointed general foreman, with office at Edmonton, Alberta, succeeding A. Mays, promoted.

Harry M. Wey has been appointed manager of the Chicago district for the Pittsburgh Testing Laboratory, Pittsburgh, Pa., with offices at 1560 Monadnock Block, Pittsburgh.

J. D. Rogers, who has been the representative of the Baldwin Locomotive Works in South Africa, has been appointed manager of the company's offices at Calcutta, India.

J. B. Cowley has been appointed road foreman of engines of the Sante Fe in charge of the Colorado division, succeeding J. B. Morritt, transferred to the Mexico division.

C. M. Yohe, assistant purchasing agent of the Pittsburgh & Lake Erie, with headquarters at Pittsburgh, Pa., has been promoted to purchasing agent with headquarters at Pittsburgh.

G. Clarke, car foreman of the Canadian National at Edmonton, Alta., has been appointed car foreman at Paddington, Man., succeeding N. C. Hooper, transferred to Mission, B. C.

M. Meehan has been appointed master car repairer of the western division of the Southern Pacific, Pacific system, with headquarters at West Oakland, Cal., succeeding H. Englebright, retired.

A. A. Murphy has been appointed resident sales manager of the industrial paint and varnish division of the du Pont Company, with headquarters at 30 Church street, New York City.

Stanton Ennes, vice-president and general manager of the Wheeling & Lake Erie, has been elected president and general manager, succeeding W. M. Duncan, elected chairman of the board of directors.

E. G. Trump, chief dispatcher, Moose Jaw division of the Canadian Pacific, Saskatchewan District at Moose Jaw, has been transferred to the Portage division, Manitoba District, Winnipeg.

N. C. Hooper, car foreman of the Canadian National at Paddington, Man., has been appointed car foreman at Mission, B. C., succeeding J. K. Nesbitt, transferred to Edmonton, Alta.

P. Heinze has been appointed acting road foreman of engines of the Canadian National, with headquarters at Prince Albert, Sask., succeeding J. G. Norquay, who has been granted a leave of absence.

R. J. Aul, storekeeper of the Indiana Harbor Belt, with headquarters at Gibson, Ind., has been appointed also to act in the same capacity for the Chicago River & Indiana and the Chicago Junction.

R. Douglas, chief dispatcher of the Canadian Pacific at Nelson, B. C., has been transferred to the Moose Jaw division, Saskatchewan District, at Moose Jaw, succeeding E. G. Trump, transferred to Winnipeg.

J. H. Rodger, western manager of the Safety Car Heating & Lighting Company, with headquarters at Chicago, has been promoted to vice-president with the same headquarters in charge of the company's western business.

Charles M. Schwab, chairman of the board of directors of the Bethlehem Steel Corporation, has been elected chairman of the board, also of the Chicago Pneumatic Tool Company, succeeding J. R. McGinley, resigned, but remaining a director.

F. W. Carter, assistant manager of the heavy traction division, railway department of the Westinghouse Electric & Manufacturing Company, has resigned to become president of the Louisville Frog & Switch Company, at Louisville, Ky.

A. L. Roberts, formerly master mechanic of the Lehigh Valley, and latterly engineer of the Atlas Crucible Steel Company, has been appointed sales engineer, railroad department of the United Alloy Steel Corporation, with headquarters at Canton, Ohio.

N. C. Ferguson has resumed duty as road foreman of locomotives on the Dauphin Division of the Canadian National at Dauphin, Man., succeeding P. Henze, acting road foreman of locomotives, who has been transferred to Prince Albert, Sask.

J. G. Barry, sales manager of the General Electric Company for the last five years, and manager of the railway department for a longer period, and A. H. Jackson, of the law department of the company, have been elected vice-presidents of the company.

J. G. Benedict, general manager of the Landis Machine Company, Waynesboro, Pa., sailed July 8 for a combined business and pleasure trip abroad. Mr. Benedict will be gone for about two months and his itinerary will include England, France, Holland, Belgium and Germany.

J. F. Gildea, formerly division master mechanic, Pennsylvania division, Delaware & Neudron Company, Carbondale, Pa., has been appointed assistant foreman of the Canadian Pacific, with office at Smith's Falls, Ont., succeeding F. G. Perkins, who has been appointed locomotive foreman at Schreiber, Ont.

C. M. Jacobsen, shop superintendent of the Seaboard Air Line, with office at Portsmouth, Va., has joined the service staff of the Franklin Railway Supply Company, and is now in charge of the Southern territory, with headquarters at Atlanta, Ga., succeeding B. C. Willcarson who has been appointed a special service representative on locomotive booster application.

H. A. Shephard, superintendent of telegraph of the New York, New Haven & Hartford with headquarters at New Haven, Conn., has been appointed superintendent of electric transmission and communication, with the same headquarters, and Charles S. Dow has been appointed superintendent of communication with headquarters at New York. The position of superintendent of telegraph has been abolished.

Col. Douglas I. McKay has been elected President of the Standard Coupler Company, and is well known among railroad men being president of the International Pulverized Fuel Corporation and the International Pulverized Fuel Equipment Corporation, to which position he was elected in 1918. Col. McKay is a graduate of the College of the City of New York and also of the West Point Military Academy. Resigning from the Army he was for three years chief of the New York state constabulary. Latterly he was appointed first deputy police commissioner of New York City, and re-appointed, but resigned to accept the position of vice-president of J. G. White & Co. and at the outbreak of the war resigned from that Company and was commissioned Major of Ordnance. In March, 1918, he was promoted to Colonel and assigned director of artillery ammunition production.

Westinghouse Railway Department Employes Honored

The employes of the Railway Department of the Westinghouse Electric & Manufacturing Company recently honored six members of their department who leave Pittsburgh to engage in Railway work in other parts of the country. The honored members were George Skipton, who has been transferred to the San Francisco office of the Electric Company; R. J.

Weber, Pittsburgh Sales office; N. C. Towle, Pittsburgh Sales office; D. E. Shroyer, Los Angeles office; George W. De Sellem, Portland, Main office, and F. W. Carter, who has resigned his office as Assistant to Manager of the Heavy Traction Division of the Railway Department to become president of the Louisville Frog and Switch Company, Louisville, Kentucky.

What Seniority Means to Shopmen

"Seniority" in railroad employment is dependent upon length of service. In the case of railroad shopmen, there are three main points of importance in seniority rules:

1. Choice of jobs within the territory affected (terminal or shops). The senior workmen, that is, those who have been in the employ of the railroad the longest time, are given first choice of the better positions.
2. As to tenure of position when reductions in the working forces are made, junior men are laid off first, and the senior men last.
3. Preference in re-employment. After men have been laid off, they are taken back in the order of seniority, and no new labor is employed until former employes, who so wish, have been returned to their positions.

Mechanical Conventions

As previously announced, the conventions of the International Railway General Foremen's Association and the American Railway Tool Foremen's Association will be held simultaneously at the Hotel Sherman, Chicago, Ill., during September 5-8, inclusive. The sessions of the separate associations will be held in separate halls. The usual exhibit of railway mechanical appliances promises to be more than usually interesting on account of the larger number of railroad men that are sure to be present. The exhibit will be comprehensive in its scope, embracing improved appliances and tools. The hearty co-operation of the executive committees of both organizations are a sufficient guarantee that the occasion will be notable. The special committees' reports will be of marked interest as marking the progress of the last two years, during which many improvements in means and methods have been perfected, and will be illustrated and discussed by skilled men actually engaged in mechanical railroad work, and from whom much matter of vital interest is expected.

The program outlined for the General Foremen's sessions will include discussions on Repairs to Steel Cars, and Appliances for Doing the Work; Labor-Saving Devices in the Locomotive and Car Departments; Methods of increasing Shop Output, and Engine Failures and Their Remedies. Completed programs will be issued by both associations in advance of

Promotions in the Baldwin Locomotive Works

J. P. Sykes, vice-president of the Baldwin Locomotive Works, in charge of manufacture, has been appointed senior vice-president in charge of plant and manufacture; C. A. Bourgeois, works manager, has been appointed vice-president in charge of manufacture; J. L. Vauclain, in the plant and equipment department, has been appointed vice-president in charge of plant and equipment; Harry Glaenzer, chief mechanical engineer, has been appointed vice-president in charge of engineering, succeeding Kenneth Rushton, deceased, and W. A. Russell, purchasing agent, has been appointed vice-president in charge of purchases.

New Machine Tool Corporation

As previously announced the formation of the Consolidated Machine Tool Corporation of America has now been completed and incorporated, with main offices at 17 East Forty-second Street, New York. It embraces the consolidation of seven machine and tool manufacturing companies controlling many important specialties. The consolidation embraces the Betts Machine Company, Rochester, N. Y.; Ingle Machine Company, Rochester, N. Y.; Hilles & Jones Company, Wilmington, Del.; Modern Tool Company, Erie, Pa.; the Newton Machine Tool Works, Inc., Philadelphia, Pa.; the Colburn Machine Tool Company, Cleveland, Ohio, and the Dale Machinery Company, Inc., New York City and Chicago, Ill.

W. H. Marshall, formerly president of the American Locomotive Company, is chairman of the board of directors of the new company and C. K. Lassiter, formerly vice-president of the American Locomotive Company in charge of operations, is president of the new company. H. J. Bailey, H. W. Breckenridge, H. W. Champion, J. J. Dale and A. H. Ingle are vice-presidents; O. D. Miller, treasurer; and R. R. Lassiter, secretary. The directors include W. H. Marshall, C. K. Lassiter, H. J. Bailey, formerly president Hilles & Jones Company, B. J. Baker of B. J. Baker & Company, bankers, H. W. Breckenridge, formerly vice-president of the Colburn Machine Tool Company, Lawrence Chamberlain, president of Lawrence Chamberlain & Co., bankers; H. W. Champion, formerly president of the Newton Machine Tool Works, Inc.; J. J. Dale, president of the Dale Machinery Company; T. Allen Hilles, A. H. Ingle, formerly president of the Betts Machine Company and Ingle Machine Company, and F. D. Payne, formerly manager of Modern Tool Company.

The company's capital stock includes $10,000,000 preferred stock of $100.00 par value and 200,000 shares of common stock

NEW PUBLICATIONS

Books, Pamphlets, Catalogues, Etc.

THE EASTERN RAILROAD, A historical account of early railroading in Eastern New England. By Francis B. C. Bradlee. Published by the Essex Institute, Salem, Mass. 122 pages, profusely illustrated.

The second edition of this notable book is now ready and with additional matter and illustrations is among the most valuable contributions to the railroad literature of our time recording as it does with an interesting minuteness the early history of railroading in New England from the opening of the Boston and Lowell railroad on April 7, 1934, and to Worcester July 3, 1835. The Boston and Providence was also opened in 1835. Perhaps the most notable feature in organizing the new enterprises was the thoughtful selection of engineers, generally graduates of the West Point Military Academy, who, at that time, were the most capable engineers in the country. It is also gratifying to learn that in spite of the bitter opposition of the stage coach companies free grants of land were made to the railroad companies, and the promptness with which the legislature endorsed the plans is a fine proof that the intellectual vision of the New Englanders was as always, clear. Public enthusiasm was very great and progress in linking the New England towns together was rapid.

The illustrations are excellent and form a historical panorama by themselves worthy of preservation. The book will be welcomed by collectors of railroad literature generally, and railroad libraries particularly.

Spontaneous Combustion in Coal

Technical Paper 311, by O. P. Hood, chief mechanical engineer, has just been issued by the Bureau of Mines. It describes fully and clearly the storage of coal and the problem of spontaneous heating. Although the risk in storing coal is small, there being no risk whatever in storing anthracite coal, the danger is in large piles of bituminous coal needed as reserves. One of the troubles has been, Mr. Hood claims, that undue attention has often been given to the minor factors, such as the sulphur of the volatile-matter content of the coal, height of pile, etc., while the main factors, such as initial temperature, breakage in handling, freshness of the coal, and the screening before storage, has been overlooked or minimized. The paper is well worthy of careful perusal, and copies may be had on application to the Bureau of Mines, Washington, D. C.

New Strain Insulator

Unusual reliability is the chief qualification of the new "Duro" strain insulators

Manufacturing Company. These appliances, although small, perform the important function of insulating the trolley wire from its supports. Should one of them fail, a tie-up on an entire section of the line would probably result and human life might even be endangered. For this reason, strength and durability in the product are necessary. The construction of the "Duro" insulator assures great mechanical strength and a high flash-over voltage. A malleable iron socket is filled with insulation in which is embedded a forged steel stud. The entire body is then surrounded by moulded insulation.

Progress in Steam Railway Electrification

A most interesting account of the progress in steam railway electrification is contained in Bulletin No. 44016 issued by the General Electric Company. Some of the more prominent electrifications throughout tthe world for which the General Electric Company has supplied the apparatus, either in its entirety or in the more important parts, are reviewed. The first important installation mentioned is the Baltimore and Ohio Railroad, and a reproduction of the first electric train order ever issued, dated July 1, 1895, forms a part of this historical setting.

Other important steam railway electrifications described in this bulletin are the Paris-Orleans Railway which now has on order for its system 200 locomotives and 80 motor cars; the New York Central Railroad with a total of 268 miles (single track basis); the Great Northern Railway, Cascade Tunnel and terminal yards; the Michigan Central Railroad through the Detroit Tunnel; the Victorian Railways radiating from the city of Melbourne; the Canadian Northern terminal and tunnel under Mt. Royal; the Montreal Harbor Commission extending along the St. Lawrence River; the Butte, Anaconda and Pacific Railway with its 122 miles, including sidings and double track; the Chicago, Milwaukee and St. Paul now operating at the present time 646 miles of route and 858 miles of track; the Bethlehem Chile Iron Mines Company at Tofo, Chile; the Spanish Northern Railway over the Pajares grade; the Imperial Government Railways, double track, between Tokio and Yokohama; the South Manchurian Railway with a total trackage of 43 miles and the Paulista Railway in Brazil operating a distance of 28 miles between Jundiahy and Campinas.

Car Loadings

Items from *Commercial Reports* show that loading of revenue freight totaled 860,907 cars during the week which ended on July 15, compared with 718,319 cars during the preceding week, which included a holiday, or an increase of 142,588 cars, according to the report of the American Railway Association. This was practically the same number of cars as was loaded during the week of June 17 last, and was an increase of 86,023 cars over the corresponding week last year. It was, however, a decrease of 81,944 cars compared with the corresponding week in 1920.

Loading of all commodities, except coal, during the week of July 15 totaled 783,573 cars. This figure has been exceeded in the history of American railroads only during the weeks of September and October, 1920, when freight loadings established a new high record. This total, however, is only 8,295 cars, or 1 per cent below the total for those same commodities loaded during the week of October 15, 1920, when the peak was reached.

Fuel Oil Burning Systems

The Schutte and Koerting Company, Philadelphia, Pa., has issued a new catalogue consisting of three bulletins and describing fuel oil burning systems and fuel oil burners in which the oil is atomized by low or high pressure air and steam. The installation, operation and maintenance of oil burning equipments, and their relative merits are fully described and illustrated in color.

Trade Standards in the Pump Industry

A pamphlet of 21 pages has been published by the Hydraulic Society containing many additional tables and explanatory data, and also a revised list of the members of the society who desire to encourage suitable standards of manufacture and of engineering practice in the pump industry. It publishes the recommendations which have been approved by the members. Copies may be secured from the Secretary, C. H. Rohrbach, 50 Church Street, New York.

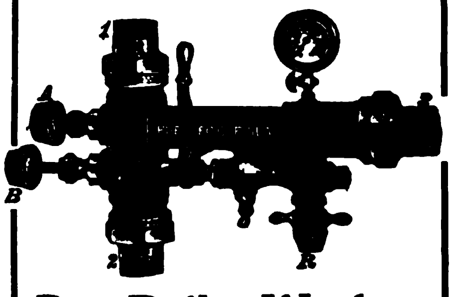
Baldwin Locomotive Works Issues Magazine

Under the title of "Baldwin Locomotives," the Baldwin Locomotive Works, Philadelphia, Pa., has published the first issue of a periodical with the announcement that it is to be devoted to the interests of transportation and the motive power problems of their clients. It is intended to illustrate from time to time the newest types of locomotives as they are constructed at the Baldwin Locomotive Works and to present articles on technical or commercial subjects allied to transportation.

The editors are Mr. W. A. Austin and Mr. P. T. Warner, and associates Mr. H. R. Barnes and Mr. C. W. Fuigle. The first issue of the publication is dated July, 1922, and subjects of the principal articles are: The First Uniform Gauge Transcontinental Railway in South America; Lubrication of Railway Car Journals; South American Business; and descriptions of the Consolidation type locomotives built for the Western Maryland Railway, and the Santa Fe and Pacific types built for the Argentine State Railways and also logging and tank locomotives. Some of the articles are printed in both English and Spanish, and the locomotive specifications are printed in these languages as well as French and Portuguese.

Revision of the Boiler Code

During the year of 1918, the first revision of the Boiler Code of the American Society of Mechanical Engineers was issued and announcement has been made that the Boiler Code Committee is preparing to hold a public hearing in connection with the annual meeting of the Society in December to consider the second revision of the Code.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV | 114 Liberty Street, New York, September, 1922 | No. 9

The Michigan Central's Mikado (2-8-2) Type Locomotive No. 8,000

Further Details of Its Design and Construction—A List of the Economic and Efficiency Producing Specialties That Contribute Largely to Its Remarkable Performance

A general description of a Mikado locomotive embodying a number of novel features, and built by the Lima Locomotive Works, was published in the August issue of Railway and Locomotive Engineering. Since that date further details of the engine and its performance have been made available, and because of the novelty involved in the whole design they are given here. As a number of these special features of the locomotive are the subject of patent applications which are still pending, illustrations and descriptions of these items in detail will be published in a later issue.

The following are the general dimensions of the machine:

Tractive effort with boosters....	74,500 lbs.
Tractive effort without booster..	63,500 lbs.
Cylinders, diameter and stroke.	28" x 30"
Valves, kind and size..........	14" piston
Greatest travel................	8¾"
Lap	1¼"
Exhaust clearance..............	1/16"
Lead in full gear..............	3/16"
Weight in working order on drivers	245,500 lbs.
Weight in working order on front truck.................	30,000 lbs.
Weight in working order on trailing truck..............	58,500 lbs.
Total engine...................	334,000 lbs.
Total engine and tender........	533,700 lbs.
Wheel base, driving...........	16' 6"
Total engine..................	37' 0"
Total engine and tender........	71' 6½"
Boiler, style..................	Straight Top
Diameter outside first ring.....	86"
Steam pressure.................	200 lbs.
Firebox, length and width......	114⅛" x 84¼"
Grate area.....................	66.4 sq. ft.
Tubes, number and diameter....	253—3¼"
Tubes, length..................	20' 0"
Heating surface, firebox.......	223 sq. ft.
Heating surface, arch tubes....	68 sq. ft.
Heating surface, tubes.........	4,287 sq. ft.
Total evap. heating surface.....	4,578 sq. ft.
Superheating surface...........	1,215 sq. ft.
Water capacity................	10,000 gallons
Fuel capacity..................	16 tons

The designers of this locomotive were confronted with the problem of obtaining a significant increase in capacity without exceeding the weights on driving wheels of the railway company's mikado, Class H7E, these being up to the capacity of track and bridges.

This problem was satisfactorily solved as shown by the following comparisons:

	Class H7E	No. 8000
Weight on drivers, lbs.......	246,000	245,500
Weight, total, lbs...........	328,000	334,000
Tractive effort, with booster, lbs.	......	74,500
Tractive effort, without booster, lbs.	59,000	63,500
Cylinder horsepower, maximum	2,624	3,070
Weight per cyl. horsepower..	125	109

One of the measures resorted to, to keep down the weight of the locomotive was the use of hollow axles and main crank pins

MICHIGAN CENTRAL LOCOMOTIVE OF THE MIKADO (2-8-2) TYPE—BUILT BY LIMA LOCOMOTIVE WORKS, INC.

cised in the design of the reciprocating parts so that not only was there a saving in the static weights, but it was also possible to reduce the dynamic augment, which is the effect at the rail at operating speeds of excess counterbalance. The table indicates the relative dynamic augment of the railway company's present mikado, Class H7E, and No. 8000 at operating speeds of thirty, forty and fifty miles per hour.

CLASS H7E
WHEELS

Speed	Front	Inter-mediate	Main	Back
50 miles.......	9,520	11,200	5,680	9,750
40 miles.......	6,100	7,180	3,630	6,240
30 miles.......	3,430	4,040	2,040	3,510

ENGINE NO. 8000
WHEELS

Speed	Front	Inter-mediate	Main	Back
50 miles........	5,340	5,340	4,080	5,160
40 miles........	3,420	3,420	2,610	3,300
30 miles........	1,920	1,920	1,470	1,860

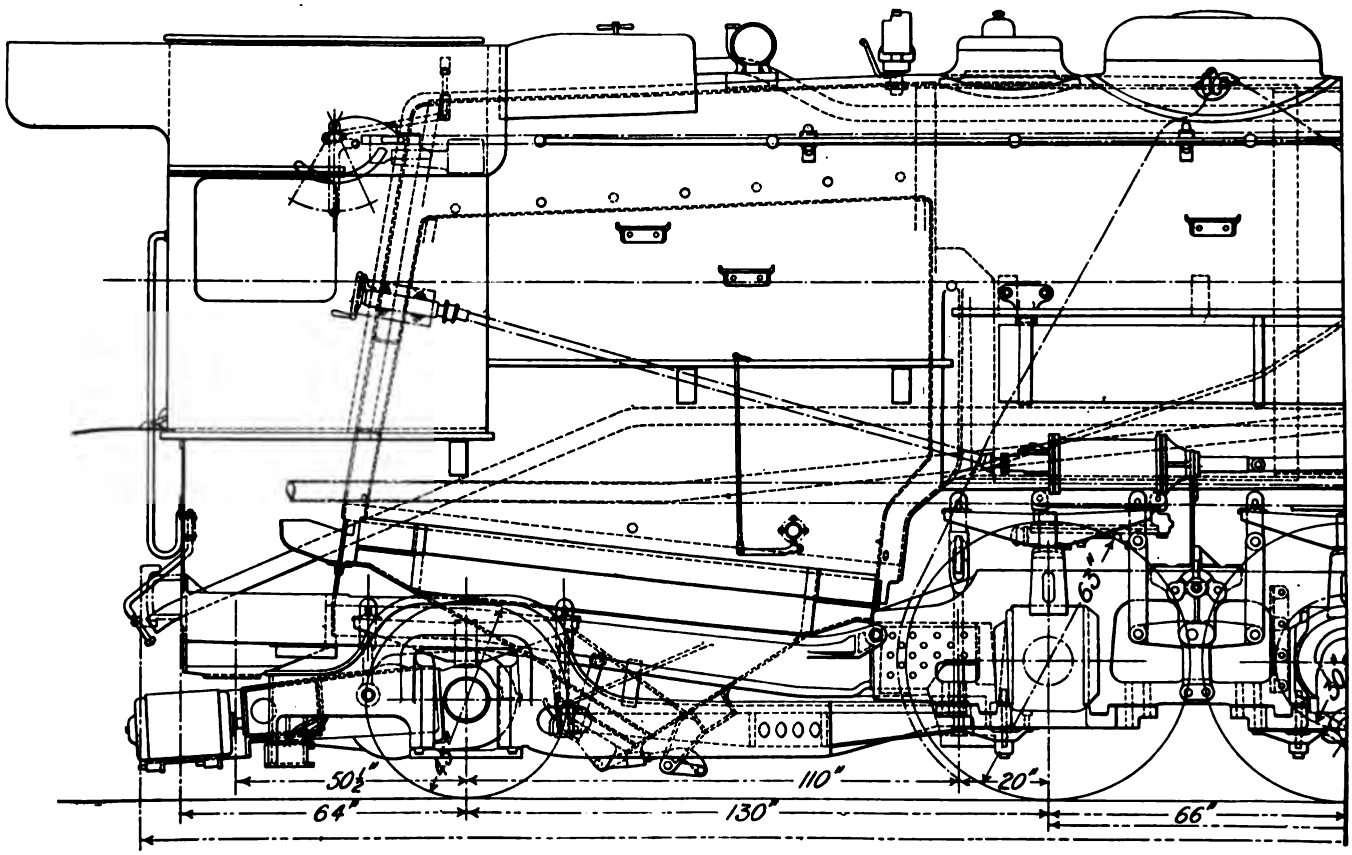
Another primary consideration in the design of No. 8000 was fuel economy, not necessarily the burning of less fuel than previous locomotives, but the ability to obtain the maximum drawbar output for the fuel consumed. This object was these are the Superheater Company's high temperature superheater designed to give a higher degree of superheat than is obtained from the usual apparatus, at the same time increasing the area of the steam passages between the superheater header and the throttle. To this was added the feedwater heater which utilizes a portion of the exhaust steam to heat the feedwater from tank temperature up to about 225 degrees, the condensate being returned to tender.

In the brick arch that is used, there is a decided modification in construction as compared with that of those previously applied. Instead of the single row of two, three or four tubes, there is a double row of tubes and a special form of brick.

The feedwater heater is carried on brackets secured to a permanent section of the smokebox front so that the main front can be removed without disturbing it. This location of the heater permits carrying the condensate to the tender by gravity.

Referring again to the main throttle The engravings show that this is located just ahead of the stack and is accessible from the exterior of the smokebox. The throttle valve is of the double-poppet type, top lift, operated by the outside rigging. The location of the throttle between the superheater and the cylinders obviates the use of the usual dampers and rigging, and quickly to the throttle than when it is placed in the dome. The difference in this respect from previous engines being very marked.

The use of superheated steam is extended to the auxiliaries where it is used in the air pump, feedwater pump, turbo-generator, the mechanical stoker and the booster. The superheated steam for these auxiliaries is taken off from the header through a special opening so as to be quite independent of the throttle and main pipe to the cylinders. In addition to this the piping of the auxiliaries is so arranged that either superheated or saturated steam can be used in them.



SIDE ELEVATION OF MICHIGAN CENTRAL LOCOMOTIVE OF THE MIKADO BUILT BY LIMA

A point that, while it might be considered as one of minor importance, may develop into one of great value is to be found in the firebox design.

It is well known that the corners are the points where the principal difficulty is experienced from leakage. A number of years ago the first step looking towards a remedy for the trouble was taken by thickening the corners of the foundation ring, so as to permit of a double riveting there. Shortly thereafter the double riveting was extended all of the way around the ring.

In the course of some investigations, a few years ago, on the expansion of the sheets of a firebox, it was found that there was a very heavy downward and back- mud ring and the staybolts, because of the inequality in the expansion of the inner and outer sheets of the firebox.

In the engine under consideration an attempt has been made to reduce the stresses, thus set up in the sheets, by increasing the radius of the corners to about 12 in. There is little doubt that this will have the desired effect of distributing the difference in the expansion of the two sheets, and thus lowering the stresses. This is, however, a matter for further determination.

There is still another matter that promises to affect the stresses set up in the firebox even more than the increase in the radius of the corners.

It has been found that in the ordinary firebox the circulation is so sluggish that there is a marked difference between the temperature of the water at the bottom of the water leg and at the top over the cornersheet. It has also been determined that a boiler can be filled with water at any temperature and there will be no deflection of the staybolts, but that as soon as a fire is lighted the deflection of the staybolts starts at once.

From observations that have been made on this engine, it has been learned there is apparently a much greater uniformity of water temperature in the water leg and other points than is usually the case, because of the rapid circulation of the water through the arch tubes. While this will sheets of the firebox as to do away with all staybolt deflection it seems probable that it will greatly modify it. So that we are warranted in looking for a considerable decrease of firebox stresses under the influence of the combination of the large volume of circulation through the arch tubes and the long radius of the corners of the firebox.

There is another item in connection with this long radius of the fire box corner that the operation of the engine seems to show will be of value in the matter of steam consumption. It has always been difficult to keep the corners, especially the back corners of the fire box so fired that holes will not be formed in the fuel bed at those places, permitting large quantities of cold air to be drawn in thus cooling the sheets and interfering with the steam generation. The long radius for the corners is credited with the abolition of this trouble and no difficulty has been experienced in keeping the corners well filled and the fuel bed free of holes.

One of the striking features of the design is the outside dry pipe. This was necessitated by the location of the throttle in the smokebox between the superheater and the cylinders, and the desirability of shutting off steam from the throttle without killing the engine. The shut-off valve for this purpose is located just outside of the dome. The handle of the shut-off valve is clearly indicated on the engraving.

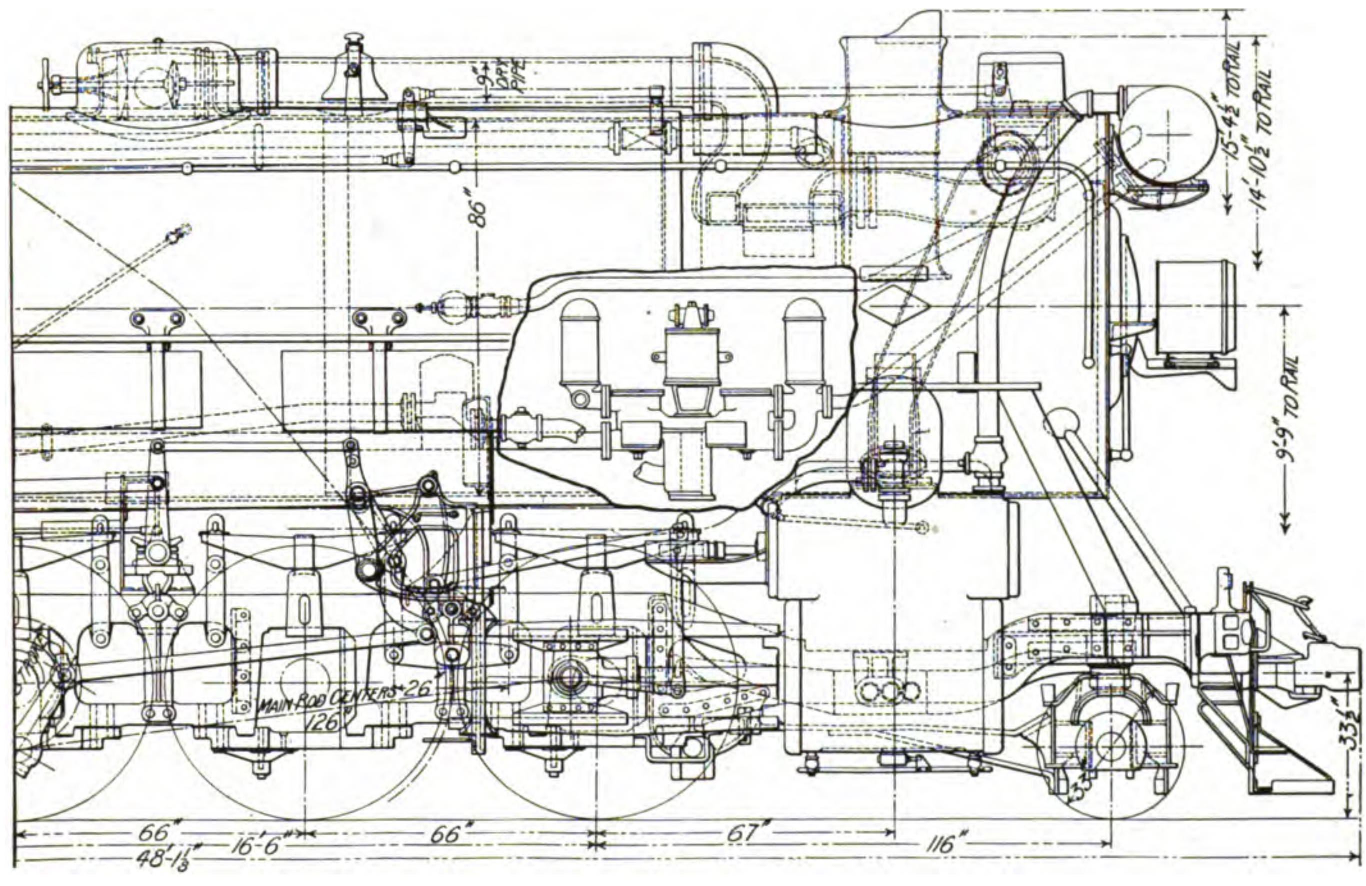
Another novel feature incorporated in this locomotive is a steam separator which is placed at the highest point in the dome. It is designed to entrain the water from the steam before it enters the dry pipe, delivering the water to the boiler at a lower level. It is of the centrifugal type and has been found to be remarkably efficient.

In order to reduce the number of joints the dome and back end of dry pipe are made integral of a steel casting.

Additional power in starting and for operating at relatively low speed is secured by the application of the Franklin Railway Supply Company's Type C-1 booster to the trailing wheels, resulting in an increase of 17 per cent. over the normal power of the locomotive.

The exhaust from the booster is carried to the front end and discharged from a ring nozzle around the outside of the main one. As the booster is geared on a ratio of three to one and the trailing wheel is much smaller than the drivers, the discharge of steam approximates that of the main engine. But, owing to the high speed of rotation of the booster shaft, the shaft is far more uniform than that of the main engines, and therefore tends to produce a greater equalization of draft, approximating that of the engine when ordinarily running at a high speed.

Among the specialties used on the engine are the: Franklin Spreader and Cellar; Main Crank Pins and Side Rods —Lima Special Steel; Franklin Type A-1 Radial Buffer; Franklin Unit Safety Bar; Commonwealth-Franklin Engine Truck; Locomotive Booster; Commonwealth Type "B" Delta Trailing Truck with Constant Resistance Centering Device; American Arch Co.'s Type "P" Arch; Franklin Adjustable Wedge; Franklin Grate Shaker; Pyle National Type K-2 Generator; Superheater Co.'s Feedwater Heater; Baker Pilliod Co.'s Valve Gear; McLaughlin Flexible Joints; Franklin Sprinkler; Franklin Type "D" Precision Power Reverse Gear; Elvin Stoker; Superheater Co.'s Type "E" Superheater; Commonwealth Tender Frame; and the Commonwealth 4-wheel Tender Truck.



(2-8-2) TYPE WITH SECTION CUT OUT OF BOILER TO SHOW FEED WATER PUMP.
LOCOMOTIVE WORKS, INC.

The engine has been given much wider range of service than is usually accorded. It was previously designed to haul a heavy train in fast freight service and especially adapted therefor, but it has proven its effectiveness in very heavy, relatively slow drag freight service to the extent of hauling 10,039 tons in 147 cars, a train 1¼ miles long, from Toledo, O., to Detroit, Mich., a distance of 47.6 miles, on June 30, 1922, in 3 hours, 31 minutes running time.

The engine has been in operation since about the first of June between Detroit and Toledo, and between Toledo and Jackson, Mich. The Michigan Central Railway is preparing to make exhaustive test of the engine, data from which will be available at a later date. So far the engine has exceeded the expectation of the builders both in developing high drawbar pull and in economy of operation.

On June 24, 9,254 tons in 138 cars were hauled from Detroit to Toledo, without help, a distance of approximately 55 miles, no trouble being experienced in starting this train with the booster in operation; in fact for the first 10 miles the tonnage was 9,394 tons in 140 cars, 2 cars being set off on account of hot boxes. On June 30, 10,039 tons were hauled over this division in 147 cars, as stated above, when no assistance was required to start or haul the train.

No trouble has been experienced in maintaining full boiler pressure when operating at maximum capacity, while the evaporation per pound of fuel is phenomenal, as shown by the fact that for 3 of the full tonnage runs made between Detroit and Toledo, the total water divided by total fuel averaged 9.7 lbs.

Pocket Respirators for Locomotive Engineers and Firemen

The development of a pocket canister or respirator which will largely alleviate the discomfort to which engine crews are subjected from the presence of sulphurous locomotive smoke when passing through railroad tunnels is announced by the United States Bureau of Mines. The canisters, which fit conveniently into a coat pocket, are filled with an absorbent mixture of activated charcoal and soda-lime, and contain filters of Turkish toweling. These small smoke respirators have had the hearty approval of the men who have used them, and retain their effectiveness for months. They may be cheaply made and are a great improvement over the sponge respirators and handkerchiefs and towels now used by engineers and firemen when passing through unventilated tunnels.

The Bureau of Mines has also conducted tests to determine the efficacy of the Army gas masks for use on locomotives in railroad tunnels. It was found that Army gas masks, having canisters filled with charcoal and soda-lime mixture and with a cotton-pad filter, gave good protection against the smoke and irritant gases. One constituent of smoke, carbon monoxide, which is poisonous but tasteless and odorless, penetrates these canisters; but experience has proven and analyses taken during the tests showed that on moving trains the amount of carbon monoxide present was not enough to be dangerous.

The extreme discomfort caused by breathing sulphurous locomotive smoke while a train is passing through a tunnel is familiar to anyone who has ever been a passenger in a coach near the locomotive, especially if all the windows are not carefully closed. Bad as these conditions are for the coach passengers, they are almost intolerable in the engine cab where the hot smoke and exhaust steam direct from the stack envelopes the cab and fills it with hot, choking gases. The temperature in locomotive cabs while passing through tunnels have been found to range up to 162°F. Track workers are subjected to great discomfort after trains have passed.

Aside from the question of extreme discomfort, locomotive smoke may contain poisonous and asphyxiating constituents which have occasionally overcome, sometimes fatally, numbers of the crew of engines that have become stalled in poorly ventilated tunnels. A number of such cases are on record.

In a tunnel, the tunnel crown deflects the smoke from the stack upon and around the locomotive. Mixed with air and exhaust steam, the smoke enters the cab and surrounds the engineer and fireman with a hot, vitiated atmosphere. Discomfort produced by the sulphurous smoke is intensified by the heat and humidity from the flue gases and exhaust steam. Slow, heavy freights going up grade through long, unventilated tunnels cause the most discomfort, especially when two or more locomotives are used; and when trains become stalled the crews are in danger of being overcome. Carbon monoxide from locomotive flue gas, augmented in its effect by the high temperatures, is the probable cause of such cases of men being overcome.

Respirators of the "pig-snout" type containing wet sponges afford some relief by cooling the gases and absorbing some of the irritating constituents of smoke. Protection is not complete and most of the men will not bother with such respirators, preferring to tie handkerchiefs over the nose and mouth.

The experiments of the Bureau of Mines were conducted in 23 tunnels of the Baltimore & Ohio Railroad between Grafton and Parkersburg, W. Va., in the Gallitzin tunnels of the Pennsylvania Railroad near Altoona, Pa., and in the Schenley tunnel in Pittsburgh. Various types of gas masks were worn by the experimenters in the cabs and by the engine crews in these tunnels; gas samples of smoke-contaminated atmospheres were taken in the locomotive cabs or at the cab windows and carefully analyzed in the gas laboratory of the Pittsburgh experiment station of the Bureau of Mines. Other tests were made by trackworkers and by the experimenters while in a tunnel on foot.

These tests represent one phase of the work carried on by the gas-mask laboratory of the Bureau of Mines at Pittsburgh, Pa. For many years the bureau has been making experiments to improve and perfect self-contained oxygen breathing apparatus for the conduct of rescue work at mine disasters resulting from fires or explosions. As a result of its experience, it was called upon early in the war, to take a large part in the development of the Army gas mask.

Details of the experiments are given in Technical Paper 292 by A. C. Fieldner, S. H. Katz, and S. P. Kinney, which may be obtained from the Bureau of Mines, Washington, D. C.

Unit Operating Costs Reduced

The Bureau of Statistics of the Interstate Commerce Commission has issued a summary, compiled from the reports of 181 Class I railroads, showing the freight and passenger train service costs for the five-month period ending May 30, 1922, compared with the same period last year. Substantial reductions in the cost of operating trains are shown.

In the five-month period in 1921 costs of repairs on freight locomotives per mile run were 4.42 cents and, in 1922, 4.19 cents. In 1921 freight engine house expenses for each mile run, per locomotive using that house, amounted to 1.18 cents. In 1922 these costs were reduced to .87 of a cent.

The costs of freight engine men and train men, for each mile run in 1921, were 2.51 cents and 3.00 cents respectively. In 1922 these were reduced to 2.25 and 2.66 cents.

Reductions in costs of fuel consumed for each mile run were reduced from 5.85 cents to 4.63 cents, and costs of locomotive and train supplies were reduced from 1.15 cents to 1.07 cents.

For passenger traffic the figures show similar reductions. Locomotive repairs were reduced from 2.63 cents to 2.49 cents and engine house expenses from .80 to .62 of a cent per mile.

Costs of the engine men and train men per passenger train mile were reduced from 1.37 cents to 1.26 cents and 1.60 cents to 1.39 cents respectively.

Fuel costs per mile were reduced from 2.63 cents to 2.11 cents and other supplies for trains and locomotives from 1.03 cents to .90 of a cent.

Self-Propelled Cars in Australia

Self-propelled cars for steam railway service are receiving attention in countries other than North America. It appears that three gasoline motor cars are under construction for the Western Australian Government Railways. The chassis for them have been built in Bedford, England, and the bodies are being built in Australia. The length of the cars are 24 ft. 4 ins.; width, 8 ft.; height, 10½ ft.; wheelbase, 9 ft.; gauge, 3½ ft.; weight car loaded, 13 tons. These cars will be driven by a 45 horsepower gasoline engine with heavy flywheel, and will be equipped with electric lighting and starting equipment. They are designed to run at a speed of 25 miles an hour on level track and 10 miles on 2.5

Daniel Willard, President of the Baltimore & Ohio on the Strike Negotiations

Mr. Daniel Willard, President of the Baltimore & Ohio Railroad Company, when asked what further steps would be made looking to a settlement of the strike, stated that he knew of no further steps to be taken and that he personally could not say what further could or would be done. That no more effective or earnest mediators could be found than the chiefs of the five engine and trainmen's brotherhoods had proved to be and he believed that the railroad executives of the minority group in their efforts to reach an agreement had made an absolutely equitable proposal and had made every concession possible under the circumstances without result, and it would seem there remained nothing to do but proceed to build up forces from those who were desirous of performing service. That on the Baltimore & Ohio Railroad there was at work more than 60 per cent of a normal force, that more than 1,600 men were employed at the Mt. Clare shops where something over 50 per cent of normal heavy repairs were turned out during the month of August. That, of course, the situation was not satisfactory and now that efforts at conciliation have failed the company was naturally redoubling its efforts to recruit forces and resume normal operations.

Concerning the conference between the chiefs of the five engine and trainmen's brotherhoods acting as mediators and the group of 52 railroads for which it was und[illegible] acted as chairman and spokesman. He said he was glad to discuss the matter because it seemed to him that in some instances the public had failed to properly interpret the statements given out in New York following the meeting. He said he wished to explain, first of all, that the fifty-two railroads referred to, which continued the negotiations, had agreed fully with the other lines in rejecting the proposition which had been submitted to the larger meeting of the Association of Railway Executives, because, while in different language, the proposition was the same as that which had previously been presented requesting the reinstatement of the men on strike with seniority and other rights unimpaired.

A considerable number of the executives, however, while unwilling to accept the proposition that had been presented, were hopeful, nevertheless, that some other proposition could be developed which would lead to a settlement and which they could in good conscience accept. This resulted in the smaller committee being formed and further conferences with the mediators.

As a result of the renewed conferences which continued the greater part of two nights and a day, the minority group of the railroads, so called, agreed to take back into the service all of the shop craft employes who had not been guilty of proven acts of violence, and to assign them in positions of the class they originally held on June 30th at the same terminal point where they were then employed, and at the rate of wages fixed by the Labor Board. It was pointed out, however, that owing to the large number of new men employed who would continue in service, some time would be required to bring about this arrangement in an orderly manner. The railway presidents agreed that they would either carry out in its entirety the proposition stated above by the first of October, or on that date they would put on pay such men as had not then been assigned to regular work.

The minority group of which I am now speaking also agreed to let the men who had been on strike retain all of their pension, pass and other privileges of that character which had been gained by their term of service with the company. In other words, the railroad companies did not seek to avail themselves of the situation to curtail privileges of any character gained by years of service.

Having in mind the normal requirements of the carriers for men of the shop crafts at this season of the year, together with increased requirements resulting from a reduced working force for nearly two months, these companies were willing to pledge themselves to find employment for all of the striking employes not guilty of proven acts of violence, believing that the requirements of the situation would afford ample work for all for many months to come. It should be clearly understood, however, that at no time did any of the railroad presidents agree, nor would they agree, to make any settlement that would in any sense adversely affect the rights or the privileges of the old men who did not go on strike, or the new men who had been hired since the strike began.

It was further proposed that a committee of ten should be appointed, made up of the five brotherhood chiefs who were acting as mediators, and the five railroad presidents who were meeting with them, and that this committee should have power to hear and make final determination concerning any matters of misunderstanding growing out of the strike and which might arise up to but not beyond the date of May 1, 1923. It was believed by the railroad executives that few matters would be referred to this committee providing both parties to the controversy were willing to approach the subject in a spirit of genuine conciliation, and this the railroad executives pledged themselves to do.

A memorandum setting forth the above terms was submitted to the fifty-two railroad executives of the minority group and they accepted it. It was also submitted by the mediators to Mr. Jewell and his associates and they rejected it. It should be evident to any one that the railroad executives in accepting the proposed basis of adjustment had in effect granted the substance of all that the striking shop crafts asked for, as it would have put all the men to work at once at the same class of work as of June 30th, and at the same terminals, with all pass, pension and other similar privileges unimpaired. The leaders were unwilling to have the men return to work even on such conditions unless the companies would agree that on the very day of their return they would be put back on the roster as of June 30th and ahead, where necessary, of men who had remained in the service.

The railway managers felt that the seniority rights which had ben gained by the employes who remained in the service under well established rules were as much a part of their compensation as the money which they had received in wages, and they were not willing, under any circumstances, nor did they feel they had a right, morally or legally, to take from the men who had remained at work any part of their compensation, whether represented in money earned or privileges acquired. I think it must be admitted that the railroad executives of the minority group in their efforts to reach an agreement made every reasonable concession possible in order to accomplish that result. They were not willing, however, to look upon their promise to the men already in the service, whether the promise was verbal or in writing, as a scrap of paper to be thrown aside at will. Short of that one thing, they were willing to grant every other concession which the men requested. It must be apparent, therefore, that no compromise settlement of the situation is possible unless the railroad executives are willing to accept the policy that a promise or contract is something to be broken and not something to be kept.

The railroads must keep their obligations to the men who are in their employ, and there is clearly now but one course left, namely, to continue to build up their force as rapidly and effectively as possible, and this the Baltimore & Ohio, like others, is proceeding to do.

Mr. Willard was chairman of the committee that represented 52 Class I roads that failed in their negotiations for separate agreements between them and the leaders of the striking shopmen on August 25th, on the issues as stated.

The Advantages of American Locomotives

A British Authority Expresses the Superiority of American Over British Designs

The superiority of American locomotives over those of British or other European manufacture was illustrated by the presentation of a paper by P. C. Dewhurst, an eminent engineering authority engaged on the Jamaica railways, before the members of the Institution of Mechanical Engineers of England, and from which we take the opportunity to make some abstracts.

Regarding the advantages claimed for the American locomotives in newly developed countries, there are: (1) Compensating gear in the spring rigging which gives an easy-riding engine even on poor track, and prevents a large proportion of the derailments which happen to uncompensated engines on such tracks; (2) the very substantial and rigid support given by the shoes and wedges, which are an inherent feature of the bar frame, and which have no frame bolts to work loose; (3) the design of axles and axle-boxes which have adequate bearing area, provides opportunity to allow ample side-play without unduly reducing the bearing area; the use of flangeless wheels; and (5) a generous allowance of boiler power, enabling poor fuel to be used. All of these features, with the exception of (2) which, however, is overcome in other ways, are as easily obtained in the British plate-framed locomotive.

The author considers the American practice of providing a larger proportion of boiler capacity for a given cylinder capacity than in British practice, is the better policy, and even after allowing for the general inferiority of coal used in America, there is still an advantage. The general effect on the British locomotives, until recent years, has been that engines dropped behind in boiler capacity until only the full normal cylinder capacity was equal to meeting the demands of traffic, with the consequence that boilers were overtaxed and the economy which might have been obtained from the relatively large cylinders was probably lost by the reduced boiler efficiency.

The latest tendency in modern British practice is to use three or four cylinders when additional power is required, necessitating larger cylinder volume than can be provided either by two inside or two outside cylinders, owing to the restrictions of the British loading gauge. No such practice has been perpetrated in America; when an engine of such power is desired that it cannot be provided for by the employment of a single pair of outside cylinders, a Mallet or other special type is used. Modern American practice proves emphatically that the more even turning movement obtained from three or four cylinders in one tractive group is not considered by American engineers to be worth the extra complication. This may be surprising, as in a comparatively few years ago four-cylinder balanced compounds were for a time much in favor.

Placing the cylinders outside is entirely preferred by the author, except perhaps in certain cases of locomotives of medium power for fast work, where the slightly steadier running and the better protection from radiation losses make it worth while to accept the attendant disadvantages.

There is little to be said when comparing the modern British method in the installation of outside cylinders, of employing separate castings for the cylinders and steam-chests on each side, and a box casting between them under the smoke-box, with the American method of using two castings only, meeting in the middle and forming a saddle between the frames for the smoke-box. The methods are conveniently applicable to the plate and bar-frames respectively. The American method possibly gives rather more weight at the leading end—where it is not wanted—but it is doubtful if this comparison holds good when the British arrangement includes a saddle casting for the smoke-box.

The employment of compensating arrangements in the spring rigging of all locomotives is the outstanding feature of American design and has undoubtedly had great effect in obtaining the American locomotive's good reputation in countries having new and difficult tracks. In long and multi-wheeled locomotives it can be clearly observed that the levers assist the easy riding of the engines almost as much as the springs themselves, and the manner in which a defective high spot in the track passes along and articulates the whole compensating gear when passed over at speed, is conclusive.

The greatest difference between the practice of the two countries is, of course, in the use of steel for fire-boxes in America. The author considers that the copper box is superior from the point of view of ease of maintenance, facility of repair and general dependability. The steel fire-box, however, can be quite successfully used under the most arduous service conditions and in British pattern boilers, even with the old system of patching when necessary; with the great strides made in electric welding, however, there now seems nothing to choose between the two materials in respect to repairs. The question is whether the extra cost of the copper fire-box is justified for the sake of its greater reliability under the circumstances and character of any particular railway and its services.

The American-Schmidt pattern is now standard in America, this type being identical with the Schmidt, except that metal-to-metal spherical-cone joints are employed in connecting the units to the header instead of the ring joints as generally used in British locomotives. The author has a very high opinion of these joints, based on experience with them under trying conditions. He is unable to see why the old ring-type joint with asbestos jointing is continued in British practice, and for the same reason he does not see any necessity for the method of fastening the unit tubes into the header by expanding them, as in some systems of fastening; this method appearing rather an arduous one to accomplish a simple result.

American practice in respect to smoke-box fronts and doors, also differs fundamentally from the British; the fronts are made easily detachable, being bolted on, are generally of pressed or cast-steel, very often of cast-iron and the door, which is also of cast-iron is always made very much smaller in proportion, usually about half to three-fifths the diameter of the smoke-box.

The author's experience is altogether in favor of the American form of injector, namely, the self-acting restarting pattern of the "lifting" type. Its [illegible] operating handle makes it much easier to "catch" the water than is the case with the British screw-cock, and further with the American injector the water-valve may be shut off to about 50 per cent after the injector has started to deliver, and thus more control over the rate of feed to the boiler may be obtained.

Steam reversing-gear is practically always fitted to American locomotives of any appreciable size now, but for many years the old plain lever was retained on even the largest engines, until, finally, the duty became so heavy that power-operated arrangements were adopted. It is remarkable that the screw-reversing gear as employed in British practice for so many years was not commonly used, except on the Pennsylvania Railway from about 1914. Observations show that drivers of engines with lever-reversing gear do not follow and take advantage of the variations of gradient as on engines equipped with screw-gears or power-reverse gears.

Piston-heads do not differ much in either country, the usual single-plate pattern now being practically universal. In American practice more attention is given to lightening the heads, rolled and cast steel being used for this purpose; this is a great improvement on the practice there a few years back of employing double-walled hollow piston-heads of cast-iron, some cast in one piece and others built up in a fashion very conductive to failures on the line due to small parts working loose.

Piston tail-rods are not commonly used in American practice, and where these are used they are for pistons 27 in. diam. and upwards, as against the British practice of applying tail-rods to pistons over 19 in. or 19½ in. diam., nor are supporting springs inserted in the piston head to confine the wear caused by its weight to the rings instead of the head itself.

Comparing the types of big ends generally used, it is noticeable that American practice usually favors the old "strap" type, similar to those commonly used on inside-cylinder engines; whilst this is no doubt cheaper in first cost, it is more troublesome to maintain than the open-end or closed-end rods generally used with outside cylinders on British engines. The large mass of metal in the strap type is concentrated in an unfavorable position, such weight being preferably beyond the big end centre, not between the two centres of the rod. In certain cases, however, where small diameter driving-wheels are combined with a long piston-stroke, open-ended big ends cannot be used owing to the chances of the filling-block bolt striking obstructions on the ballast, at level crossings, etc. No comment is made regarding little ends, the usual types being common to both countries.

American railways use a heavier bodied oil than British, generally speaking, and mostly depend on saturated elastic packing, as it is termed—composed of cotton and wool waste with a small proportion of horse-hair, then saturated and drained—in the keeps or cellars of the axle-boxes; auxiliary oil-boxes, etc., are never used either for the journal-bearings themselves or for the wedges, some strands of the elastic packing worsted, leading from the small well of oil in the axle-box top to two holes running into the journal oil groove, and a few other strands leading to the rubbing faces of the box, being the usual method.

Slide-bars, motion rods, etc., are lubricated similarly to British practice, but controlled by adjustable needle-valves instead of trimmings, although considerable use is now made of grease for connecting and coupling rods, being placed in the ordinary oil-cups (but with the stems removed) and caused to work its way into the bearings, partly by initial pressure applied by means of a long plug-cap substituted for the ordinary cap, and partly by the heat generated by the bearings themselves. A great many American-built engines are now running, in which the axle-boxes are also grease-lubricated — from below — special spring-operated "lifters" fitted in the keeps causing the grease to be applied under the axle-journal; this is stated to give great economy in lubrication costs.

Another point of interest in the lubrication of American locomotives is the entire absence of independent suction-lubricators, comparable to the "Furness" type, to come into action automatically when the engine is drifting. This is explained by the practice current there of running down-hill with the throttle slightly open, thus keeping sufficient steam circulating to afford lubrication, together with the ordinary sight-feed lubricator. In some cases a special steam-cock is provided in the cab for the express purpose of supplying this small amount of steam when drifting with an entirely closed regulator.

It is not proposed to go into the question of air-brakes versus vacuum brakes—this being a subject of sufficient magnitude to form a Paper by itself. Certain points in connection with brake-rigging—foundation brake-gear as it is termed in America—may, however, be noticed. The methods of attaching brake hangers to frames did not generally receive such care in American practice as in British, but nowadays more attention is given to the matter, and it has become general to provide special bosses and lugs integral with the bar-framing for the purpose.

It is unquestionable that central automatic couplers as used in America are superior to the old British system of hooks, links, and drawbars, together with side-buffers. Side-buffers increase the resistance of trains rounding sharp curves—unless the couplings are slack, which is a defect in itself—and are theoretically incorrect. Further, the hooks and links are not sufficiently strong to cope with the large loads which are hauled in America, and in some of the Colonies.

In conclusion, the author expressed a belief that his views would be supported by most locomotive engineers who had had experience both in American and British locomotive practice, and it is a peculiar circumstance that British engineers are slow to adopt improvements that are so transparent, but this is not entirely confined to British engineers alone as it took many years for Americans to see, or at least to adopt the outside systems of valve gears long after they had become almost an absolute necessity on the longer types of locomotives.

Electrification of French Railways

According to information recently given out by the French Minister of Public Works, it has been decided to electrify the whole French railway system, thereby reducing costs and doing away with the importation of foreign coal. Following an exhaustive inquiry, confirmed by the visit of a technical commission to the United States, the direct-current system of 1,500 volts has been adopted, and already various companies have begun work on the electrification of the more important sections.

The three railway systems making greatest progress toward electrification are the Midi, the Paris-Orleans, and the Paris-Lyon-Mediterranee. It is hoped to make the change within a few years on the Paris-Vierzon-Brive line, and also on the branches between Limoges, Montluçon, Gannat, Brive, Tulle, and Cleremont-Ferrand. This region is situated in the vicinity of the Dordogne River and its tributaries, which have hydroelectric power estimated at 400,000 kilowatts capable of development. The lines of the Midi between Tarbes and Bagneres-de-Bigorre, Lourdes and Pierrefite, and Perpignan and Villefranche have already been electrified; within two years the lines between Toulouse and Dax and between Montrejeau and Luchon will be completed.

The electrification of the Paris-Orleans and the Mediterranee railways will be rendered easy by the water power of the Rhone, the Alps, and the central plateau. The company has planned the electrification of 1,430 miles of its lines, or about 23 per cent. Within four years the line from Culoz to Modane will be electrified, as an experiment; later on, the stretches from Nice to Coni, Lyon-Marseille-Ventimiglia, Lyon to Geneva, Lyon to Grenoble, and the suburban lines about Paris will be run by electricity.

Automatic Control on British Railways

Automatic control systems are being gradually but steadily introduced on the railways of Great Britain. The Great Western Railway has about 200 miles of track and 100 engines fitted with an electro-mechanical apparatus and the North-Eastern Railway has equipped about eighty-nine route miles with a purely mechanical appliance and seventy-five per cent of the company's locomotives have been fitted with the apparatus. On the Great Central system forty-two route miles of railway have been selected for the installation of an apparatus which gives full control at stop signals. The Ministry of Transport Committee on automatic train control, after examining about two hundred inventions, came to the conclusion that the system likely to prove most suitable to existing conditions is of the contact type designed to operate in conjunction with existing methods of signalling. The need of standardizing the apparatus used is emphasized and in the scheme outlined by the committee there is general control and an audible warning device at distant signals to meet fog conditions. The initial cost of the sheme is about £4,660,000 and if, for financial considerations, it cannot be given effect to in full, preliminary steps for introducing control at selected stop signals are to be taken.

A Thermostatic Control of Car Heating

A Detailed Description of a Recent Development in Electro Thermostatic Control

To satisfactorily control the temperature of passenger cars has been a problem ever since the first stove was placed in the center of a coach and developed the maximum known variation in the heat of that limited space. Thermostatic control was undreamed of in those days, but from the date of the introduction of steam heating from the locomotive, temperature control has been gradually improving.

One of the latest and most successful developments along this line is a method of thermostatic control brought out by the Vapor Car Heating Co. of Chicago.

The fundamental principle of the system consists in the use of an electric current whose circuit is made or broken by a thermometer placed in the car, to regulate the flow of steam to the heating pipes. In order to effect the maximum of economy in the use of steam two thermometers are used, one in which the circuit is made when the temperature of 50° Fahr. is reached and the other when it rises to 70°. The former is used for holding a moderate amount of heat in the cars while they are standing in the yards and the other while they are occupied and in service.

This regulating circuit is shown in diagrammatic form in the accompanying engraving, Fig. 1. The two mercury thermometers marked 70° and 50° respectively have wires fused into their tubes below the ordinary mercury line and at the 70° and 50° points respectively. This is done before the thermometers are calibrated so that the amount of mercury put in can be gauged accordingly.

Without going into a detail description of the wiring it will be necessary to follow the flow of the current from the battery in order to fully understand the operation of the automatic regulation of the temperature.

With the car cold and no air in the brake system both thermometers are below their contact points and the circuits there are broken. The solenoid bar and contact breaker *A* is in its lowest position, resting on the supports *B* while the connection between the two contact points *C* is broken. The wire *D* leads to the contact ring *G* of the air selector switch through which a current can flow to the wire *E* when the mercury in the 50° thermometer has risen to that point.

Under these conditions the current flows from the battery through the resistance coil, to and through the relay coil and the wire *I* to the battery. This current energizes the relay coil which lifts the solenoid core and contact bar *A* away from the supports *BB* and into contact with *CC*. This short circuits the current which, following the line of least resistance, flows across the gap *CC*, through the wire *H*, the "On" coil of the solenoid steam valve to the wire *F* and *I* to the battery.

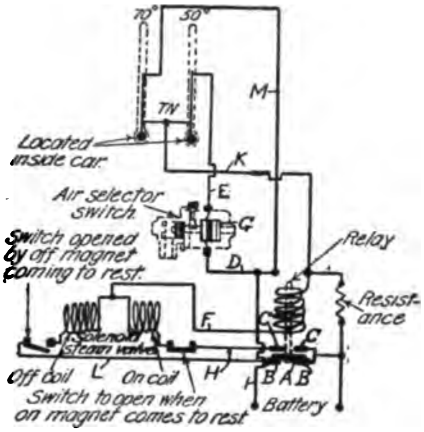


FIG. 1. DIAGRAM OF WIRING.

But as soon as the "On" coil of the solenoid steam valve is energized it opens the valve admitting steam to the car system. This opens the switch next the "On" coil and closes that of the "Off" coil, breaking the contact between the "On" coil and the battery, while the contact of the "Off" coil is broken by the position of the bar *A* against the two contacts *CC*.

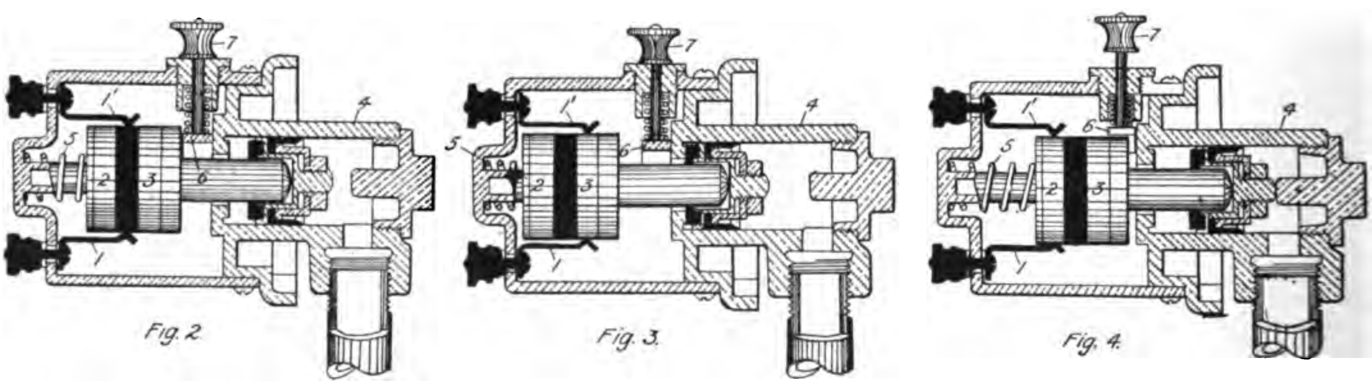
Steam is thus admitted to the car and its temperature rises until the 50° thermometer registers at that point. Then with that contact made, the current again follows the line of least resistance, passes through the resistance to the wire *K*, through the 50° thermometer, back through the wire *E*, across the air selector switch to the wires *D* and *I* to the battery. This diversion of the current, de-energizes the relay and the bar *A* drops, forming a contact at *BB*. As soon as this is done the current flows through *B* to the wire *L* through the previously closed switch at the "Off" coil, energizes the "Off" coil which closes the steam valve, opens the "Off" coil switch and closes that of the "On" coil. This breaks all circuits except that of the 50° thermometer circuit.

With the steam shut off the temperature of the car falls until the thermometer contact is broken and the cycle is repeated.

This is for maintaining the low temperature in the yards.

When the cars are made up into a train and the brake system is charged with compressed air, the air selector switch which previously occupied the position shown in Fig. 2, is moved to that shown in Fig. 3. This moves the cylinder so that the two contact brushes 1 and 1' rest upon the insulating washer 2 and no current can flow between them.

Under these conditions the mercury contact of the 50° thermometer has no effect upon the flow of the current and the steam remains turned upon the car until the contact is made by the 70° thermometer, when the car temperature has reached that point. The current then flows through the 70° thermometer to the wire *M*. As soon as this occurs the relay solenoid is de-energized and the bar *A* drops permitting the current to energize the "Off" coil which closes the steam valve and opens the "Off" coil switch. The temperature of the car then falls until the 70° contact is broken



SHOWING VARYING POSITIONS OF AIR SELECTOR SWITCH.

and the cycle of operation repeats itself.

The energizing of the "On" or "Off" coil of the solenoid of the steam valve is the matter of an instant only; too short to be measured, so while the current consumption required to move the valve is comparatively high, it lasts for so brief a period as to put no appreciable drain on the battery. In fact the total consumption is less than one-tenth of an ampere.

The air selector switch is shown in enlarged detail in Figs. 2, 3 and 4. It consists of an air cylinder 4 with a piston packed with an ordinary special Wabco cup packing.

On the same stem with the piston is the cylinder already referred to, which is built up of the two insulating washers 2 and 3 and the contact washer *G*. Back of this is a spring 5 which is always in compression and tends to push the cylinder and piston to the right.

Under conditions when the brake system is free of air the spring pushes the cylinder and piston to the right until the former is

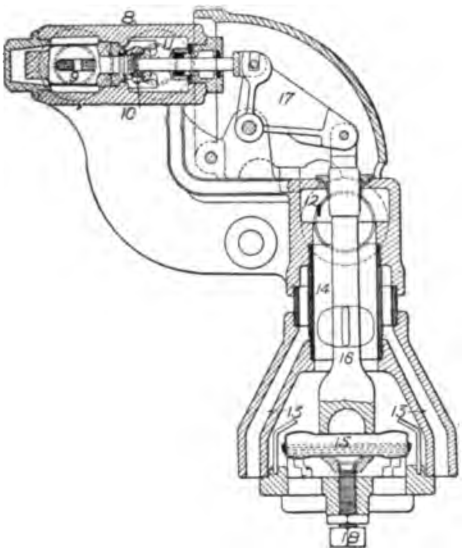


FIG. 5. VAPOR REGULATOR.

in contact with the stop 6 as shown in Fig. 2, and the contacts 1 and 1^1 can then carry the current when the 50° thermometer closes its contact. As soon as air pressure is built up in the car the piston and cylinder are moved to the left as shown in Fig. 3 and the contact brushes rest upon the insulating washers 3.

If it is desired to raise the temperature of the car to 70° while it is standing in the yard and there is no pressure in the air line, the stop 6 is raised by the stem 7 and the spring 5 will then push the cylinder and piston to the right, as shown in Fig. 3; when circuit of the 50° thermometer will be broken because the contacts 1 and 1^1 are then resting on the insulating washer 3 and the 70° one brought into action as when air is on the car.

After the car has been put into the train, and air applied the piston and cylinder are moved to the left and the stop 6 is pushed spring, when the system functions as before.

So much for the thermostatic portion of the apparatus. As the name of the controlling company implies the system uses a vapor method of heating instead of steam under pressure.

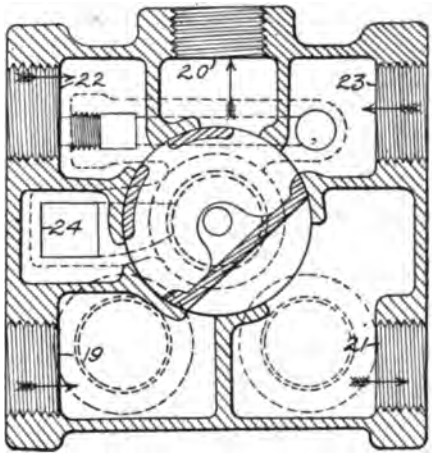


FIG. 6. CUT-OUT VALVE, SHUT OFF POSITION.

This involves some special features that are embodied in the form of valve and trap that is used and which is shown in section in Fig. 5. The valve casing 8 contains a chamber 9 in which steam at full train line pressure is always present. Steam from 9 passes into the chamber 11 past the valve 10, which is made to close against the pressure in 9. From 11 the steam flows into the radiator pipes of the car, through which it passes freely to the outlet 12. As it enters the regulator at this outlet the water of condensation drops down into the annular space 13 and drips on the ground. At the same time, the uncondensed steam flows down through the central space 14 and comes into contact with the enclosed expansive diaphragm 15. This diaphragm is partially filled with a volatile liquid which, as it is heated by the steam, expands and lifts the stem 16 and, thence, through the bell crank 17 closes or tends to close the valve 10 and thus restrict the flow of steam from the chamber 9 to the chamber 11.

As the lower end of the tube 14 is always open to the atmosphere it is impossible for any pressure to accumulate in the radiator pipes, which can only be subjected to atmospheric pressure; a condition that avoids the necessity for the use of traps.

The flow of steam into the car pipes under atmospheric pressure is, thus, automatically controlled by the expansion of the diaphragm 15 whose position, for the purposes of accurate regulation of the flow of steam, can be adjusted by the set screw 18 upon which it rests.

With this arrangement steam is admitted to the car only in such amounts as will insure the maintenance of the proper temperature of the diaphragm 15. Its admission to the radiator pipes for controlling the temperature of the car has already been

The solenoid of the steam valve is attached to the stem of a directing or cut out valve, not a true shut-off valve. This valve serves merely to direct the flow of steam to the radiator pipes or direct to the valve and trap of Fig. 5.

The construction and operation of this valve is shown in Figs. 6 and 7. These represent a cross section of the steam valve.

In Fig. 6 the directing or cut out valve is shown for the closed position and the steam, which enters at the connection 19 will flow across and past the valve to the outlet 21 and into the regulator or drip. At the same time any water of condensation in the radiator pipes flows down by gravity and through the openings 20, 22 and 23 and across the back of the valve to the drip chamber 24 directly to the ground. The whole system is thus open to atmospheric pressure.

In Fig. 7 the directing valve is shown in the open position as directing the flow of steam into the car. In this case the openings to the passages 22 and 24 are closed. The steam admitted at 19 flows through the wing valve and out at 20 into the radiator system. After circulating through one-half of the radiator system it returns through 22 where the water of condensation is deposited in a plain trap, or water seal, which connects through chamber 23 to outlet of regulator shown by the dotted lines, while the steam flows on in to the other half of the coils and back in at 23 from which it passes through the other side of the wing valve and out to the drip of regulator through the outlet connection 21.

With this system of automatic thermal control, there is no necessity of using a variable number of coils to meet the requirements of the outside temperature. Either all or none of the coils are in use at any one time.

In ordinary practice the thermometers

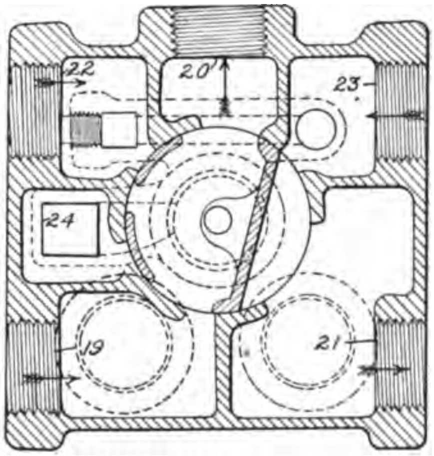


FIG. 7. CUT-OUT VALVE, OPEN POSITION.

are located about 6 ft. from the floor against the side near the center of the car. With the warm air rising directly against them they are apt to register the cutting off temperature before it has been reached distribution of heat, the amount of radiator surface is made greater at the ends than at the center. A system of piping that is recommended for the accomplishment of this purpose is shown in Fig. 8, using the same amount of pipe heretofore installed but distributed differently.

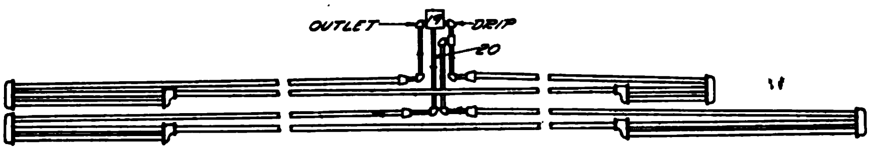


FIG. 8. GENERAL ARRANGEMENT OF RADIATOR PIPING.

The steam enters at 19, passes through the directing valve and out at the pipe 20. It then follows in the direction indicated by the arrows, passes to one end of the car, thence back to the other and finally back to the center where the water of condensation flows out at the drip and the steam makes another round of the car before it finally escapes to the trap. It will be noticed that at the ends of the car the single lead pipe is discharged into two pipes through a Y connection, thus increasing the radiating surface at the ends and maintaining the temperature at these up to that obtaining at the center.

The whole system is, thus, automatic with the single exception when the car temperature is to be raised or held to 70 degrees when there is no air pressure in the brake system. In that case the stop of the air selector switch must be lifted to the position shown in Fig. 4, by hand.

Interstate Commerce Commission Locomotive Inspection

The Senate recently sent a request to the Interstate Commerce Commission for a report as to the condition of locomotives on the railroads of the United States as to their availability for safe operation. This was done because of the statements issued to the effect that, in consequence of the strike of the shop crafts, many engines were being run in an unsafe condition and in violation of the law. The report was sent to the Senate on August 29, and states that but 4 per cent of the engines inspected during July, out of 4,085, were found to be unsafe to operate and were ordered out of service. The report also stated that there was a "general letdown in the matter of inspection by carriers which gives cause for concern."

The report, after quoting the Senate's resolution, gives a brief résumé of the scope of boiler and locomotive inspection that has been assigned to the commission, stating that it now covers both locomotive and tender and then continues as follows:

Inspection of locomotive boilers is at present being made in all federal locomotive boiler-inspection districts by our inspectors, but all inspections by the carriers as contemplated in section 5 of the act are not being made by and upon all commerce. The reports from our inspectors indicate a very general letdown in the matter of inspection by the carriers which gives cause for concern. The carriers report various reasons for not making these inspections. Some of the reasons assigned are as follows:

"No monthly inspection made of this engine since 6-16-22 account of not having competent inspectors in the service due to walkout of the shop crafts.

"Unable to make inspection account insufficient help due to strike.

"Not inspected account strike.

"Inspection not made July.

"Unable to make inspections or tests account strike conditions."

There are approximately 70,000 locomotives within the general purview of the act. A determination as to the extent to which the act currently is being violated would involve ascertainment of the condition of each locomotive and information as to the use being made thereof. The condition varies even as to the same locomotive from day to day. It is not possible for us to make this determination. The locomotives referred to are housed or repaired at approximately 4,600 different points and are operated on more than 265,000 miles of track. We are permitted by the act to have 50 district inspectors. During July last they made 717 separate inspections covering 4,085 locomotives and tenders on 162 railroads. The July activity of our inspectors is typical. The act does not contemplate that our inspectors shall inspect all locomotives. Section 6 of the act provides that the inspectors' "first duty shall be to see that the carriers make inspections in accordance with the rules and regulations established and approved by the Interstate Commerce Commission, and that carriers repair the defects which such inspections disclose before the boiler or boilers or appurtenances pertaining thereto are again put in service."

The services of our inspectors are general in character, and they are given such direction as is designed to bring about a compliance with requirements by the carriers.

In pursuance of the duty of inspectors to see that requirements are complied with, and that equipment is kept in safe condition, the inspectors deal with the varying situations and conditions in that manner which is deemed likely to accomplish the best practical results. The exercise of discretion and judgment is always involved. Obviously a locomotive may be defective and in need of repairs and yet be in a condition in which it is "safe to operate ... or limb." In many instances defects discovered and brought to the attention of carrier representatives are immediately repaired without retiring the locomotive. Under section 6 notice is given of the more serious defects and the locomotives are required to be retired.

While we are not in position to make report regarding the condition of all locomotives and the extent to which the requirements as to inspection and repairs are not being complied with currently, there are indications as to conditions generally and certain deductions and conclusions may be drawn from the conditions disclosed, by the work of our inspectors during the month of July last. At 717 different points they made personal inspection of 4,085 locomotives. Of these, 2,456 disclosed defects of the varied character mentioned above and more or less serious; 169 were found to be in such condition that they were not "safe to operate" and notices were served upon the carriers under section 6 of the act requiring them to be withdrawn from service. Of the others, 992 were found to have defects less serious in character but in need of prompt attention. In 1,295 cases, defects, though not such as to give cause for immediate concern, were such as, in accordance with sound practice, should have attention.

It will be noted that it is the "use" of a locomotive not found to be in proper condition and safe to operate, and not the condition itself, which is a violation of the law. The withdrawal of locomotives for repairs, the restoration of locomotives to service, and the use of reserved or surplus locomotives, are factors contributing uncertainty when considering the condition of locomotives in service to which the act applies.

When considering the extent of our inspection, cognizance should be taken of the fact that the act limits the number of inspectors to 50, and that the amount directly appropriated to carry out its provisions for the current fiscal year is $290,000. This sum may be spent in monthly allotments of $24,166.66, as provided in the Anti-deficiency Act of February 26, 1906. The amount expended during the month of July, 1922, in carrying out the requirements of the act was $24,025.63.

Reliable Welding

The tensile strength of a welding wire has been considered by many welders as an indication that a wire of a given tensile strength will produce a weld of equal strength, but available data proves conclusively that there is little or no relation between these figures. The success or failure of a weld depends on the welder, design of weld, welding equipment, metal to be welded and the welding wire. Metallurgy distinctly proves that certain elements are detrimental. Dependable welding material

Mechanical Refrigeration of Railroad Cars

The Technical, Economic and Operating Aspects of Various Attempts to Employ Mechanical Refrigeration in Railroad Refrigerator Cars, Together with Details of a Proposed Dense-Air System for That Purpose

By W. M. Baxter,[1] Chicago, Ill.

The subject of mechanical refrigeration as applied to railroad equipment is fraught with tremendous difficulties. First, the physical achievement of a successful mechanical process which will meet the multifarious demands of modern railroad transportation has not yet become a fact. Second, the economics of the problem are such as to lead the author to believe that it will be some time before a practical refrigerating machine can be applied to individual refrigerator cars. Third, from a railroad operating viewpoint any mechanically refrigerated railroad equipment must be held in specified traffic. This is a serious drawback because of the lack of universality of its use, and especially in its acceptance in interchange.

Again, being mechanical, such equipment must have the attention of attendants who must be specifically and practically trained in its maintenance and operation, and even with the most practical achievements along these lines it would be a long time before such a piece of railroad equipment would be heralded by the American railroads.

Refrigerating Machines

Refrigerating machines, or heat pumps, are machines which will carry heat from a cold to a hotter body. (This statement is not at variance with our knowledge that heat does not flow of itself from a cold body to a hotter body.) This, as the second law of thermodynamics asserts, cannot be done by a self-acting process, but it can be achieved by the expenditure of mechanical work. Any heat engine will serve as a heat pump or refrigerating machine if it is forced to operate in such a way as to trace its indicator diagram backward so that the area of the diagram represents work *spent on*, instead of *done by*, the working substance. Heat is then taken in from the cold body and is rejected to the hot body.

The standard systems of mechanical refrigeration are:

1. *The Dense-Air System*, so called because the air which is the refrigerating system is never allowed to fall to atmospheric pressure. This is done in order to reduce the size of the cylinders and pipes through which a given weight of air may be circulated. This process does not depend upon the liquefaction of the air, as it is not liquefied but simply compressed and expanded adiabatically.

2. *The Compression System*, using ammonia, carbon dioxide, sulphur dioxide, ethyl chloride, methyl chloride, etc., so called to distinguish it from the third system because a compressor is used to raise the pressure of the vapor and deliver it to the condenser and there liquefy it, after removing it from the evaporator or expander.

3. *The Absorption System*, using ammonia and so designated because a weak water solution removes the vapor from the expander or evaporator by absorption. The richer aqua ammonia so formed is pumped into a high-pressure chamber (called a generator) in communication with the condenser where the ammonia is discharged from the liquid solution, or rich liquor as it is called, to the condenser by heating the generator, to which the solution is delivered by the only moving part in the process, namely, a slow-moving pump.

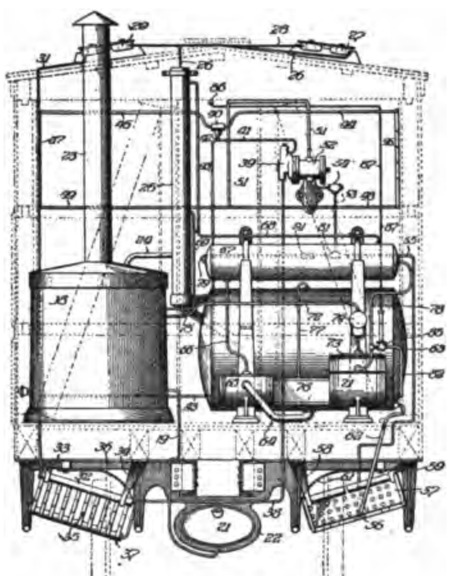


FIG. 1. CAR REFRIGERATING SYSTEM

The coefficient of performance of refrigerating machines is expressed by the

$$\frac{\text{Heat extracted from the cold body}}{\text{Work expended}}$$

This ratio may be employed in estimating the merits of a refrigerating machine from the thermodynamic point of view. When the limits of temperature T_1 and T_2 are assigned, it is very easy to show that no refrigerating machine can have a higher coefficient of performance than one which is reversible according to the Carnot cycle; for let a refrigerating machine *A* be driven by another *B*, which is reversible and is used as a heat engine in driving *A*, then, if *A* had a higher coefficient of performance than *B*, it would take from the cold body more heat than *B* (working reversed) rejects to the cold body, and hence the double machine, also purely self-acting, would go on extracting heat from the cold body in violation of the second law. Reversibility, then, is the test of perfection in a refrigerating machine, just as it is in a heat engine.

When a reversible refrigerating machine takes in all its heat, namely, Q_c at T_2, and rejects all, namely, Q_a at T_1, then, representing the heat equivalent of the work done by $W = Q_a - Q_c$, the coefficient of performance is as already defined:

$$\frac{Q_c}{W} = \frac{Q_c}{Q_a - Q_c} = \frac{T_2}{T_1 - T_2}$$

hence—and the inference is highly important in practice—the smaller the range of temperature, the better the performance. To cool a large mass of any substance a few degrees will require a much smaller expenditure of energy than to cool, say, one-fifth of the mass through five times as many degrees, although the amount of heat extracted is the same in both cases. If it is desired to cool a large quantity of water or air, for example, it is better to do it by the direct action of a refrigerating machine working through the desired range of temperature than to cool a portion through a wider range and then let it mix with the rest. This is only another instance of a general principle that any mixture or contact of substances at different temperatures is thermodynamically wasteful, because the interchange of heat between them is irreversible.

The foregoing explains why it is mechanically more efficient to produce refrigeration on a large-quantity basis than on a small. In consequence, the amount of energy and machinery in proportion to

[1]*President, Baxter-Stewart Refrigerator Transport Co.; Vice-President, Ideal Truck Equipment Co.*

Abstract from paper presented at a joint meeting of the Metropolitan Section of the A.S.M.E., and the American Society of Refrigerating Engineers, New York, May 16, 1922. All papers are subject to machine on a refrigerating car is thermally out of proportion to the work done.

The Author's Earlier System of Mechanical Refrigeration

In 1913, when connected with the Canadian Pacific Railroad at Montreal as assistant to the general manager, the author began the study of mechanical refrigeration for railroad cars and built an absorption-system car, which was followed by two more cars constructed by him in the United States. The condenser and absorber were located underneath the car and the source of energy was a slow-burning charcoal fire.

Fig. 1 shows National Refrigerator Co. Car No. 1003, in which are incorporated modifications of an earlier design of the author. It was found necessary to add an analyzer and increase the temperature-exchanger capacity. Charcoal was also abandoned as a fuel in favor of petroleum. The analyzer is shown at 26, while 63 is the secondary absorber, 57 the primary absorber, 67 the temperature exchange, 35 the condenser, 18 the generator, and 25 the petroleum tank.

The generator consisted of a conical coil of pipe surrounding a kettle hung by means of a trunnion and provided with one central large flue. The rich liquor and as the ammonia gas was distilled off it passed up through three take-offs from various points in the coil to a dome. The other end of the coil was led into the top of the kettle of the generator and there further fractional distillation carried on, the gas passing off through the dome to the analyzer and the condenser. A pipe led out from the generator kettle at the height it was desired to hold the weak-liquor level. This ran to the valve-controlling mechanism of the pump and thence to the power end of the pump, which was driven by the weak liquor and some additional gas.

Fig. 2 shows the general placement of the various elements of the apparatus. Underneath the car in the upper view is seen the absorber, while in the lower view—of the opposite side of the car—is seen the condenser. Within the car itself on the upper side walls are located the refrigerating coils, while the heater coils are positioned along both sides of the side walls. On the roof of the car are placed the super-heat-dissipating coils, and in one end of the car is located the operating mechanism.

This car operated successfully on one occasion for nine consecutive days without attention, standing still. The tempera- tween 32 and 34 deg. Fahr. and as low as 26 deg. was reached with an outside temperature of 80 deg. The car was empty.

Fig. 3 shows a diagrammatic plan of the process. Functioning as a refrigerator the operation is as follews: The charcoal magazine is first filled with crushed charcoal; the generator *B* is then filled with a rich charge of aqua ammonia and the secondary absorber to about one-third of its capacity. The fire being lighted, fractional distillation takes place and the gas thus expelled passes to the analyzer through pipe *F*, where a certain amount of dehydration takes place. The gas passes on to the condenser *G* and is liquefied in the header which connects to the automatic expansion valve *H*, the latter not opening until 15-lb. gage pressure has been reached. This retains enough pressure to start the pump automatically. The liquefied ammonia passes through the expansion valve and is expanded in the refrigerating coils *I*, *I*, passing from there to the absorber *J*. The weak liquor leaves the generator through the pipe *K* which projects into the kettle of the generator sufficiently high to obtain the minimum level of liquid desired. This hot weak liquor is conducted to the temperature ex-

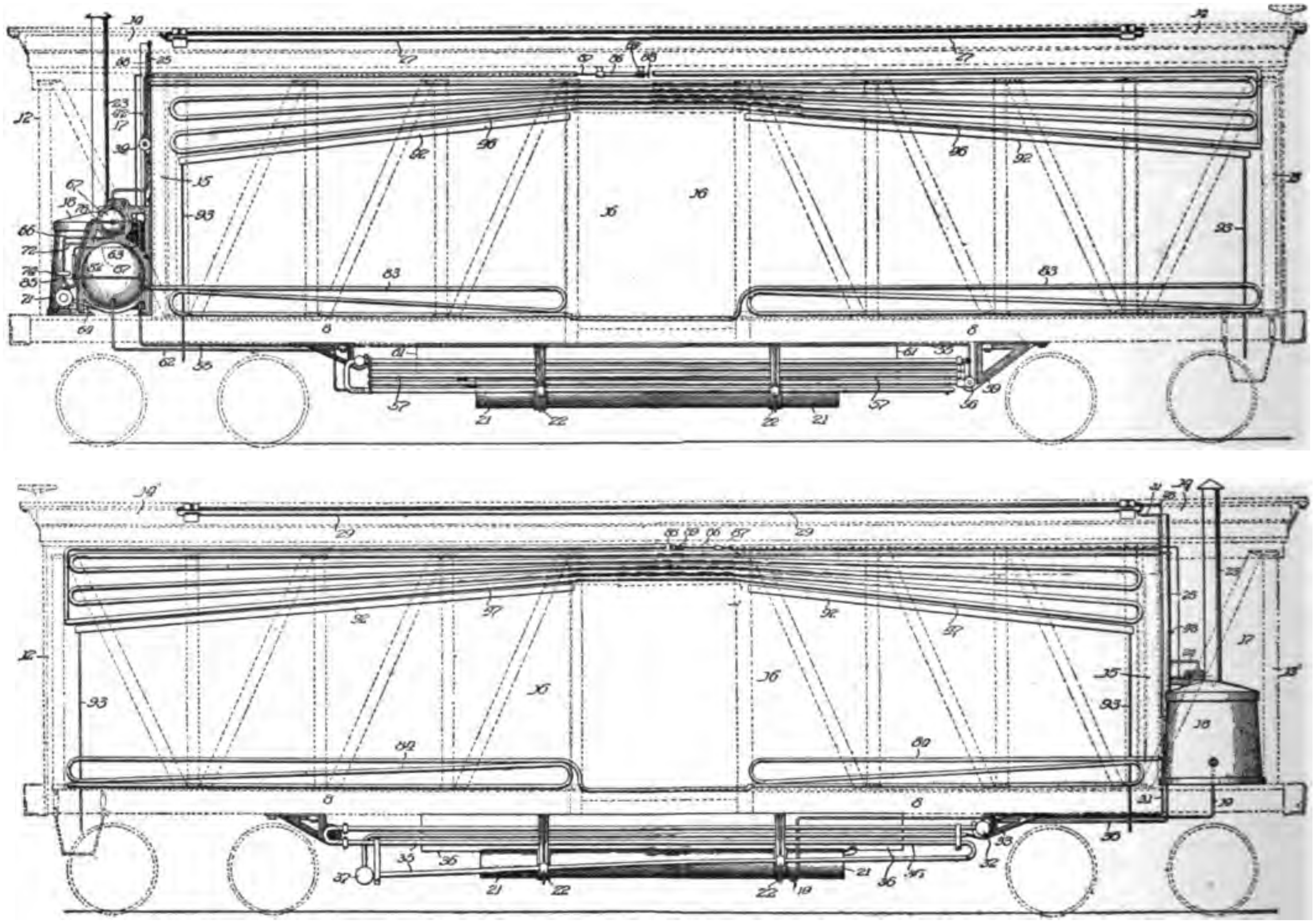


FIG. 2. GENERAL ARRANGEMENT OF APPARATUS OF CAR EQUIPPED WITH AUTHOR'S ABSORPTION REFRIGERATING SYSTEM. (Upper figure shows absorber underneath car; lower figure, of opposite side of car, shows condenser underneath car. Refrigerating coils are shown on upper side walls and heater coils at lower; superheat-dissipating coils on roof of car, operating mechanism at end.)

liquor coming from the absorber *J* and which is being pumped by the pump *C*. It gives up its heat to this rich, hot liquor and is cooled by the countercurrent of cold strong liquor. It is then sprayed into the primary absorber *N by* means of a nozzle *M* and is further cooled by radiation by the coils *O, O*. It is thence conducted to the top of the absorber *J* and sprayed into this chamber. The pump is gas- and weak-liquor driven, and is controlled by the float regulator *Q*. The exhaust from the pump is conducted to a secondary counter-current temperature exchanger where most of its heat is absorbed by the cold rich liquor on its way to the primary temperature exchanger *L*, which liquor is finally conducted into the absorber tube *N* and thence taken up. The operation is continuous and automatic.

liquor passed to the condenser and no anhydrous ammonia remained in the refrigerating coils.

The Dense-Air System of Car Refrigeration

In 1917 the author abandoned all ammonia processes and attempted to achieve the result by means of the dense-air process. In this he has been quite successful. A large refrigerated motor truck, equipped with a one-ton dense-air refrigerating machine and having a capacity of 30,000 lbs. of dressed beef at a load. The temperature maintained is 36 deg. on a 90-deg. day. A fleet of these trucks have been in continuous service for four years in the stockyards district of Chicago, handling traffic in a radius of 24 miles.

Fig. 4 shows diagrammatically the process as used on two of these trucks. The plant has a refrigerating capacity of 1,000 lbs. Its source of energy is gasoline engine and the refrigerating medium is the air. With this combination the only operating supplies necessary are gasoline and oil. The refrigerating mechanism is located in a space occupying 2 ft. of the length of the body on the front end, leaving a receiving chamber for perishable goods 23 ft. 6 in. long, 7 ft. 4 in. wide, and 6 ft. 2 in. high. The refrigerating coils are located in the roof of the car and are fastened to the steel plate and angle-iron carlines, which makes it possible to swing carcasses from the coils by meat hooks. The refrigerating machine is adjusted thermostatically to maintain the temperature of 36 deg. Fahr. It can also be adjusted to reasonably lower room temperature if desired, it being possible to carry the expanded air temperature of the refrigerating medium to 30 deg. below zero.

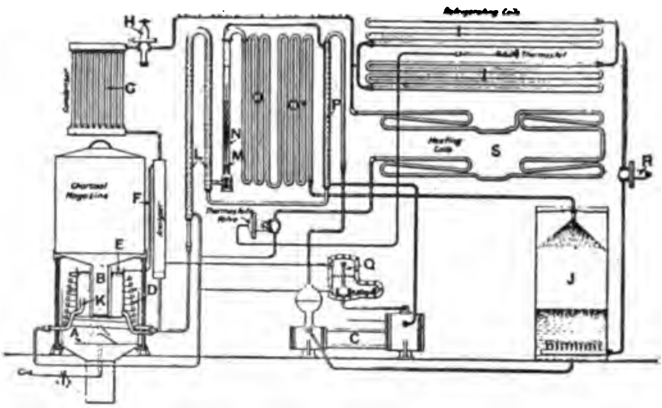


FIG. 3. DIAGRAMMATIC PLAN OF CAR REFRIGERATING SYSTEM.

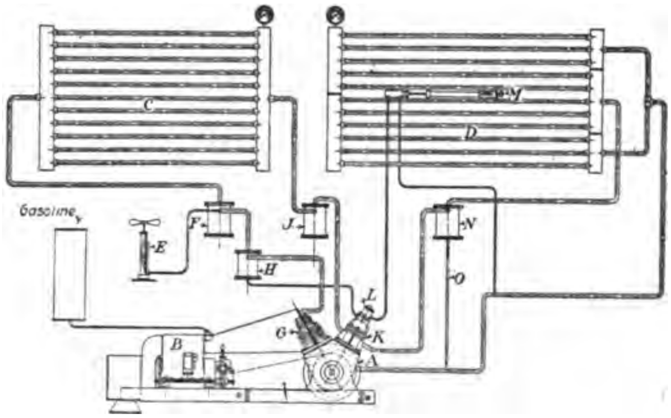


FIG. 4. DIAGRAM SHOWING PROCESS EMPLOYED ON MOTOR TRUCK.

To convert the machine into a heater, the thermostat located in the ceiling of the car functions the thermostatic valve. This opens a direct connection between the hot liquor of the generator and the heating coils *S*. After throwing off the heat imparted to the liquor by the fire, the fluid is conducted directly into the refrigerating coils, where additional heat of absorption by chemical action is further generated, assisting in warming the car, and the liquor passes on to the absorber in the usual way. The working of the machine is unaltered in all of its other operating functions. When the car has risen sufficiently in temperature the thermostat closes the thermostatic valve and the machine is again a refrigerator.

While this car, from a construction point of view, was a success in that it stood rough usage, met all the requirements of the Master Car Builders' Association, was cheap to build and economical in operation, nevertheless it was difficult to keep the pipe joints tight and leak-proof. The real cause of failure, however, was due to boil-overs or foaming as soon as the car was switched or put in motion. The author devoted much time to this feature but was never able to prevent it. Of course, as soon as this occurred the car became inoperative as

The Refrigerating Machine

The dense-air process is based upon the fact that a perfect gas under pressure, expanding adiabatically and performing external work will suffer a drop in temperature proportional to the mechanical energy produced. Its fundamental advantages lie in these characteristics: There is an unlimited supply of the agent everywhere, as air is the medium; it is readily dried by the use of deliquescent salts, it is innoxious, non-poisonous, and its explosive force lies only in its expansibility under pressure; a leak may be readily sealed and the air, once dried, becomes a perfect medium of refrigeration at temperatures much lower than is possible with any agent except CO_2.

The refrigerating unit consists of a compressor employing two cylinders (5 in. bore by 5 in. stroke), and an integral expander consisting of two cylinders (4⅛ in. bore by 5 in. stroke), both sets of cylinders operating from the same crankshaft. The unique feature of this design lies in the valve mechanism and means for controlling the expander unit. The exhaust valve is a rotary valve functioning both cylinders. The inlet valves are controlled and timed by a compound rotary cam whose length is adjustable by thermostatic control, thus making it possible to alter and control by thermostat the ratio of expansion, and therefore the resultant temperature. Castor oil is used as a lubricant in both the compressor and expander sides and the oiling system is in itself a closed cycle. The expander mechanism is oiled from the oil separator in the exhaust from the compressor and fed under pressure of the high side to the cams, valve mechanism and pistons of the expander. The compressor pistons are lubricated by splash from the crankcase and an oil separator in the low side returns the oil to the crankcase.

In operation the machine requires 1¾ hp., which is furnished by an air-cooled engine of the Henderson motorcycle type. The engine also drives an exhaust fan of approximately 4000 cu. ft. capacity which produces a rapid flow of air across the compressed-air cooler, the compressor cylinders and gasoline engine cylinders. Proper ducts are provided to connect the various members to be cooled.

The Thermodynamic Cycle

In order to illustrate the system

and to set forth the simplicity of the refrigerating process and the incidental mechanism, attention is again called to Fig. 4 in which *A* is the refrigerating unit, *B* the gasoline engine which supplies the power, *C* the compressed-air cooler and *D* the refrigerating coils.

The device is primed by the use of the hand pump *E* connected with the drier *F*, operation of the hand pump being continued until the gage indicates the density required, as the capacity of the machine depends upon the densities of the two sides, regardless of the ratio of expansion. Priming, therefore, is necessary to increase the relative capacity of the device.

In operation the compressor cylinders *G* take air through their pistons from the crankcase and discharge into the cooler *C* first through the oil separator *H*, thence through the drier *F* which removes the entrained moisture, converting the hydrous content into a fixed brine and allowing the anhydrous air to pass on to the cooler *C* where the thermal coefficient of the mechanical energy performed and the specific heat due to change in volume are removed, the cooler serving to bring the temperature of the compressed air down to a point approximately 27 deg. higher than the weather temperature of the day.

The compressed air which has been cooled now passes through the secondary drier *J* to the expander, the secondary drier serving as a precautionary device to remove any moisture which may have passed the drier *F* because of high temperature at that point. In the expander *K* the air is expanded adiabatically at the ratio of expansion determined by the position of the control piston in the cylinder *L*, which in turn is controlled by the thermostat *M*. The expanded air, of extremely low temperature, is carried to the oil separator *N* in which any oil is removed before it may enter the refrigerating coils *D*, as oil in the coils produces a decided loss in efficiency. The oil extracted in the separator *N* is returned to the return pipe from the refrigerating coils *D* by a crossover *O*, both oil and air being finally returned to the crankcase from which the compressor cylinders take their supply.

The thermostatic control of the ratio of expansion is acomplished by means of a piston whose position determines the length of the cam face, which in turn determines the proportionate time of opening and closing the inlet valves, and therefore the ratio of expansion. The position of the control piston is determined thermostatically by a leak-off connected with the thermostat, by which high-pressure air is allowed to escape to the low-pressure side and move the piston proportionately to its rate of escape.

In a device having extremes of temperature such as the one under consideration it is highly important that lubrication be effective and automatic. Castor oil is used because of the fact that its viscosity is temperature of the compressor or the extremely low temperature of the expander. The compressor cylinders take their air from the crankcase and lubrication of the compressor cylinders is effected by the splash of the crank. It follows that a comparatively large amount of oil is carried with the air into the compressor cylinders, where not only the cylinders but the valves and valve mechanism are amply lubricated. This oil is separated from the compressed air by the separator *H*, and being under the pressure of the high side is fed through a tube to the cam pocket and valve head of the expander mechanism. This constitutes a crossover for the oil. Some portion escapes around the pistons into the crankcase. The remainder is carried with the expanded air to the separator *N* where it is removed centrifugally and by-passed and returned through the tube *O*.

The Ethyl Chloride System

In addition to the systems described there is another, of the compression type, using ethyl chloride as the medium. Ethyl chloride boils at 54.5 deg. Fahr. and liquefies at the low pressure of 15 lbs., with condenser water at 65 deg. Fahr. Its critical temperature is 365 deg. Fahr., which is sufficiently high to preclude the danger of generating permanent gases. Being a neutral gas, it is possible to use thin seamless drawn copper tubes, and the joints may be soldered if desired.

As the boiling point of ethyl chloride is so low, a partial vacuum is necessary on the low side of the machine to produce the required temperature in the car. The medium is handled by a valveless rotary compressor.

The machinery is located in the end of the car and the method of operation is as follows: The medium is evaporated in the refrigerator pipes in the refrigerating compartment. The gas is then drawn to the compressor and forced into the condenser where it is liquefied. The condenser consists of a series of copper tubes placed vertically in the compartment with the compressor. The heat of compression is removed by means of a small spray of water fed to the top of the condenser, and this water is cooled by a fan so arranged that the current of air is distributed equally over the entire surface of the condenser. The power to drive this mechanism is taken from the axle of the car by means of a belt and countershaft below the compressor. Between the countershaft and the truck axle are interposed two idler pulleys upon a common guide, these pulleys being held together by springs and placed upon a guide in order that they may operate in either direction. The arrangement is such that in whichever direction the car is running the machine automatically takes up its refrigerating work. The water for cooling the condenser is carried in a tank underneath the car, from pump attached to the main shaft of the compressor. An oil engine is provided for the purpose of continuing the operation of refrigeration when the car is standing still, thus making it possible to set the car out of the train when necessary. The water for cooling the cylinder of the engine is carried in a small tank on the roof of the car.

Conclusion

As stated at the beginning of the paper and for the reasons there mentioned, it will be some time before mechanical refrigeration will be adopted on American railway cars. However, the author believes that it can be accomplished by equipping refrigerator cars with a thermosiphon system and providing a tank in the roof of the car with two compartments, one for receiving ice from regular icing stations and the other for holding a weak brine solution into which is submerged a refrigerating coil; the source of energy for cooling this brine to come from a central refrigerating-plant car carried in the train and having a capacity sufficient to refrigerate ten cars. The brine cooled in this central car would be pumped under a pressure of two or three pounds to the refrigerating coils in the various refrigerator cars, and even remove the latent heat of the brine in the tanks, if necessary, thus freezing it, thereby storing refrigerating work to be used if the car should be set out; or if the car is to be used in traffic where it is not operated from the central-plant car, then, as previously mentioned, it may be iced in the usual way, and by means of the thermosiphon system a rapid automatic circulation of the secondary refrigerating coils will take place whether the car is standing or in motion. It should be possible to store enough latent-heat energy to operate one of these cars at least 72 hours without re-icing or reconnection to the central-plant car.

This central-plant car should have installed within it a dense-air refrigerating machine of 30 tons refrigerating capacity for a ten-car unit. This machine may be driven by any of the standard forms of gas or oil engines, preferably of the Diesel type, and the entire operation can be so designed that no water need be provided to carry away the heat of compression.

Railway Electrification in Sweden

While the question of electrification of Swedish railways has been discussed for a long time, but little actual progress has been made, as witnessed by the fact that only 380 kilometers out of a total of 15,160 kilometers of railway lines are at present using electric traction power. The electrification of the Goteborg-Stockholm railroad, one of the principal trunk lines of the country, has been projected at an original cost of 75,000,000 crowns, later

The Railway Situation in Canada*

By C. M. Howard, Vice-Pres't.
Canadian Manufacturers' Association

The Dominion of Canada has over forty-two thousand five hundred (42,500) miles of railway, with a population of eight million seven hundred and twenty-nine thousand (8,729,000) people, which gives one mile of railway for two hundred and six (206) inhabitants.

No other country in the world has the same mileage as compared with the population. The United States has approximately twice the number of inhabitants per mile, whereas the United Kingdom has ten times the number. It has been found that railway traffic increases approximately in proportion to the square of the tributary population, which indicates that the situation in the United States should yield four times the traffic per mile of railway as compared with what could be expected in Canada.

The Federal Government now controls over twenty-two thousand (22,000) miles of railway, made up of the Canadian National and Grand Trunk Systems, which have recently been co-ordinated to the extent of eliminating competition and operating on a partnership basis, but notwithstanding these efforts, the net results for the year 1921 showed a deficit of seventy-two million, three hundred and forty-six thousand, two hundred and thirty-three ($72,346,233) dollars, and for the previous year the deficit amounted to over seventy-four million (74,-000,000) dollars.

It has been stated that it will cost the United States Government approximately two billion dollars ($2,000,000,000) to assist the railways through the war period, but this enormous sum does not represent the losses actually incurred.

All the countries involved in the war had to face this difficult railway situation, and they have adopted various means for keeping the railways in service and restoring their credit, whereas Canada has decided upon Public Ownership, on a tremendous scale, at a cost which is staggering, and which will continue, unless radical measures are adopted.

It would be out of place at this time to discuss the advisability of Government Ownership, which has now been adopted. All sections of the community are vitally interested, and it is in order to consider the situation as one would review his private business in the face of a critical situation.

In the first place, it must be realized that the Government Railways represent a tremendous business, amounting to over three hundred and forty million ($340,-000,000) dollars per annum, extending over twenty-two thousand (22,000) miles of territory and employing over eighty-nine thousand (89,000) persons. In such a business, an imprcvement of only one per cent in efficiency, economy, or better administration would mean a saving of three million, four hundred thousand ($3,400,000) dollars per annum.

This consideration indicates at once that the first necessity is to have the best possible executive, who must be thoroughly familiar with all branches of the railway business and the requirements of the country, and he should not be hampered by any political considerations, and should have the confidence and full support of the public.

600 Miles Unprofitable

In the second place, the public must realize that mistakes of the past have to be rectified, as well as possible, at this late date. We have a railway mileage very much in excess of the actual needs, parallel lines serving the same territory, and branch lines serving no substantial purpose except to swell the annual deficit. A brief survey of the existing Government lines will indicate that over six hundred (600) miles of railway now in existence in various parts of the country are entirely unwarranted and can be abandoned at once. More can follow in due time, as conditions develop, but six hundred (600) miles of unprofitable and unnecessary railway, with all their attendant losses, can be discontinued forthwith; rails and other material can be salvaged, and in some cases the right-of-way can be used for highway purposes, which would be desirable in certain sections.

The railways have shown that it is entirely practical to operate on a leased line of railway, as they are doing this between Toronto and Hamilton, where the traffic, perhaps, is denser than in any other part of Canada.

Large Savings Possible

It is difficult to estimate what the total saving would be by this course, as it would vary in different localities, but very large savings can be effected by this means without delay. It is for the general public to realize that such a course is necessary, and should be insisted upon, notwithstanding some local and selfish opposition that may develop.

The same remarks apply, with equal force, to train service. More trains are being operated in some localities than are necessary to handle the business, and every unnecessary train represents a continual tem. Such trains should be discontinued entirely or reduced to the actual necessities of the district. It is possible these communities could be served by operating a gasoline car, as is being done now between Winnipeg and Transcona. Very substantial savings can also be effected by this means. Some complaints will doubtless be made at local points, but it is essential to realize that train service has been forced upon the railways in the past, and is one of the chief causes of the heavy losses now sustained. The public, in general, should not be expected to pay the losses in order to furnish certain ambitious communities with more trains than they can use.

The heaviest single item of expense in the railway business is the payroll. During the past year the wages paid out on the Government Railways amounted to over one hundred and thirty million ($130,000,-000) dollars, which is considerably more than half of the gross traffic receipts.

While it is important that wages should be sufficient to maintain a suitable standard of living, it is equally essential that an honest day's work should be performed for a fair wage. The willingness, ability and discipline of this large number of employes is a vital factor in the operation of the railways, as was recently demonstrated in the United States. During the years 1914 to 1917, the railways in that country handled an increase in freight traffic of thirty-one (31%) per cent, with an increase in employes of ninety-three thousand (93,-000), or three thousand (3,000) men for one per cent increase in freight traffic. After that date, when employes became demoralized and unwilling, it required an increase of twenty thousand (20,000) men to handle an increase of one per cent in freight traffic. From this it can be seen that a proper spirit on the part of the employes is essential, and the country cannot afford to employ any but active and willing men in any capacity. Here again the public must realize this necessity and support the management in its efforts to obtain an honest day's work for a far wage, and to man the railways with a class of men who are prepared to reognize their duties to the public.

Another heavy item of expense is the coal bill. During the year 1921, the Government Railways consumed six million, two hundred and thirty-nine thousand, two hundred (6,239,200) tons of coal, at a cost of thirty-six million, six hundred and ninety thousand, one hundred and fifteen dollars ($36,690,115), of which a considerable amount was necessarily purchased in the United States, thus helping to increase

* Statement presented by Mr. Smith at the

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New Locomotive Designs

Locomotive designers in the United States have, for very many years, shown an independence of precedent that has always been inspiring. And if we compare the latest developments with the first English engines that were imported and copied the difference is so marked that the two can hardly be classed in the same species. The three-point suspension, the camel back, the development of the mogul and consolidation, the Wootten boiler, the lifting of the boiler and center of gravity, the introduction of the trailing wheel, the mallet. The latest example is the mikado, which is illustrated on another page in this issue.

With the exception of the wheel arrangement there is hardly a point on this engine that has not been touched up or adjusted to meet or come up to the requirements that the designers had in view. The first step taken was to consult the engineers of the road over which the locomotive was to run and ascertain the limits of stresses that could be imposed upon the bridges. Then the designers were given a free hand to go ahead. The result is an engine that would attract attention at once. The large feedwater heater on top of the smokebox, the outside drypipe, the feed- the conventional locomotive is concerned.

It is, of course, needless to say that a departure from the lines of ordinary design was not the primary object but the production of an engine that should do the maxinmum of work for the minimum of operating cost. In going over the design it would be difficult to find anything that has been omitted which would contribute to the realization of the object as stated above.

Without entering into a detailed discussion of all of the points, it will be well to emphasize the departure that has been made in the firebox construction. The mere rounding of the corners on a long easy radius must appeal to everyone who knows of the difficulty of keeping the ordinary corners tight. That difficulty is not so much due to the sharpness of the turn and thicknesses of metal near that point, because tightness can always be secured there in a new boiler. But, when the boiler is in action, the variation in the expansion of the two sheets, the low temperature of the water in contact with the foundation ring and the cold air driving against the bottom of it, tend to set up stresses against the rivets of such magnitude that the sheets buckle away from the ring and the inevitable leak follows.

In the ordinary boiler the water is slow in reaching steam temperature at the back end of the water leg at the bottom, and it may be said to never reach it at the front. The double set of arch tubes used in this engine, with new arrangement of brick arch, are said to keep up such a rapid circulation in the water leg that the temperature at the bottom rises to and is held at steam temperature during the whole period of the time that the engine is in active operation.

This will naturally tend to an equalization of the expansion of the two sheets and thus decrease the tendency to buckle near the ring, while the long radius of the corner will serve to distribute such stresses as will be unavoidably developed over a greater distance and prevent their concentration at one point.

This long curve should show an immediate result in improved evaporation because of the better firing made possible by it, and later in boiler repairs.

The use of superheated steam for auxiliary power is also a novelty and will undoubtedly manifest its advantage in a reduced steam consumption; for there is no reason why a saving should not be obtained in these smaller consumers as well as in the main engines, though the rate will probably be less.

And so in reviewing the machine the points of interest are many and each one promises to give a good account of itself in economy of operation and efficiency.

The Strike of the Shop Crafts

People always speak and think of a or less of contempt. It is not considered sportsmanlike to accept awards on luck in one's favor and refuse to accept the reverse. The decision of the railroad shop crafts to strike was looked upon in very much that light by the general public. They had accepted awards in their favor, had gone to the Labor Board with their case, with the full understanding that the decision would be accepted by both parties to the controversy. At least that was the understanding of the railroads and the public. But as soon as the decision was handed down, instead of doing what was expected of them, the leaders ordered a strike vote which, somehow, always seems to be an affirmative. There was not even an acceptance of the award pending appeal.

Prices are falling everywhere. It would be ruination to the country to attempt to maintain the inflated or artificial standard that prevailed throughout the war; and with the tendency of the day, it was naturally expected that railroad wages should fall into line.

The combination of these two circumstances sent the strikers out, deprived of every particle of sympathy on the part of the public; a sympathy that is absolutely essential to the winning of such a move. Add to this the well-known fact that many of the men went out against their will, and that some had even tried to get a special dispensation permitting them to work, and the making of a failure was evident from the start.

The recruiting of new forces was done with rather remarkable rapidity, under the circumstances, and then arose the question of seniority.

Seniority has its good and bad sides. As an inducement to stick to the job and a guarantee that the best and easiest work will come to him who waits, it is good. It guaranties a man against worry and gives him a confidence that all will be well. But as a destroyer of initiative, and a damper for an ambitious man it is unexcelled. It is the incubator of the drone.

So, when the railroad executives told their old men, who stuck, that their seniority would have a step-up and the new ones that they should be guaranteed their place in the line, there was consternation and wrath in the ranks of the strikers. And straightway their main effort was diverted from the point of maintaining the old wage condition to that of insuring their old seniority rights when they returned to work.

This was the crux of the whole matter. To have conceded their position in this would have been to put a premium on revolt. It would have been to discourage loyalty and to have made it impossible for any man to accept the word of a railroad official. Discipline would have gone to the winds and agreements have become a laughing stock.

Then came the propaganda by which an

that unsafe rolling stock was in use. But so many roads had had locomotives in white lead on July first that there was enough to keep trains moving in spite of individual deteriorations and the public was not persuaded.

It is generally acknowledged that the Scarborough raid was one of the greatest tactical mistakes that the Germans made in their conduct of the war. They mistook the temper of their enemies. It did more, that bombing of an unguarded seaside resort, to consolidate English patriotism and arouse the fighting blood of the island than anything else could have done. So the dynamiting of the West Shore train and the removal of the rail joints at Gary, with the attempt on the lives of innocent passengers, neither struck terror into the community or convinced anyone that rolling stock was unsafe. The public simply branded the strikers as outlaws.

As to the situation as it stands the shop crafts appear to be holding the losing hands. The forces are being rapidly recruited, so far as reports are available, and with the public stand against and contempt for terrorism, it does not seem that it has very much to fear. The strike was a mistake and is probably now recognized as such by the leaders, but in one thing it has served a good purpose in bringing definitely to the front the right of a man to work as well as to strike; and that to try to prevent either is a criminal offense.

Train Control or the Automatic Stop

The order has been issued and, in time, we will have demonstrations on an extended scale of the operations and effects of train control or automatic stop according to the choice of the individual roads affected.

This order differs from previous requirements of the Interstate Commerce Commission in the matter of safety requirements in the mental attitude induced toward it. When the automatic coupler was up for discussion, for example, there was a universal agreement in the opinion that it was a vital necessity and the only point against it was the expense which a president of a very big railroad declared would bring many lines to the verge of bankruptcy. In this case there was a really popular demand for the reform. As for the power brake requirements and the safety devices of grab irons, etc., the railroad fraternity recognized their desirability, but the general public, knowing nothing and caring less about the operation of freight trains, gave it no attention. The brake was acknowledged to be necessary to the safe and proper handling of a long train and uniformity of shape and location of grab irons was so evidently a move in the direction of safety that the matter only aroused discussion to the extent of determining the best shapes and locations.

But the automatic stop raises other points in opposition besides cost. It is argued that an automatic control or stop will cause a relaxation of vigilance on the part of the engineer; that there is no device so sufficiently perfected as to make its practical application on a large scale feasible, and finally the weak one of not being necessary. The latter may be dismissed without comment in the face of the latest Missouri Pacific disaster caused by the lack of vigilance of an engineer with an unbroken record of one hundred per cent. carefulness for more than thirty years.

As to the practicability of any and all devices thus far offered, it is hardly to be expected that even one can be found without flaw or blemish. A statement that partakes very much of the nature of a platitude and which can be applied to all human devices. But a mechanism may be workable and admit of a wide practical application and yet be many degrees removed from perfection. And the evidence seems to be conclusive that there are several devices that will meet this simple specification.

As for the main claim that the installation of such a device will merely dull the vigilance of the engineer and, by that very influence, promote the liability of accident. On this opinions differ and will for some time to come; but such evidence as we have on the subject is quite contradictory of this. Testimony from roads using such devices is very emphatic to the effect that such devices tend to keep the engineer alert rather than lull him into a semi-somnolent security.

As for the relative merits of the automatic control or stop, the final conclusion will probably not be reached until both systems have been tried for a time sufficient to demonstrate their relative values. Both have their merits, but it would seem that the stop must be superimposed on the control in order that there may be no possibility of an approach to the Missouri Pacific disaster.

Operating Income and the 6 Per Cent Return Compared

The Bureau of Railway Economics has compiled figures showing how much the 6 per cent return on the tentative valuation of the railroad properties is for each month of the year.

In no district have the railroads as a whole realized during the first six months of this year a return of 6 per cent on their tentative valuation, according to tabulations based on reports filed by the carriers with the Interstate Commerce Commission. For the country as a whole the carriers have realized a net operating income during the first half of this year amounting to $349,092,945, which on the basis of their tentative valuation would mean a return of only 4.44 per cent, or $123,130,993 short of a 6 per cent return.

The net operating income for the railroads in the Eastern district for the first six months totaled $187,883,726, or a return of 5.21 per cent on their tentative valuation. This was $28,368,372 below what they should have earned to receive a 6 per cent return.

Reports for the Southern district show that the net operating income for the carriers in that part of the country totaled $54,528,110, or a return of 5.13 per cent. This also fell short of a 6 per cent return by $9,272,735.

The net operating income for the carriers in the Western district amounted to $106,681,109, or 3.33 per cent. The roads in that district, however, lacked $85,489,886 of realizing a 6 per cent return.—Railroad Data, Aug. 24.

The "6 per cent on tentative valuation" is computed on the tentative valuation made by the Interstate Commerce Commission in Ex Parte 74 for rate making purposes, adjusted by the Bureau of Railway Economics to apply to railways of Class I, and to include the net amount of additions from January 1, 1920, to September 30, 1921. It is allocated to the several months on the basis of monthly variations in railway operating income, so as to reflect seasonal fluctuations in traffic and earnings. This monthly distribution follows the actual average results of the five-year period ended December 31, 1916.

New Railroad Laws in 1921

In 1921, 588 laws, drafted to affect railroad operation, were introduced into the State Legislatures of the United States. Only 166 of these were passed. This is shown in a report of a special committee of the American Railway Association on relations of railway operation to legislation.

In the State Legislature of California, 46 laws were introduced and 13 became laws. This represents the greatest number of railroad laws introduced and passed in any State in the country.

The Pennsylvania Legislature considered 31 laws, but passed only 2, and of the 30 introduced in the Ohio Legislature only 9 became law. In Iowa 23 bills were proposed and 10 passed, while these figures for Wisconsin were 20 and 8, respectively. In Texas 23 bills were introduced and 7 became laws.

Taking the States by groups, less railroad legislation was proposed and passed in the New England States than in any other group of States in the Union, although there were no laws intoroduced in New Jersey.

The subjects to which the 588 laws introduced and 166 passed pertained included every phase of railroad operation, such as train rules, taxes, rates, passes, maintenance of way, crossings, leases, accidents and many other subjects.

Laws affecting taxation amounted to 14, a greater number than those passed on any other subject. Legislation affecting livestock totaled 13 laws, while 11 laws affecting rates were passed and 10 each on crossings and equipment.

Germany Tending to Impress Its Industrial Standards on All Import Countries

"The day may not be far distant when American manufacturers will receive inquiries from oversea countries to furnish goods according to the German national standards, and it behooves us to plan in time to meet such conditions."

This statement is contained in a communication to the American Engineering Standards Committee from Oscar R. Wikander, an American Engineer, who has just returned from Germany, where he represented the committee in conferences concerning the international standardization of ball bearings. Describing the great strides in standardization that have been made by German industries during the last few years and the important foreign trade advantages accruing to German industries because of their intense standardization activities, Mr. Wikander said:

"There is no doubt in my mind that one of the main reasons why forward-looking Germans force their standardization work is because they want to introduce German standards in the great importing countries, and possibly in the whole world. Holland, Switzerland, Austria, Sweden, and many other European countries follow the German lead very closely. The great German deliveries in kind to France will no doubt be made as far as feasible according to German standards, thereby introducing them in that country.

"It was only a few years ago that the 'Normenausschuss der Deutschen Industrie,' an organization corresponding to our American Engineering Standards Committee, was formed but the amount of work which it has already accomplished is stupendous. The 'Normenausschuss' has already issued several hundred sheets of approved standards, and about twice as many are already published as proposed standards. This enthusiasm is due to a more or less general recognition, created under the pressure of war conditions, of the great economic value of standardization, and to the very generally accepted opinion that a standardized industry would be one of the strongest weapons in Germany's struggle for economic rehabilitation and financial reconstruction.

"To give a concrete illustration of this point, I may mention that at the time of my visit, a syndicate of nineteen German manufacturers and one Swedish manufacturer were executing an order for seven hundred locomotives for Russia, all of the same design, and every part in every one of them was being made interchangeable with the corresponding part in all

factured to the same fits and tolerances. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for all the others. In one case a locomotive was assembled from parts machined in twenty different shops, with no more difficulty than a locomotive which was built complete in one shop. In case of future orders, the Russians will no doubt specify that all new locomotives of this class be built not only of the same design as above, but so that every part is interchangeable with the above.

"It is easy to realize what great advantages German manufacturers of locomotives will have over those of other nations when competing on the basis of such specifications, and this example illustrates the economic advantage which can be gained by German industry in introducing its standards in all countries importing mechanical equipment."

Seniority and Pensions

In recent public discussions of the shopmen's strike, the erroneous statement has been repeatedly made that loss of seniority, by returning men, also involves forfeiture of accumulated pension privileges. On the Pennsylvania Railroad, and on other systems generally, seniority rights and pension privileges are entirely separate and distinct matters. A man's seniority is determined by the position his name occupies on a roster kept for his particular craft at the point, or for the division, where he is employed. If he leaves the service, and returns, his name goes to the bottom of the roster as of the date on which he is re-employed. The importance of seniority is that it entitles a man to the choice of shifts, day or night, and to priority in bidding for better or otherwise more desirable positions, as such opportunities open; also that it gives him preference over junior employes in holding his work when it is necessary to lay men off. Seniority depends upon continuity of employment.

Pensions, however, are based upon the total years of service, regardless whether they are continuous or not. Under the Pennsylvania Railroad's plan every employe, regardless of grade or rank, must retire at the age of seventy years. If incapacitated he may be retired at sixty-five or over if he has been in the service thirty years. He receives as a pension one per cent of his average monthly earnings during his last ten years of work, multiplied by his total number of years of service. He may enter or leave the service once or half a dozen time during his career, and the method of computing the pension will be the same in any case.

Therefore, if a shopman now on strike on the Pennsylvania Railroad seeks reinstatement and is accepted he loses seni-

of the seniority roster at the point where he is employed. But he does not lose anything at all of the accumulated benefit of his previous years of service with respect to his pension privileges. The Pennsylvania System management's position on the seniority issue does not in any way impair or lessen the pension privileges of its former employes who are now out of the service, provided they seek reinstatement and are accepted.

Another error which has received circulation lies in supposing that the pensions of railroad employes are paid for, in whole or part, by contributions from the men themselves. This is not the case on the Pennsylvania Railroad, nor on other American railroad systems. Pensions are paid entirely out of the funds of the company, as a voluntary gift in recognition of long and faithful service, and to assist old employes who have passed the period of active work. The company pays the pensions and bears the entire cost of operating the Pension Department.

The pension system on the Pennsylvania Railroad was inaugurated January 1, 1900. Since that time it has paid out $26,800,000 in pensions. At the present time 6,893 employes are being carried on the pension rolls, and the annual payments of pensions are now at a rate exceeding $3,000,000 per year.

Development of Stainless Steel

The special properties of stainless steel render it a valuable material for many purposes when ordinary steel is either less effective or unsuitable. In many cases, stainless steel is replacing some of the non-ferrous metals owing to the high mechanical strength which is associated with its non-staining and non-resisting properties. In a list of over two hundred articles and machinery parts in the manufacture of which stainless steel has been either actually used or suggested the following are particularly noticeable: wheels, gears, shafts, ventilators, decorative metal work, gasoline engines and parts, condensers and ball bearings; while in cutlery the uses to which the metal is put are legion.

Railway Ties for Egypt

The Egyptian State Railways are calling for bids for 201,700 ties. Certain American hardwoods and softwoods are included in the list as acceptable. It is recommended that the matter be taken up preferably through local agents in Egypt.

General Requisites of Train Control

In a paper read recently before the Franklin Institute in Philadelphia, Frank J. Sprague, the well known electrical engineer, who has been devoting a great deal of attention to the subject, laid down the trol, which seemed to him fundamental for the highest measure of success in meeting the increasingly difficult conditions of railroad operation.

Specifically, a successful system should:

Be applicable to any single or multiple track railroad, with or without automatic signal equipment; and in the case of the former, regardless of whether AC or DC normal danger or normal clear signals are used, with or without interlocks and overlaps.

Be suitable for any road, regardless of the kind of power used, whether steam or electric; and in the latter case uninfluenced by the kind of current or type and location of conductors.

Not encroach upon the clearance lines of rolling stock or track equipment; or be limited by extraneous equipment along the right-of-way; or interfere or be interfered with by snow plows or dragging equipment.

Be unaffected by climatic extremes, proof against interruption by water, snow or sleet, and subject to a minimum of depreciation.

Provide distinctive cab signals and full block protection, as reliably as any possible wayside signal.

Provide speed limitation, regardless of signals, on tangents and curves where required, and insure slowing down to safe running speeds on entering caution territory.

The engine equipment should be:

Readily applied to all types of road engines, passenger and freight, and once installed be a matter of no concern to the engineman as to adjustment, upkeep or replacement.

Unaffected by shock, jar and vibration, and proof against roadway dust and changes in atmospheric humidity.

Readily replaceable, at least as easily as the standard parts of the regular brake equipment.

Of such character that a locomotive can be used interchangeably on all kinds of train service, and with any kind of braking which may be required.

Subject to speed control, that is, to a proper coördination of the elements of train speed and braking power of equipment.

Engine and track equipment should be as nearly as possible fool-proof, and demand the minimum of upkeep and attention, both as to time occupied and special knowledge required; and necessity for adjustments by the engineman should be eliminated.

Finally, the system should be the engineer's friendly mentor and guide, aiding, not necessarily opposing him, a thoroughly reliable but unobtrusive partner in the operation of his engine, which, while at all times interposing an effective shield between him and disaster, will leave, within all proper limits, the handling of the train

Gasoline Railway Motor Car in Service on the New Orleans and Lower Coast Railroad

For nearly two years there has been in service on the New Orleans and Lower Coast Railroad, on a run between Algiers and Buras, Louisiana, a gasoline motor railway car, the operation of which at a steady and substantial profit, has proven to the officials of that road, the practicability and efficiency of gasoline motor car equipment for the service requirements of the division.

A steam train was formerly operated on this sixty-mile run at a steady loss. During the war the continuance of steady losses appeared to be inevitable so the morning train on this particular run was discontinued entirely. After the war the officials of this line decided to re-establish the service using gasoline equipment. They purchased a chassis from the Four Wheel Drive Auto Company, Clintonville, Wisconsin, and built a body for it with a seating capacity of thirty passengers, in their own shops. It was completed and installed so that the car was placed in service on November 3, 1920. Since that time the car has made one-round trip daily, except Sundays, between Algiers and Buras. In making this run the speed of the car ranges up to a maximum of 35 miles per hour and the entire run of sixty miles, including time for stopping, is made in about four hours.

MOTOR CAR ON NEW ORLEANS AND LOWER COAST RAILROAD.

An average cost of about fifteen cents per mile is necessary to operate the gasoline car. This includes fuel, oil, repairs, replacement parts, salaries of motorman and conductor, insurance, etc. The cost of operating the train consisting of a steam locomotive and two coaches over the same run is 41.8 cents per mile. This cost is computed on the same basis as the cost of operating the motor car. Neither one of these figures includes the right-of-way maintenance cost, but it stands to reason that the heavy locomotive with two heavy coaches would do more damage to the right-of-way than the motor car which weighs only about six and one-quarter tons. In other words, the motor car saves 26.8 cents per mile, and if the right-of-way

of these figures the saving would probably be considerably more. Figuring on a 302-day year with 120 miles of travel to the credit of the motor car each day, the saving through the use of motor equipment mounts up into thousands of dollars per year.

Since the inauguration of motor car service on this run the patronage of the line has increased to such an extent that an addition to the equipment has become necessary. However, instead of going back to the use of a steam train, the officials of the road purchased a trailer chassis from the Four Wheel Drive Auto Company and have built a body for it. By changing their seating arrangements in the motor car, the two-car train now seats fifty-two passengers, it also has a baggage and mail compartment and a toilet. With this addition to the equipment a more complete service is given and the comfort of passengers is increased.

It is believed that the additional car will not make it necessary to increase the running time between Algiers and Buras, nor will the expense of operation per mile increase materially.

In operating their motor equipment, the New Orleans & Lower Coast Railroad have adopted the policy of having a man spend a short time each night going over the equipment after it has been placed in the shed and seeing that everything is in ship-shape. This plan not only insures safety to passengers and eliminates delays through breakages during the run, but it adds to the life of the equipment.

The use of self-propelled railway cars may be novel to railway men not accustomed to their application, but an earnest study of their engineering problem is important for a better development of this class of rolling stock.

Although operating conditions vary on different railroad lines, such facts and figures as given above are fast convincing railroad operators that railway motor equipment has an important place in the success and profitable operation of the

Improved Shop Devices for Railroad Work

A Coupler Yoke Rivet Cutter—Flanging Clamp Made From Old Air Brake Cylinders—Dies for Pointing Staybolts

Coupler Rivet Nipper

A very simple home-made device for cutting the rivets that hold the yoke to the coupler is shown in the accompanying engraving. Its motive power is a cylinder 16 ins. in diameter with a piston stroke of 6 ins. The piston rod is attached to the long end of a lever having a ratio of 78 ins. to 15 ins. between the fulcrum and the point of its attachment and that of the cutter. So that for the full stroke of the piston the movement of the cutting end will be a little more than 1⅛ in. And if an air pressure of 60 lbs. per square inch be used the pressure exerted to shear the rivet will be about 62,700 lbs.

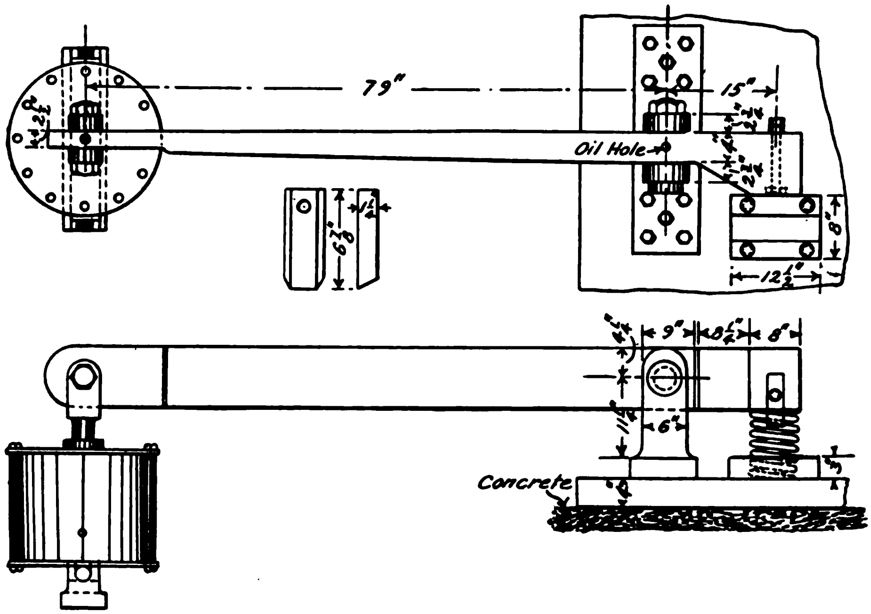
The piston rod is 2½ ins. in diameter and drives through a 2-in. bolt at the end of the lever. The fulcrum bolt is 3 ins. in diameter and is held by a heavy casting with jaws 6 ins. wide and 2¾ ins. thick, which is bolted by ten 1⅛ in. bolts to a heavy baseplate set on a bed of concrete. The lever has a uniform depth of 8½ ins. for its whole length with a thickness of 2¼ ins. at the cylinder end and 4 ins. at the fulcrum.

The anvil is 12½ ins. long and 3 ins. thick with a width of 8 ins., which serves to hold the coupler or yoke while shearing. The cutter is dove-tailed into the face of the lever and has a bearing at its upper end against the solid metal so that the fastening bolt is relieved of all shearing stress.

Beneath the broad foot formed at the short end of the lever there is a heavy spring of 8 ins. outside diameter that when the air is released from the cylinder.

The shape of the cutter is shown in the small drawing. It has a length of 6⅞ ins. and a thickness of 1⅛ in.

With this machine the yoke rivets can be cut as rapidly as the men can handle the couplers on and off of the anvil.



DEVICE FOR CUTTING THE RIVETS THAT HOLD THE YOKE TO THE COUPLER.

Flanging Clamp

In this machine the discarded air brake cylinder comes to the front as a means of operation. This clamp *A* is drawn down against the bed *B* by the two old air brake cylinders CC, which are 14 ins. in diameter with a piston stroke of 12 ins., and they are set 15 ft. 4 ins. apart from center to center. The clamping bar *A* has a uniform thickness of 4 ins. for its whole length, with a depth of 7½ ins. at the center and 4½ ins. at the ends.

The uprights *E* which form the guides for the bar *A* are L-shaped and are bolted to the main base.

Air is admitted and exhausted from each end of the cylinder by the valve *D*, as the weight of the pistons and the bar would settle down to rest against the base unless they were held up by air pressure beneath them. The valve is, therefore, so arranged that when admitting air to one end of the cylinders it is exhausting it from the other. With 60 lbs. per square inch air pressure above the pistons the clamp is drawn down with a pressure of about 18,950 lbs. plus the weight of the moving parts.

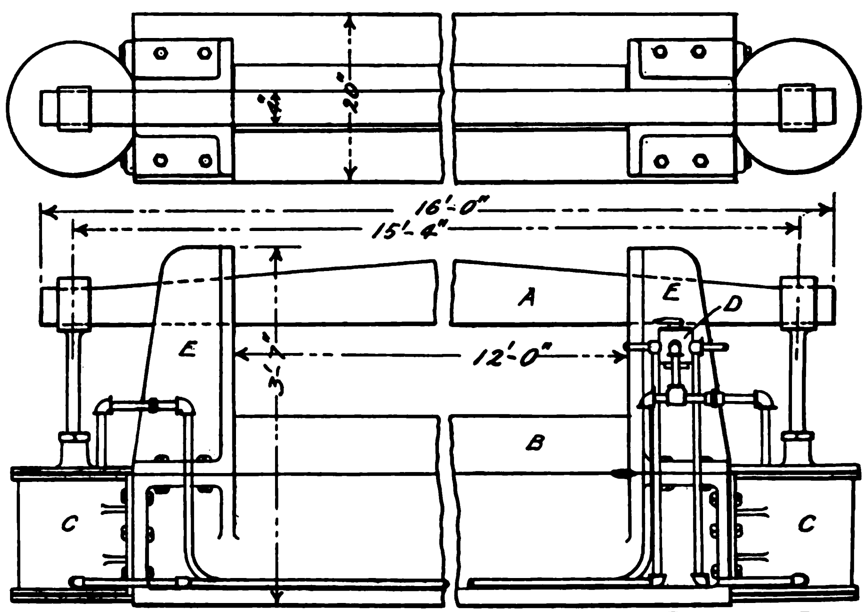
Such a clamp as this can be made very cheaply and of any desired size and power.

Dies for Pointing Staybolts

The pointing of staybolts is sometimes troublesome and time consuming, and the dies shown are designed to eliminate the trouble and reduce the time to a minimum.

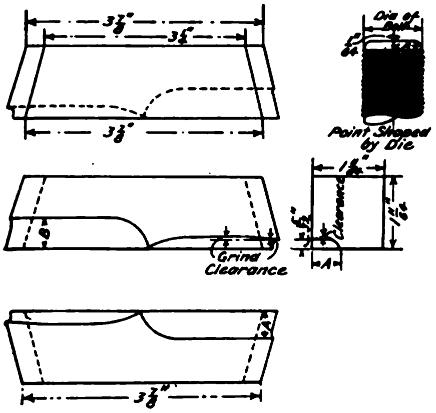
The die or cutter is made 1 11/64 in. square and has the cutting edge and contour ground out of one corner as shown at A. The staybolt is held in a chuck and revolved while the end of the cutter is forced up against it, thus forming the point as indicated by the special engraving.

The shaped cutting edge *A* is ground



just deep enough so as to leave no teat on the end of the bolt.

The dies can be used on bolts of 1 in., 1 1/16 in. and 1⅛ in. In order to do the cutting the value of the distance *A* is made 31/64 in., 33/64 in. and 35/64 in., re-



DIES FOR POINTING STAYBOLTS.

spectively, or so, that twice the distance *A* will be 1/32 in. less than the diameter of the bolt. The diameters of the points on the three bolts, after finishing, will be 15/16 in., 1 in. and 1 1/16 in., respectively.

In making these bolts the distances *A* and *B* are ground so as to cut bolts of different diameters and care should be exercised that there is a proper clearance back of the cutting edge.

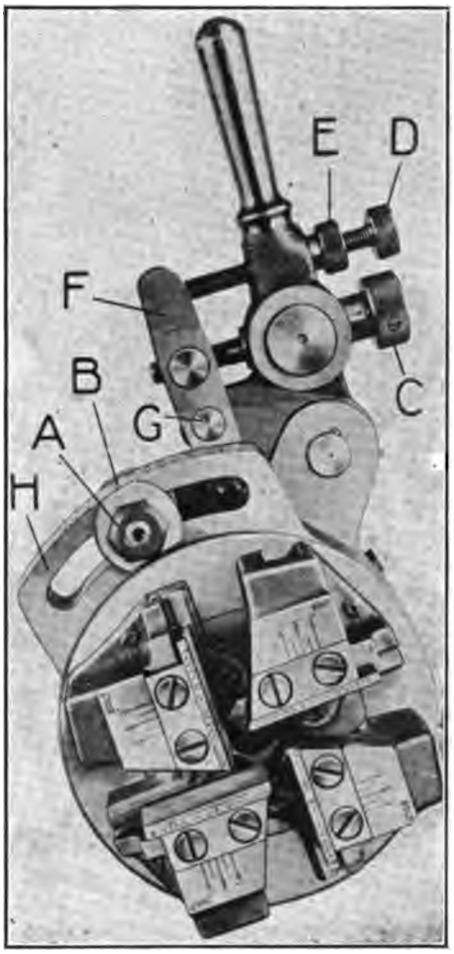
Landis New Die Head

The Landis Machine Company, Waynesboro, Pa., has recently developed a stationary type die head with micrometer attachment. This head is particularly valuable when cutting threads of special form requiring one or more roughing cuts and a finishing cut. With the micrometer attachment it is possible to set the die head so that the same amount of metal is left for the finishing cut at all times. The head is graduated for both right and left hand for all sizes of bolts and pipe within its range. These graduations are stamped on the outer surface of the closing ring above the circular slot.

The operation of the die head, referring to the illustration is as follows: To adjust the die head to size loosen the clamping nut A with the left hand and bring the index mark B opposite the required graduation on the graduated scale with the right hand. Further adjustment can be made if desired, through the micrometer attachment, and great accuracy attained.

To adjust the micrometer attachment back off stop screw D after first loosening the stop screw lock nut E. Then the micrometer screw C can be adjusted for increasing or decreasing the diametrical adjustment.

To increase the diametrical adjustment of the die head, turn the micrometer screw C in a counter clockwise direction. This swing to the left about the center G. The swing of the link F to the left pulls the closing ring H to the right and increases the diametrical adjustment. Turning the micrometer screw C in a clockwise direction causes a counter movement of the link F and decreases the diametrical adjustment.



NEW DIE HEAD WITH MICROMETER ATTACHMENT.

After the micrometer adjustment is made, the stop screw D should be set against the link F and locked in place with the stop screw lock nut E. To adjust the die head for the roughing cut, turn the micrometer screw C in a counter clockwise direction until the desired diametrical adjustment is obtained. The stop screw D should be left in the locked position. Two or more roughing cuts can be made by decreasing the diametrical adjustment of the die head in one or more increments through the micrometer screw C. After the roughing cut has been made, the micrometer screw C should be turned back in a clockwise direction until the link F come against the stop screw D. The die head is now set to the final diameter and is ready for the finishing cut.

Arrangements can be made to apply this die head with micrometer attachment to turret lathes, engine lathes, and hand-operated screw machines. It may also be applied to lathe type of threading ma-

Safety on the Pennsylvania

The Pennsylvania System operated throughout the year ended May 31, 1922, without a passenger being killed in train accident.

In that period, 1,400,000 passenger trains were operated over more than 11,000 miles of road, while the number of passengers carried totaled 152,000,000, which represented approximately one-seventh of the passenger business of the railroads in the United States.

A single defect in track or equipment or the violation of a safety rule may cause a fatal train wreck. The record cited of immunity from fatal injury to passengers in train accident will therefore be better appreciated when it is understood that the Pennsylvania System embraces 27,000 miles of track, owns 271,000 freight cars, 8,000 passenger cars and 8,000 locomotives, and has approximately 200,000 employes.

Southern Pacific's Improvement Plan

The Southern Pacific Company, during the current year will expend a total of $29,000,000 in carrying out its extensive programme calling for new construction, betterments and additions to facilities and equipment. The work at present under way, calls for an expenditure of about $11,300,000 for new rails, ties and ballast, $4,500,000 for new locomotives, $12,500,000 for new rolling stock and $700,000 for plant facilities.

Westinghouse Electric Company

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has just completed the preparation of a 64-page illustrated publication on mine locomotives and other mining apparatus. In addition to line material, the publication, which is known as Catalogue 6-M, contains much information about mine safety switches, Frankel solderless connectors, tapes, babbitts, solders, micarta gears, mine locomotive headlights, etc.

This company is also distributing a Publication 4249-A, describing its line of insulating and soldering compounds. Some of the materials treated in the publication are baking varnishes, air-drying varnishes, insulating compounds, finishing materials, insulating glue, soldering flux, and lubricating oil.

Traveling Engineers' Association

Owing to the unsettled conditions, the executive committee of the Traveling Engineers' Association have considered it necessary to change the date of the annual meeting from September 12, 13, 14 and 15 to October 31, November 1, 2 and 3 of the current year. The hotel accommodations and all other arrangements will be the same as were arranged for the first-named date of the convention. J. H. DeSalis is president and W. O. Thompson, 1177 East 98th street, Cleveland, O.,

Snap Shots—By the Wanderer

It has been suggested as one of the means of untangling the snarl of union supervision of shop and railroad industry that an appeal be made to the local officers for co-operation in increasing the efficiency of the men, and to ask opinions as to the value of proposed changes in facilities. It has a beautiful sound, but like many another Eutopian ideal, it has but little chance of being worked out so as to give practical and tangible results.

My range of vision and experience is not all-inclusive by any means; but, as far as it has extended, it has failed to find any trace of any union anywhere setting forth a definite or even an indefinite movement for an increase in the efficiency of its members. But, on the other hand, so far as I know, the policy has been to cut down the efficiency and output of the best to that which can easily be attained by the mediocre and least efficient. This holds for times of peace and times of war; in good times and bad times. The command has been to hold back the best and never apply the spur to the poor. It isn't a very high ideal, to be sure, but it appeals to man's natural laziness and his age-old desire to avoid the condemnation to live by the sweat of his brow. Then add the seniority law and you have the making of indifference, inefficiency and neglect. A good man, an ambitious man who wants to rise, has a hard time. He cannot outstrip his fellows without anathema. Excellence has no reward under seniority rights, and initiative is killed while mediocrity or less occupies the saddle. So the suggestion would be glorious if it could be executed, but of that I hae me douts.

Of course, one swallow does not make a summer, and one man's experience cannot establish a general law, but it may have its value as an indicator.

It so happened that I was loitering about the shops of a large road, running out of Chicago, on the first of July in this year of our Lord, at the time of and before the walk-out of the shopmen. It also happened that I was thrown into pretty close personal contact with a number of the men who were "ordered" out. I say "ordered" out advisedly, because not a single man with whom I had the privilege of talking either wanted to strike or had any sympathy with those who did. And a number of them even went so far as to ask permission to remain in the service of an outside company where they would not be doing repair work but would be at work on railroad property. This was refused, much to their disgust.

Since then I have wandered down through Indiana, Ohio, Tennessee and West Virginia and have run across a goodly number of shopmen, none of whom would acknowledge to me that they wanted to strike. When asked why they did so, the invariable reply was:

"Why! I've got to."

"I've got to." That tells the whole story. Not allowed to work for an outside party, because if one man is idle all must be. Well, that may be all right, but somehow it doesn't seem quite right to me.

It has been my lot to see a good deal of the publicity work of railroad departments, and it does not impress me as being very efficient. That is, it does not always, in fact, very seldom, give the information that the techincal man would like on technical subjects. There are many words put together in flowery and grandiloquent sequence, but seldom getting down to brass tacks, as it were. And the trouble is that real information is hard to obtain.

To take a notable example. Probably the 999 of the New York Central was the most extensively advertised locomotive that has ever been built in the United States. Its publicity was a piece of advertising of the passenger department of the road. There was very much talk, but nothing regarding the peculiarities of the design, the power it was capable of developing, its boiler or engine efficiency, or anything, in fact, that was of interest to the engineer or designer. It was known to have run at an exceedingly high speed, but many of us had our suspicions that that speed was, like the height of a parade elephant, based on circus measurement. Well, it is very natural that things should be like that, for it takes an engineer to gather, compile and issue engineering information, and publicity work is not usually in the hands of engineers.

Rapidity of action is certainly not a general attribute of mankind. The slow saunter is the pace on the street and obliviousness to the desires of others to be able to move characterizes a good working majority. This slowness seems to me to be one of the contributing elements of the inability of late trains to make up time. Passengers move in and out of cars with an exasperating degree of moderation, and this is especially the case in country districts.

When the elevated railroads were opened in New York its patrons moved so slowly that station stops seemed interminable. Then was introduced the slogan of "Step lively, please." Every guard said it, and repeated it and repeated it again at every stop, until it became a byword in the city. And the effect was that people did step more lively than was their wont, and station delays were about cut in two.

This urgent request to step lively, please, has never been used on the surface railroad trains and they are being inordinately delayed because of the slow moving crowd, and the country crowd or country people are the slowest of the lot. Why not have the trainman, when he announces the station, make the request to step lively, please, because we are late and want to make up time? And then urge the oncoming passengers to do likewise?

Train schedules are usually so made that there is little chance of making up time by faster running, but it can be done by expediting the movement of passengers. I was on a long local run the other day on which there were fifty-two stops. The train was late and remained late; but it could easily be seen that a rapid passenger movement at each station could have saved an average of thirty seconds for every stop. Well! That would have put the train in ahead of its actual arriving time by twenty-six minutes, which would have made it twenty-four minutes late at terminal instead of one hour.

There is no good reason why a surface railroad passenger should remain seated until the train stops; and there is no good reason why the passenger should not be told that by so doing he is delaying the costly train, wasting the time of his fellow passengers, and adding to the cost of railroad operation; because it certainly does cost more to get a late train over the road than one that is on time.

Indolence and thoughtlessness are responsible for this, and there is every reason why the indolent and thoughtless man should be told of his defects and asked or even be forced to remedy them, when they are costing the community time and money. But he will never think of it himself because—— Well, you know, thinking is not much of a human characteristic. The thinking of the world is done by a microscopic minority.

I am impressed and frequently unfavorably by the fear manifested by many railroad men to talk for publication about things that have happened or are happening about them. They are obsessed with the idea that if they speak and so much as hint that the men and the shop committees are not the most reasonable of men and merely lack a halo to be candidates for cannonization, that some dire vengence will be wrought upon them. They will tell tales that make their hearers bristle with indignation, for private subrora circulation only, quiet oblivious of the fact that the best and quickest way to correct an abuse is to throw it into the light of day and give it all of the publicity possible.

Railroad Equipment Notes

Locomotives

The Baltimore & Ohio has ordered 15 Pacific type locomotives from the Baldwin Locomotive Works.

The Detroit Terminal has ordered two locomotives of the 0-8-0 type from the American Locomotive Company.

The Southern Pacific has ordered two snow plows, having 12 ft. cut, and cylinders 18 by 26 inches, from the American Locomotive Company.

The Illinois Central has ordered 15 switching locomotives from the Baldwin Locomotive Works, 25 Santa Fe type locomotives from the Lima Locomotive Works and 25 Mikado locomotives from the American Locomotive Company.

The Chicago & Eastern Illinois has ordered 10 Mikado type locomotives from the American Locomotive Company and six Pacific type locomotives from the Lima Locomotive Works.

The Erie has placed an order for 30 Mikado locomotives with the Baldwin Locomotive Works.

The Union Pacific has placed an order with the American Locomotive Company for 55 Mountain type and 10 Mallet type locomotives.

The Lima Locomotive Works have received an order for 19 locomotives for the New York, Chicago & St. Louis. It is also reported that the Lima Locomotive Works have received an order for five switching engines from the Indianapolis Union Railway.

Baldwin Locomotive Works will construct 25 Consolidation type engines for the State Railways of Poland.

The Missouri, Kansas and Texas is inquiring for 40 Mikado, 5 Pacific, and 10 eight-wheel switching locomotives.

The Chicago & Northwestern has inquired for 40 Mikado type 2-8-2 superheater freight locomotives. Total weight of engine in working order will be 304,000 lbs. Total weight of tender in working order will be 168,000 lbs., with capacity of 15 tons of coal and 8,275 gallons of water. Also 10 Pacific type 4-6-2 superheater passenger locomotives. Total weight of engine in working order to be 169,000 lbs., and weight of tender in working order 170,500 lbs., with capacity of 15 tons of coal and 8,275 gallons of water.

The St. Louis Coke & Chemical Co. has ordered a switching locomotive from the American Locomotive Company. This engine will be of the 0-8-0 type, have cylinders 21 x 26 in. and weigh in working order about 147,000 lbs.

The American Locomotive Company has also received orders for small switching engines from the Public Service Company of Northern Illinois, The Wheeling Steel and Iron Company of Wheeling, W. Va., and the David J. Joseph Company

The Union Pacific has ordered 15 2-10-2 type engines from the Baldwin Locomotive Works.

The Chicago, Milwaukee & St. Paul is contemplating the purchase of 75 locomotives.

The Missouri Pacific has placed an order for 25 Mikado type locomotives with the American Locomotive Company.

The Missouri, Kansas & Texas has ordered 10 eight-wheel switches from the American Locomotive Company.

Freight Cars

The Missouri Pacific has placed orders for repairs of 1,250 cars with the American Car & Foundry Company; 1,000 with the Sheffield Car & Equipment Company; and 250 with the Mount Vernon Manufacturing Company.

The Chicago & Northwestern has placed orders for repairs of 500 box cars with the American Car & Foundry Company, and 1,000 box cars with the Western Steel Car & Foundry Co.

The Chicago, Rock Island & Pacific has placed orders for the repairs of 400 wooden box cars, 300 automobile and furniture cars and 400 steel underframe box cars with the Western Steel & Foundry Company.

The United States Copper Company has ordered 24 ore cars from the Pressed Steel Car Company.

The Great Northern has ordered 300 underframes from the Minneapolis Steel & Machinery Company.

The Manila Railroad Company has ordered 50 cane cars of 30 tons' capacity from the Koppel Industrial Car & Equipment Company.

The Delaware, Lackawanna & Western has ordered 370 gondola car bodies from the American Car & Foundry Company.

The Chicago, Burlington & Quincy is having 500 box cars repaired at the shops of the Streater Car Company, and 500 steel gondolas at the shops of the American Car & Foundry Company.

The New York Central is having repairs made to 500 box cars at the shops of the Streater Car Company and 500 steel gondolas at the shops of the American Car & Foundry Company.

The Fruit Growers' Express is inquiring for 1,000 refrigerator cars.

The Seaboard Air Line has placed an order for repairs to 900 freight cars with the Magor Car Co.

The Lehigh and Hudson is reported to be in the market for 100 fifty-ton gondola cars.

The Illinois Central is in the market for 75 caboose cars.

The Western Pulp & Paper Co. is in the market for 10 steel underframe box cars.

The Laconia Car Co. will repair 1,000

The Canadian Pacific has ordered 250 refrigerator cars from the National Steel Car Corporation.

The West Virginia Pulp and Paper Company, New York City, is inquiring for 20 fifty-ton box cars and 20 fifty-ton composite gondola cars.

The Chicago, Milwaukee & St. Paul is reported to be in the market for a number of freight cars.

The Central of Georgia is in the market for 75 steel underframe flat cars.

The Chesapeake & Ohio has placed orders for repairs to steel coal cars as follows: 1,500 with the American Car & Foundry Co.; 1,000 with the Richmond Car Works; and 500 with the Keith Railway Equipment Co.

The Chicago, Burlington & Quincy is inquiring for 2,000 composite gondola cars.

The Lehigh Valley has ordered repairs to 1,000 steel gondola cars from the American Car & Foundry Co., and the Buffalo Steel Car Company.

The Indiana Gas & Coke Company has placed an order with the General American Car Company for the repair of 50 hopper cars.

The Chicago, Indianapolis & Louisville is inquiring for 300 composite gondola cars.

The Polish Government has ordered 7,000 freight cars, originally built for overseas service during the war, from the War Department of the United States Government.

The Philadelphia & Reading has ordered 100 refrigerator cars from the American Car & Foundry Company.

The Long Island is inquiring for 6 locomotives suitable for passenger service in summer and freight in winter.

Passenger Cars

The Pittsburgh & West Virginia has ordered nine coaches, one passenger and baggage, two passenger, baggage and mail and two baggage cars from the American Car & Foundry Company.

The Boston Elevated has ordered 40 tunnel cars from the Pullman Company.

The Chicago Elevated has ordered 100 cars from the Cincinnati Car Company.

The National Railways of Mexico have ordered 5 first class and 10 second-class narrow-gauge passenger coaches from the Pullman Company.

The Northern Pacific has placed an order for 70 express refrigerator cars for passenger train service with the American Car & Foundry Company.

The Maryland & Pennsylvania is said to have placed an order for two gasoline motor cars and two trailers with the Russel Company of Kenosha, Wis.

The Pennsylvania is reported to be in the market for 20 gasoline motor cars for branch line service.

The Tennessee, Alabama & Georgia contemplates the purchase of a number

The Canadian Pacific is reported to have ordered 15 baggage cars from the National Steel Car Corporation.

The Chicago, Aurora & Elgin is said to have ordered 19 steel passenger cars and one dining car from the Pullman Company.

New Shops and Other Buildings

The Missouri, Kansas & Texas is reported to have made a contract for the steel work in a new locomotive shop to be erected at Waco, Tex.

The Missouri Pacific has awarded a contract for the construction of a car repair shed to be erected at Sedalia, Mo., costing about $25,000 to the T. S. Lecke Construction Company, Chicago.

The Wabash has awarded a contract for the construction of a new freight station and the remodeling of a passenger station at Kirksville, Mo., to the T. S. Leeke Construction Company, Chicago.

The Pennsylvania is perfecting plans to erect new shops and freight houses at Lancaster, Pa., besides making extensions and boat terminals at Salisbury, Md. This is proposed to be the terminal of the steamboat line between the eastern shores of Maryland and Virginia.

The Chicago, Burlington & Quincy has awarded a contract for the construction of a power plant at Aurora, Ill., to the Great Lake Construction Company, Chicago, and also for the construction of a new roundhouse at Rock Island, Ill., to G. A. Johnson & Sons, Chicago.

The Pere Marquette has awarded a contract to the Arnold Co. of Chicago for the construction of new shops and other buildings at Grand Rapids, Mich, representing an expenditure of about $1,000,000.

The Canadian Pacific is planning a new engine house at Medicine Hat, Alta., that will cost about $30,000.

The Atchison, Topeka & Santa Fe is asking bids for the construction of a boiler and tank shop at Albuquerque, New Mex., to cost about $400,000.

The Erie is said to be planning the consolidation of the shop, roundhouse and terminal facilities of the Kent, Marion and Cincinnati divisions of the road at Marion, Ohio, which will involve an expenditure of about $750,000.

The Illinois Central has asked for bids for the construction of nine water treating plants to be located at Council Bluffs, Logan, Dunlap, Denison, Rockwell City, Wall Lake and Fort Dodge on the Iowa division and at Amboy, Ill., and La Salle on the Wisconsin division, four of these to be of 10,000, three of 20,000 and two of 30,000 gallons per hour capacity. This road is also asking bids for rebuilding of existing water treating plants at Manchester, Iowa, Galena, Ill., and Scales Mound on the Minnesota division, to increase their capacity from 10,000 to 20,000 gallons per hour. This company has awarded a contract to Joseph E. Nelson & Co., Chicago, for the construction of a water station, including a 100,000 gallon storage tank at Matteson, Ill., in connection with grade separation work at that place.

The Minneapolis, St. Paul & Sault Ste. Marie is asking for bids for the construction of an 18-stall brick roundhouse at Gladstone, Mich.

The Union Pacific is planning the construction of shops and classification yards on a 516 acre plot adjoining the city of Los Angeles, which will involve an expenditure of about $29,000,000.

The Ulster & Delaware has awarded to the Michand-Campbell Co. a contract for the construction of a locomotive erecting shop at Kingston, New York.

The Union Pacific has awarded to the Graver Corporation a contract for the construction of a 30,000 gallon per hour Graver Type "K" Ground Operated Water Softener, to be located at Granger, Wyoming. This plant will be equipped with two standard Graver Pressure Filters 8 ft. in diameter to 12 ft. long. The contract also covers the reconstruction of five of their present treating plants over to the improved Graver Type "K" design.

The Missouri, Kansas and Texas is asking for bids for the construction of a brick and steel locomotive shop at Waco Texas. This company has awarded to the Graver Corporation, Chicago, a contract for the construction of 15,000 gallon per hour Graver Type "K" Ground Operated Water Softener with storage capacity at top of softener capable of holding 100,000 gallons of treated water for installation at Glen Park Yards, Kansas City, Kansas; a 10,000 gallon per hour Graver Type "K" Ground Operated Water Softener for installation at Nelogony, Oklahoma; a 5,000 gallon per hour Graver Type "K" Ground Operated Water Softener for installation at Eufaula, Oklahoma; and four standpipes 14 ft. diameter by 32 ft. high and one 18 ft. diameter by 32 ft. high for installation in Texas.

The Union Pacific has awarded a contract to the Graver Corporation for the erection of a 200,000 gallon steel water storage tank at Ogallala, Neb., and an 800,000 gallon steel water storage tank at Council Bluffs, Ia.

The Michigan Central R. R. is reported to be considering the erection of new car shops at Bay City, Mich., to replace its present main shops at Detroit.

The Chicago Milwaukee & St. Paul Ry. has ordered the abandonment of the division shop at Tomahawk, Wis., and the transfer of all machinery and equipment to the main shop of the Wisconsin valley division at Wausau, Wis., which is to be enlarged.

The Illinois Central R. R. is reported to have tentative plans under way for the locomotive repair shops at Evansville, Ind., estimated to cost about $75,000.

The Richmond Fredericksburg & Potomac Ry. has placed a contract with the Roberts & Schaefer Co., of Chicago, for the construction of two, all solid poured, reinforced concrete, four track, locomotive coaling plants with 200 tons per hour, automatic, electric, elevating equipment and sanding facilities. These plants will be equipped with 15 ton steel weigh hoppers for issuing and recording all coal passing to locomotives used by the Pennsylvania R. R., the Baltimore & Ohio R. R., the Chesapeake & Ohio Ry., and the Richmond, Fredericksburg & Potomac Ry.

Increased Use of Block System

Statistics just made public by the Interstate Commerce Commission show that 102,467 miles of railroad were equipped with block systems up to January 1, 1922, which was an increase of 584 miles, compared with January 1, 1921. Of the total, 39,061 miles were equipped with automatic block systems and 63,406 with non-automatic. This was an increase of 517 miles in the length of road operated by the automatic block system and 66½ miles operated by the non-automatic block system.

These statistics also show that during the year 1921 there was a decrease of 635 miles in the length of railroad on which the telegraph was used for the transmission of train orders, while there was an increase during the same period of 1,231 miles in the length of railroad on which the telephone was used for the transmission of train orders.

Railway Extension in South Africa

It is reported that a bill has been introduced in the parliament of South Africa providing for the immediate construction of 22 short railway connections, aggregating 851 miles of line, involving an expenditure approaching $20,000,000.

Locomotives Exported

Domestic exports of steam locomotives from the United States, by countries, and their value, for the month of June, 1922, were as follows:

Countries	*Steam locomotives Number*	*Steam locomotives Dollars*
Canada—		
Quebec and Ontario....	..	......
Br. Columbia & Yukon..	1	3,900
Panama	4	15,120
Mexico	..	......
Cuba	1	3,750
Argentina	25	400,250
Brazil	7	64,200
Colombia	1	27,000
Peru	..	......
China	5	249,925
Japan	2	18,025
Total	46	783,170

Items of Personal Interest

R. D. Smith has been appointed Master Mechanic, of the Interstate Railroad Company, with offices at Andover, Va., vice O. S. Kuhn, resigned.

A. R. Kipp, formerly mechanical superintendent of the Soo Line has entered into partnership with P. L. Batley, consulting engineer, at Chicago, Ill.

J. J. Killingsworth has been appointed electrical supervisor of the Grand Trunk, with headquarters at London, Ont., succeeding F. J. Coleman, deceased.

M. D. Stewart, formerly general foreman of the Southern at Spencer, N. C., has been promoted to master mechanic, with headquarters at Bristol, Va.

Carl G. Henderson, general foreman of the Southern, with office at Chattanooga,

H. A. MATTHEWS.

Tenn., has been appointed master mechanic, with office at Charleston, S. C.

W. R. Meeder has been appointed master mechanic of the Missouri & North Arkansas, with headquarters at Harrison, Ark., succeeding C. W. Bugbee, who resigned.

W. L. Whiter, transportation inspector of the Pennsylvania, with headquarters at Ft. Wayne, has been appointed assistant trainmaster, with the same headquarters.

A. Mays, general foreman of the Canadian National, has been appointed assistant master mechanic, with headquarters at Big Valley, Alberta, succeeding W. L. Loomis, transferred.

Col. J. E. Braudt, formerly road foreman of engines of the Chicago & Northwestern, has entered the employ of the Nathan Manufacturing Company, with headquarters at Chicago.

F. W. Boardman has been appointed general master mechanic of the Texas & Pacific at Dallas, Tex., vice L. F. Dix-

resigned. Mr. Boardman was formerly fuel supervisor at this point.

E. M. Sweetman, master mechanic of the Southern, with office at Knoxville, Tenn., has been appointed superintendent of motive power in charge of lines west, with headquarters at Cincinnati, Ohio.

J. J. Hennessy and Hugh Bonham have been appointed assistant superintendents of the lubrication division, railway traffic and sales department of the Texas Company, New York, with headquarters at New York and Chicago respectively.

C. C. Clark has been appointed general sales manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with headquarters in the Farmers' Bank Building, Pittsburgh, Pa., succeeding K. C. Gardner, resigned.

A. D. Prendergast, mechanical superintendent of the Texas & Pacific, with headquarters at Dallas, Tex., has been appointed to the newly created position of general mechanical inspector of the Central of Georgia, with headquarters at Savannah, Ga.

A. L. Roberts, formerly master mechanic of the Lehigh Valley Railroad and more recently chief engineer of the Atlas Crucible Steel Co., Dunkirk, N. Y., has been appointed sales engineer of the railroad department of the United Alloy Steel Company, Canton, Ohio.

C. M. Jacobson has joined the service staff of the Franklin Railway Supply Company, New York, and has been placed in charge of the southern territory, with headquarters at Atlanta, Ga., succeeding B. C. Wilkerson, who is acting as special representative of the company on the installation of locomotive boosters.

W. J. Cooper has been appointed district road foreman of engines on the Sante Fe, with office at Needles, Cal., and others appointed to similar positions on the same road are J. C. Love at Los Angeles, Cal., F. C. Iber at Winslow, Ariz. T. E. Galligan has been appointed road foreman of engines at Needles, Cal., and Lee Pearson at Seligman, Ariz.

The Sharon Pressed Steel Co. announces the election of four new directors to fill vacancies on the board. Those elected were: L. B. Le Bel, vice-president and director, Cleveland Discount Co.; Edward O. Peck, secretary and director, Cleveland Discount Co.; Harold G. Mosier, attorney, Cleveland; and A. E. Swan, first vice-president, Sharon Pressed Steel Co., Sharon, Pa.

H. A. Matthews, formerly sales manager of the Railway Division of the U. S. Light & Heat Corporation, has been elected a vice president of the company.

Mr. Matthews entered the railway supply business in 1912 with the U. S. Light & Heat Corporation at Chicago. Prior to

that he had been employed by the L. S. & M. S. Railway as clerk to the general superintendent at Cleveland, and later entered the services of The Pullman company. For seven years he was secretary to the president of The Pullman company, which position he held up to the time he joined the U. S. L. forces at Chicago. In 1917 he was transferred to the factory at Niagara Falls and placed in charge of the railway sales department.

G. B. Pierce, who has been connected with the Westinghouse Air Brake Company for the last 12 years as mechanical expert, attached to the St. Paul office, has been promoted to the rank of air brake engineer and transferred to the Orient, where he will act in that capacity both

G. B. PIERCE.

for the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company, in a territory covering Japan, China, Manchuria and Korea. Early in September Mr. Pierce will sail for Japan to associate himself with W. G. Kaylor, manager of the Westinghouse air brake interests in the Orient, with whom he expects to make his headquarters in Tokyo. Mr. Pierce is a former railroad man who graduated from the ranks. After serving his apprenticeship as a fireman, he became an engineer on the Montana division of the Northern Pacific in 1901. This division is one of sharply contrasted road conditions, the eastern section being virtually level with the two western sections out of Livingston, one to Butte and the other to Helena, to traverse ranges of the Rockies with attendant heavy grades. These conditions gave Mr. Pierce an opportunity to attain marked proficiency in the handling of trains, especially in the matter of brake operation, and his skill in this respect, together with his mechanical knowledge of air brake principles and design, soon won him recognition among his associates. For a time he served as acting road foreman of engines on the Montana division and for three years was a member of the local examining board on transportation rules at Livingston. In 1910 he left the Northern Pacific to join the Westinghouse Air Brake Company, assuming the title of mechanical expert and acting as assistant to F. B. Farmer, Northwestern representative, at St. Paul. One of Mr. Pierce's most important duties in the Orient will be the instruction of enginemen, train crews and shopmen in the operation and maintenance of the Westinghouse air brake, which is rapidly coming into general use on the leading steam and electric railways of the Far East.

William A. Webb, formerly assistant to the president of the Missouri, Kansas & Texas, has been appointed commissioner of the State Railways of South Australia. Mr. Webb was born at Eaton, Ohio, in 1878, and educated at the high schools there. He entered railway service with the Colorado Midland as a messenger in 1890, and was successively, roadmaster's clerk, telegraph operator, stenographer to superintendent, chief clerk and stenographer to the general manager and president. In 1903 he became secretary to the president of the Colorado & Southern, and in 1903 was chief clerk to the vice-president of that road. In 1905 he was appointed assistant to vice-president and remained in that capacity until 1911, when he became general manager of the Texas Central. In 1912 he was appointed assistant to the president of the Missouri, Kansas & Texas.

W. D. Robb has been appointed ranking vice-president and general manager of the Grand Trunk Railway. Mr. Robb was born at Longueuil, Quebec, Canada, in 1857. Educated at Sherbrooke Academy, and at St. Francis College, Richmond, Quebec, he began his railroad career with the Grand Trunk in 1871 as an apprentice machinist. He was foreman at the Montreal shops in 1883, and at Belleville shops in the same year. In 1897 he was appointed master mechanic of the Middle division, with headquarters at London, Ontario, and in 1901 was appointed acting superintendent of motive power at Montreal, and superintendent of motive power in 1902, which position he occupied until 1917, when he became vice-president in charge of motive power, car department and machinery. In 1918 his jurisdiction was extended to take in the operating, maintenance and construction departments of the system. Mr. Robb is the first native born Canadian to be called upon to occupy the chief executive office of the Grand Trunk Railway, having risen to the chief executiveship with an unbroken record of service from his apprenticeship with the railway.

OBITUARY—JAMES KENNEDY

It is with profound sorrow that we record the death of James Kennedy, president of the Angus Sinclair Co., and for the past ten years managing editor of RAILWAY AND LOCOMOTIVE ENGINEERING. The sad event occurred suddenly at his home in New York, on August 14, 1922.

Mr. Kennedy was born in Aberlemno. Forfarshire, in 1850, and received his early education in the high school in Dundee, Scotland. He served his machinist apprenticeship in his native land and in 1868 emigrated to America. He entered the employ of the Singer Manufacturing Company, and continued his studies, graduating from the old Thirteenth Street High School, New York, in 1875. The following year he entered the employ of the Cooke Locomotive Works, Paterson, N. J. In 1877 he was employed as a machinist on the Lackawanna and Bloomsburg (now a part of the Delaware, Lackawanna and Western), at Kingston, and was later a foreman at Scranton, Pa. From 1879 to 1902 he was foreman at the New York Elevated Railway shops in New York City. The following year he was engaged in the Water Department of the City of New York, and he was later deputy superintendent of elections. He was a constant contributor to the railway press, and in 1905 joined the staff of RAILWAY AND LOCOMOTIVE ENGINEERING, and in 1911 became managing editor of the publication. In 1919, he was elected president of the Angus Sinclair Company. He was the author of a number of books on the locomotive which have had a wide circulation.

JAMES KENNEDY.

He took much interest in matters of a civic nature, and was prominent in Republican politics in New York.

Characteristic of the true Scoto-American, he was fired by patriotism and self-sacrificing loyalty and devotion for his adopted land. At the same time he had an eye for all the beauties of nature, and his heart was stirred with a deep love for Scotland and all things Scottish. As a poet, essayist and lecturer on things of a Scottish nature, he was undoubtedly the most dominant figure in America. Through his command of the Scottish dialect, with its graphic and expressive vocabulary, he gave voice to all that was noble and good in regard to his native land. His poetical work appeared in many editions over the past 40 years, the last being in 1920.

He was a member of the St. Andrews Society, past chief of the Clan MacDuff, which he organized, and was past royal deputy for the State of New York of the order to which he belonged. He was president of the Burns Society of the City of New York, 1915-1916, and wrote and spoke much on the poet.

Services were conducted on the evening of August 17 at the Scotch Presbyterian Church, New York, by the Rev. Dr. David G. Wylie, who delivered a most beautiful eulogy.

Mr. Kennedy's death brings a deep sense of personal loss to his associates in the publication of RAILWAY AND LOCOMOTIVE ENGINEERING. His fine philosophy, practical wisdom, the rugged simplicity and honesty of his character, together with his broad humaneness, endeared him not alone to his associates, who were guided by his counsel and advice, but to all who enjoyed the privilege of his acquantance.

Those that knew him intimately mourn the loss of one whose remarkable character earned and merited their confidence and affection, and with whom he leaves the deep impression of the beautiful example which his having lived afforded.

FRANK BURR SMITH

Frank Burr Smith, of Cherry street, Milford, Connecticut, Works Manager of The Bullard Machine Tool Company, Bridgeport, Conn., died August 16th, at Grace Hospital, New Haven, succumbing to an acute attack of appendicitis. Taken suddenly ill, he had undergone an operation the following day, but was unable to survive the strain incident to conditions which had developed. He was in his fiftieth year and is survived by his widow, Estella Conrad Smith, and brother, Hubert C. Smith, of Milford, Conn.

Mr. Smith was born at Mohican Springs Farm, Fairfield, Conn., November 22, 1872, and obtained his early education in the public and high schools of Bridgeport. He entered the employ of The Bullard Machine Tool Company at their old Broad Street Plant in 1890 as a machinist apprentice. Upon completion of his apprenticeship he was connected with their Engineering Department.

In 1894 he went to Colorado to recuperate from a bronchial difficulty and while there turned his attention to prospecting and mining for gold. He returned East in 1896 and was employed by various machine shops and at one time was prominent with the Steam Works of Boston. His next position of importance was with the Laird Gold Production Company, as Mechanical Engineer. In 1903 he joined the DeLaVergne Machine Company, as expert erection and installation engineer. He returned finally in 1911 to The Bullard Machine Tool Company. With the Bullard organization he became manager of the Employment and Industrial Relations Department at the Broad Street Plant, and his efforts in this capacity were largely responsible for the singular effectiveness of Bullard activities under those trying conditions which existed in Bridgeport during the War years. When the Broad Street Plant was disbanded in 1920, and all manufacturing was transferred to the Black Rock Plant, he was made Works Manager and continued in this capacity until his death. Mr. Smith was prominently active in the mechanical development of Bullard Products, and his genius was further demonstrated by patents obtained in connection with mining and automotive industries.

CHARLES W. JONES

Charles W. Jones, general manager of the Chicago, Rock Island & Pacific lines west of Kansas City, Mo., died at his home at Des Moines, Iowa, on July 22, in the sixty-fifth year of his age. Mr. Jones had been in the employ of the Rock Island for over 46 years, and had filled nearly every position in the operating department, beginning as agent's helper in 1876, and in a few years promoted to dispatcher, rising to chief train dispatcher in 1890, and latterly superintendent on various divisions.

ANTHONY C. DOUGLAS

Anthony C. Douglas, construction engineer, died last month at Niagara Falls in the sixty-eighth year of his age. He superintended the construction of the tunnel through Bergen Hill at Jersey City for the Delaware, Lackawanna & Western. Among other tasks he had charge of the construction of the first Niagara power tunnel, and a portion of the Croton dam for the supply of water to New York City. He served for four years as Mayor of Niagara Falls.

RICHARD MAURICE BIRDSALL

The death of Richard M. Birdsall is announced as occurring at Chicago on July 27. Mr. Birdsall was the originator of cold storage plants and is credited with planning the first refrigerator railroad car. He was vice-president for many years of the Western Cold Storage Company. He was in his seventy-ninth year.

G. E. A. LETOURNEAU

G. E. A. Letourneau, manager of the Co., Ltd., Montreal, Canada, died suddenly at his home, August 5th.

CHARLES S. REA

Charles S. Rea, vice-president of the Ralston Steel Car Co., Columbus, Ohio, died in the Allegheny General Hospital at Allegheny on August 1st. Mr. Rea was suddenly stricken in his office in Pittsburgh and removed to the hospital where he died without regaining consciousness. Mr. Rea represented the Ralston Steel Car Co. for fifteen years, as vice-president at Pittsburgh.

COLEMAN SELLERS, JR.

Coleman Sellers, Jr., president of William Sellers & Co., Incorp., Philadelphia, Pa., died on August 15th, at the home of his daughter in Bryn Mawr, Pa., after an illness of several months. His connection with the Sellers concern began in 1873, after his graduation from the University of Pennsylvania. He served a practical course in the shops for several years, took a position in the drafting room and soon became the head of the department.

In 1887, he was elected a director and at the same time was appointed assistant manager of the company. In 1902 he was elected engineer, and in 1905, president, which last office he held continuously until his death.

Mr. Sellers was known as a man of liberal ideas, and while his principal inclinations and activities were in mechanical and engineering lines, he took keen interest in many other directions, scientific, literary, educational and arts, and was active in the civic life of Philadelphia. He was long active in the affairs of the Franklin Institute, of which he was vice-president at the time of his death. He was a member of the Board of Commissioners of Navigation of Pennsylvania, to which he was appointed in 1907. He was active in the affairs of the American Society of Mechanical Engineers, the American Society of Naval Architects and Marine Engineers and Engineers Club of Philadelphia of which he was one of the founders. He was president of the Chamber of Commerce from 1909 to 1913. He served as chairman of the local draft board during the early stages of the world war.

Mr. Sellers was a descendant of a family of engineers that have been continuously associated with railways since their development in America began. As early as 1835, the Sellers Brothers built a locomotive for the Philadelphia and Columbia Railroad which had several original features, among others the first counterbalanced driving wheels. His father, the late Dr. Coleman Sellers, was one of the foremost mechanical engineers that Amer-

Locomotive Fuel Economizer Tests at Purdue University

There has just been completed at Purdue University a series of tests of a Boyce Locomotive Fuel Economizer. These tests were made on an Atlantic type passenger locomotive generously loaned by the Big Four Railway. This locomotive was placed on the university's locomotive testing plant in the absence of the regular test engine, Schenectady No. 3, the Purdue testing laboratory locomotive, which is now at the Monon Railway shops in Lafayette awaiting heavy repairs, the application of new cylinders, valve gear, etc.

In order to place the Big Four locomotive on the testing plant it was necessary to shift the supporting wheels for the drivers forward nearly seven feet. One may appreciate some of the difficulties in conducting these tests when the testing plant was designed for a locomotive having a total weight of 103,000 pounds, whereas the Big Four locomotive has a total weight of 188,000 pounds. The maximum indicated horse power of the Schenectady No. 3, is about 750; that of the Atlantic type used in the tests is about 1600. In these tests it was possible to develop with the latter a maximum of only about 900 horse power because of the limitations of the testing plant.

The Boyce Locomotive Fuel Economizer is an automatic device by means of which the proper amount of air is drawn into the fire box over the fire, and is thoroughly mixed with the gases by means of blasts of exhaust stem, which discharge alternately and obliquely across the fire. The air supply is heated and admitted through the back boiler head, and the exhaust steam is taken to the fire box from the exhaust passages in the front of the engine after it has done its work in the cylinders, through necessary small pipes, separators, check valves, etc. The arrangement provides the proper amount of air and steam for the locomotive at all times regardless of the many changes of speed or other working conditions, and is not subject to control or adjustment by the engineers or firemen. It has been discovered that the greatest percentage of gain in economy is developed when the locomotive is worked hardest, or at the time in present practice when locomotives usually waste the most coal.

When running at a speed of 25 miles per hour and the valves cutting off steam at 22 per cent of the stroke of the pistons, the locomotive when equipped with the economizer used about 6 per cent less coal for each horse power of work done at the draw bar, than when not so equipped, all other conditions being the same for both tests. At the same time the draw bar pull was 1,000 pounds more in the first case than in the second. When the speed was increased to 30 miles per hour and with a cutoff of 30 per cent, the economizer showed a fuel saving at the draw bar of nearly 20 per cent and an average draw bar pull of nearly 1,600 pounds more than shown by the engine when not equipped with the economizer.

Report of the British Automatic Train Control Committee

The Automatic Train Control Committee of Great Britain after carefully considering the continuous automatic train control system has come to the conclusion that expenditures to the extent necessary for such control would not be justifiable upon surface lines in Great Britain. Attention was therefore directed to localized control, which supplements rather than replaces existing signaling and block-telegraph systems. Localized control can be either of the non-contact or contact type, of which the latter is the best known and most developed.

Despite the inherent disadvantage, in regard to shock effect, which is common to all forms of contact control, apparatus of this nature has proved reliable after many years' operation under working conditions, and capable of withstanding satisfactorily the effects of high-speed traffic. Three indications can readily be provided, viz., Clear, Warning, and Danger, and alternative methods for obtaining brake release can be arranged. Devices of this type do not necessarily require either primary or secondary bateries on the locomotive. In conjunction with local track circuiting, this type of control can be used with automatic and three-position signaling. Moreover, as track circuiting is extended, the control exercized by any localized device, although not strictly continuous in character, will confer nearly all the benefits obtainable from a continuous system.

The safeguard shock effect in the case of contact devices at wayside signal locations, locomotive and track elements used to obtain control effects at distant signals should be more robust than those at stop signals. Trains are authorized to pass, and do pass, distant signals at high speed, whether they indicate Clear or Warning. It follows, especially if separate indications for Warning and Clear are required, that contact between locomotive and track elements will be of high frequency. On the other hand, the occasions upon which trains pass stop signals at Danger are comparatively rare, and it is not considered necessary for the stop signal apparatus to provide more than one effect, *i. e.*, Danger. In special cases a Clear indication can, if required, be provided at stop signals by other means, *e. g.*, hand signaling. Whilst, therefore, means for detecting the integrity and correct position of the track mechanism for affording control at stop signals will be required, to ensure that contact is made when enginemen pass them at danger, it is not a matter of primary importance should damage to the apparatus result from contact between locomotive and track elements at such signals.

The employment of "speed control" and "time element relay" devices, in conjunction with other indirect or direct methods, is, after very full consideration, not recommended by the committee. Out of 193 accidents which were fully analyzed it was found that in only three cases could it be said that a speed-control device would have proved remedial by itself. Such accidents could, in the committee's opinion, be adequately safeguarded, if not entirely prevented, by installing a train control device either of a permanent or temporary character, which would provide an audible indication, as well as a brake application, to remind enginemen of the existence of a speed restriction over any curve, crossing, etc., in advance.

Railway and Locomotive Engineering

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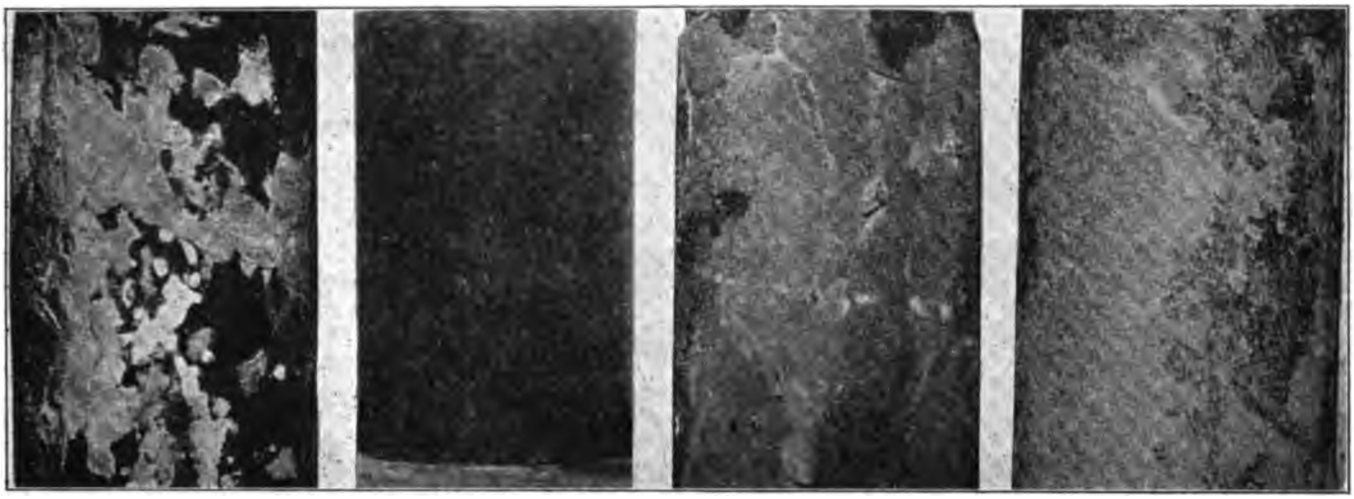
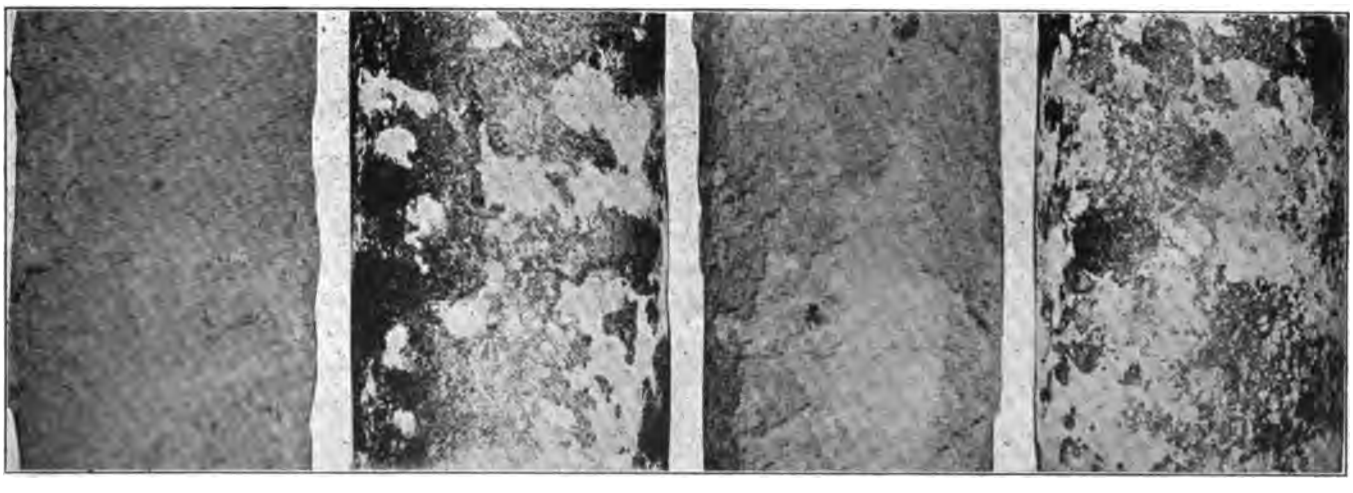
The Effect of Polarized Mercury on Boiler Tubes

By Geo. L. Fowler



1—PARTIALLY DESCALED. TREATED TUBE 2—SCALE REMOVED BY SCRAPING. TUBE COATED WITH BLACK MAGNETIC OXIDE OF IRON TREATED TUBE 3—WITH SCALE 4—SCALE REMOVED UNTREATED TUBE NO. 3



1—WITH SCALE 2—SCALE REMOVED UNTREATED TUBE NO. 1 3—WITH SCALE 4—SCALE REMOVED UNTREATED TUBE NO. 2

The boiler compound known as polarized mercury and manufactured by the Bird-Archer Co. of New York, possesses the peculiarity of coating the tubes, from which it has removed the scale, with a smooth, black, shiny film.

Sometime ago an investigation was made as to the peculiar characteristics of

The film, as it was found on the tube, was a smooth, glossy black much smoother than the original surface of the tube when new, and having a slightly lustrous polish resembling that of Russia iron.

It was exceedingly hard and brittle, and very closely adherent to the metal beneath, and could only be removed with never be peeled off but could only be separated from the metal by using an exceedingly hard and sharp scraper; the removed material coming off in the shape of a finely divided powder. There were no flakes for the brittleness was such that any disturbance of it caused it to crumble.

When subjected to the influence of a

and arranged itself about the poles in filamented clusters as shown in the photographs herewith presented.

The tube examined was partly covered with a dense grayish scale, averaging about one-sixteenth of an inch in thickness. The bare portions were coated with the film as already described and its general appearance is shown by the photograph of the treated tube partially descaled. It was a very easy matter to remove this scale, as it was readily scraped off with an ordinary scraper leaving the tube clean and quite free from any adhering particles as shown in the photograph of the treated tube marked "Scale removed by Scraping." The scale flaked off and was adhering but slightly to the tube. When cleaned the tube was found to be almost entirely covered with the black film already alluded to and formed the source of supply for the samples used for chemical analysis.

In order to compare the adhesion of scale to the black film on the treated tube with the adhesion of a similar scale to the metal of a tube that had received no treatment, samples of tubes were procured from two railroad companies, having coatings of scale. These are shown as received, in the photographs of the untreated tubes Nos. 1, 2 and 3. The tubes Nos. 1 and 2 were covered with a porous scale of carbonate of lime of which vigorous scraping only succeeded in removing a part; the balance being so closely adhesive as to make it impossible to scrape it off.

The third tube, No. 3, was coated, as shown in the photograph, with a scale almost identical with that found on the treated tube. But here, too, it was found to be impossible to remove that scale by scraping and the final condition of the tube, after being cleaned as well as it was possible, is shown in the photographs of the same marked; "Scale removed."

From this it appears that, as far as this investigation went, the scale does not adhere to the black film formed on a treated tube with anything like the intensity that it does to the metal of tubes that have not received the polarized mercury treatment.

The physical examination of the film, therefore, showed it to be a dense, glossy, hard and brittle substance, with highly magnetic qualities to which scale does not readily adhere.

In the microscopical examination, attention was directed towards the detection of any mercury that might appear in the film; the measurement of the thickness of the film and its texture under comparatively low magnification.

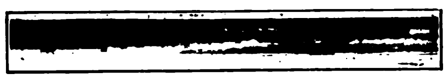
As to the first point, it is impossible to det[illegible]y trace of mercury on the exposed surface with magnifications ranging from fourteen to eighty-seven diameters. The results in this respect were, therefore, purely negative.

As to the second item a photograph was made of the edge of the film magnified to eighty-seven diameters. This photograph is reproduced in the engraving. In this the film shows a thickness of from 3/32 in. to 5/32 in. which divided by 87, would make its actual thickness from .0011 in. to .0018 in. or in round numbers, from one to two-thousandths of an inch thick.

The surface texture of the film is shown in the accompanying photograph. Here it is shown under a magnification of 26 diameters, and will be seen to be of a slightly mottled character, but continuous and unbroken.

The microscopical examination, then, gave negative results as to the presence of mercury, showed a uniformly mottled surface and developed the fact that the film was exceedingly thin.

POWDER OF FILM UNDER MAGNETIC INFLUENCE—14 DIAMETERS



EDGE OF FILM FORMED ON TUBING—87 DIAMETERS

The chemical analysis was made in two ways, and had for its purpose the determination of the actual chemical composition of the film itself, as well as the detection of the presence of any mercury, combined or uncombined that might be present in it.

One source of supply of the film for this analysis was the fine black powder obtained by scraping from the surface of the tube. The other was the removal of the film by disolving it in a few cubic centimeters of diluted hydrocloric acid.

The method by which this was accomplished was first to coat all parts of the tube from which the film had been broken, and the unprotected metal exposed, as well as the ends and interior of the tube with a coating of paraffine, and then rotating the tube in a bath of diluted hydrochloric acid, thus dissolving off a portion of the film. The solution thus obtained was then analyzed and special mercury determinations made. The two analyses so made checked and showed that the film consisted of the black magnetic oxide of iron ($Fe_3 O_4$) with some ferric oxide ($Fe_2 O_3$). This latter is present in too small a quantity to be measured. There was, also, a small amount of free mercury present, but the quantity was a mere trace and an attempt to collect it on a gold-plated platinum lid covering a platinum crucible was unsuccessful, as the amount was invisible and unweighable, but positive evidence of its presence was found on a piece of filter paper containing a drop of palladium chloride and another of silver nitrate solution. It is true that similar results might be obtained with arsenic, but a most thorough examination of the film showed conclusively that arsenic was absent from it.

The presence of the mercury can be demonstrated by heating a specimen of the film in a platinum crucible covered with a lid, and under this lid have placed two strips of filter paper, one carrying a drop of palladium chloride solution. If any mercury is present a black color will show on the palladium chloride paper and a brown color on the nitrate of silver paper.

The film as it was formed on the tube was also subjected to the action of diluted sulphuric acid, which attacked it.

This chemical examination shows that the film consisted of the black magnetic oxide of iron ($Fe_3 O_4$), in which a trace of free mercury has been imprisoned, and associated with it is a minute quantity of non-magnetic ferric oxide ($Fe_2 O_3$).

The film itself may, therefore, be considered as consisting of the black magnetic oxide of iron ($Fe_3 O_4$).

While there is no positive data as to the method of the formation of this material, the following statement and suggestion is offered as a possible explanation of its appearance.

Natural magnetic oxide of iron has long been known to be unaffected by chemical conditions. The beautiful surface of Russian sheet iron, which resists rust to a moderate extent, is due to the fact of its having a coating of magnetic oxide or a very near approach to it, but this is an accident of manufacture.

Prof. Barff produced a magnetic oxide on iron and steel surfaces for the purpose of protecting them from rust. His process consisted in placing the object in an iron muffle which is heated by an external application of heat to a high temperature, when steam superheated to about 1,000° Fahr. is turned into the muffle and the formation of a magnetic oxide immediately commences. The heated metal of the object to be treated decomposes the steam, taking up certain definite proportions of the oxygen forming (Fe_3O_4) or magnetic oxide. The thickness of the coating depends upon the duration of the operation This has been modified in the Bower-Barff process, wherein the articles are heated by gases burned with a slight excess of air over that needed for perfect combustion. This raises the article to the proper temperature and at the same time gives it a coating of dark red oxide on the outside, with a slight coating of magnetic oxide underneath. This coating of sesquioxide (Fe_2O_3) is then reduced to magnetic oxide (Fe_3O_4) by the admission of producer gas to the furnace.

This means that the principle of the Bower system is to produce an artificial coating of rust in the first instance and then to reduce it to a lower oxide which is rustless.

It is also known that pure water, freed from oxygen, in contact with iron at a high temperature causes a slight coating of magnetic oxide of iron to be formed, which protects the metal from further corrosion.

Let us take these facts in connection with the formation of the black magnetic oxide of iron film on boiler tubes and plates, where polarized mercury is used as a descaler in boilers already encrusted.

Where the treatment is used on a boiler having clean sheets and tubes, the adhesion of scale is prevented but the black magnetic oxide is not formed. It appears only where there has been a previous deposit of scale.

The suggestion as to its formation is this:

The mercury of the compound is attracted to the steel and works its way into contact with it through cracks or openings in the scale. Coming into contact with the hot metal of the tube or plate, its high coefficient of expansion causes it to pry off or separate the scale from the metal without actually breaking or loosening it. This leaves a very thin cavity between the two into which water infiltrates, where it is first converted into steam and then superheated. The metal protected by the scale is heated to a higher temperature than would otherwise be the case. The water, first made pure by the deposition of its scale and then freed from gases by heat, comes into contact with the hot metal either as a purified and de-gasified water or as superheated steam and thus forms the black magnetic oxide, as already indicated.

This seems possible from a consideration of these two facts. The film forms most readily in the hottest parts of the boiler, and only where scale has previously been deposited, so that its formation in the method outlined seems quite possible, and the presence of the free mercury is fully accounted for in that it was trapped by the forming oxide after it had made the space in which the work was done.

The boiler then acts as its own furnace and laboratory in covering its plates and tubes with a well-known rust-resisting coating, the black magnetic oxide of iron (Fe_3O_4).

It is known that this black magnetic oxide coating appears on the water surfaces of the tubes and plates of the boiler that have been treated with polarized mercury. It is not, however, an amalgam, but a result of the loosening of the scale by the expansion of mercury whereby confined spaces are developed in which steam is generated and possibly superheated and a crude Bower-Barff process carried on.

It is needless to add that the whole object of the Bower-Barff process in forming this film of black magnetic oxide of iron is to coat the surface of the object treated with a rust-resisting film. It, therefore, so happens that the results of the treatment of a boiler with polarized mercury is to coat the interior surface with a material that is recognized as being among the best for the purpose of protecting steel or iron against rust.

Dynamometer Tests of the Locomotive Booster

The company manufacturing the locomotive booster for the Franklin Railway Supply Co. have a small testing plant arranged so that each booster is tested with a proney brake resistance before it is sent out for service. It is a very simple arrangement consisting merely of a shaft carrying an eighteen inch gear similar to the gear which is put upon the trailer axle of locomotives for connection with the booster. At the ends of the shaft there is a proney brake by which any desired resistance can be developed in the testing of the machine.

An elaborate series of tests has recently been conducted on this plant for the purpose of determining the efficiency of the machine, under various loads and at various speeds in order that a predetermination might be made as to its probable performance in actual service. The tests were made under conditions as nearly similar road service as possible. In such matters as steam pressure, the length of the exhaust pipe and other minor details that would have to be taken into consideration.

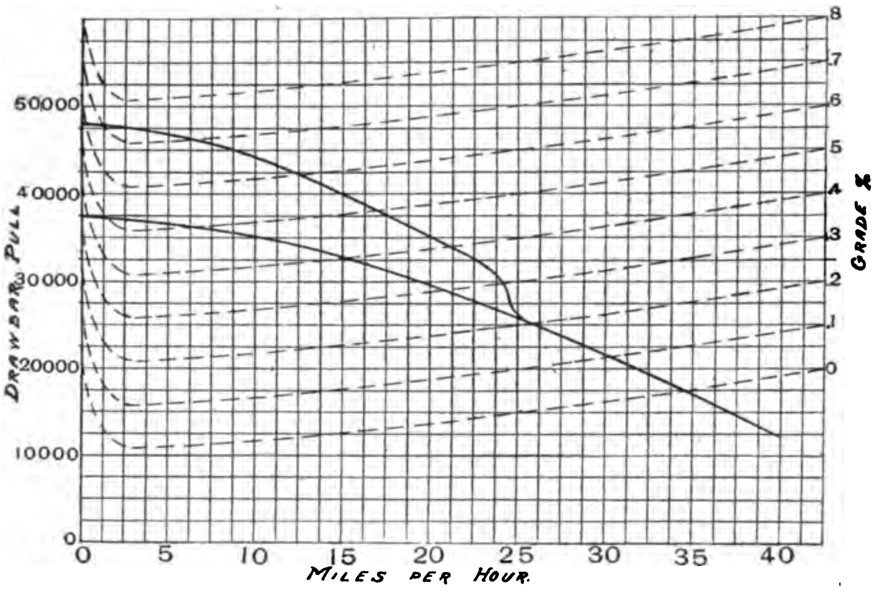
One of the major points brought out by these tests was the high efficiency of the mechanism as a whole. That is to say the high efficiency in the trans- cylinder to the rim of the trailer wheel or as it is represented in this case by the rim of the proney brake. It might be stated that the engine consists of a pair of engines with cylinders 10 in. in diameter and 12 in. stroke with the cranks set at 90 deg. with each other. The power is transmitted from the gear of the engine shaft through an idle gear, which may be thrown in and out of contact with the gear of the axle shaft, the ratio between the engine gear and the axle gear being as fourteen to thirty-six. It has been found that the mechanical efficiency in the transmission of power through this mechanism ranges from ninety to ninety-five per cent. The lower efficiency being that of the lower speeds of about six miles per hour, whereas the high efficiency is obtained at speeds running from twelve to sixteen miles per hour. The valve motion of the engine consists of a piston valve driven by a return crank and set to drive the engine in one direction only at a cut-off of eighty-five per cent of the stroke, so that the lap is correspondingly short. This is a constant cut-off and any variation in the amount of power developed by the engine is due to wire drawing of the steam or the back pressure creases in speed and the difficulty in getting rid of the exhaust is correspondingly increased.

Diagrams have been prepared showing the increase in brake horse power and the falling off in drawbar pull as the speed increases. The curve of the brake horse power is not a straight line but somewhat resembles that of a parabolic curve. For example the engine develops sixty horse power at two miles per hour. At eight miles per hour it develops about 210 horse power and at sixteen miles per hour it develops about 306 horse power. On the other hand the drawbar pull falls in an corresponding way. The highest pull is of course at the start where it reaches to nearly 11,000 lbs. falling off gradually on a curve to about eight miles per hour where it is about 9,900 and then drops on nearly a straight line to about 7,200 lbs. at sixteen miles per hour. This is of course in exact accord with what would have been expected.

In the same way a diagram has been prepared showing the fall in the drawbar pull for various steam pressures as this speed increases. In this it is found that the drawbar pull at twenty miles per hour is about 65 per cent of the drawbar pull at five miles per hour, and under the same-of course understood that this is not a fixed figure but only a general statement, as the actual ratio will vary with the steam pressure. As the drawbar pull falls with increasing speed so the steam consumption increases and it is found that the steam consumed at twenty miles per hour is approximately 2½ times that the five miles per hour with the necessary allowances made for variations in the boiler pressure. These figures are taken from diagrams which have been very carefully prepared and which may be used to give a clear idea of what may be expected of the booster in service.

One of the most interesting and valuable diagrams that has been prepared as a result of this investigation is one showing the possibilities of locomotive performance when assisted by the booster and when running without such assistance. The diagram is based upon a performance of a Pacific type of locomotive hauling a train of 2,500 tons averaging forty tons per car on the level and on grades increasing by 0.1 per cent from the level to 0.8 per cent.

The dotted lines in this diagram indicate the train resistance on a tangent track on the several grades. It is hardly necessary perhaps to call attention to the fact that the train resistance of itself is a constant quality and that the differences between the several grades are due solely to the grade and that the difference may be obtained by multiplying the weight of the train by the per cent of the grade. For example, it will be seen from a section of the diagram that after the first drop due to the high resistance of starting and when the train has acquired a speed of about five miles per hour that the dotted lines are all parallel to each other and that the difference between the



CURVES SHOWING RESULTS WITH A PACIFIC TYPE LOCOMOTIVE HAULING 2,500 TONS WITH AND WITHOUT THE LOCOMOTIVE BOOSTER

for the 0.8 per cent grade, for example is 40,000 lbs. or the weight of the train multiplied by the per cent of the grade. That is to say 5,000,000 times .008. The solid lines drawn through the diagram indicate the drawbar pull of the locomotive. The lower one of the two indicates the drawbar pull of the locomotive without the assistance of the booster. The upper one indicates the total drawbar pull with the boosted added and the difference between the two will indicate the drawbar pull due to the booster itself.

From previous descriptions of the booster it will be remembered that it is so arranged that when the reverse lever is drawn back to a point for obtaining the proper cut-off at a speed of twenty miles or possibly twenty-five miles an hour the booster is automatically cut-off and ceases to operate and in the diagram under consideration this is shown to have occurred at a speed of twenty-five miles per hour.

In order to appreciate the full significance of the assistance which the booster can render to the movement of a train over a division, it will be well to study this diagram carefully. For example, suppose a train to be moved over 0.7 per cent grade; the starting resistance of the train under consideration would be about 57,500 lbs. which is above the possibilities for starting of either the engine itself or the engine with the booster. But if that train were under motion and was moving at a speed of five miles an hour or more when it encountered the grade the booster would enable it to ascend it at a speed of about six miles per hour, where it would have stalled without the booster. On the other hand on a 0.5 per cent grade the locomotive with the booster would have started the train and could have kept it in motion on

miles per hour as indicated by the point at which the booster drawbar pull line crosses the line of train resistance on the 0.5 per cent grade. On the other hand the engine without the booster would have been unable to start the train on the grade but if it had encountered the grade at a speed greater than eight miles per hour it would have been able to ascend at a speed of about six miles per hour as indicated by the point where the drawbar pull of the unassisted engine crosses the train resistance line on the 0.5 per cent grade. This makes a difference in the speed of the ascending grade of about eleven miles per hour with and without it. If we consider this in the light of the time occupied in traversing a grade of ten miles in length it will be seen that the time required without the booster would be one hour and forty minutes, as against thirty-five minutes for the operation over the same distance with the assistance of the booster. As grades of this length and rate are quite common on most railroads it will be seen that the saving in operation especially on single track lines will be materially aided.

While this diagram has been worked out for a Pacific type of engine alone it is evident that relatively similar results will be obtained from any other type to which a booster could be applied and the drawbar pull of the engine into that of the gear will be the per cent of advantages to be obtained by the use of the booster mechanism.

These tests have also made it possible to plot diagrams from which engineers are able to predict the results that will be obtained from any given set of conditions. For example, such as may be due to variations in the diameter of the trailer wheels; the speed of the engine; the steam pressure and the variations in drawbar pull due to speed. These tables are rather complex but still are clear enough for an engineer to draw definite conclusions from their indications. In the same way charts have been developed for determining the steam consumption of the machine when running at various speeds with various diameters of trailer wheels and boiler pressures.

The gist of the whole matter may be summed up in the statement that the booster adds practically about 11,000 lbs. initial drawbar pull to the engine to which it may be applied by an addition of about 5,300 lbs. to the weight of the engine. Under ordinary operating conditions that 11,000 lbs. drawbar pull would necessitate approximately 50,000 lbs. additional weight to the engine, so that the effect of a booster on a locomotive is obtained by an increase of about 5 per cent in the static tresses to which the roadway and bridges will be subjected, which is well within the range of tolerance of ordinary bridge construction and can be used on

The Rise of the Firing Floor

Locomotive Development Has Increased the Height Above the Rails With a Proportionate Rise of the Center of Gravity of the Engine as a Whole

Almost the only objection raised to the building of the old 4-4-0 Class K locomotive of the Pennsylvania R. R., which was designed by Theo. N. Ely in 1881, was that the center of gravity was so high as to render the machine unstable. But the fact that the engine ran on its trial trip at a speed of sixty miles an hour over the crooked tracks of the Middle Division with remarkable steadiness, wiped that single objection away and little has been heard of it since. In that engine the radical change from existing practice consisted in raising the boiler and setting the foundation ring on the top of the frames instead of dropping down between them as in prior practice. The increase of heating surface was only brought up to about 1,750 sq. ft. as compared with from 1,250 to 1,300 sq. ft. in previous locomotives, and the height of the center of gravity was not excessive.

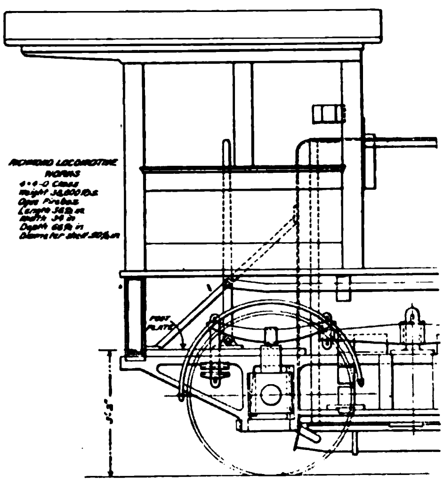


FIG. 1

Experience has shown that the engine with a high center of gravity rides more easily and puts less lateral stress on the truck than a similar weight hung lower would do. A fact that has probably tended to produce a false security as to the actual stability of the machine. That these machines of high center of gravity upset more readily than their lower brothers there is no doubt, and this is evidenced by the large proportion of derailed engines that turn over on their sides.

With a track base of about 5 ft. between the bearings on the rails, an engine of almost any height can be built and run on any straight track and it is only on curves and uneven rail surfaces that the high center of gravity is apt to make trouble. This added to the gyroscopic effect of probably responsible for some locomotive derailments and overturnings. As to just what the gyroscopic effect may be there is no definite information, but from calculations made in connection with certain electric locomotives a number of years ago, there is some evidence that it is far from being a negligible factor.

As for the effect of the height of the center of gravity on the flange thrust against the rail, there is little data at hand, but in the matter of its influence on the overturning of a locomotive, the case resolves itself into one of a purely mathematical calculation.

The elevation of the outer rail adds materially to the amount of centrifugal force that would be required to overturn a locomotive.

When a locomotive is passing a curve at the speed for which it is elevated the load put upon each rail is the same and the engine is at its maximum stability, just as it is when standing upon a tangent track. But when this speed is exceeded the centrifugal force tends to overturn the machine and whether this is accomplished or not depends on the radius of curvature and the speed. In this, with the same radius of curvature, the force required to overturn the engine will vary with the ratio between the sine and cosine of one-half of the angle included between two lines drawn from the center of gravity and the centers of the two rails of the track. As the cosine decreases and the sine increases with the angle it is evident that the lower the center of gravity the more stable will be the machine and the greater will be the force required to overturn it. This is so self-evident that it may seem useless to repeat it.

The point to be considered is as to how far we can go in the elevation of the center of gravity without endangering the safety of the locomotive. For example if we take a locomotive whose center of gravity is about 6 ft. above the top of the rails it will require a horizontal thrust of centrifugal force of about 40 per cent of its weight to overturn it. But if this center of gravity is raised to 9 ft. the amount of force required to overturn it will be only about 26.8 per cent of its weight. Then, as the centrifugal force increases with the square of the speed, it is evident that speed regulations of high engines on sharp curves should be carefully made.

There is another point that should be given as much attention as speed on curves and that is the condition of the surfacing of the track over which the engine is to

It has been found that a single inequality in one of the rails will not have any appreciable effect on the motion of the engine at either high or low speeds. If there is a hump in the track that is short and the engine traverses it at a high speed the wheels will lift under the springs and the latter will act or yield to the rise but will not have any effect on the boiler and frames because the wheels will drop away and the springs resume their normal position before the pressure brought to bear against the frames has had time to take effect. While, if the engine traverses the hump at a low speed, the whole engine and boiler will be slowly raised and lowered and there will not be enough inertia on recovery to carry the springs beyond their normal position, with the result that there will be no rolling of the engine and no perceptible excess stresses imposed upon the track.

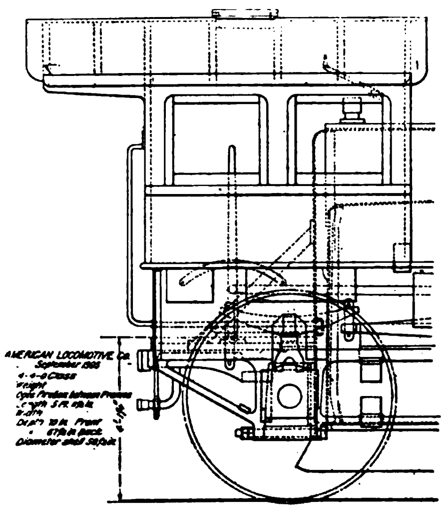


FIG. 2

If, however, the hump is extended so that the locomotive will be upon it for a sufficient length of time to enable the springs to recover their normal position and thus lift the engine, the latter will be rolled over to one side and an increase of weight will be put upon the lower rail; and, with it, a somewhat greater outward thrust. Then as the engine rolls off from the hump the whole machine will roll back to its normal upright position again.

Such a hump can even be repeated on the other rail without any very greatly detrimental effect. But if a third hump follows closely on the second, the engine will, then, be given such a roling action on the springs, that, at high speeds, it may easily become dangerous.

Experiments of this kind where the

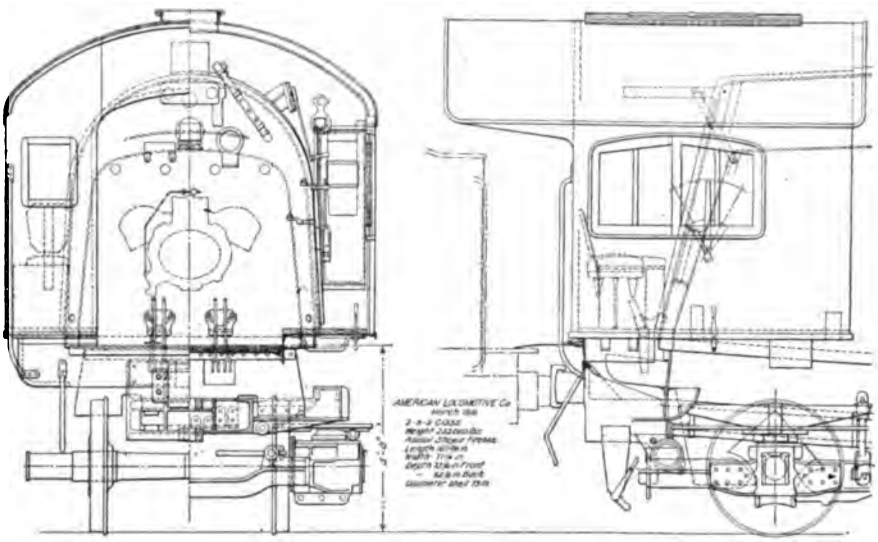


FIG. 3

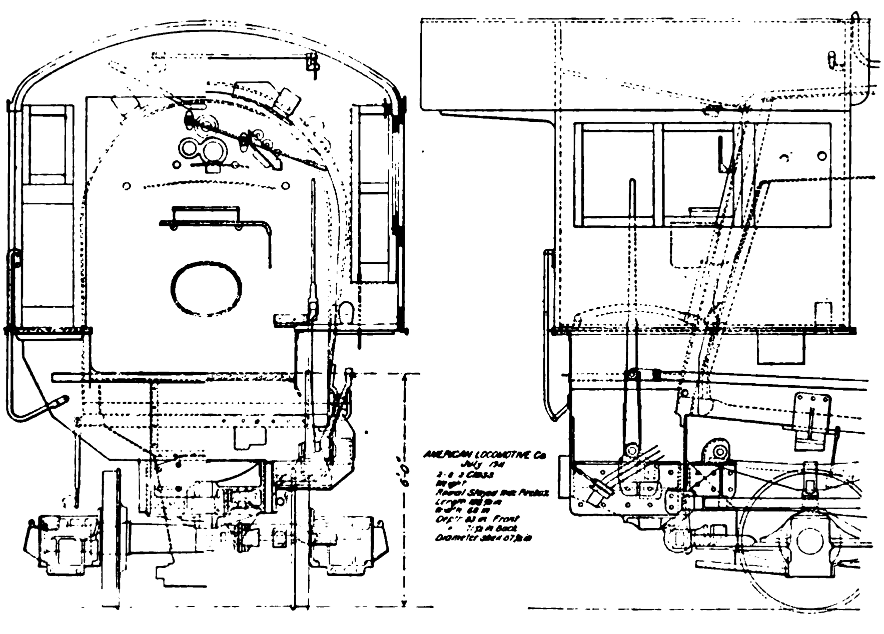
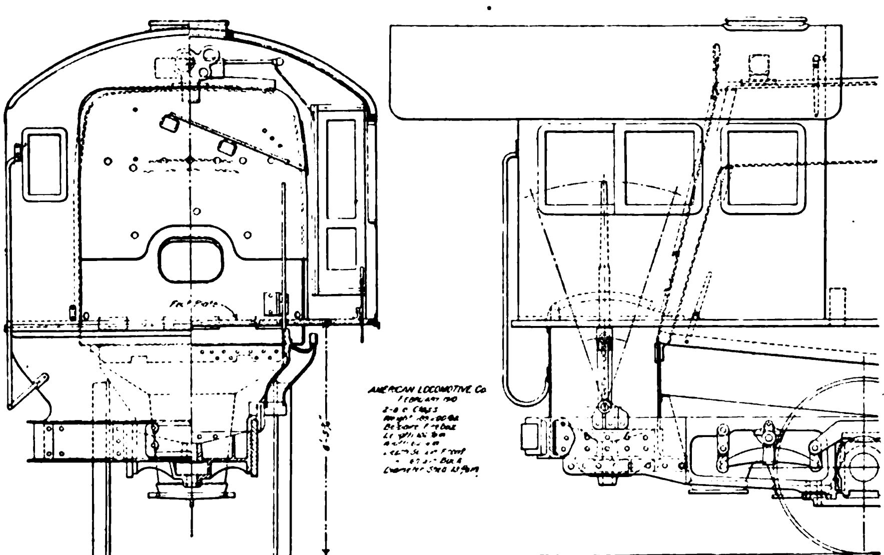


FIG. 4



and were traversed at sixty miles an hour, developed such a heavy rolling of the engine as to appear to be exceedingly dangerous.

We have become so accustomed to the high locomotive, that it is difficult to realize how very much higher the present day locomotive is than was its predecessor of a few years ago.

In order to show how the matter stands a number of illustrations are given in order to set forth what the increase in height has been. In the illustrations the height of the engine deck above the rail is given and this will indicate the proportionate rise of the center of gravity of the engine as a whole.

Fig. 1 is a side elevation of the back end of an old eight-wheeled locomotive that was built in the latter part of the nineties whose deck was only 3 ft. 2 in. above the rails. This with the low boiler of small diameter, made an engine that it would be very difficult to upset even though it left the rails under most unfavorable conditions.

Fig. 2 is a similar elevation of an eight-wheeled locomotive that was built in 1905. This had a deck about 12 in. higher than that of Fig. 1, and as its boiler was 8 in. larger in diameter, it would have required less force to upset it, but was nevertheless quite stable because the whole was still probably below that of many engines which had preceded it of the Pennsylvania Class K class.

In Fig. 3 we have an example of the Mikado class where the deck had been lifted to a height of 5 ft. and the diameter of the boiler shell increased to 79 in. This condition places the engine among the group of high center of gravity locomotives, but with a chance for still further increase.

Fig. 4 is also of the Mikado class but with the deck raised to a height of 6 ft. above the rails and the boiler shell increased to a diameter of 87½ in. This brings the center of the shell to a height of about 9 ft. above the rails. Of course the center of gravity of the engine as a whole is much below this and the machinery will have a steadying effect on the tendency of the boiler to roll, but such a large shell filled with water may easily receive a lateral impulse of sufficient magnitude to put an excessive stress on the springs and exert a marked lifting effect on the machine as a whole.

Fig. 5 shows a Consolidation engine fitted with a Belpaire boiler that is a step backwards in the course that we are showing as far as the probable height of the center of gravity is concerned, though the deck has risen to 6 ft. 5¾ in. above the rails. The boiler shell is smaller in diameter than that shown in Fig. 4 which will drop the whole somewhat, but the center of the shell is probably not much below 9 ft.

present limit. The deck is 7 ft. 2 in. above the rails and the diameter of the shell of the boiler is 9 ft. 10½ in. This will make the center of the shell about 9 ft., possibly a little more, above the rails, with the probable center of gravity raised above that of the other engines alluded to because of the greater weight of boiler and contained water. Such a locomotive is not a high speed machine and there is very little danger of an upset under ordinary running conditions. But it would seem that the limit of heights had been about reached with the present gauge of track, in which there is little likelihood that there will ever be any change.

These facts are presented because of the fact that some of these high center of gravity locomotives have left the rails with every evidence that the derailment and consequent upsetting was due to the high center of gravity, and in a future issue an example will be given of a disaster that was so evidently caused by the cars having been upset because of the high speed, at which they were running, as to be a full demonstration that such a thing can occur.

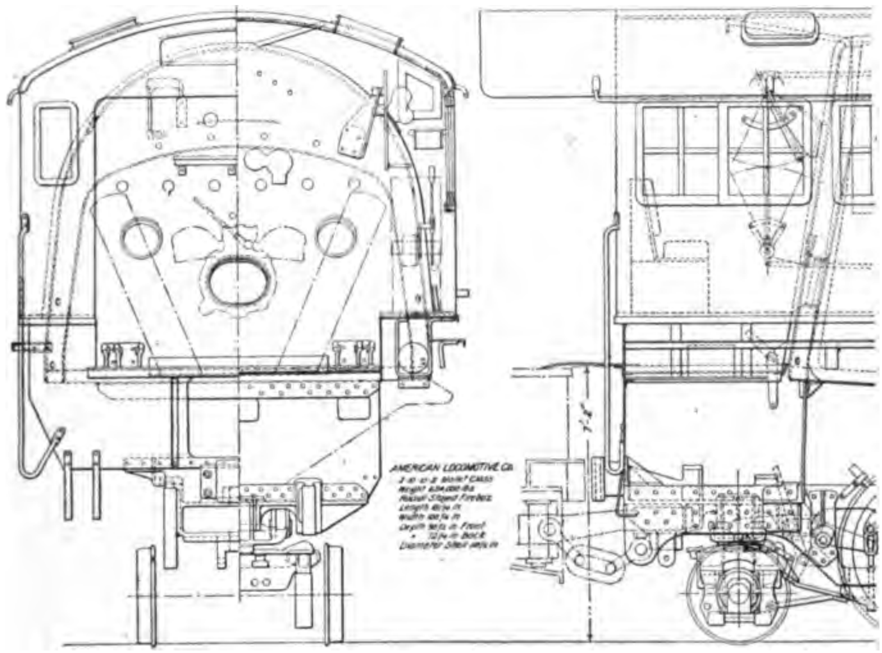


FIG. 6

Improvement on French Railways

Since the enactment of the French transportation law of 1921, and the consequent consolidation of the French railways into six great systems, there has been a widespread interest in the results of this legislation. For the first six months of 1922, according to data submitted by the Minister of Public Works, there has been a marked improvement in French railway finances, equipment and safety operation, according to Charles D. Westcott, the American Economist Consul in Paris.

"Improvement in the finances of the six trunk-line railways of France is indicated by an uninterrupted decrease in operating deficits since 1919," continues Mr. Westcott. "In 1920 that deficit approximated 3,000,000,000 france, in 1921 it declined by 33 per cent., to about 2,000,000,000 francs, and at the close of 1922 it will be further reduced by a probable 50 per cent, to an estimated 1,000,000,000 francs.

"During the first six months of 1922 operating expenses decreased and receipts increased; the decline in the resulting operating ratio indicated increased operating efficiency in all departments. From January 1 to July 1, 1922, receipts were 200,000,000 francs greater than for the corresponding period of 1921. Receipts on the Nord and Est Lines, traversing the devastated regions, were 40,000,000 francs greater than during the preceding half year. It is estimated that on December 31, 1922, total receipts of all roads will be 1,000,000,000 francs in excess of the 1921 operating income.

"There has been consistent improvement in the operating equipment of all roads since the war. In July, 1914, rolling stock in poor condition and not used included 1,700 locomotives, 4,500 passenger coaches and 15,000 freight cars; in December, 1919, this class of locomotives numbered 3,418, passenger coaches 13,800 and freight cars 59,300; by June, 1922, rolling stock out of commission for repairs had been reduced to 2,717 locomotives, 7,764 passenger coaches and 49,134 freight cars.

"Higher efficiency in repair work since the war, with resulting decrease in rolling stock out of commission, has been due mainly to the policy of having repair work done under contract by the machine shops of the country. Before the war such repairs were made in shops of the railway companies. During June, 1922, private corporations, thoroughly overhauled 103 locomotives, 783 passenger coaches and 10,220 freight cars. They did the work in 20 per cent less time and at a lower cost.

"Safety of passengers and security of freight carried are the paramount considerations of the entire French railway system. That security is further insured through close supervision of the roads by the Railway Administration, under the direction of the Minister of Public Works. Two improvements now being introduced on all lines are important controlling factors in operating safety: (1) The 'crocodile,' an electrical apparatus installed in the locomotive cab which automatically registers visually and audibly the semaphore signals along the line, thereby reducing to a minimum any possible failure by the engineer to observe the signal; (2) electric lighting of all passenger cars.

"Precautionary measures already introduced have resulted in a marked decrease in the number of railway accidents and casualties. In 1913, when the various lines carried 541,342,165. passengers, there were 142 accidents, with 60 persons killed and 413 injured. In 1918, with about the same number of passengers carried, there were 379 killed and 1,435 injured. In 1921, with 665,000,000 passengers carried, there were 72 accidents, with 137 killed and 656 injured. During the first six months of 1922, with 335,000,000 passengers, 20 were killed and 166 injured."

Railways Germany's Greatest Coal Users

Germany's greatest user of coal is the Federal Railway, which formerly was able to utilize only 55 to 70 per cent of its combustible material, the remainder (cinder and ashes) having been regarded as worthless. In order to make use of this waste, which is said to contain 50 per cent or more of combustible material, about two years ago the railway adopted the Meguin system of recovering coal from ashes. Thirteen large works, with a capacity for handling 420,000 tons of cinders and ashes annually, are now in operation or under construction. The amount of pure coke obtained is estimated at 164,000 tons, with an average calorific value of 5,500 units, compared with 7,000 units for good hard coal.

The fine coke, with the addition of fine coal and hard pitch, is used in making briquets, about 74,000 tons of coke briquets being thus obtained, with a calorific value of 6,500 units. In addition to this, 256,000 tons of non-combustible clean slag are obtained; this serves for the manufacture of 130,000,000 slag stones, which are employed in building and possess the good qualities of both brick and schwemmstein (a kind of sandstone).

A Box Car Unloader for Grain

In Operation at the Port Arthur Grain Elevator on the Canadian National Railways

The unloading of box cars filled with grain has been a problem of no little magnitude and the best that has been, until recently, developed has been the power shovel.

At the September meeting of the Institute of Canadian Engineers, Mr. F. Newell, mechanical engineer of the Dominion Bridge Co., presented a paper describing a mechanical unloader for box cars that has been installed at the Port Arthur grain elevators of the Canadian National Railways. Before entering upon the description of the device Mr. Newell laid down the general requirements for a successful unloader as follows:

(1) It must not damage the railway rolling stock, no matter how defective the condition of such rolling stock on arrival at the elevator.

(2) It must be designed to handle all types of box cars that may be received at the elevator.

(3) It must remove all grain from the car to the elevator pit without loss of grain and without hand labor.

(4) It should have means of removing the grain door quickly and without damaging same.

(5) It must be made practically foolproof in operation, and safe and reliable under all conditions of operation.

(6) It must have speed and economy of operation such as will more than justify its first cost.

(7) It must be served by trackage that will permit rapid handling of cars to and from the unloader without interruption to the unloading process over long periods.

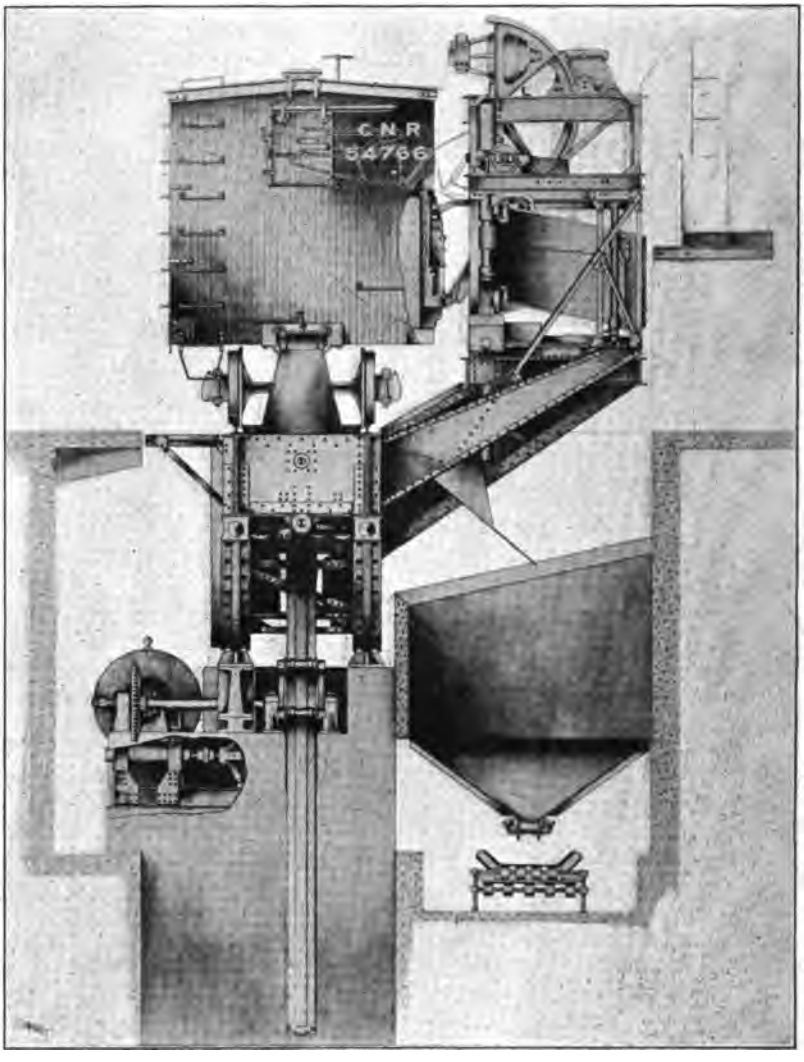
The unloader described is what is known as the roller type, operated without side tilt, but with deflecting baffles and an automatic door opener, which opens the grain door without damage and carries it clear of the outward flow of grain from the car. The rolling type was used because it is possible to obtain a higher virtual axis of rotation than with the trunnion type, and has not the possibility of breakdown and consequent delay which might occur with the use of live rollers or knife edge suspension. The higher virtual axis of rotation allows the unloader, whether empty or loaded with a full car of grain, to be in stable equilibrium. The point of support moving in a horizontal plane in the direction of rotation causes a less out-of-balance moment with a loaded car and a better distribution of grain in the receiving hopper than would obtain with the trunnion type.

The prime function of an unloader is its ability to efficiently handle all sizes of box cars in existence, or contemplated in the near future, which might be used at any time for the transportation of grain, and, in the design of the unloaders at Port Arthur, due consideration was given to the following: (a) Weight of all box cars and contents; (b) variation of length, width, and height of all box cars; (c) variation in elevation of floor of box cars, both when loaded and unloaded; (d) variation in width and height of grain doors.

The result of a thorough consideration of all these points is that the unloaders have been built to cover all possible variations in the above mentioned features of box cars, with the possible exception of a few freak cars.

GENERAL DESCRIPTION

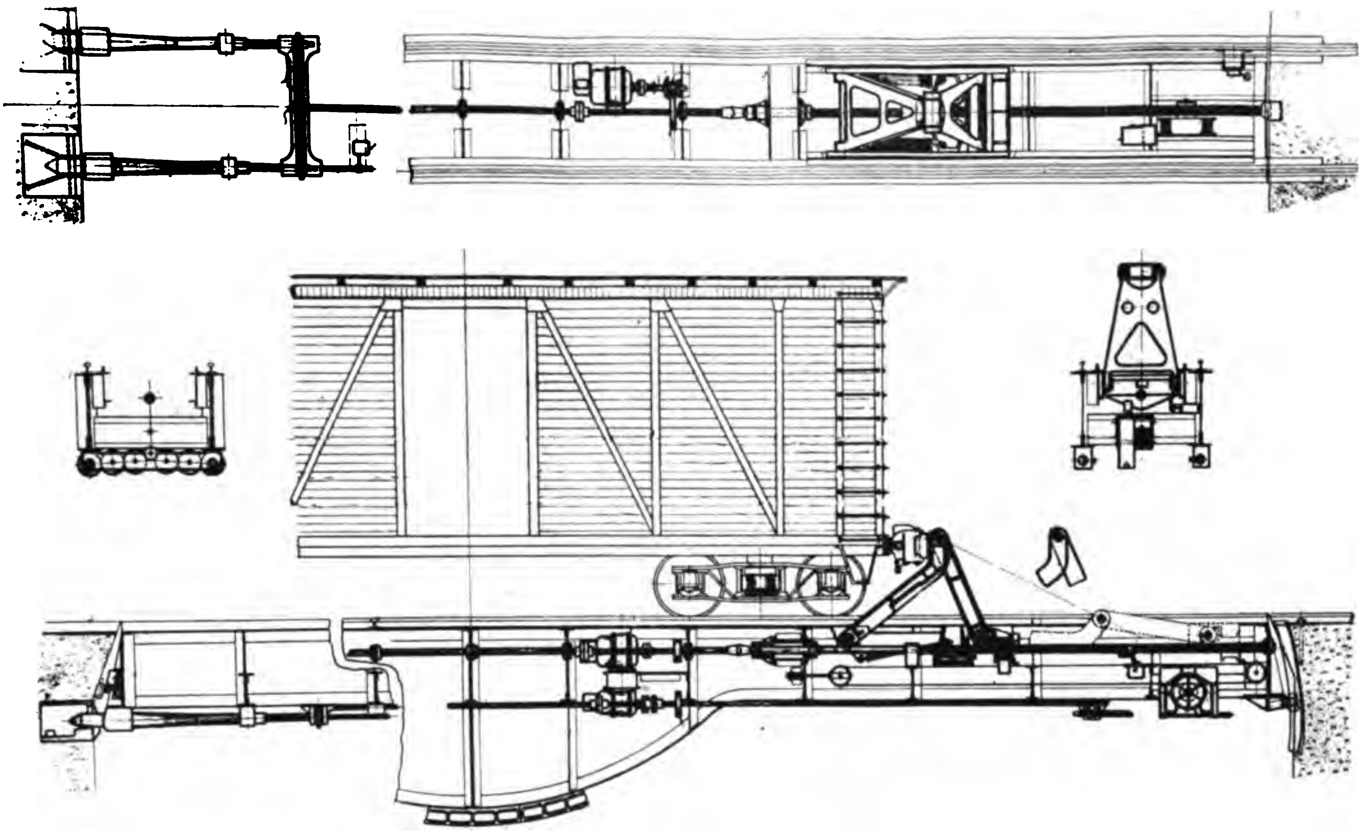
The unloaders consist of a heavy structural rocking cradle, capable of being tipped with its longitudinal axis at a maximum elevation of 45° to the horizontal in either direction. This cradle carries the car of grain, and is provided with end locks to definitely support the ends of the cradle while cars are being taken on and off, and with collapsible end bumpers to bring the car to a central position on the cradle, clamp the car in this position, and take the total end thrust on the couplings of the car during the time the car is tilted at any angle to the horizontal in either direction. One side of the cradle is provided with heavy structural steel brackets which carry the door opening mechanism, two deflecting baffles, and baffle operating mechanism. Between these brackets and opposite to the grain door is a deflecting hopper or chute to insure the grain being carried well into the center of the receiving hopper. Steel gratings are provided to protect the chute and to cover all the open spaces around the unloader. Flexible deflectors are also provided to prevent any spillage of grain along the side of the walls of the car, or in any manner except



GENERAL ARRANGEMENT OF BOX CAR UNLOADER FOR GRAIN into the receiving hopper. A closed operating cab from which all movements of the unloader are controlled is placed in a fixed position opposite the grain door, and at an elevation from which all movements of the grain can be observed.

CRADLE

The cradle consists of two heavily built web plate girders, having the lower portion at the center formed into a circular tread which rests on steel cast tracks supported on a heavy concrete foundation. These girders are rigidly braced in a horizontal plane, and also at right angles to the axis to prevent side flexure, and to make the girders act together as a whole rigid tilting platform. The girders are designed to take a maximum loaded box car estimated to weigh 180,000 pounds, that is 60,000 pounds for the car, and 120,000 pounds for the grain; the girders being able to take this load with the horizontal axis tipped to 45° from the horizontal in either direction. The girders are also designed to take a 380,000 pounds locomotive when in the horizontal position and with the end pins in place. The circular tread at the bottom of the girder is made from heavy steel castings of a depth necessary to transmit the reaction over a sufficient length of web and also to take the load from the radial stiffeners down into the fixed tread. Heavy rolled plates were at one time considered for the circular tread,



BUMPER AND LOCK ARRANGEMENT OF UNLOADER

sibility of a creeping action and consequent shearing of rivets due to constant reversal of rolling, as when using a thin plate the heavy concentrated load is liable to put a buckle into the plates between rivets, and during the tilting operation this buckle would be rolled forward across the plane of each pair of rivets holding the tread to the flange angles, and would in time cause the rivets to shear; the action taking place on each pair of rivets as the load passes over them, and being increased in effect due to the reversal which takes place in tilting in the opposite direction.

The fixed roller treads were designed with projecting lugs which roughly fit into corresponding holes in the rolling tread, these lugs being used to prevent the possibility of any slip between the cradle and the fixed tread during the tipping operation.

TIPPING MACHINERY

The tipping machinery consists of a 75 h. p., wound rotor motor, equipped with a full torque solenoid brake, driving the main operating pinions through a worm and worm wheel, equalizing gear and bevel gears. Two pin-connected struts are fastened to the cradle, each having, respectively a rotating axis at a point beyond each end of the circular tread. These struts are equipped with cast steel racks, engaging the main operating pinions. When tipping the cradle, the racks are subjected to a constantly changing velocity due to the rolling action of the cradle on the fixed tread. The variable velocity of the racks, one with the other, necessitates the introduction of equalizing gears. These are of the spur pinion type, designed with three points of application equally balancing the load about the axis of the shaft, to prevent undue bending on the main cross shaft. The equalizing gear and worm gear are enclosed in an oil-tight case in order to obtain a high efficiency; the thrust from the worm being taken by ball thrust bearings. The efficiency of this mechanism is such that it is possible under load to drive the worm by pressure applied to the worm wheel teeth. The racks and struts are provided at the outer end with guides when in the lowered position, as at this time the yoke or carriage maintaining alignment between the pinion and the rack are at the upper end of the strut close to the connecting pins. The ends of the cradle are also guided by rollers at each end to assure an alignment of the track rails after tipping operations are completed.

END LOCKS

Four end locks are provided, each consisting of heavy steel pins, one at each corner of the cradle. The pins are pointed at the ends for easy entrance into the castings bedded in the concrete abutments, and are operated by a 5 h. p. motor through a screw and spur gear. They are designed to take the weight of a loaded car or engine coming on or off the cradle and give a zontal and vertical direction. They are interlocked with the bumpers or car clamps so that they cannot be withdrawn until the car is centralized on the cradle, and in the reverse, the bumpers cannot be lowered until the end locks are driven home; thus preventing any accident due to the possibility of running a car or engine on or off the unloaders, excepting when the cradle is supported at the ends by the four interlocking pins.

BUMPERS OR CAR CLAMPS

The bumpers or car clamps are arranged so that the car does not have to be spotted in an exactly central position on the unloader, but can be pulled on the unloader into any position within two or three feet, and will be pushed into a central position by the bumpers. They are also designed so that practically any length of box car can be clamped in a central position on the cradle.

The clamps or bumpers at each end consist of two steel cast slides connected to a pair of tension and compression links capable of rising to the level of the car coupler and then traveling forward, forcing the car to a central position when the bumper at the other end will strike the coupler and clamp the car. The front slide, that is, the one nearest the transverse center line of the unloader, is fastened to a wire rope coiled upon a drum, which is in turn clamped with a retarding torque sufficient to hold the slide in a fixed position. The rear slide, which is definitely operated by a screw, is, at the same time, lifting the tension and compression links to the required height. When this has occurred, the two slides come together and travel forward until the car is clamped at both ends. The slides are operated simultaneously at both ends by a single 10 h. p. motor operating the screws and traveling nuts through a pair of spur gears.

On account of the variable length of cars, the length of travel is *not* controlled by limit switches, but a slip clutch is provided between the motor and gearing so that the motor can run after the mechanism has been stalled by the bumpers clamping the car at both ends; the clutch being supplied with a positive drive in the reverse direction to overcome the static friction of the mechanism when operating in the opening direction. The question of placing limit switches in parallel on the contact between bumper and coupler was at one time considered, but not installed due to the variable time element which would occur, in the operation of the switch, inertia of the rotor and application of the solenoid brake.

In applying the clamping device, as described above, to the couplers of the car, the component of the weight of the car and grain along the rails is taken on the coupler, which is designed for such loads. The bumpers were designed for a maxi-

very efficiently, allowing practically no end play when rocking the car.

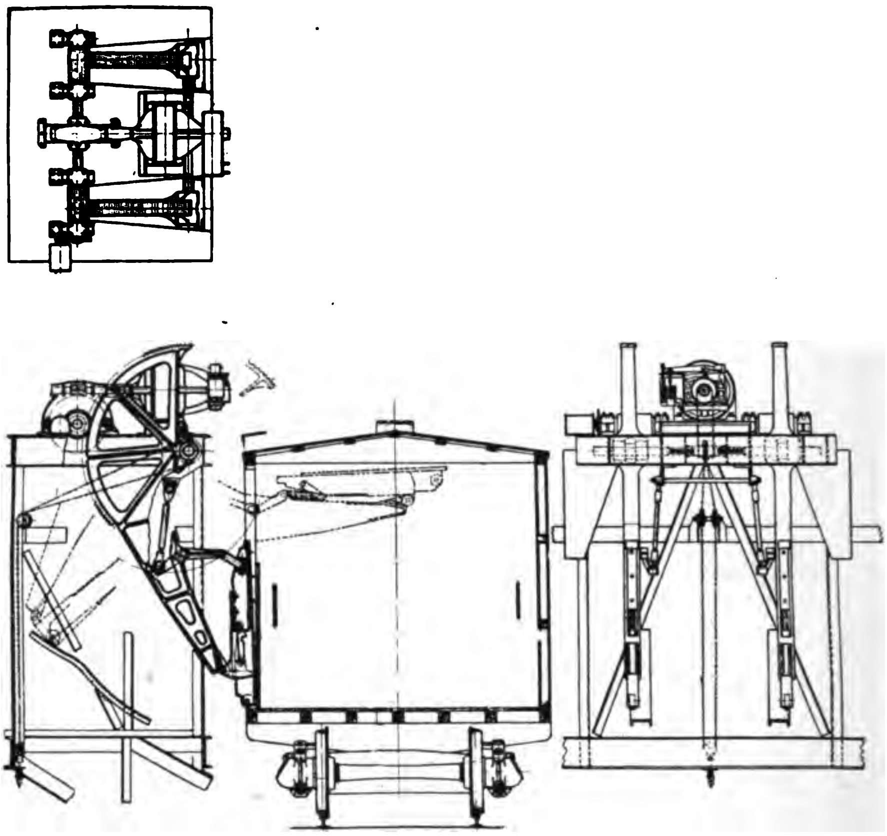
When the car has been clamped in a central position and the end locks are removed, an interlocking switch comes into operation allowing the door opener to be operated, the cradle to be rotated, and the baffles to be inserted.

The door opening mechanism consists of two steel cast pressure arms, cast integrally with spur gear quadrants, pivotally mounted on trunnions and rotated by spur pinions from a common shaft driven through worm gearing by a 22 h. p. motor.

the car and clear of the flow. The pressure of the grain against the door is released by the leakage of grain into the hopper, which occurs as soon as the smallest opening is effected, and the outward flow of grain allows an easy clearance space through which the door can be pushed. During this operation about 10 per cent of the grain in the car is discharged into the hopper

BAFFLES

While the door is being held up inside the car by the opener, the cradle is tilted



DOOR OPENER ARRANGEMENT OF UNLOADER

Means are provided for adjusting the width of the pressure arms to suit the varying width of door openings and are arranged so as to strike the door as close to the door posts as possible. When the pressure arms first touch the door, their lower ends are kept above the elevation of the highest car floor and are so arranged that a slight pressure on the door releases a telescopic arrangement at the bottom of the arms allowing an extension to come down until it strikes the door sill. By this means the pressure is exerted over the total height of the door regardless of the elevation of the car floor and as close to the door posts as possible, thus avoiding any undue damage to the grain door. This, in itself, is quite an economy, as by the old hand method doors were invariably broken.

The opener enters the grain with an upward and inward movement, carrying the

through an angle of about 20° and about another 25 per cent of the grain is discharged into the hopper, the remainder running down toward the other end of the car. The baffles are arranged so that they are tilted with the car and cradle, and while the car is in this position the upper baffle is inserted into the car as far as possible without crowding on the grain. The car is now tilted to an angle of about 40° in the other direction, when about another 50 per cent of the grain strikes the baffle and is discharged into the hopper. The baffle which is in the car, and which was in the upper position, is now in the lower and can be easily withdrawn. At the same time the other baffle, which is now in the upper position, can be inserted, and as only 15 per cent of the grain remains in the car, the baffle can be pushed forward over the floor of the car until the nose reaches the far side. The car is now tilted through when the last remaining portion of the grain is emptied into the hopper and the cradle can be brought into the horizontal position and the baffle withdrawn.

The baffles consist of a pair of plated rectangular structural frames of right and left hand, having their faces at right angles to the floor of the car, and capable of being slid into the car so that the rectangular face, or the trace of the plane of the baffle, is at 45° with the longitudinal axis of the car. As stated before, this gives a trough having an angle of slope of 30°, when the floor of the car is tilted to 45°. Down this trough the grain will readily flow out of the car. A wire rope attached to the front end of each baffle, passes round a grooved operating drum and thence to the rear end of the baffle, so that the baffle can be pulled in or out of the car by rotating the drum. The rear end of the baffle is guided at its upper and lower ends in tracks having a setting and curvature specially designed to keep the overall width of the unloader down to a minimum; while the front end passes through a pivoted yoke so that the baffle is held in its correct location for any position in or out of the car.

The elevation of the front yokes, and consequently the front end of the baffle, is determined by a vertical driving shaft to which the operating drum is also keyed. The upper end of this shaft is of square section, and is driven by a 5 h. p. motor through a worm and worm gear. The lower end is threaded and screwed into a sliding nut supported in a definite location so as to take the unbalanced weight of the baffle when not supported by the car floor. The front end of the baffle is balanced by an adjustable counterweight acting through the lower yoke to relieve the pressure on the car floor.

At the time of entry, the baffle is at least three inches above the highest car floor, but as it is driven forward is lowered by the screw and nut until contact is made with the floor and the weight is relieved from the sliding nut, after which any further driving forward of the baffle only causes the sliding nut to travel up the shaft without altering the elevation of the yokes. The back end is flexibly retained in its tracks in such a manner that the lower edge of the baffle makes contact with the car floor along its entire length. To further prevent the escape of grain to the lower end of the car, a flexible canvas sealing strip is attached to the bottom edge.

To prevent the flow of grain from traveling too far down the baffles, along the baffle track, and out of the hopper, spring doors are provided to seal the entrance of the baffle and to close the opening when the baffle is fully withdrawn. Flexible, hand operated, deflecting baffles are arranged to prevent leakage of the grain along the sides of the car, and deflecting plates are provided under the car door to carry the grain well into the center of the receiving hopper. Steel gratings are also provided to protect the fixed hopper and to cover all spaces around the unloader, as well as to catch any large foreign substances which might come out of the car with the grain.

SAFETY FEATURES

Throughout the design of the unloader, the choice of type and the choice of method of operation were, to a large extent, governed by the desire to obtain a maximum safety of operation, and particular attention has been paid to features governing this requirement. The cradle is in stable equilibrium under all conditions of loading, so that should a breakage occur in the tipping mechanism, the car and cradle will come to a horizontal position without damage. All power transmission is made through self-locking worm or screw gearing, so that motion cannot take place unless it is so intended by the operator. The operations are electrically interlocked, so that they have to be carried out in proper sequence, and so ordered that damage cannot occur to either the car or the unloader. Limit switches are also provided, where necessary, for limiting the travel of each mechanism.

A completely closed operator's house is placed at a good elevation opposite to the car door, and is provided with glass windows so that the operator can, at all times, observe the process of unloading. The house contains the complete electrical control board, controllers, and resistances, so that the operations are under the direct control of the operator.

TIME OF OPERATION

The average time taken by the various operations in unloading a car of wheat is as follows:

Raising bumpers and centering car...	40	seconds
Withdrawing end locks.............	10	"
Opening door (10% of grain discharged to hopper)...............	15	"
Tipping cradle 20° to left without baffle (further 25% of grain discharged)	20	"
Insert baffle and tip cradle 40° to right (further 50% of grain discharged)	40	"
Withdraw right baffle, insert left, and tip cradle 45° to left (final 15% of grain discharged).........	50	"
Withdraw left baffle and bring car to horizontal	10	"
Withdraw door opener..............	12	"
Insert end pins....................	10	"
Drop end bumpers and inspect car..	30	"
Complete time of operation.....	237	"
	(or about 4 minutes)	

The time taken to remove the empty car and spot a loaded car on the unloader platform depends, in a large degree, on the trackage layout. At the Canadian National Railways' elevator this occupies about three minutes, and the results obtained by observation show that where wheat is being unloaded, and no delays in distribution occur, it is easily possible to unload at the rate of eight cars per hour. When unloading oats, the time of operation is about one minute longer than that heretofore detailed, as the car requires at least one extra tipping of the cradle. Further, the time of operation over long periods of unloading is certain to be increased by delays incidental to distribution and other causes. Results, however, show that about 250 cars can be unloaded in a ten-hour day, on four unloaders at the Canadian National Railways' elevator, or an average of six and one-quarter cars per unloader per hour.

POWER CONSUMPTION

As all of the auxiliary motors are of small capacity, and are only required to operate for a few seconds, twice during each cycle of unloading, their power consumption is of small moment. The tipping motor, operating for about two minutes during each cycle and being of 75 h. p., capacity is, however, a very important factor. The size of this motor was determined from the maximum out-of-balance load which could be obtained under the worst conditions of loading, viz: by assuming the largest possible amount of grain which could be left in the upper end of the car when tilted to the maximum elevation.

This was found to be equal to approximately double the normal torque of a 75 h. p. motor at the motor shaft, and as it only occurs momentarily, and then only under the worst conditions, a 75 h. p. motor was chosen for operating the tipping mechanism. After actual conditions of operation had been determined by trial at the site, and again assuming the worst conditions of operations with a maximum loaded car, a horse-power curve was calculated and plotted on a time base. This curve agrees with the original idea regarding power requirements, and further, it is found that the average power required over a complete cycle of tipping is about 40 h. p.

ECONOMY OF OPERATION

The average rate of unloading in an elevator equipped with multiple pits and having a pair of power shovels at each pit is about one car per hour for a ten-hour day. While the unloader has an unloading capacity of at least six cars per hour over the same period. The average unloading staff in a house equipped with a number of pits is approximately two men per pit, while on one unloader, an operator, one attendant and two laborers, a total of four men are required.

As one unloader will do the work of six hand pits, the saving of labor is represented by twelve men on the hand pits against four on the unloader, or a saving of eight men, and the monetary saving is in the same ratio, as the shovelers can be put on the unloaders as operators with very little training. Assuming a period of work during the year equivalent to the employment of the maximum staff for 200 days, the saving in labor will amount to 1,600 men-days. To convert this into dollars will of course depend on the rate of pay for this class of work, but assuming a rate of $5.00 per day, would amount to a saving of $8,000 per year per unloader. There is also a further saving due to the grain doors being removed undamaged. Maintenance costs are smaller than for an equivalent number of power shovels. The labor turnover and the danger of tying up operation by strikes is naturally lessened on account of the very great improvement in working conditions. Power costs are rather less for one unloader than for six shovels. The initial cost of installation will, of course, depend upon conditions at different elevator sites, but will in many cases permit of a saving due to a less expensive trackage layout.

The question of the economy of installation in existing elevators is one which would have to be studied for each separate case by expert elevator engineers. The writer believes, however, that where a large volume of grain is handled that a study of the question would be well worth while and that unloaders can be installed to advantage in most existing elevators without making any essential changes.

Some Qualities of Bearing Metals

The A. W. Cadman Manufacturing Co. of Pittsburgh, Pa., have recently issued two very interesting pamphlets on the subject of white bearing metals. They deal with the general structural details of the ordinary babbitt metals and show how that structure has an important influence on their friction-reducing qualities.

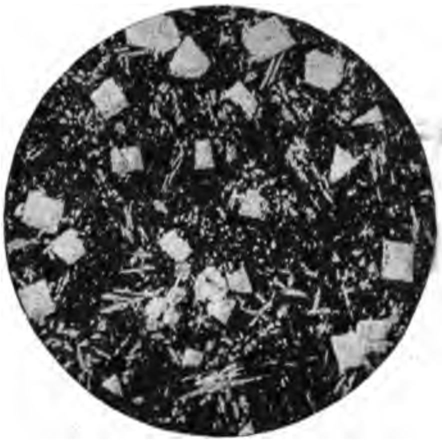


FIG. 1. GENUINE BABBITT. ANALYSIS IDENTICAL WITH FIG. 2. TIN 88.9, ANTIMONY 7.4, COPPER 3.7

FIG. 2. CADMAN ACORN METAL. ANALYSIS IDENTICAL WITH FIG. 1. TIN 88.9, ANTIMONY 7.4, COPPER 3.7

In the matter of the preparation of a bearing one point is brought out upon which too much emphasis cannot be placed, and one to which it may be said that no attention at all is paid. That is the temperature at which the metal shall be poured. Every iron founder in the country and every steel maker knows that unless he pours his metal at a proper temperature, the resulting castings or ingots will be defective. Yet it is safe to say that there is hardly a railroad company in the country, if indeed there is one, where a thermometer or pyrometer is used to determine the temperature at which bearings are poured. Yet, as one of the pamphlets states: "It is as wise to expect good bread from a cold or overheated oven as good bearings from a cold or overheated babbitt. The pouring temperature of every metal has a definite relation to the quality of the casting, and to secure uniform results it is imperative to observe a uniform pouring temperature. This is such an easy thing to do that it is more than strange that no attention is paid to it.

Of course it is well known that anything would do for a bearing metal if the film of the lubricant could always maintain the separation between the bearing and the shaft. So long as these two do not touch, all will be well. But when the oil film is broken and the two come into contact then the need of a proper bearing metal is at once apparent; and among its chief characteristics is on those of a low coefficient of friction and relatively high heat conductivity. The first in order to reduce the amount of heat developed to a minimum and the second in order to carry off and dissipate what heat is developed as rapidly as possible. And babbitt metal, which is simply the old pewter of eighty years ago, possesses these two qualities to an eminent degree.

But babbitt metals of the same chemical composition may show wide variations in structure. Where the metal is alloyed in the ordinary way it obtains its hardness from the antimony crystals that are embedded in the softer matrix and from which they project and form the actual points of contact with the shaft. 'If these crystals are too numerous or unduly large, the metal assumes the nature of the hardening material rather than that of the matrix."

The bulletins, issued by the company, show the structure of two grades of metal as made in the ordinary manner and by the Cadman process. It will be seen from the accompanying illustration that the company's process gives an evenness of structure that the ordinary method cannot attain.

One of the desirable qualities of a bearing metal is that it should cause an even distribution of the lubricant over its surface and tend to hold it there. This can, manifestly, be better accomplished over a finely granular structure than on a coarser one where the prockets in the matrix between the crystals of the harder material are larger and deeper and thus tend to hold the lubricant in pockets contrary to the most advantageous distribution of the same.

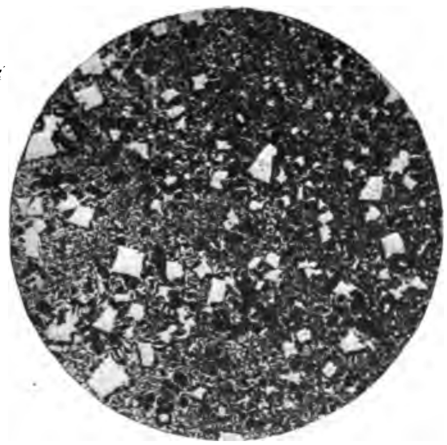


FIG. 3. HIGH GRADE LEAD BASE. ANALYSIS IDENTICAL WITH FIG. 4

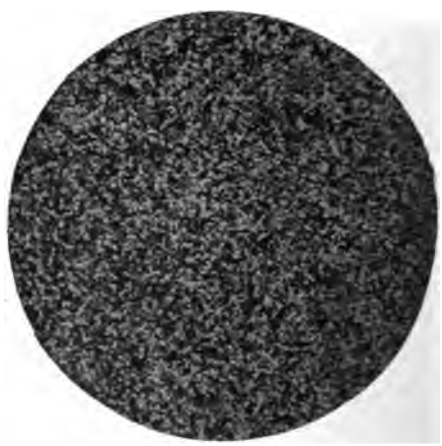


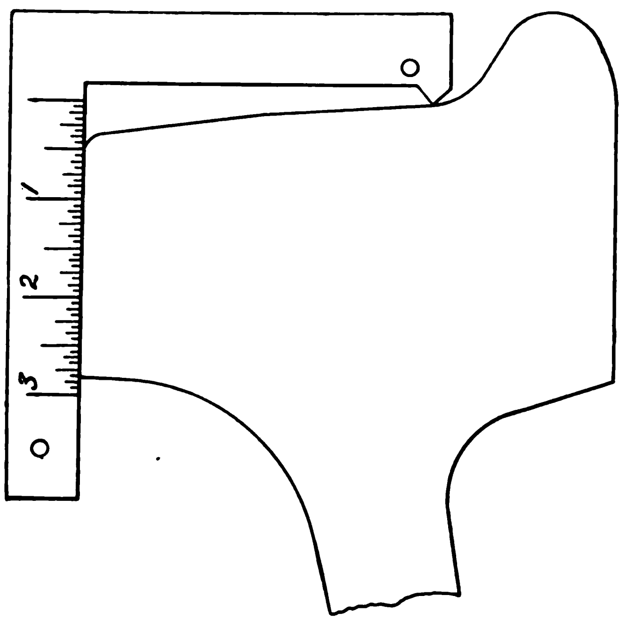
FIG. 4. CADMAN BEARITE. ANALYSIS IDENTICAL WITH FIG. 3

Railway Shop Kinks

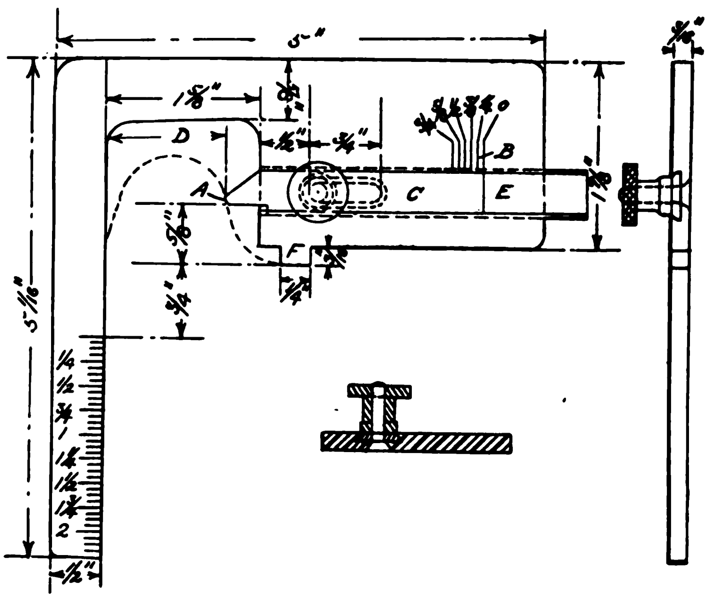
Some Special Tools in Use in the Richmond Shops of the Chesapeake & Ohio R. R.

Gauge for Determining the Thickness of Rim of Rolled Steel Wheels

To start with there is a very simple gauge for the determination of the thickness of the rims of rolled steel. It consists of a steel square having legs 4½ in.



GAUGE FOR DETERMINING THICKNESS OF RIM



GAUGE FOR DETERMINING AMOUNT OF METAL TO BE REMOVED FROM TREAD

and 5 in. long, respectively. The shorter or horizontal leg of the illustration has a projection on the inner side the point of which is 3⅝ in. from the other leg. The longer leg is cut with a scale subdivided into sixteenths so that when it is brought against the outside face of the rim and the point on the other leg rests against the tread of the wheel the marking of the scale at the inside edge of the rim will show the thickness of the same; or that portion of the scale in contact with the limit of wear groove will show the amount of metal still available for wear.

Gauge to Determine Amount of Metal to Be Turned from Tread to Form Flange

Where the flanges of steel wheels have run sharp, it is necessary to turn off a portion of the tread in order to obtain the metal from which to cut a new one. It is, therefore, desirable to have a means at hand to determine the amount to be removed from the tread for this purpose. The gage shown makes this possible.

It consists of a steel plate 3/16 in. thick cut to the form shown and having a dovetailed groove planed in one side to admit flange and can be adjusted so that the point rests against the inner face of the flange.

On the body of the gauge the scale *B* is laid off with the graduations 1/16 in. apart.

When the vertical leg of the gauge laid against the inside face of the wheel and the projection *F* of the gauge is brought down against the tread, the point *A* of the slide will bear against the flange when the index line *E* on the slide is in alinement with the zero line of the scale above it, and the flange is of the full standard contour.

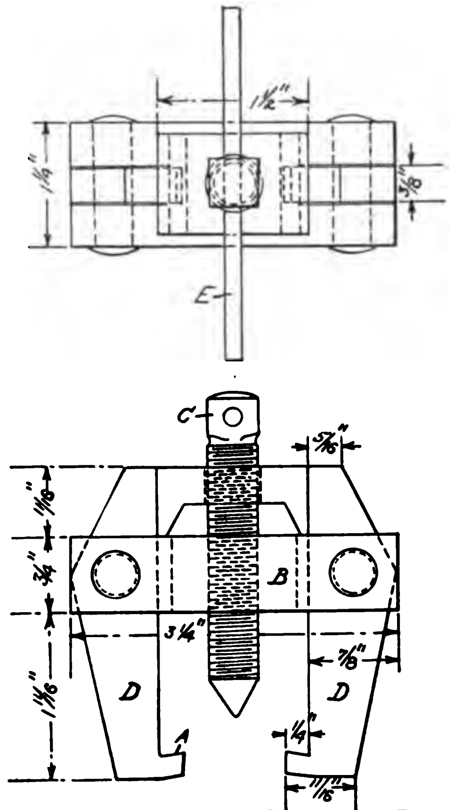
If, however, the flange is worn thin the slide will have to be moved to the left to make a contact at *A*, in which case the index line will also move to the left beneath the scale and the amount of metal, to be removed from the tread at the point where the projection *F* comes into contact with it, will be indicated by the figures attached to the scale *B*. This amounts to about ⅛ in. for each 1/16 in. of wear of the flange.

The scale on the vertical leg also serves to indicate the amount of metal available for turning. The zero of the scale is set ¾ in. below the surface of *F*. Then, if the gauge is turned around, the reading at the inside of the rim will give the amount of metal left on the tread of wheel.

This gauge in connection with the one previously described makes it possible for an inspector or wheel turner to determine at once not only the amount of metal to metal left in the tread to make such a building up possible.

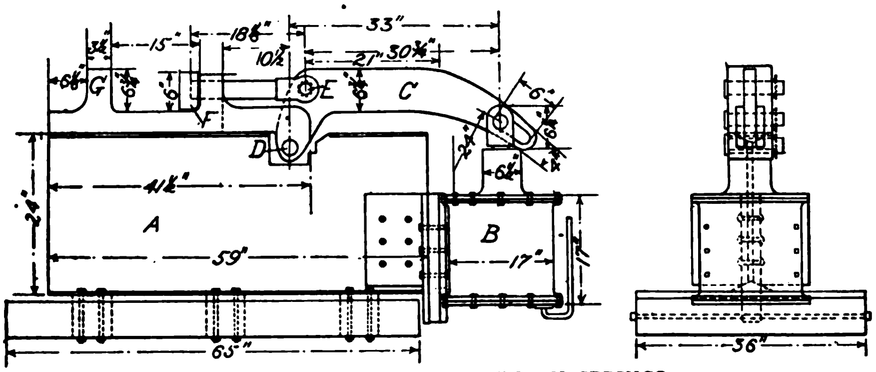
Safety Valve Clamp for Hydrostatic Tests

Ordinarily when a hydrostatic test is to be made on a locomotive boiler, the safety



valves are screwed down and their springs compressed so that they will not open under the excessive pressure to which they are to be subjected. The result of this tightening is that, after the test, it becomes necessary to readjust the valves so that they will open at the proper and desired steam pressure.

This simple clamp makes it possible to avoid all of this trouble and expense. It consists of a yoke *B* which is threaded for



DEVICE FOR PUTTING BANDS ON SPRINGS

the ½-in. set screw *C*. At the outer ends of the yoke the two clamping pieces *D* are pivoted. The lower ends of the clamping pieces are made hook-shaped at *A*.

The set screw *C* is 3¼ in. long and its point is set in the center of the valve stem while the hooks of the clamps at the lower end of *D* are brought beneath the lip or beading on the casing of the valve. Then, by turning the set screw down on the valve stem by means of the 3/16 in. steel wire *E* the valve is forced firmly against its seat and held there against any pressure that may be applied to the boiler in the course of a hydrostatic test. The safety valve springs are not called upon to resist any of this pressure, and when it is removed they are already in adjustment to work under the boiler pressure to which they had previously been set.

Machine for Putting Bands on Elliptic Springs

This is a machine for putting the final squeeze on the bands of elliptic springs after they have been put about the leaves.

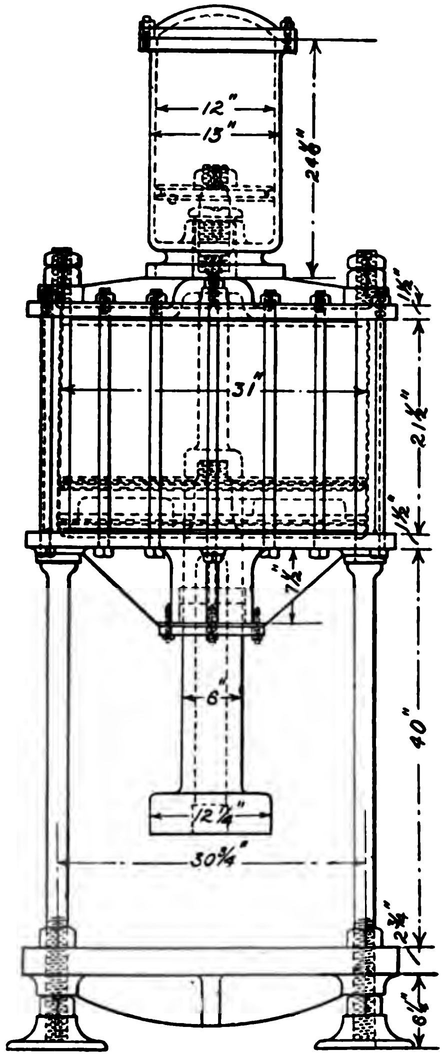
It consists of a frame *A* to one end of which the vertical cylinder *B* is bolted. This cylinder is 17 in. outside diameter and 16 in. inside, and is fitted with an ordinary single-acting piston, working under air pressure that is admitted through the pipe entering the cylinder at the bottom. The piston rod, which is 2¾ in. in diameter, acts against the slot in the long arm of the bell crank lever *C*, which is pivoted on the frame on the bolt *D* that is 1⅝ in. in diameter.

The plunger rod is pivoted to the heel of the lever 1¼ in. out of the vertical center line through the pin *D* on the 2-in. pin E. The vertical distance between the fulcrum bolt *D* and the driving pin *E* is 9 in., and the horizontal distance to the con-

ing a leverage of 3⅔ to one. This leverage, combined with 90 lbs. air pressure in the cylinder, will give an effective pressure on the plunger *F* of about 66,000 lbs. This thrust is carried by the upwardly projecting angle block *G*, which is cast solid with the base through which the bolt *D* passes.

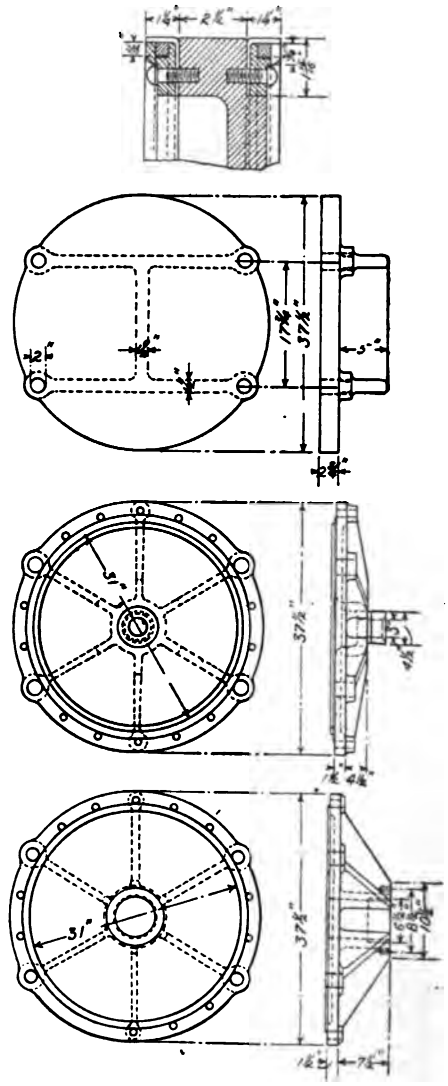
Twenty-Ton Air Press

This air press is intended for forcing bushings in or out of rods and doing any other work of that character. The working cylinder is 31 in. in diameter and has a piston stroke of 16 in.



In order to avoid the jumping that is likely to occur when work is done with a direct pneumatic pressure, this press is fitted with an upper and smaller cylinder which, being filled with oil, serves as a brake by which the movement of the piston is regulated. This cylinder is 12 in. in diameter inside and the piston which works in it has a leakage way through which the oil may pass. This offers such a resistance that the movement of the whole is steadied regardless of the pressure being exerted or the variations therein.

The main cylinder consists of a shell of 33½ in. outside and 31 in. inside dia-



20-TON AIR PRESS

meter. This is held between the bottom and top heads and by fourteen 1-in. bolts, in addition to the four heavy column bolts of 2 in. diameter, which serve as supports for the press.

These heads are shown in detail. The heads are 1½ in. thick and the lower one is strongly ribbed. The ribs radiate from a heavy stuffing box which has an inside diameter of 6½ in. This holds a hydraulic packing by which the heavy plunger is packed. The plunger is 6 in. in for nearly its whole length, which serves to materially lighten it. At the upper end, the plunger has a taper fit in the piston, and the thread at the extremity is screwed into a socket at the lower end of the rod connecting the two pistons. This latter rod is 3 in. in diameter and is held to the upper piston by a taper fit and nut on top.

The packing between the two cylinders is effected by means of a packing held in place by a gland screwed to the teat on the upper side of the top head.

The platen or anvil is a casting with a base 2¾ in. thick, which is strengthened by ribs 1½ in. thick and 5 in. deep. This is held, as shown, on the column bolts which in turn are screwed into the feet upon which the whole machine rests.

The air piston is shown in section. It is formed of a central cast iron follower into which the rings are fitted and to which they are bolted. These rings are grooved on their outer edges to receive the expansion rings, which, in turn, hold the leather cup packings out against the inside face of the cylinder. This arrangement serves to pack the piston for both upward and downward movement.

The press is operated by a four-way cock which will admit air to either end of the cylinder while exhausting it from the other.

Eleven Men on a Two-Man Job

In a statement just issued Mr. F. H. Alfred, president of the Pere Marquette Railway, said, concerning the union rules which obtain in railway shops throughout the country:

"I believe that there is not a railroad in the country that could not afford to pay its shopcraft men 10 per cent more were it not for the obnoxious national rules on employment.

"There are 186 of these rules which were drawn up by the representatives of labor during war times, and the end and aim seems to have been the creation of the most jobs that could be made."

Mr. Alfred then listed, as an example, the classes of labor which must be used to replace a broken staybolt in a locomotive:

1. The cab carpenter and his helper remove the running board.
2. The sheet metal worker and his helper take off the jacket.
3. The pipemen remove the pipe.
4. The machinist and helper remove the running board bracket.
5. The ox welder and helper burn out the staybolt.
6. The boilermaker and helper take out the staybolt.
7. The boilermaker and helper put in the staybolt.
8. The running board bracket is replaced by machinist and helper.
9. The running board is fastened on by a cab carpenter and helper.
10. The jacket is replaced by a sheet metal worker and helper.
11. The pipe work is replaced by a pipefitter and helper.

Before the day of "national agreements" such a job was often done by two men.

Refrigerator Cars

The latest reports show that the steam railways of the United States had in their own service on January 1, 1921, a total of 60,768 refrigerator cars, whereas private corporations, such as the packers and others, owned 36,200 refrigerator cars. The railway ownership was nearly twice as great as the private ownership.

Unserviceable Engines This and Other Years

The average number of unserviceable freight and passenger locomotives for the year 1919, in which year the roads were under Federal control, was 26.9 per cent of the total. In 1920, for ten months of which the railroads were under private control, the number of unserviceable locomotives was reduced to 24.5 per cent. In 1921 the average number of unserviceable engines was further reduced to 23.7 per cent, and the average for the first six months of the year, that is, up to July 1, had been 23 per cent. This represents a decrease of nearly 4 per cent.

Automatic Control on the Chicago & North Western

The Chicago & North Western has contracted with the General Railway Signal Company, Rochester, N. Y., for an installation of automatic train control between West Chicago, Ill., and Elgin. [West Chicago is 30 miles west of Chicago and Elgin is 12 miles north of West Chicago.] The line to be equipped has some double track and some single, with both mechanical and electric interlocking plants. The intermittent induction type will be used, with speed control.

French Railway Orders Control Equipment for 120 Electric Locomotives

An order covering the complete control equipment for 120 electric locomotives, now under construction has been received by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., from the Paris-Orleans Railway of France as part of an electrification contract amounting to approximately $8,000,000.

The Paris-Orleans Railway, which is one of the largest systems in France operating over 5,000 route miles of track, is electrifying 125 miles of its main line between Paris and Vierzon. This is the first of an extensive program laid out by the Paris-Orleans for the electrification of its lines.

The complete order of control equipment will be manufactured in the United States and shipment of this order will commence in January, 1923, and extend to December, 1924.

New Plant for Davis Boring Tool Company.

One of the latest developments in machine tool circles is the announcement of the purchase of an ideal factory site by the Davis Boring Tool Company of St. Louis. Preliminary work is now under way for the erection of a modern three-story daylight factory which will be undertaken in the near future and when completed will be one of the largest and most complete manufacturing plants in the Middle West. The remarkable progress of this company has attracted nationwide attention—growing from an original investment of $1,000 to a capitalization of $1,000,000 in a period of eighteen years, in that time outgrowing four different factory buildings. Today they are the largest exclusive manufacturers of expansion boring tools and expansion reamers, supplying the entire world with efficient boring and reaming equipment. The extensive line of boring tools and expansion reamers that they manufacture provides a tool for all classes of metal boring in railroad shops, automobile manufacturing plants, automobile repair shops and industrial manufacturing plants. Tools for boring car wheels are an adopted standard throughout the United States, Canada and Mexico. The unquestioned merit of the tools can be attributed to the development of original ideas that mark a departure in expansion boring and reaming equipment.

Heat Losses of Stored Coal

Calorimeter tests to determine the losses in calories of coal heated in the air for various lengths of time are being made at the Pittsburgh (Pa.) experiment station of the Bureau of Mines by J. F. Byrne. At 125° C. the following heat losses were obtained:

Time of Heating	*Per Cent Loss*
30 min.	.30
1 hour	.26
2 hours	.311
3 hours	1.01
20 hours	3.3
46 hours	5.7

Samples were heated for various periods of time ranging from ½ hour to 100 hours, and the b. t. u. run by the coal laboratory. The results show no regularly increasing loss in heating value as the time of heating increases. The coal samples show a change of weight on heating—at first a decrease in weight, due to the loss of moisture. The decrease is generally less up to 24 hours, when there is an increase in weight of .64 per cent. After heating 100 hours at 125° C. there is an increase in weight of 1.35 per cent and a loss in heating value of 3.02 per cent.

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New Railroad Equipment

That there is a revival of business along the lines of railroad equipment is evidenced in part, by the list of orders for locomotives, and cars published in these columns a month ago. That list included 403 locomotives and 8,594 freight equipment cars, as on orders or about to be ordered at the present time, and elsewhere in this issue will be found some recent orders.

Equipment reports show that since the first of January there has been a marked increase in the number of cars and locomotives acquired by the railroads as compared with the same time of one year ago.

The latest data that is, at present, available is, up to August 1. According to the reports the railroads have installed or had on order on August 1, 95,199 freight cars of various kinds as compared with a total of 69,436 which were ordered or put into service during the whole period of 1921. This increase applies to all types of equipment. Of coal cars, for example, only 30,698 were ordered and placed in service in 1921, while up to August 1, of this year, there was a total of 41,405 that had been ordered or installed. The proportion of box cars ordered in 1922 as compared with 1921 is even greater than the coal cars. For the first seven months of 1922 the number of coal cars ordered to those ordered for the whole year of 1921, was in the ratio of about four to three; whereas the ratio of box cars for the same periods is about as two to one, since there were only 21,543 new box cars ordered and actually installed in 1921, while for the first seven months of 1922 the figures stand at 39,612.

The railroads are also augmenting their supply of refrigerator cars but in a lower ratio than the box cars, and the actual numbers involved are far less. These do not quite drop to the figures of a year ago. For the whole year 1921 they were 9,355 or about 780 per month. For the first seven months of 1922 there had been 10,318 ordered or installed or about 860 per month. This shows an increase over 1921 though not so great as in the case of the coal and box cars.

It is unsafe to say definitely that, under different conditions, there would have been an even greater increase of rolling equipment ordered than the books show. But it is very evident that the strike of the shopmen did have a deterrent effect on orders, because the time and attention of the officials was necessarily devoted almost exclusively to the immediate and pressing problems that presented themselves from day to day, to the exclusion of other matters that could be postponed and the designing and purchasing of new equipment was one of those things.

But laying this aside, the increase of orders for rolling equipment coupled to the substantial orders that have been placed for new shops and tools, is an indication of a decidedly upward trend in the demand for railway supplies.

This favorable outlook is warranted by the prospects of traffic that will be offered to the railroads, which there is every reason to believe will be exceptionally heavy, and already car loadings are far in advance of that of any recent volume of traffic. Take the report of the Geological Survey which estimated the production of soft coal for the first week in September at 9,500,000 tons as an example. This of itself, would form the basis for a very large traffic movement for several weeks to come. The steel output is also working back to its high level output, so that there are these additional reasons for an optimistic outlook.

The Purchasing Department as an Inspector.

The matter of the close relation that ought to exist between the motive power and purchasing departments was brought well and emphatically to the fore by Mr. H. C. Pearce, the director of purchases and stores of the Chesapeake & Ohio R. R. in an address at the September meeting of the New York Railroad Club.

It is the province of the motive power department to ask for, that is specify, what it wants and for the purchasing department to see that it is supplied at the proper time and place. But it is difficult, or quite impossible, for the purchasing department to do its portion of the work unless it knows what is wanted. In other words unless proper specifications have been drawn up on which purchases can be made. The lack of these also make inspections impossible. For that reason Mr. Pearce urged that at least minimum specifications should be drawn as a guide. Then if something better or different is desired it is a simple matter to make a revision in the standard specification to cover the additional requirement. In the meantime the manufacturer will be protected in the production of goods for which he will be, practically, insured a market.

In the matter of inspection it was urged that this should be in the hands of the purchasing department and also that, in the matter of the examination of material, the engineer of tests should also report to the purchasing agent. This would throw the whole responsibility for the purchase, inspection examination and delivery of all material upon the shoulders of the agent and relieve the motive power department of a piece of routine work that does not really belong to it. Because if inspection is in the hands of the motive power department and shows material to be defective it is the purchasing department that has to make the adjustments with the manufacturer; while, if it is satisfactory that department has simply the negative information that no complaint is made and it is presumably satisfactory.

In the same way the store department should have control of the reclamation of waste material. Mr. Pearce's definition of reclamation is that it is the "making useful that which has been discarded." He then went on to say that the "fundamental principle underlying reclamation is that nothing must be reclaimed that will not be needed for future use or that cannot be reclaimed at a saving." It is this last and commercial aspect of the matter that points to the purchasing department as the one that should have charge of the reclamation work; because it would only be by the constant interchange of information regarding prices, and that, too, the prices of small details that would make it possible for any other department to do the work. In this connection the statements were made that the supply department is organized for the purpose of supplying materials, and the reclaiming of material is one of its sources of supply;

"That the work of dismantling, disposing and sale of all materials, including released equipment, is one of the duties of the supply department;

"That this work can be done more economically in conjunction with the handling and marketing of scrap, of which it is a part."

These features will strike some mechanical officers as revolutionary, because they have always regarded everything pertaining to the mechanical operation of a railroad as belonging to their peculiar province. To ask that they shall surrender the inspection of material to a department which has not done it, simply because it is a logical thing to do, would be though to be asking a good deal.

The mechanical department is the user and everything it has comes to it through the purchasing department. The objectionable point on inspection is that the supply department would have no latitude in the matter of inspection. It would have to work rigidly to specification and there might be minor variations which the user could ignore on its own responsibility but which the purchasing agent's inspection might not feel at liberty to do. It is this necessity for some flexibility in inspection that will militate against the complete control by the purchasing department. However, if that is where the work belongs, there is probably some way in which a satisfactory solution can be worked out.

Locomotive Loading and Bridge Design

In a paper presented at a recent meeting of the American Society of Civil Engineers Mr. D. B. Steinman called attention to the inadequacy of the old Cooper classification for bridge rating and stress calculations. The Cooper system was formulated by the late Theodore Cooper about thirty years ago and was almost universally adopted in American bridge practice. It was based on the stresses induced by two consolidation locomotives and their tenders followed by a train imposing a uniform loading per lineal foot. At the time the classification was made the E-40 rating represented the heaviest loading to be provided for as imposed by two consolidation locomotives having 40,000 lbs. on each pair of driving wheels followed by a train with a uniform loading of 4,000 lbs. per lineal foot.

But locomotive weights have increased enormously during the past thirty years and wheel arrangements have been subjected to revolutionary changes. The Mallet, for example, has come in and other types are in common use, so that it is no longer possible to simply multiply a consolidation loading or Cooper rating by a factor and have a result that will even approximately represent present conditions. Mr. Steinman, therefore, proposes a new classification based on the composite loadings of seven of the heaviest locomotives now in service. These engines are the Erie triplex, the Virginian heavy Mallet, the Pennsylvania and Erie Santa Fe's and the Mikado, U. S. Standard and Lake Shore & Michigan Southern Mallets. The system, which has been called the M-60, will give stresses for all spans equal to or slightly greater than the maximum stresses producible by the heaviest existing locomotives. At the same time it provides for a future increase.

On the other hand, if an attempt were to be made to apply the Cooper rating to a bridge designed for modern loading it will be found that there may be an error of from 20 to 37 per cent. So that as a measuring or rating standard for present day traffic, the Cooper system yields results that are radically inconsistent.

It is because of this inadequacy of the Cooper system to represent modern loading conditions that this suggested composite standard has been suggested. It is called the "M" because M may stand for "modern," "motive power" or "Mallet."

It makes it possible to design bridges strong enough in all their parts, without waste, for the heaviest existing locomotive loadings without requiring separate computations for each loading, besides giving a bridge of uniform strength to all of its parts.

These are advantages too great to be ignored, and are of especial interest to locomotive designers in the preparation of a new type. When this work is to be undertaken, the designer must first consult the bridge engineer to ascertain as to the wheel loads permissible on existing structures. If these are rated on the Cooper classification, it may be necessary to go over everything in order to ascertain as to what can be done with the new design. The Cooper classification was a wonderful step in advance of the conditions that had preceded it. But the changes of the past thirty years have outrun its flexibility and adaptability, and it appears that having had a long and useful life it must yield to something else. If not to the classification proposed by Mr. Steinman, at least to something based upon the new order.

The Reheating of Compressed Air.

The engineering experiment station of the University of Illinois has just issued Bulletin 130, entitled "The Reheating of Compressed Air," by C. R. Richards and J. N. Vedder. It deals with an investigation undertaken to determine the ideal thermodynamic efficiencies resulting from the heat expended in the reheating process, the efficiency of external and internal combustion reheaters and the performance of an engine operated with air used expansively, with steam alone, and with a mixture of air and steam, the steam being injected into the air pipe as a means of reheating the air.

For many years compressed air has been employed as a medium for the transmission of power. The ease and economy with which compressed air may be transmitted for comparatively long distances through pipe lines, and the variety of air motors and tools now available have led to the extensive use of compressed air in mining, quarrying and tunneling, in various shop processes and in the development of power.

In the smaller air motors, air-driven tools and devices operated by compressed air that are run intermittently, the air is not as a rule used expansively, economy of operation being sacrificed for simplicity and minimum initial cost of equipment. When motors are operated continuously for considerable periods of time, economy of operation becomes a factor and it is essential that the air be expanded in the motor. The temperature of the air as it reaches the motor would normally be little if any above atmospheric; consequently, in accordance with well-known principles, after expansion it would be so low as to cause serious operating difficulties resulting both from the freezing of the moisture in the air and the consequent accumulation of ice in the exhaust pipe, and from the interference with cylinder lubrication and resultant loss of mechanical efficiency. These difficulties may be overcome by heating the air before its delivery to the motor to an initial temperature such that the exhaust temperature will be above the freezing point of water, this heating process being commonly designated as "reheating." Reheating not only reduces operating difficulties but also affords a means of increasing the total output of power per pound of air by the expenditure of a small amount of heat energy.

Copies of Bulletin No. 130 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Westinghouse Company Receives French Railway Contract.

An order covering the complete control equipment for 120 electric locomotives, now under construction, has been received by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., from the Paris-Orleans Railway of France as part of an electrification contract amounting to approximately $8,000,000.

The Paris-Orleans Railway, which is one of the largest systems in France, operating over 5,000 route miles of track, is electrifying 125 miles of its main line between Paris and Vierzon. This is the first of an extensive program laid out by the Paris-Orleans for electrification of its lines.

After a careful and exhaustive study by the railway engineers of the various systems of control now on the market, they selected the Westinghouse electro-pneumatic control which is now standard on most of the large railroads in America.

The complete order of control equipment will be manufactured in the United States, and shipment of this order will commence in January, 1923, and extend to December, 1924.

Standardization of Small Tools*

By Carl J. Oxford,[1] Detroit, Mich.

Machine tools and small tools are so closely related and interdependent on each other that their respective developments logically should go hand in hand. In the past we have had instances of close co-operation between machine-tool builders and small-tool manufacturers. The results have invariably been noteworthy and beneficial, both to the co-operating firms and to the tool-using industries in general.

Powerful and rapidly operating machine tools may be designed and built; but their success is largely nullified if they require cutting tools of prohibitive cost and of short life. Conversely, small tools may be developed which with the proper machine tools will produce wonderful results, but which again with unsuitable machines are complete failures.

We have been, and are still passing through a period in our industrial development where the reduction of expenses has become the watchword. Particularly is this true of those expenses which may be classified as production costs. Facing, as we now do, keenly competitive markets, it becomes necessary to cut the cost of production to the core if the manufacturer is to show a balance on the right side of the ledger.

There seems to be but a scant likelihood that either raw material or labor costs will retract to a lower level in the near future. In fact, we have recently seen slight increases in both. The lowering of production costs must therefore be accomplished through improvement in methods, and through increased productivity and efficiency of tools and equipment as compared with first costs.

It is the primary purpose of this paper to point out how greatly the first cost of small tools can be lowered, without sacrificing their efficiency, by the adoption of standards that will permit manufacturers of tools to produce on a quantity basis.

Classification of Small Tools

Twist drills, reamers and milling cutters all are classed as small tools. In this paper only these three types will be considered. Usually the manufacturer classifies them as being either standard or special.

Standard tools are those sizes and designs which are regularly catalogued and carried in stock by the larger manufacturers, while special tools are those made up to the customers' specifications.

There exists, at present, a fair uniformity of general dimensions in the tools catalogued as standard by the various makers. This is a step in the right direction; but the belief is expressed here that this uniformity could be carried more into detail, and that the number of standard items listed could be cut almost in two without any serious handicap to the metal-working industries in general.

It is difficult to realize, by those not actively engaged in the small-tool business, what a wide variety of styles and sizes are catalogued as standard tools. An examination of several tool-manufacturers' catalogues shows the following average number of items:

Twist drills	3400 items
Reamers	2200 items
Milling cutters	4500 items

Roughly this makes a total of 10,000 items. Certainly this ought to be enough of a variety to take care of every conceivable requirement. That such is not the case, however, is illustrated by the fact that small-tool manufacturers are annually making thousands of items of tools not listed in their catalogues, and must continue to do so as long as their customers insist on having them.

Standard vs. Special Tools

It is conceded that there are numerous instances were special tools are necessary; but the statement is made advisedly that in many shops from 40 to 60 per cent. of the work now performed with special tools could be equally well performed with standard tools, *and at a much lower tool cost*. To accomplish this it would be necessary, however, to educate the designers of both the manufactured article itself and of the various holding and locating fixtures to the importance of adapting their designs to the most economical uses of tools.

Instances are numerous where no end of troubles are encountered in machining because the designers have paid more attention to the purely technical side of design than to the practicability of performing the various machine operations specified.

In the production of many manufactured articles the cost of perishable cutting tools, such as drills, reamers and milling cutters, represents a large percentage of the total productive cost. As a consequence, the question of efficient and long-lived tools has come in for considerable attention. The present tendency, however, seems to be toward the use of special tools where an increased production is desired, or where trouble is encountered.

This is believed to be a fallacy in a great many cases. For if a little time and effort is expended in adapting the conditions, such as surface speeds, chip thickness and holding devices, it is often found that equally good, or better results can be produced with standard tools than with special tools, although the latter must be obtained at a much higher price.

In addition to the higher price of special tools it must be borne in mind that these are only made up in quantities as specified by the user. Hence the source of supply is restricted, and deliveries are subject to delays. Standard tools, on the other hand, can be purchased on the open market and can usually be delivered from the manufacturers' stock.

Relative Costs

Standard tools which are carried in stock by both manufacturers and dealers can naturally be made up in fairly large quantities. Usually from about five hundred or ten or twenty thousand of each size and kind can be put through the factory at one time. This means that many of the benefits accruing from quantity production are realized.

There is little time lost on setting up the machines, operators become more efficient on repetition operations, and in many instances it is possible to utilize multiple equipment and other time-saving devices.

The non-productive overhead, incidental to every order, is also spread over a great number of pieces, so that the amount chargeable against each piece is very small. All these conditions combined result in a low unit cost.

Compare this with the cost of producing special tools. These are as a rule ordered in small quantities ranging from one to ten or twenty pieces. Highly skilled all-around machine operators must be employed for this class of work. There is just as much time lost in setting up each of the various machines for one piece as for one thousand or ten thousand. There is no opportunity of using multiple equipment on such small numbers of pieces, nor do the machine operators acquire any increased efficiency from repetitions.

Non-productive overhead expenses are nearly as high for one or two pieces as for several thousand. The difference is that *in one case these expenses must be absorbed by one or two pieces, while in the other case they can be distributed over a very great number*. It is obvious how this will affect the respective unit costs, and eventually the price at which the tools must be sold.

Concrete examples of comparative costs will perhaps illustrate the point more forcibly. Let us compare the two twist drills *A* and *B*, Fig. 1. Both are 19/32 in. in diameter and of identically the same design throughout except that drill *A* is of standard length, or 8¼ in., while drill B

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*Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25-27, is 2⅜ in. longer, or 10⅞ in. Five hundred of the drills *A* were made at one time, this being a standard size. The drills *B*, being special, could be made only in quantity as specified by the customer, in this case six.

The direct labor cost of *A* proved to be only 38 per cent. of the corresponding cost of *B*. Adding the non-productive overhead, chargeable against the respective orders of which these drills were a part, the total cost of the standard drill *A* was found to be but 21 per cent. of that of the special drill *B*.

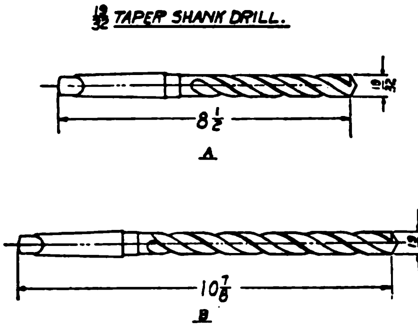


FIG. 1

Representing this in another way, we may say that the increase in length of *B* over *A* was 28 per cent., while the increase in cost was 480 per cent.

Similarly, we may compare the two milling cutters *C* and *D*. The special cutter *C* is slightly smaller than the standard cutter *D*. Yet, owing to the quantities manufactured in each case, the total cost of the cutter *D* was found to be 270 per cent. higher than the corresponding cost of *C*.

These are but ordinary illustrations of conditions as encountered by every tool manufacturer.

Necessarily the cost of producing must be reflected in the cost to the consumer. Pursuing this line of thought, it becomes evident that the high cost of special tools is eventually levied against the manufactured articles on which the tools are used, and in turn is passed on to the purchaser of these articles.

Let us suppose that a certain operation requires a special milling cutter costing $30 and that the life of this cutter is 4,800 pieces. If we are able to adapt this same operation to the use of a standard milling cutter of approximately the same dimension we shall have effected a considerable saving. This latter cutter can probably be bought for about $18.

The total cost for one operation is then reduced from $6.25 to $3.75 per thousand pieces. With a great number of machine operations on which such savings may be effected, it is easily conceivable that the results may mean the difference between a possible business loss and a tidy profit at the end of the year.

Elimination of Special Tools

It has already been stated that the total elimination of special tools is impracticable, for there will always be conditions now and then where a standard tool cannot be used; but there can be no doubt that the number of special tools used in the average manufacturing plant, with a little foresight, can be greatly reduced. Engineers and designers responsible for the design of both the manufactured product and of the various jigs and fixtures, must be brought to realize the great economic advantage of standard tools over special tools. Especially is this true where production of large quantities of duplicate parts are involved.

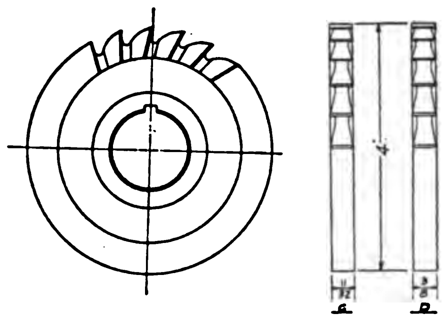


FIG. 2

A jig or fixture is a comparatively permanent thing, while cutting tools are in many cases very short-lived. Therefore a small additional expenditure, in order to adapt such jig or fixture to the use of standard tools, eventually becomes a highly profitable investment.

Numerous cases can be mentioned where such simple expedients as the shortening of a jig bushing or the slight reduction in height of some projection on a milling fixture will mean from 20 to 50 per cent. reduction in tool costs for that particular operation, inasmuch as it will permit the use of standard tools.

From my own experience in the manufacturing of automotive parts there comes to mind, too, several instances where the factory, in order to get out the required production, was compelled to ask the engineering department to alter its designs sufficiently so that practical and economical cutting tools could be used. It is a regrettable fact that many engineers, either through ignorance of, or through failure to attach sufficient importance to small tools requirements, are in this way wasting money that legitimately should be used either to reduce the cost of the goods, or to pay a profit on the invested capital, as the case may be.

Technical schools and colleges would render a real service to the metal working industries if they were to include in their machine shop curriculum at least a limited amount of instruction along these lines.

It may be properly argued that some of the tools now embodied in the tool manufacturer's standard list do not represent the highest degree of efficiency, and that there are certain other tools, now regarded as special, which will give better results. This is a sound and logical development of the small-tool industry, a development which should be encouraged through the elimination from the standard tool list of obsolete styles and designs and the substitution of tools, developed through experience and research, that have proved more efficient under all conditions.

We have, for instance, the matter of numbers of teeth in milling cutters and numbers of flutes in reamers. The majority of manufacturers maintain a fair uniformity in this respect, based more or less on practical experience. However, materials and machine-tool equipment are being developed which in many cases demand numbers of teeth or flutes varying from the old established standard. As a consequence many users of tools are specifying numbers of teeth, according to their own pet ideas. Obviously this at once classifies the tools as special, because it is impossible for the manufacturer to anticiate consumers' whims.

It seems reasonable to assume, though, that there is one number of teeth or flutes which in general will work most satisfactorily. It is in cases such as these that standardization becomes important from an economic point of view.

If standards can be established, and these adhered to, the consumers will derive great benefits, through the elimination of expensive special tools and the substitution of more moderately priced standard tools.

For the general good of the metal-working industries as a whole, a program of standardization should be carried out. Attempts should be discouraged to capitalize by attributing fancied advantages to minor construction details and charging special tools prices for those which legitimately are standard. Standardization will undoubtedly go far toward the total elimination of such practices.

Reduction in the Number of Standard Tools

It is also believed that a material reduction in the number of tools now regarded as standard can be effected without any hardship to anyone.

A majority of the tools used in the metal-working industries today are made from high-speed steel. They are consequently expensive, due to the high cost of the raw material. When it is remembered that a small-tool manufacturer must carry in stock some 5,000 to 10,000 items of these tools, each in sufficient quantities to care for the possible requirements of the trade, it is easily seen that this imposes on him a large overhead, merely as interest on the investment involved. Therefore, the elimination of a number of items will mean a corresponding decrease in the price of those remaining. Some suggestions are given here which, if followed, will accomplish much in this direction. It is at least hoped that these suggestions may serve as a basis for future action. The actual carrying out of the changes proposed must of course be left to the tool manufacturers, but they can do so only after the consumers have been educated to the great economy made possible.

STRAIGHT SHANK WIRE DRILLS.

No. BY GAUGE	DECIMAL DIAMETER	No. BY GAUGE	DECIMAL DIAMETER	No. BY GAUGE	DECIMAL DIAMETER	No. BY GAUGE	DECIMAL DIAMETER	No. BY GAUGE	DECIMAL DIAMETER
80	.0135	64	.0360	48	.0760	32	.1160	16	.1770
79	.0145	63	.0370	47	.0785	31	.1200	15	.1800
78	.0160	62	.0380	46	.0810	30	.1285	14	.1820
77	.0180	61	.0390	45	.0820	29	.1360	13	.1850
76	.0200	60	.0400	44	.0860	28	.1405	12	.1890
75	.0210	59	.0410	43	.0890	27	.1440	11	.1910
74	.0225	58	.0420	42	.0935	26	.1470	10	.1935
73	.0240	57	.0430	41	.0960	25	.1495	9	.1960
72	.0250	56	.0465	40	.0980	24	.1520	8	.1990
71	.0260	55	.0520	39	.0995	23	.1540	7	.2010
70	.0280	54	.0550	38	.1015	22	.1570	6	.2040
69	.0292	53	.0595	37	.1040	21	.1590	5	.2055
68	.0310	52	.0635	36	.1065	20	.1610	4	.2090
67	.0320	51	.0670	35	.1100	19	.1660	3	.2130
66	.0330	50	.0700	34	.1110	18	.1695	2	.2210
65	.0350	49	.0730	33	.1130	17	.1730	1	.2280

FIG. 3

Let us first consider the ordinary straight-shank twist drill with which everyone is familiar. In the sizes up to and including ½ in. in diameter we find the following standard sizes listed:

Fig. 3 **Straight-Shank Wire Drills**
Fig. 4 **Straight-Shank Letter-Size Drills**
Fig. 5 **Straight-Shank Drills—Jobbers' Lengths**
Fig. 6 **Straight-Shank Drills — Taper-Shank Lengths.**

Summing this up, we have the following total:

Straight-shank wire drills...........	80 items
Straight-shank letter-size drills......	26 items
Straight-shank drills—jobbers' lengths	31 items
Straight-shank drills — taper-shank lengths	29 items
Total	166 items

This does not include the approximately 140 sizes of millimeter drills under ½ in. diameter, nor the various odd styles of straight-shank drills, such as tell-tale drills, dowel bits, etc. We are here dealing only with the kinds of drills in general use.

The establishment of sizes, particularly in Figs. 3 and 4, appear to have been entirely empiric, as there are many duplications or near duplications with the fractional size drills, Figs. 5 and 6. One is unable to find any uniform variation in diameter between consecutive sizes.

Fig. 7 is an attempt to establish uniformity of variation in diameter, and to eliminate sizes which are thought unnecessary. This will mean a reduction from 166 to 73 sizes.

It will be noted that the old symbols

STRAIGHT SHANK LETTER SIZE DRILLS.

SIZE BY GAUGE	DECIMAL DIAMETER	SIZE BY GAUGE	DECIMAL DIAMETER	SIZE BY GAUGE	DECIMAL DIAMETER
A	.234	J	.277	S	.348
B	.238	K	.281	T	.358
C	.242	L	.290	U	.368
D	.246	M	.295	V	.377
E	.250	N	.302	W	.386
F	.257	O	.316	X	.397
G	.261	P	.323	Y	.404
H	.266	Q	.332	Z	.413
I	.272	R	.339		

FIG. 4

have been retained; but that the amount of variation in consecutive sizes has been arranged roughly in a geometrical progression. Thus we have:

From No. 80 to No. 78, diameter increases approximately 0.001
From No. 77 to No. 57, diameter increases approximately 0.002
From 3/64 in. to ⅛ in. diameter increases approximately 0.004
From No. 29 to ¼ in., diameter increases approximately 0.008
From 17/64 in. to ½ in., diameter increases approximately 0.016

Reamers and milling cutters can be made subject to similar methods of standardization and with equally profitable results. No specific proposals are made, because it is realized that such standards must be created through suggestions from a wide field and through careful consideration and discussion of the suggestions offered.

Tolerances and Nomenclature

The British Engineering Standards Association in 1920 published their bulletin No. 122, entitled British Standards for Milling Cutters and Reamers. From the introduction to this publication the following is quoted:

> The standards herein contained have been arrived at as a result of conferences, research and direct co-operation between the small-tool makers, machine-tool makers, and users of this country, at whose instance the work was undertaken. . . .

An examination of the work done by the British engineers reflects their desire for uniformity in both design, tolerance and nomenclature. Much of the material could

STRAIGHT SHANK DRILLS.
JOBBERS LENGTHS.

DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER
1/32	.03125	5/32	.15625	9/32	.28125	13/32	.40625
3/64	.046875	11/64	.171875	19/64	.296875	27/64	.421875
1/16	.0625	3/16	.1875	5/16	.3125	7/16	.4375
5/64	.078125	13/64	.203125	21/64	.328125	29/64	.453125
3/32	.09375	7/32	.21875	11/32	.34375	15/32	.46875
7/64	.109375	15/64	.234375	23/64	.359375	31/64	.484375
1/8	.125	1/4	.250	3/8	.375	1/2	.500
9/64	.140625	17/64	.265625	25/64	.390625		

FIG. 5

STRAIGHT SHANK DRILLS.
TAPER SHANK LENGTHS.

DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER	DIAMETER INCHES	DECIMAL DIAMETER
1/16	.0625	3/16	.1875	5/16	.3125	7/16	.4375
5/64	.078125	13/64	.203125	21/64	.328125	29/64	.453125
3/32	.09375	7/32	.21875	11/32	.34375	15/32	.46875
7/64	.109375	15/64	.234375	23/64	.359375	31/64	.484375
1/8	.125	1/4	.250	3/8	.375	1/2	.500
9/64	.140625	17/64	.265625	25/64	.390625		
5/32	.15625	9/32	.28125	13/32	.40625		
11/64	.171875	19/64	.296875	27/64	.421875		

FIG. 6

PROPOSED STANDARD FOR
STRAIGHT SHANK DRILLS.

SYMBOL	DECIMAL DIAMETER	SYMBOL	DECIMAL DIAMETER	SYMBOL	DECIMAL DIAMETER	SYMBOL	DECIMAL DIAMETER	SYMBOL	DECIMAL DIAMETER	SYMBOL	DECIMAL DIAMETER
80	.0135	1/32	.0313	50	.0700	31	.1200	7/32	.2187	25/64	.3906
79	.0145	66	.0330	49	.0730	1/8	.1250	1	.2280	13/32	.4062
1/64	.0156	65	.0350	5/64	.0781	29	.1360	15/64	.2344	27/64	.4219
78	.0160	63	.0370	46	.0810	9/64	.1406	C	.2420	7/16	.4375
77	.0180	61	.0390	44	.0860	25	.1495	1/4	.2500	29/64	.4531
76	.0200	59	.0410	43	.0890	5/32	.1562	17/64	.2656	15/32	.4687
75	.0210	57	.0430	3/32	.0937	19	.1660	9/32	.2812	31/64	.4844
74	.0225	3/64	.0469	40	.0980	11/64	.1719	19/64	.2968	1/2	.5000
73	.0240	55	.0520	38	.1015	15	.1800	5/16	.3125		
72	.0250	54	.0850	36	.1065	3/16	.1875	21/64	.3281		
71	.0260	53	.0595	7/64	.1093	9	.1960	11/32	.3437		
70	.0280	1/16	.0625	33	.1130	13/64	.2031	23/64	.3594		
69	.0292	51	.0670	32	.1160	4	.2090	3/8	.3750		

FIG. 7

probably be bodily adopted for use in this country, while some of it would necessarily have to be changed to suit our own conditions.

We all recognize the desirability of having definite limits established. It seems that as far as reamers are concerned there would be an excellent field for co-ordination with the existing standards of tolerances on shafts and holes.

Uniformity of nomenclature is particularly desirable for the sake of avoiding confusion and loss of time. We have frequently had cases where a customer will order some sort of tool we never heard of before. When we of necessity ask for further particulars, it is found that a standard tool is wanted, but that a local term is used for designating the same.

On the whole it is believed that the engineering societies in taking up this question of standardization of small tools will perform a service to the manufacturers of tools; but more particularly to the users.

In the end it is of course the consumer who pays the bill, and if through standardization this bill can be reduced we shall have made a step forward in the march toward the goal of economical manufacturing.

The Angus System of Automatic Train Control

For twelve years or more A. R. Angus, an Australian, has been engaged in developing a system of safeguarding and controlling railway train movements, and in 1912 and 1913 trials were conducted on a section of the West Somerset Mineral Railway near Minehead, rented by Mr. Angus for the purpose. Trials were also inaugurated in Russia on the line from Vladimrskiya to Gatchina, and in 1917, during the war (which precluded further developments in countries involved), in Sweden on the Osmo-Nynashamn Railway.

As soon as possible after the conclusion of the war it was decided to resume trials in England, and an arrangement was made with the London Brighton and South Coast Railway to install it on the Dyke branch from Hove, for testing and demonstration purposes. Here the plant has been developed in several respects, and during this year it has been inspected by Colonel Pringle, R. E., and expert members of the Train Control Committee appointed by the Ministry of Transport, by signal engineers of many of the leading railways in the United Kingdom and by representatives in England of many of the Colonial, South American and foreign lines.

In its earlier form ramps or track contacts were used, but now these have been dispensed with. Instead, each locomotive has two narrow casings fitted between the wheels over the rails, the lower face being parallel with, and about two inches above, the running rails. The essential feature is that a low voltage alternating current of slow periodicity, usually 5 to 10 volts and five periods per second, is supplied to the track rails (provided that the section is clear), and this acts inductively, first upon a relay of robust type adapted for the small currents received, which actuates a more powerful relay conected with a magnetic device whereby the control valves of the steam cylinder, which operates the steam regulator and the brake valve, are prevented from acting to shut off steam and apply the brakes. This control device includes also a weight element, so that the normal tendency is always to prevent the engine from moving or to bring a train to a stand unless the track current is properly received. A failure in any respect, an obstruction on the line, or the absence of the track current for any reason, therefore, tends to bring the train to a stand, or will prevent it moving should conditions not be right therefor.

In practice, the track current is controlled by track circuit—or rail contacts, as in "lock and block," can be used—and this is associated with a system of route sections. These are arranged according to the lay-out of the station or portion of line concerned, and, before a train is permitted to move, it is necessary for the signalman to "test" for track clearance by moving a switch for each section. Unusually these switches would be associated with the signal and point levers, or there may be one for each traffic route, so that unless the track circuits or rail contacts indicate a clear road, with allowances for the possibility of fouling vehicles and the usual overlaps, the control circuit cannot be established. Usually this is a simple matter of direct-current track circuit, and if this responds on the basis of a clear route the alternating current tract current is placed on the rails and the engine is free to move as desired. If for any reason the track circuit shows track occupancy, or a rail breaks or a bond gives, it is, of course, impossible for the track current to be switched on. Similarly, should an obstruction occur after a train has started, or another train enters a conflicting section, the track circuit acts to break down the track current, thereby bringing the train to a stand.

The apparatus is of a simple character, and the slow periodicity of the track current removes almost every possibility of interference from extraneous sources, or from power circuits on adjacent conductor rails or overhead wires, or from return or signaling currents on the running rails. As mentioned, a whistle gives the driver warning that he is to pull up, and steam is not shut off and the brakes applied unless he fails to respond. When the section clears, after a stop, a bell rings as an indication that the driver may proceed.

Although the system can be applied in connection with existing signals, it is contended that signals can be dispensed with, and trains may run safely at normal speeds even in dense fog, while Mr. Angus has associated with his system several special developments, including a speed control element, whereby (1) trains are protected against derailment at curves, an indication being given automatically on the engine when the train is at a safe distance from a curve, indicating the degree of the curvature ahead of the train, the safe limit of speed at which the curve may be passed by the train; (2) as the train approaches points or switches, an indication is given on the train as to whether or not the points are safe to cross, in the latter case the driver can then telephone from the locomotive to the signal box and call attention; and (3) a number of classes of accident can be prevented in the following situations: (a) deformation of road due to spreading, sudden heat or other causes; (b) enginemen travelling too fast around curves; (c) signalmen's errors; (d) buffer stop collisions, this system being a positive continuous one so far as the movement of trains is concerned; (e) certain obstructions on railways; (f) broken rails; (g) errors of drivers after they have passed the distant signal; (h) failure of the apparatus installed: (i) failures of the automatic brake apparatus, and (j) certain other causes.

It is reported that arrangements are being made for installing the "Angus" automatic safety system on several railways as soon as the Board of Trade has investigated the details.

Better Situation as to Bad Order Cars

On the 1st of September there were 8,890 fewer freight cars requiring heavy repairs than there were at the beginning of the strike of the shopcrafts on July 1, according to reports filed with the Car Service Division of the American Railway Association.

On September 1 there were 5,981 more cars requiring minor repairs than at the beginning of the strike, making a net decrease in the number of cars needing both classes of repairs since July 1 of 2,909.

Comparing the situation on September 1, 1922, with that of August 1, 1922, a decrease in the number of cars needing light or heavy repairs of 23,339 is reported. Of this 23,339 cars, 15,292 were cars requiring heavy repairs, and 8,407 cars requiring light repairs.

Comparing the situation on September 1, 1922, with September 1, 1921, an improvement in the bad order car situation is also shown. On September 1 of this year cars requiring heavy repairs were 33,237 fewer than they were on the corresponding day a year ago. There was also a decrease of 19,176 in the number of cars requiring light repairs, as compared with a year ago, a total for both classes of 32,413.

Snap Shots—By the Wanderer

The shop crafts strike has been a rather expensive detail in our national life. Outwardly it has probably hit the improvident among the men themselves the hardest, though even the thriftiest among them cannot help feeling the pinch. All this is easily estimated by simply multiplying the time lost by the daily wage. As for the railroads that is another story. To the lay mind it seems like a problem impossible for solution, because of the many indeterminate factors that enter into it, one of the most elusive of which is the cost of turnover. Oh that turnover! Someone estimated, in connection with a big industrial concern that it cost from $50.00 to $250.00 to change a man. My own experience is to the effect that a man going into a strange shop, no matter how skillful he may be, is of little or no use for the first week, and his wages are almost a total loss. Add to this the cost of teaching him the ways of his new surroundings and fifty dollars is apt to fall a little short of the mark. If now this single man be multiplied by thousands, the total intangible, indeterminable. cost runs up into figures that are staggering in their magnitude.

Once in a while a man is met who appreciates the cost of change and who clings to that which is with "hooks of steel." In discussing this with the president of a large street railway company some time ago, he said: "Yes I know that my mechanical man is not all that is to be desired and I could easily replace him with a much better man. But he knows the road, he knows me and I know him. He has been here for years and there is not a piece of track, a tool or a car that he does not know all about. It would take a new man, who devoted his whole time to it, from five to ten years to acquire this knowledge and meanwhile the road would be paying out good money every day to meet the cost of his ignorance and inexperience here."

"But the change will have to come some time."

"Yes! But when it does M——will have trained his assistants to step into his shoes at a minimum of expense to the company.

And that is just what happened later.

The old-time method of clearing out everybody, that has been followed so much by new executives, was a costly operation and its avoidance is one of the good things to look to.

The lack of interest in the principles of the strike has been driven home to me in the last month as I have wandered to and fro. I have asked in the shops of the A. B. C. as to how they were coming on.

"Fine, we are recruiting at the rate of a couple of hundred a day. Some new hands to be sure, but mostly old and experienced men that have come over from the X. Y. Z. and L. M. N. They didn't want to go to work on their home ground as long as the strike was on, and so they came over here."

Then it happened that my wanderings took me to the shops of the X. Y. Z. where I heard the identical story with the bare transportation of the round initials to meet the local requirements of the case. And somehow this and other little details of individual reluctance to strike that I have mentioned before, leads me to believe that the heart of the men was not in the move that started so quietly on July 1. But then comes the insistent psychological question: "If they did not want to strike, why did they do so? Curiously paradoxical? Was it the thoughtless action of a woman's club that votes affirmatively on everything that is proposed? For sometimes his actions make it difficult to believe in the classification of man as a thinking animal. Or—did he really vote to strike? Who can tell? Who can decide?

There has been a good deal of discussion in the papers of late as to the attitude of the railroads towards the college bred man. In short do they want him? Of course they want him and will do what they can to get and keep him. Of that there is no doubt, they have no use for him and will not have him about. He is worse than useless. Quite contradictory opinion and opinions in perfect consistency, and often emanating from the same source. It depends altogether on the character of "Him." The mere fact that a man has a college diploma is no evidence that he is or ever will be of the slightest use in the world. It merely means that he has completed a certain course of study, and has brains enough to have done that. It does not signify that he has any ability beyond that of a super parrot. Chinese students committed in sing-song rote the writings of Confucius. There were thousands of them, yet very few had the ability, the initiative, to apply their memorizing to the affairs of life.

It cannot be a very difficult thing to go through college, if the mental caliber of a good many graduates whom we all know forms any basis for the drawing of a conclusion. Observation also shows that the nature, the human nature of college students is not so very different from that of other men.

So when we consider all these things, we are driven to the conclusion that the railroader's consistent paradox is based on the fact that he is looking at the man himself and not so much at his education. If the man is all right then the education will accentuate his rightness and increase his desirability. But if the man is of no good, then no amount of education is apt to help put him in the desirable class.

I believe it was Cicero who, in commenting on education said in effect that every possible credit was due to the self-made man for what he had achieved, but if his ability had been supplemented by careful training, how much greater might not his achievements have been.

Therefore, with the right kind of a man to start with, a college education gives him an advantage over the untrained man that it is difficult to estimate. But the right man untrained need have no fear of the wrong man regardless of the elaborateness of the training of the latter.

So that when we come to sift the thing down to a finality it looks like this. The right man educated is most desirable, but this presupposes initiative and that attribute of genius, the capacity for hard unremitting work, and the combination is apt to attract outside capital and lure him away.

With the result that it is not that kind of a college man whom the railroad gets rid of but who shakes the cinders of the railroad from off his feet.

On the other hand the wrong man that is the one of small ability is apt to be given an exaggerated idea of his importance and value by his education and quickly proves his worthlessness and so he is held in incongenial subordinate positions until he leaves or is dropped.

What the railroader wants is a man that will do the work and do it regardless of the hours. If he has a college education and knows how to use his head, that is so much to the good. But the prime requisite is to do the work and do it without being driven to or told.

Harking back to the shop craft strike again. I referred, a month ago, to the reluctance of many of the men to strike. This reluctance has taken the form in many cases of a determination not to be out of a job, and of whipping the devil about the stump in order to hold it. As a good and loyal member of the union, Tom Smith struck and went out with the others on the A. B. C. But, being anxious to work, he straightway lost his identity and drifted out into the world as Sam Jones. Sam Jones, having no affiliations with any union, went over to the X. Y. Z. and got a job like unto his old one, and there he proposes to remain until the storm is over. Then he may go back to the A. B. C. as Tom Smith, or may frankly go to the shop superintendent and continue his career there under his own rightful name. I wonder if the union officials know as to how much of this has been done. What consideration has been given to the moral effect on the men.

The Baltimore & Ohio Baldwin Engine "Dragon"

By J. Snowden Bell

The interesting exhibit of the Baltimore & Ohio Railroad Co., at the World's Columbian Exposition of 1893, at Chicago, included that Company's eight coupled locomotive No. 57, which, as shown, had a "diamond" stack and a cylindrical sand box, with mouldings, of the Mason design of 1857. The name "Dragon" was painted on the cab of this locomotive, and a placard, bearing the following inscription, was attached to the front of the smoke box:

"The first with rocking grate
Philadelphia 1848
Baldwin
Original Engine
After 48 years' service."

Both the name and the placard on this locomotive were incorrect, and in view of the facts that the *actual* engine "Dragon" originated its type on the Baltimore & Ohio Railroad, and that further misstatements regarding it appear in *The World's Railway*, by J. G. Pangborn, at whose instance the above quoted placard, and incorrect name, were doubtless placed on engine No. 57, the truth as to the two locomotives should, as a matter of historical accuracy, be put on record.

The advantage, if not the absolute necessity, of applying the weight of a locomotive available for adhesion, through more than two driving axles, was recognized at a very early date, the first application of such a design being apparently that which was made in locomotives built for the Wylam Colliery Railroad, in England, which are quite well illustrated and described in Wood's *Practical Treatise on Railroads,* published in London, in 1825, Pages 154-157, and Plate IV, and are also shown in *Record of Recent Construction No. 89,* of the Baldwin Locomotive Works. In these locomotives the pistons of vertical cylinders were coupled to a horizontal shaft, which, through spur gears, eight in number, operated the four axles which, through their eight driving wheels, supported the entire weight of the locomotive. The objections to the transmission of operating power through such a system of gearing, in a locomotive, are manifest, and the design of the Wylam locomotives does not appear to have been duplicated. The author, Wood, who was at the time a standard authority, states that the railroad on which the engines travel is too weak to support the weight divided on four wheels, and, therefore, that recourse was obliged to be had to eight wheels. He notes that the use of so many cog wheels "adds much to the complication of the engine, which, of course, increases the friction by the multiplication of cog wheels and other moving parts."

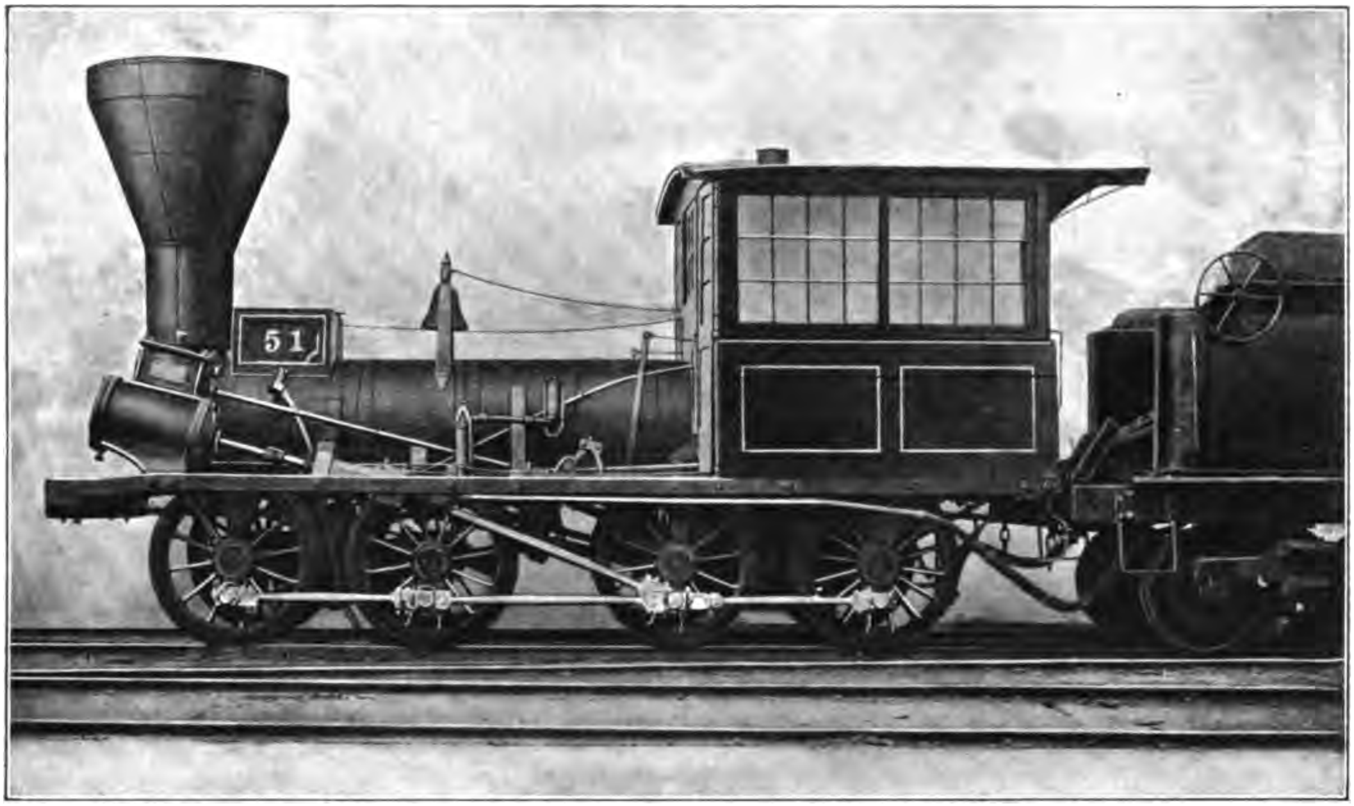


FIG. 1

The next succeeding design of eight coupled locomotive, which was that of Ross Winans, of Baltimore, Md., also failed to provide direct transmission of power from the cylinders to a driving axle, although it reduced the number of gears to two. Twelve locomotives, of the class known as "Mud Diggers," were built by Mr. Winans for the Baltimore & Ohio Railroad between the years 1844 and 1846. These engines had horizontal boilers, cylinders 17 x 24, eight driving wheels, 33 inches in diameter, and weighed 23.5 tons. The main connecting rods were coupled to cranks on a shaft across the frames in the rear of the firebox, and geared, by spur wheels, to the rear axle. The four driving axles carried end cranks, which were coupled by side rods.

The first eight driving wheel locomotives in which the objectionable feature of gearing was eliminated, by coupling the main connecting rods directly to the crank pins of the main driving axle, were designed and built by M. W. Baldwin, seventeen of them having been constructed by him, on a single order, for the Philadelphia & Reading Railroad in 1846. The characteristic feature of these engines was what was known as the "Baldwin flexible beam truck," in which the boxes of the first and second axles were fitted in beams, which were articulated, independently, to the main frame, on opposite sides of the engine, by spherical joints. The wheels of the third axle had flat or "blind" tires, and, by this construction, the engines were enabled to pass around curves of very short radius.

The application of this type of locomotive was inaugurated on the Baltimore & Ohio Railroad, in the engine "Dragon," subsequently numbered "51," which was built by Mr. Baldwin and placed on the road in January, 1848. As shown in Fig. 1, which is reproduced from an excellent photograph taken about 1863, when in yard service at Benwood, Va., this engine was equipped with the Baldwin flexible beam truck; the firebox was between the third and rear axles, and the second and third axles were spaced further apart than is required by the diameter of the driving wheels. The illustration also shows a connecting bar for the left hand starting bar of a drop hook valve gear, and part of the independent cut-off valve gear, the cut-off valves having been removed before the photograph was taken.

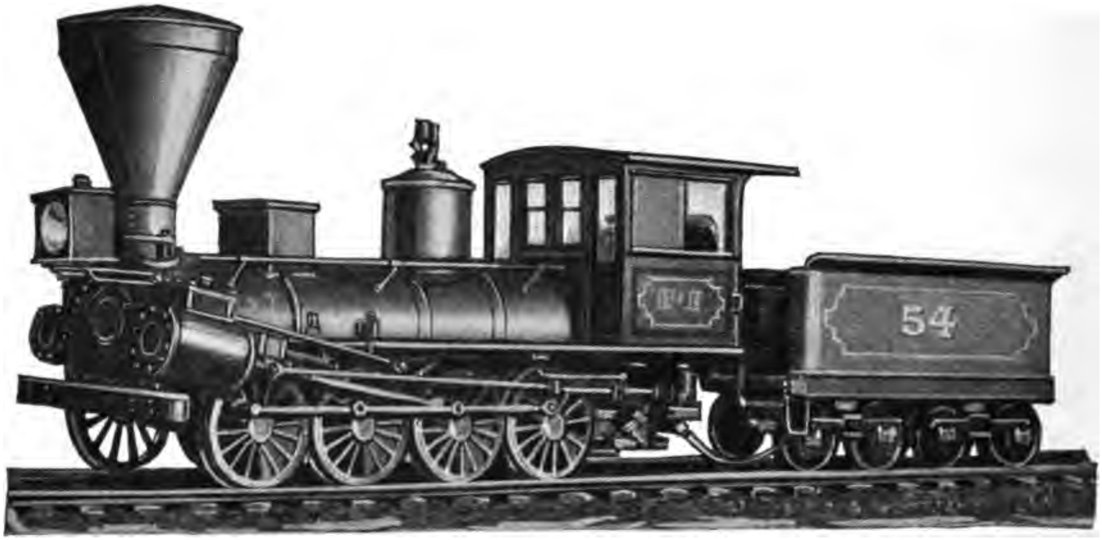


FIG. 2

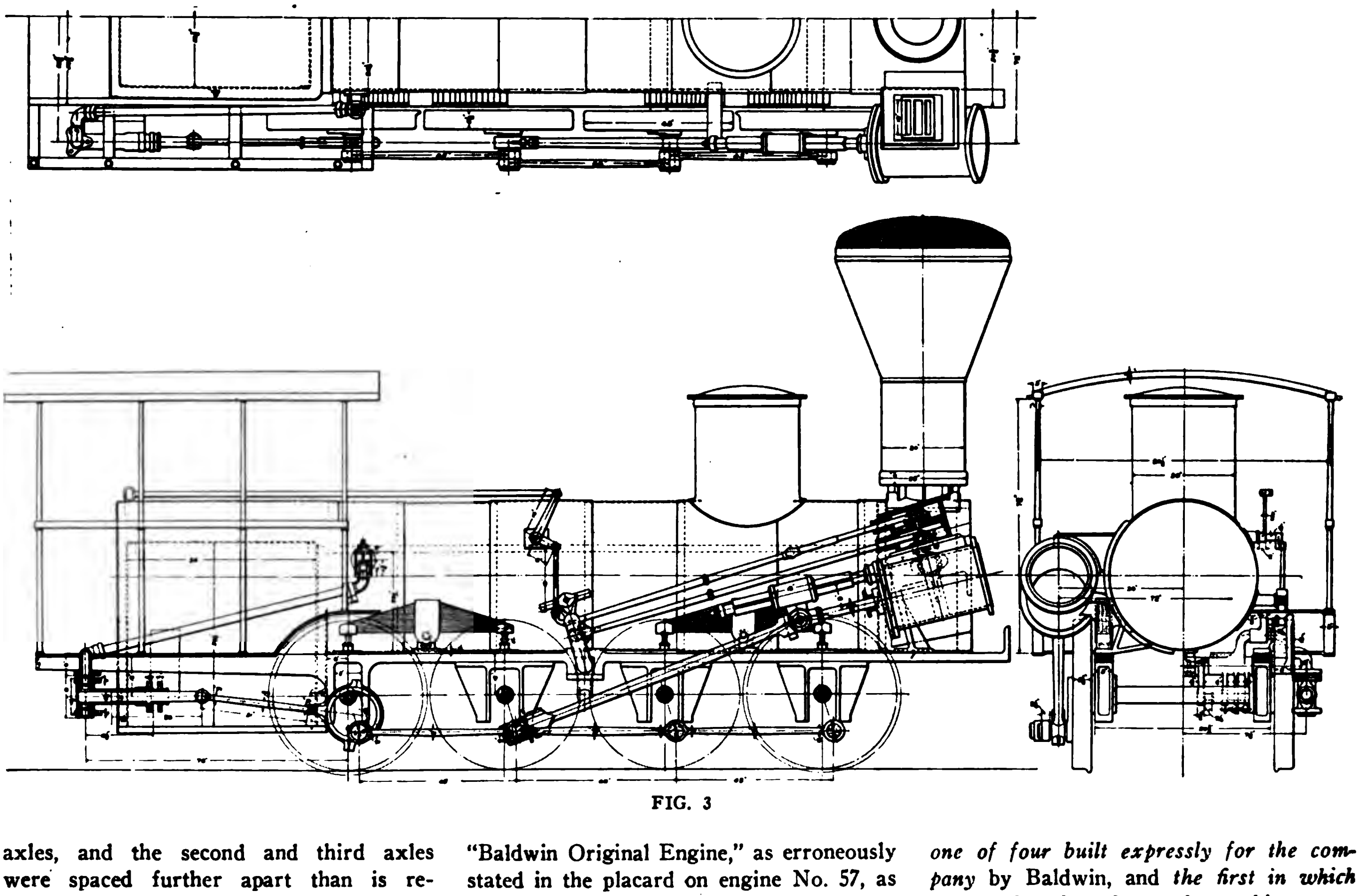


FIG. 3

The cylinders of the "Dragon" were 14½ x 18 inches; driving wheels, 43 inches; 108 tubes in boiler, and the engine weighed 41,000 pounds. The tender was six-wheeled, with a water capacity of 1,200 gallons. This engine was *not* the "Baldwin Original Engine," as erroneously stated in the placard on engine No. 57, as three Baldwin engines, all of the six coupled type and fitted with the Baldwin flexible beam truck, had previously been put in service on the Baltimore & Ohio Railroad, *viz*: the "Baldwin," No. 44; "Wisconisco," No. 50, and "Unicorn," No. 53.

A small, but correct, illustration of the "Dragon" appears on Page 91 of Pangborn's *The World's Railway*, and a short descriptive notice on Page 130, which contains the following statement:

"Another eight-wheel coupled locomotive on the Baltimore & Ohio is the "Dragon," *one of four built expressly for the company* by Baldwin, and *the first in which that maker introduces the rocking grate* * * * the main rod *is bent to clear the second crank pin and stub end*. Valves are worked *by two eccentrics each and a link*."

It would be difficult to present as many errors in the same space as appear in the foregoing statement. As shown by the records, the "Dragon" was *not* "one of four built expressly for the company"; was *not* the first on which that maker introduced the rocking grate; its main rod was *not* "bent to clear the second crank pin and stub end"; and the valves were *not* "worked by two eccentrics each and a link," but by *three* eccentrics on each side and *drop hook* valve gear.

The decided advantage of a direct connected eight driving wheel locomotive, as demonstrated in practical service by the performance of the "Dragon," was too plain to be overlooked by any one of the mechanical skill and ability of Thatcher Perkins, who was, at that time, Master of Machinery of the Baltimore & Ohio Railroad, and a locomotive of this type, the "Hero," No. 54, was designed and built by him, and put in service on the road in May, 1848. The design of this engine differed, however, from that of the "Dragon" in the following particulars. The Baldwin flexible beam truck was not applied; the driving axles were set as closely together as the diameter of the driving wheels permitted, reducing the wheel base to 11 feet 3 inches; the wheels of the second and third axles had blind tires; the boiler was of larger diameter, and its firebox was set behind the rear axle, and independent cut-off valves were not used.

No particulars of this engine have been found of record, other than that the cylinders were 17 x 22 inches and the driving wheels 43 inches. Fig. 2, which is reproduced from an illustration in the *Baltimore and Ohio Magazine,* indicates the general design of Engine No. 54, and is the only representation of it which the writer has been able to develop.

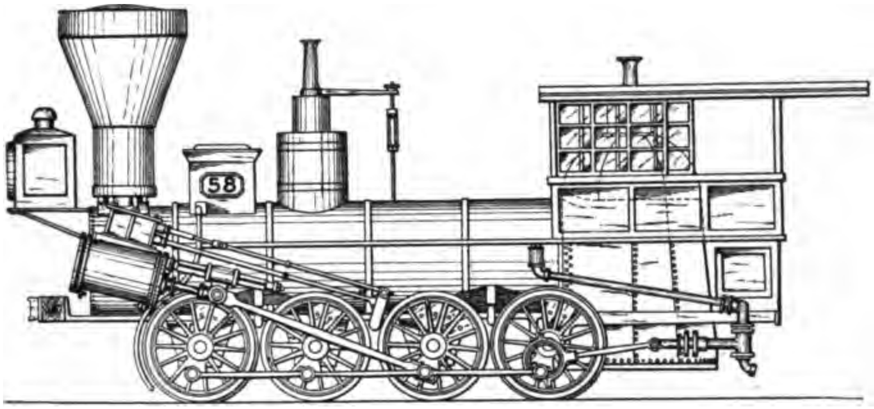
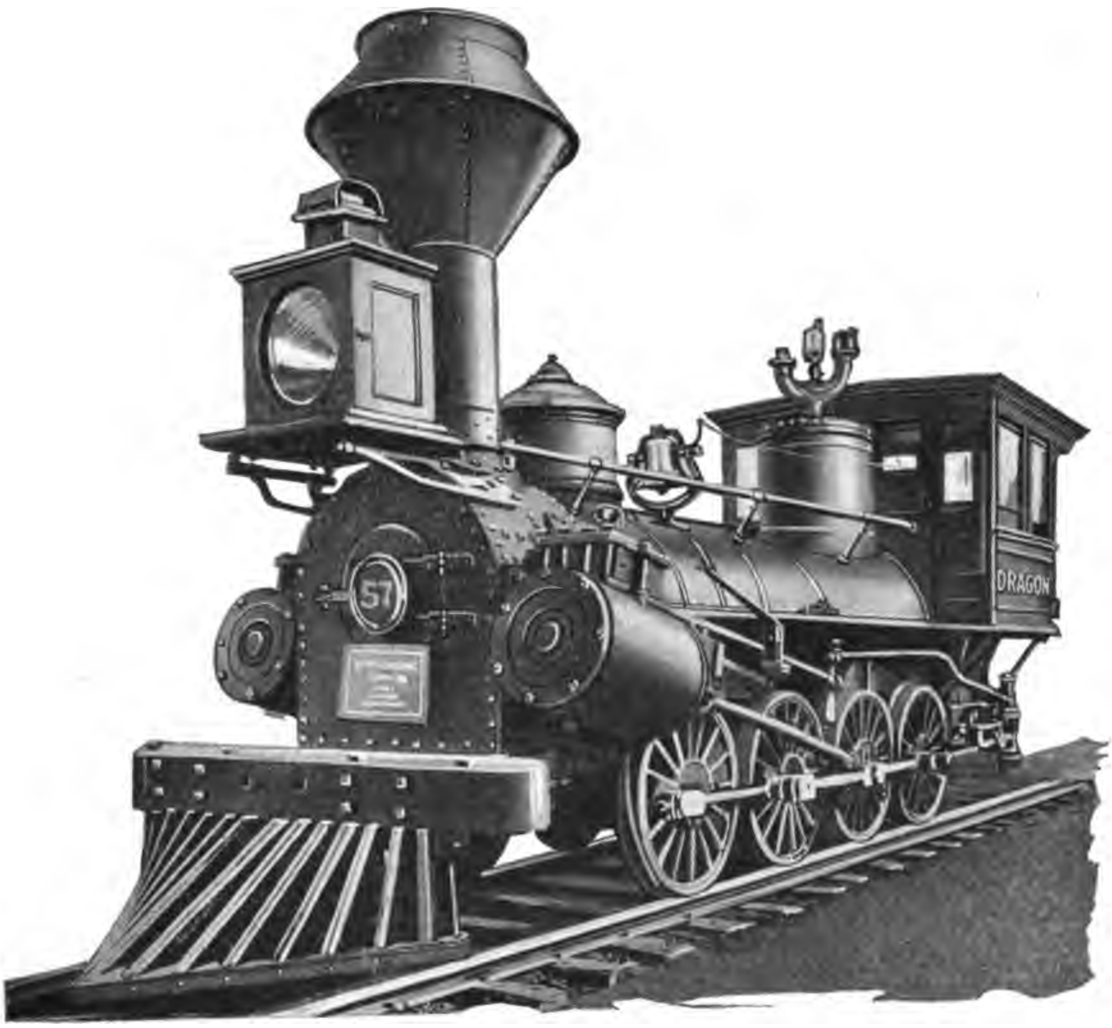


FIG. 4



The Perkins design, being apparently found to be satisfactory by the Baltimore & Ohio management, that company issued an advertisement, dated September 18, 1847, for proposals for building four locomotive engines in conformity with an accompanying specification in 25 sections, in which, among other features, it was provided that the weight should not exceed 20 tons, and to come as near to that limit as possible; the wheel base was not to exceed 11½ feet; the cylinders to be 17 x 22 inches; the number of wheels to be eight; 43 inches in diameter; the four intermediate wheels to be without flanges, thus avoiding the flexible beam truck patent; and the cut-off to be effected by a double valve, worked by separate eccentrics.

Another advertisement, calling for proposals for building five locomotives, with a specification in 27 sections to the same general effect as those of the former one, was published by the company January 14, 1848.

The only drawing having relation to the specifications of the above advertisements which the writer has been able to develop was one (not entitled or dated), which was in one of the cases of the drawing room of the Machinery Department of the Baltimore & Ohio Railroad at Mount Clare shops, in 1863, and thereafter until destroyed, with others, by the order of a superintendent of mo-failed to appreciate their historical value. Fig. 3 is a reduced reproduction of a tracing of this drawing, which was made under the writer's supervision, many years ago. It accords, in all substantial particulars, with the specifications of the advertisements, differing therefrom in not showing the upper and lower fire doors provided for in the first advertisement, and the smoke box having "a capacious bottom to receive the waste coal and cinders carried through the tubes," called for in Section 22 of the second advertisement.

According to the best information which was obtainable, the contract for the five locomotives referred to in the second advertisement was awarded to M. W. Baldwin, but only three were actually built by him. The first which was delivered, having proven too heavy, was returned, and the weight of three more was reduced from about 52,000 pounds to 47,000 pounds, so that they were found acceptable by the company. These were the "Hector," No. 58, placed on the road in October, 1848; the "Cossack," No. 60, December, 1848, and the "Tartar," No. 62, January, 1849.

As shown in Fig. 4, the three Baldwin engines of this lot had their driving boxes fitted in pedestals rigidly secured to the frame; their axles were set to a limited wheel base, as provided in specification 18 of the first advertisement, and the second and third pairs of wheels had "blind" tires. The Baldwin flexible beam truck was consequently not applied; independent cut-off valves were used, and the pumps were worked from eccentrics on the rear axle.

Probably in order to avoid delay in delivery, the two other locomotives, intended to be built by Mr. Baldwin, were let to the New Castle Manufacturing Co. These were the "Saturn," No. 56, placed on the road in June, 1848, and the "Memnon," No. 57, in July, 1848, the latter being that which was in the Chicago exhibit. These engines did not comply strictly with the specifications of the advertisements, as they did not have independent cut-off valves nor a "separate dome on the forepart of the boiler," being, in these particulars, similar to the Perkins' engine No. 54.

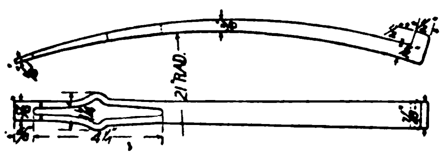
Fig. 5 shows the "Memnon," No. 57, at the Chicago Exposition, and, with the foregoing description, should be sufficient to clearly differentiate this engine from the "Dragon," which name was painted on it. Except as disguised by the later styles of stack and sandbox, the New Castle Manufacturing Co.'s No. 57 will be readily recognized as being of similar design to the earlier Perkins No. 54, but only by the most careless or unskilled observer could it be mistaken for the Baldwin "Dragon," No. 51.

The correction of all the positively erroneous statements, and misleading partially true ones, with which locomotive history abounds, would be a task beyond the capacity of the writer, or, as he believes, of anyone else, but, in this instance, the misrepresentation of the facts happens to be capable of correction from his personal knowledge of them, and being so radical as to matter bearing on the development of a special type of locomotive, seems of sufficient interest, historically, to warrant the foregoing presentation of the actual facts.

A Safety Key for Brakeshoes.

The Buffalo Brake Beam Company, of New York, has brought out a brakeshoe key for the Christie head that has a very simple safety device incorporated in it to prevent its loss as the result of working loose.

As will be seen from the side elevation, the contour is the same as that of an ordinary key. The safety feature consists in cutting a slot starting at a distance of



SAFETY BRAKESHOE KEY

⅝ in. from the point and having a width of ¼ in. and a length of 4¼ in. After punching the sides of the slot are opened to a width of 1¼ in. This spreading comes at a point where the key has been driven through the bottom eye of the brakehead and as it springs out behind the eye, prevents the key from backing out and up under the jar of the truck.

Locomotive Syphon Applications

Recent orders for Thermic Syphons received by the Locomotive Firebox Company to be applied to locomotives now on order for the following roads include: Erie, 30; Nashville, Chattanooga & St. Louis 5; Akron, Canton & Youngstown, 2; Munising, Marquette & Southeastern, 3; Central of Brazil, 1.

Results of Efforts to Save Fuel

The efficient use of fuel on the railroads means an important reduction in the operating expenses. Within the past two years the railroads have been making determined efforts to reduce their fuel consumption, by new devices, enlisting the co-operation of the employes, and competitive campaigns between different divisions of the large roads.

The ten railroads in May, according to the "Railroad Data," having the lowest fuel consumption per 1,000 gross ton miles —that is for each 1,000 gross tons carried one mile—are as follows (the figures represent pounds of coal):

1 Pittsburgh & Lake Erie.......... 89
2 New York, Chicago & St. Louis... 100
3 Michigan Central................ 117
4 Atlantic Coast Line............. 119
5 Chesapeake & Ohio............... 120
6 New York Central................ 121
7 Cleveland, Cincinnati, Chicago & St. Louis....................... 122
8 Pere Marquette.................. 124
9 Southern Pacific................ 126
10 Minnesota, St. Paul, Sault Ste. Marie, Northern Pacific........ 130

Cuba Locomotive and Machine Works

The Cuba Locomotive & Machine Works has been formed by the Baldwin Locomotive Works to handle its repair work in Cuba. Articles of incorporation have been filed in that country for the new company. Cuba has long been a customer of the Baldwin Locomotive Works, especially for plantation engines.

Increased Tractive Power of Locomotive

Locomotives on United States Railways, increased in the seven years ending with 1913, by 23½ per cent and their total tractive power increased 50 per cent. In the seven years ending with 1920 the number of locomotives increased only 2.3 per cent and their tractive power only 23 per cent.

Railroad Purchases Vital to Industry

A recent survey by the Bureau of Railway Economics indicates that the railways of this country purchase and consume 29.8 per cent of the bituminous coal output and 5.9 per cent of the anthracite coal output, or 24.5 per cent of anthracite coal combined. They purchase and consume 11.8 per cent of the total of petroleum. This consumption represents largely fuel oil consumed by oil-burning locomotives. Railway consumption of fuel oil is nearly half the total fuel oil consumption of the country as a whole.

The railroads also purchase and utilize from 30 to 40 per cent of the iron and steel output of the United States, more than 25 per cent of the lumber and timber cut, not less than 20 per cent of the copper and brass output, and varying percentages of the output of other metals, cement, cotton, ballast and other commodities.

Government Ownership in Australia

Government ownership is on the wane in Australia. In August the Australian Government announced it is going out of the shipbuilding business and also out of the business of owning and operating merchant steamers. As for its woolen mills, it has decided that they should be handed over to private enterprise, on the theory that the government should not engage in an undertaking which requires it to go out and solicit trade. In the business of operating ships the Australian Government has encountered exactly the labor troubles that confronted the employers with a few extra thrown in for good measure.

Railroad Equipment Notes

Locomotives

The Tennessee, Alabama & Georgia Ry. has ordered one consolidation type locomotive from the Baldwin Locomotive Works.

The Chicago, Burlington & Quincy contemplates buying 50 locomotives.

The Delaware, Lackawanna & Western has ordered 15 Mikado type locomotives from the American Locomotive Company.

The Lehigh Valley is inquiring for 25 Mikado type locomotives.

The Seaboard Air Line is contemplating the purchase of 15 Pacific type locomotives.

The Atlantic Coast Line has ordered 25 Pacific type locomotives from the Baldwin Locomotive Works.

The Pennsylvania Railroad has placed an order with the Baldwin Locomotive Works for 100 Decapod freight locomotives of the heaviest type ever used by that road. This carrier will also build fifteen locomotives of the same type at its Altoona shops.

The Baltimore & Ohio has placed an order for 50 additional Mikado type locomotives with the Baldwin Locomotive Works.

Mitsui & Co. of New York is reported to be in the market for one side tank locomotive for export to Japan.

The Western Maryland R. R. is reported to have placed an order with the Baldwin Locomotive Works for ten locomotives of the Consolidation type.

The St. Louis-San Francisco is reported to have placed an order with the Baldwin Locomotive Works for 35 locomotives of the heavy Mikado type, and fifteen heavy Mountain type passenger locomotives.

The Duluth & Iron Range R. R. is in the market for eight locomotives of the Mikado type.

The Virginian Railway is reported to be in the market for several locomotives of the Mallet type.

The Denver & Rio Grande Western R. R. is reported to have purchased ten of the heavy freight locomotives.

The Louisville & Nashville has ordered 42 Mikado type locomotives from the American Locomotive Company. These locomotives will have 27 in. by 32 in. cylinders and a total weight in working order of 320,000 lb. This road ordered also 8 Mikado type locomotive from the Baldwin Locomotive Works.

The Norfolk & Western has ordered through Gibbs & Hill, New York City, from the American Locomotive Company, 4 double-unit electric locomotives. These locomotives will have a total weight in working order of 750,000 lb.

The Chicago, Indianapolis & Louisville has ordered 4 Mikado type and 3 Pacific

comotive Company. The Mikado type will have 23 in. by 28 in. cylinders and a total weight in working order of 294,000 lb., and the Pacific type will have 28 in. by 30 in. cylinders and a total weight in working order of 237,000 lb.

The Chicago, Rock Island & Pacific is inquiring for 10, 2-10-2 type locomotives, and contemplates buying 30 Mikado type and 10 Mountain type locomotives.

The Northern Pacific is contemplating the purchase of a large number of locomotives, the number of which is still undetermined.

The Missouri Pacific has ordered 4 Mountain type locomotives from the American Locomotive Company.

The New York Central R. R. is reported to have placed an order with the Rome Locomotive & Machine Works for repairs to 50 locomotives.

McKelvey Brothers of Hollidaysburg, Pa., are reported to have ordered a 50-ton Shay locomotive from the Lima Locomotive Works.

The Norfolk & Western Ry. has placed an order with the American Locomotive Co. for 30 Mallet type locomotives.

The Texas & Pacific Ry. is reported to have placed an order with the American Locomotive Co. for eight locomotives of the Pacific type and eight switchers.

The Northern Pacific Ry. is said to be considering the purchase of a number of locomotives.

The Tavares & Gulf has ordered two Prairie type locomotives from the American Locomotive Company. These locomotives will have 16 in by 24 in cylinders and a total weight in working order of 110,000 lb.

The Nashville, Chattanooga & St. Louis R. R. is reported to have placed an order with the Baldwin Locomotive Works for seven locomotives of the Mikado type.

The Atchison, Topeka & Santa Fe Ry. is reported to be considering the purchase of 100 locomotives.

The Chicago, Rock Island & Pacific Ry. is in the market for ten locomotives of the Santa Fe type, and is also considering the purchase of ten Mountain type and thirty Mikado type locomotives.

The Chesapeake & Ohio Ry., mentioned in last week's issue as being in the market for 50 compound Mallet type locomotives, has ordered this equipment from the American Locomotive Co., and is inquiring for 2 Mountain and 6 Pacific type locomotives.

The New York, New Haven & Hartford R. R. is reported to be inquiring for 10 Mountain type locomotives.

The New York Central R. R. has placed an order with the American Locomotive Co. for 50 Pacific type and 40 Mikado type locomotives.

The Great Northern is contemplating a

Freight Cars

The Baltimore & Ohio is inquiring for 1,000 steel hopper cars of 55 tons capacity.

The Bangor & Aroostock is reported to have placed an order with the American Car and Foundry Co. for the repair of 300 freight cars.

The Belt Railway of Chicago is inquiring for 150 hopper cars of 55 tons capacity.

The Tennessee, Alabama & Georgia is inquiring for 25 gondola cars of 50 tons capacity, and 25 box cars of 40 tons capacity.

The Canadian Pacific has ordered 250 refrigerator cars from the National Steel Car Corporation.

The Jacob Dold Packing Company, Buffalo, N. Y., will build 35 refrigerator cars in its own shops.

The Wilcox Company, Chicago, Ill., has ordered 50 hopper cars from the Western Steel Car & Foundry Company.

The Philadelphia & Reading has ordered 100 refrigerator cars from the American Car & Foundry Company.

The Texas Company has ordered five tank cars of 500 gallons capacity from the Pennsylvania Tank Car Company.

The Warner Sugar Refining Company, New York, has ordered from the Miranda Sugar Company, 150 cane cars of 30 tons capacity from the Magor Car Corporation.

The Chesapeake & Ohio has ordered 50 refrigerator cars of 40 tons capacity from the American Car & Foundry Company which will be built at the company's Berwick, Pa., plant.

The Atlantic Coast Line R. R. is making inquiry for 2,000 40-ton box cars.

The Manati Sugar Company, New York, has ordered 50 cane cars from the Magor Car Corporation.

The Chicago, Indianapolis & Louisville has ordered 300 composite gondola cars of 50 tons capacity from the Pullman Company.

The Mathieson Alkali Works, N. Y., has ordered from the General American Tank Car Corporation, 20 tank cars of 15 tons capacity for carrying liquid chlorine.

The Texas & Pacific has placed an order with the American Car & Foundry Company for 150 10,000-gal. tank cars of 50 tons capacity.

The Czarnikow Rionda Company, New York City, N. Y., has ordered 40 cane cars of 30 tons capacity from the Magor Car Corporation.

The St. Louis-San Francisco Ry. has placed an order with the American Car & Foundry Co., for 1,000 55-ton hopper car bodies.

The West Virginia Pulp & Paper Co., has placed an order with the Western Steel Car & Foundry Co., for ten box cars.

The Western Pacific R. R. is reported

The Elgin, Joliet & Eastern Ry. is said to be in the market for 200 steel gondola cars of 500 tons capacity.

The Northern Pacific Ry. is reported to have placed an order with the Western Steel Car & Foundry Co. for 1,000 steel center constructions.

The Union Pacific is inquiring for 50 caboose cars.

The Western Pacific is inquiring for 100 gondola cars.

The Atlantic Coast Line is inquiring for 2,000 box cars of 40 tons capacity.

The Wabash is inquiring for repairs to 300 stock cars, 250 automobile cars and 500 box cars.

The Bethlehem Chile Iron Mines Company is now inquiring for 20 50-tons special hopper ore cars.

The Chile Exploration Company, New York City, is inquiring for from 20 to 25 hopper bottom dumping ore cars for export. These cars are to have a capacity of 50 tons.

The Pacific Electric reported as inquiring for 200 dump cars of 50 tons capacity has ordered same from the American Car & Foundry Co.

The St. Louis-San Francisco Ry. has placed orders as follows: 500 hopper cars to the Pullman Co., 1,000 hopper cars to the Chickasaw Shipbuilding & Car Co., 1,500 box cars to the American Car & Foundry Co., and 300 stock cars to the Mt. Vernon Car Manufacturing Co.

The Pittsburgh Shawmut & Northern R. R. is in the market for 200 stock cars of 30 tons capacity, and 50 box cars of 40 tons capacity.

The Schenectady Varnish Company, Schenectady, N. Y., has ordered one tank car of 8,000 gallons capacity from the Standard Tank Car Company.

The Central of Georgia has ordered 100 cars of 40 tons capacity from the Virginia Bridge & Iron Company.

The Cincinnati, Indianapolis & Western is inquiring for from 200 to 300 high side gondola cars of 50 tons capacity.

The American Oil Company, Baltimore, Md., has ordered 5 tank cars of 10,000 gallons capacity from the Standard Tank Car Company.

The Phillips Petroleum Company, Bartlesville, Okla., has ordered 75 insulated tank cars of 8,000 gallons capacity from the Standard Tank Car Company.

The Atchison, Topeka & Santa Fe Ry. has issued inquiries for 50 caboose cars.

The Great Northern is inquiring for 100 tank cars, new or second of 12,000 gallons or less capacity for carrying fuel oil. The company is also considering the question of leasing 100 tank cars.

The Central of Georgia Ry. is reported to have placed an order with the Virginia Bridge & Iron Co., for one hundred flat cars of 40 tons capacity.

The New York, New Haven & Hartford R. R. has placed an order with the Keith Car & Manufacturing Co. for six caboose cars.

The Illinois Central R. R. has placed an order with the American Car and Foundry Co., for 75 caboose cars.

Chicago & North Western is inquiring for 800 gondola cars and 200 flat cars.

The Grank Trunk is inquiring for 2,000 automobile cars, 4,000 box cars and 700 refrigerators.

The New York Central is having general repairs made to 200 stock cars at the shops of the Streator Car Company.

The Grey Steel Products Company, New York, has ordered 2 steel hopper cars of 55 tons capacity from the Pressed Steel Car Company.

The General Petroleum Corporation, Los Angeles, Calif., has ordered three insulated tank cars of 10,000 gallons capacity from the Pennsylvania Tank Car Company.

The Grand Trunk has ordered 250 refrigerator cars from the American Car and Foundry Company.

The Maine Central is inquiring for 350 single sheathed box cars, 150 rack cars and 10 produce cars all to be of 40 tons capacity and 50 general service cars of 30 tons capacity.

Passenger Cars

The National Railways of Mexico have ordered 5 first-class and 10 second-class narrow gage passenger coaches from the Pullman Co.

The United States Bureau of Mines has ordered 2 rescue cars from the American Car & Foundry Company.

The Long Island contemplates inquiring soon for 90 steel passenger coaches, 80 of the cars are for electric service and 10 for steam engine.

The Chicago Elevated Railways contemplate the purchase of 100 steel passenger coaches.

The Chicago, Indianapolis & Louisville has placed an order with the Pullman Company for 4 passenger coaches.

The Chicago & Eastern Illinois is inquiring for 17 70-ft. steel baggage cars.

The Graysonia, Nashville & Ashdown, successor in part to the Memphis, Dallas & Gulf, contemplates the purchase of passenger, express and baggage motor car equipment.

The Atlantic Coast Line has ordered 25 steel express cars and 25 steel coaches from the Bethlehem Shipbuilding Corporation.

The Chicago & Eastern Illinois Ry., are in the market for 17 baggage cars from the Pullman Company.

The Mexican Government Postal Service is in the market for 30 40-ft. mail cars.

The Tennessee Central Ry. has placed an order with the Bethlehem Shipbuilding Corporation for 3 combination mail and baggage cars, 3 combination coaches, and 3 steel coaches.

The Atchison, Topeka & Santa Fe Ry. is reported to have placed an order with the Pullman Company for 8 library cars.

New Shop and Other Buildings

The Illinois Central has awarded contracts for the construction of water treating plants at Matteson, Galena, Amboy, Ill., Fort Dodge and Council Bluffs, Ia., to Joseph E. Nelson & Sons Chicago. Contracts have also been awarded to the Railroad Water & Coal Handling Company, Chicago, for the construction of water treating plants at Wall Lake, Logan, Rockwell City and Denison, Ia. This company has also awarded a contract for the rebuilding of twelve water treating plants to the International Filter Company, Chicago.

The Missouri Pacific is asking for bids for the construction of a car repair shop at Kansas City, Mo.

The Atchison, Topeka & Santa Fe has awarded a contract for a new repair shop at Waynoka, Okla., to E. Ware, El Paso, Tex.

The Lake Superior & Ishpeming will construct a steel repair shop, a paint and coach shop and a woodmill at Marquette, Mich. It is estimated that the cost of these improvements will be $250,000.

The Chicago, Burlington & Quincy R. R. is to have awarded a contract to the Stearns-Rogers Co. of Denver, Colo., for the construction of shop improvements.

The Pennsylvania Railroad is reported to be planning the construction of a new shop at Enola, Pa., for the repair of car wheels. This company is also said to have plans under way for the construction of five or more new engine houses with repair shops on sites to be selected in the state of Pennsylvania.

The Minneapolis, St. Paul & Sault Ste. Marie has awarded a contract to Smith & Vandanaker, St. Paul, Minn., for the construction of a 20-stall roundhouse at Gladstone, Mich.

The Norwalk Iron Works Company, South Norwalk, Conn., has been consolidated with the Automatic Carbonic Machine Company of Peoria, Ill. The plant and equipment of the latter company has been moved to South Norwalk.

The Pennsylvania has awarded a contract to Meredith & McVaugh, Detroit, for the paving of the driveways of the Summit street yard. The principal engine house, which will serve both passenger and freight locomotives, will be built by the Pere Marquette for the Pennsylvania at Nineteenth street and will cost approximately $1,000,000, including a turntable, water tank, coaling station and other buildings.

Items of Personal Interest

Bert C. Walling has been made roundhouse foreman of the Rock Island at Pratt, Kan.

G. W. King has been made assistant car foreman of the Rock Island shops at Pratt, Kan.

N. B. Garrett has been appointed master mechanic of the Mobile & Ohio, with headquarters at Tuscaloosa, Ala.

F. Bennett has been appointed assistant locomotive foreman of the Canadian Pacific at London, Ont., Canada.

E. E. Machovec has been appointed mechanical superintendent of the Atchison, Topeka & Santa Fe at Amarillo, Texas.

W. J. McKay has been appointed assistant locomotive foreman of the Canadian Pacific at Chapleau, Ont., Canada.

R. W. Harrison, master mechanic of the Atchison, Topeka & Santa Fe, has been transferred from Chanute to Argentine, Kansas.

Pell W. Foster has been appointed New England district manager of the Power Specialty Company, with headquarters at Boston, Mass.

W. H. Finley, president of the Chicago & Northwestern Railway, has also been elected president of the Chicago, St. Paul, Minneapolis & Omaha Railway, a subsidiary of the Chicago & Northwestern. Mr. Finley succeeds James T. Clark, who died September 8.

Robert Collett has been appointed superintendent of fuel and locomotive performance of the New York Central Railroad, with headquarters at New York. Mr. Collett will have charge of fuel conservation and inspection and such other duties as may be assigned to him in connection with locomotive performance.

George Kefer has been appointed purchasing agent of the Long Island, with headquarters at Jamaica, Long Island, N. Y. Mr. Kefer entered the employ of the road in 1885 and occupied clerical positions until 1889, when he was made chief clerk to the purchasing, in which capacity he served for 33 years, until his recent promotion.

F. P. Wilson has been appointed erecting shop foreman of the Chicago, Rock Island and Pacific at Harton, Kansas. Other appointments on this road and at this point are: J. K. Norton, master blacksmith; F. Schoenberger, master boiler maker; F. J. Heath, car foreman; William Beddow, locomotive shop foreman; J. J. Kunis, painter foreman; and J. W. Garrison.

H. H. Stephens, mechanical superintendent of the Southern lines of the Western District of the Atchinson, Topeka & Santa Fe, with headquarters at Amarillo, Tex., has been appointed superintendent of shops at Topeka, Kan., to succeed W. B. Deveny, deceased. E. E. Machovec, division master mechanic, with headquarters at Argentine, Kan., has been promoted to mechanical superintendent of the Southern lines of the Western District, with headquarters at Amarillo, Texas, to succeed Mr. Stephens. W. R. Harrison, master mechanic, with headquarters at Chanute, Kan., has been transferred to Argentine, Kan., in place of Mr. Machovec. G. F. Tier, general foreman of Emporia, Kan., has been promoted to master mechanic, with headquarters at Chanute, in place of Mr. Harrison.

A. W. Donop, formerly Pacific Coast District Manager, has been made District Manager Railway Department, U. S. Light & Heat Corporation, with headquarters at 1402-04 Railway Exchange, Chicago, Ill.

A. W DONOP

Mr. Donop has been identified with electric car lighting since its inception, having operated and maintained some of the original head-end equipments on Pullman cars. Later he joined the Pennsylvania Lines' East force when that road established a car-lighting maintenance department. Afterwards, in the order named, he was connected with the Gould Storage Battery Company, the Lehigh Valley Railroad, in charge of car lighting, and in 1907 entered the service of the United States Lighting and Heating Corporation, which later became the U. S. Light & Heat Corporation. As Chief Inspector and Travelling Engineer his duties took him to all parts of the United States and Canada, as well as to Mexico and South America, thus giving Mr. Donop a wide acquaintance throughout the railroad field.

The American Flexible Bolt Company announces a complete reorganization with general offices at Zelienople, Pa. The reorganized company retains the original charter, but has added additional working capital. There is also a complete change in the board of directors. Stephen Robinson, Jr., is now president and in charge of sales; H. T. Frauenheim, vice-president; Charles A. Seley, consulting engineer and district representative at Chicago; J. A. Trainor, Eastern district representative; L. W. Widmeier, Cleveland district representative; W. S. Murrian & Co., Southern District representative; E. F. Boyle, Western District representative; H. G. Doran & Co., Chicago representative; W. F. Heacock, Chicago representative. The plant management will be under the supervision of L. Finegan, formerly shop superintendent, Mount Clare shops, Baltimore & Ohio. The purchasing will be handled by James F. McGann at Zelienople, Pa.

W. S. Rugg, assistant to the vice-president, has been appointed general manager of sales of the Westinghouse Electric & Manufacturing Company. The appointment, which was announced by Vice-President H. D. Shute, takes effect immediately. The position of general sales manager is a new one in the Westinghouse Electric Company and Mr. Rugg's appointment to the post is in recognition of his broad experience in the electrical industry and his capabilities in sales work, in which he has been engaged for many years.

Mr. Rugg was born in Broadhead, Wis., and graduated from Cornell University. He became identified with the Westinghouse Electric & Manufacturing Company in 1892 and three years later was transferred from Pittsburgh to the Chicago office as district office engineer.

In 1901, Mr. Rugg was transferred to the New York office as special sales engineer, and in 1909 was made manager of that office. In 1917, he was transferred to the East Pittsburgh works and made manager of the railway department. Shortly after he became manager of the marine department also. During his administration of the railway department, started when the industry, due to the war, was at its lowest ebb, the most constructive work of the department of any previous period was accomplished. His success in the railway department resulted in his promotion in 1920 to assistant to Vice-President Shute, in charge of sales. His duties in this position gave him special jurisdiction over negotiations and district office personnel and especially fitted him for the general sales managership. Mr. Rugg is a member of the American Institute of Electrical Engineers, the National Electric Light Association, the American Electric Railway Association, the Franklin Institute, the American Association for the Advancement of Science and the Engineers' Club of New York. He resides at the University Club, Pittsburgh.

OBITUARY

Robert Quayle

Robert Quayle formerly general superintendent of motive power and machinery of the Chicago & Northwestern, died at his home in Oak Park, Ill., on September 13. Mr. Quayle retired on April 30, 1922, after 54 years' continuous service with the Chicago & Northwestern. He came to this country from the Isle of Man in 1868 and settled in Chicago. He served his machinist apprenticeship, became a journeyman, and in 1877 was promoted to assistant foreman of the Chicago shops. In 1880 he was given charge of the maintenance of machinery, and continued in this capacity until 1885, when he was appointed master mechanic of all lines in Iowa. Mr. Quayle was made general master mechanic of the Milwaukee, Lake Shore & Western Railway in 1891, this road being absorbed by the Chicago & Northwestern in 1894. While serving in this capacity at Kaukauna, Wis., Mr. Quayle constructed the first locomotive testing plant, and as chairman of the Master Mechanics' Association Locomotive Front End Committee, he and his committee published a report that has been considered a classic in that line of research. In 1894 he was appointed superintendent of motive power and machinery of the Chicago & Northwestern, with headquarters at Chicago. He was made general superintendent of motive power and car departments in 1913, and in 1920 was appointed general superintendent of motive power and machinery.

Frederick W. Cooke

Frederick W. Cooke, who was general manager of the Cooke Locomotive Works until 1914, died on August 30 at his summer home, Quogue, Long Island, at the age of 62. He was a graduate of Stevens Institute. His father, John Cooke, was the founder of the Cooke Locomotive Works, now a part of the American Locomotive Company.

John H. Flagler

John H. Flagler, who organized the National Tube Company and served as its president until it was merged with the United States Steel Corporation, died on September 8 at his country home in Greenwich, Conn.

W. B. Deveny

W. B. Deveny, superintendent of shops of the Atchinson, Topeka & Santa Fe Railway, with headquarters at Topeka, Kan., died August 22 as the result of an automobile accident.

U. S. Safety Appliances Handbook

A new edition of the Safety Appliance Handbook, first published by the Master Carbuilders' Association in 1915, has just been issued by the Mechanical Division of the American Railway Association. It contains the latest amendments and rulings of the United States Safety Appliances for all classes of locomotives and cars. Members and others may secure copies through V. R. Hawthorne, Secretary, Mechanical Division, American Railway Association, 431 South Dearborn street, Chicago, Ill.

Locomotive Injectors

William Sellers & Co., Inc., Philadelphia, Pa., has recently issued a new catalogue of 95 pages, in which is described and illustrated their line of injectors and boiler attachments. The results of high pressure steam tests of a No. 10½, Class N, improved self acting injector, and also injector maintenance and repair hints.

New Flood and Searchlight Catalogue

The Pyle National Company, Chicago, has recently issued supplement 2, of catalogue 101, illustrating and describing a series of flood lights and searchlights adapted to the lighting of yards, loading platforms, locomotive coaling operations and construction work and general roundhouse illumination. The bulletin includes a list of parts for this equipment and presents illustrations to show the application of the lights to various kinds of night work.

New Slack Adjuster Catalogue

Gould Coupler Company, New York, N. Y., and Chicago, Ill., have just issued their second edition catalogue on Gould Universal Automatic Slack Adjusters (Sauvage Patents). This edition contains illustrations and descriptive matter of the different electric railway type slack adjusters manufactured by the company. The steam railroad types are not dealt with in this issue.

Northwestern Roads Exceptionally Busy

Railroads of the Northwestern district, commonly known as the "grain carriers," besides carrying about 20 per cent more grain than last year, are hauling a considerable increase in most other commodities. This is seen in a detailed report of the loadings for the week ending September 16, this year and last, compiled by the American Railway Association. In 1921 these roads loaded 15,742 cars with grain and in 1922, 18,928, an increase of 3,186 cars, or 20 per cent.

There was a large increase in the number of cars loaded with forest products, the figures being in 1921 11,131 cars, compared with 16,049 cars in 1922, or an increase of about 45 per cent. Loadings of ore show an increase of 88 per cent., the figures being 18,376 in 1921 and 34,472 in this year. General merchandise loadings and miscellaneous freight show slight increases, but these are not comparable to the increases in grain, live stock, forest products and ore loadings.

New Type of Sleeper in Western Service

The Atchison, Topeka and Santa Fe Railroad sleeping cars constructed with seven rooms to each car, each room accommodating five persons, will be placed in service. There will be eighteen of the new style cars. Each room will contain a lower and an upper double berth and a day lounge and bed, with full lavatory equipment.

Railway and Locomotive Engineering

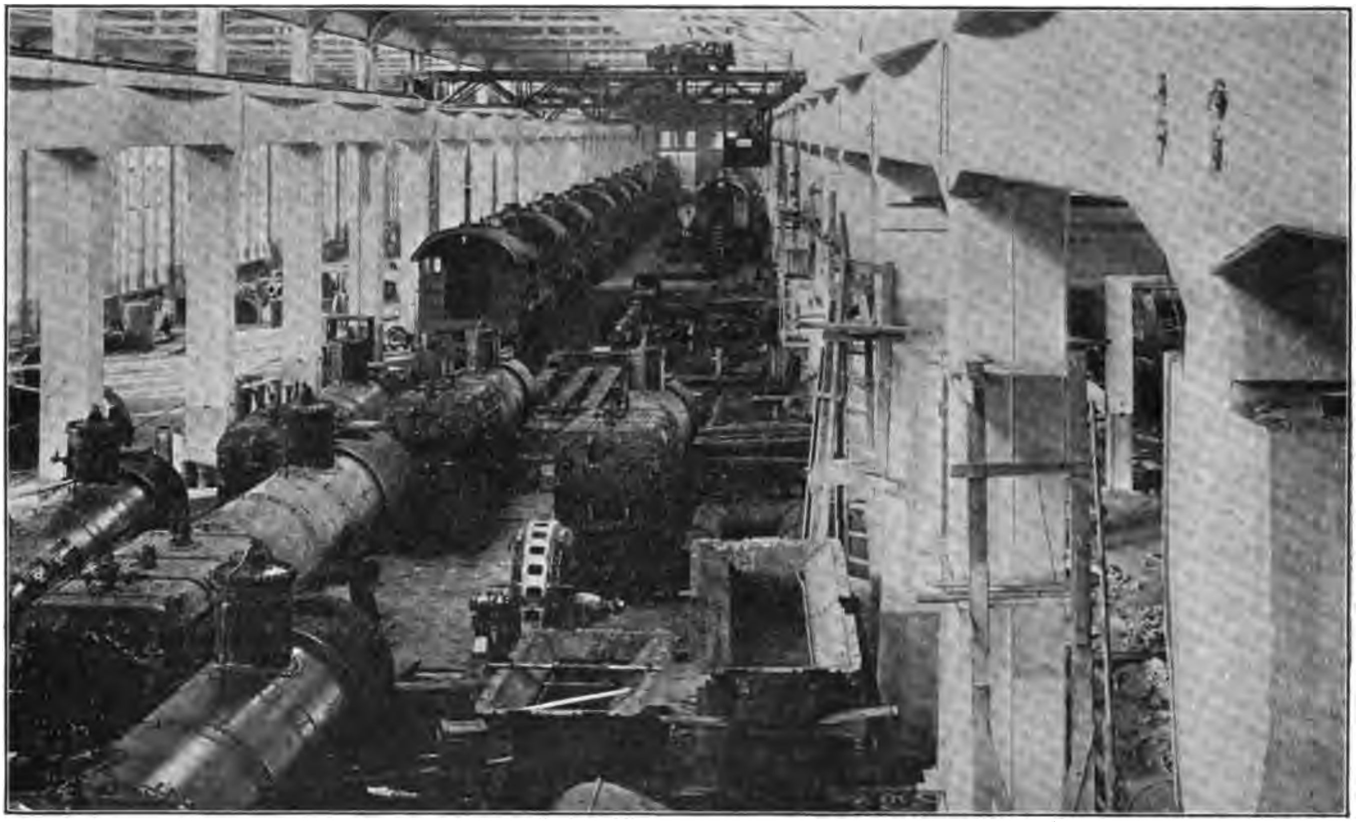
A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXV 114 Liberty Street, New York, November, 1922 No. 11

Where Soviet Locomotives Are Built

Nydquist and Holm Establishment of Sweden to Build 1,000 Locomotives of the 0-10-0 Type

One of Sweden's modern industrial plants, in which the whole country is greatly interested just now, is the Nydquist and Holm establishment at Trollhattan, near the west coast of Sweden. It is here that locomotives are being built for the Russian Soviet Government. When the Soviet Government in 1921 set about trying to rebuild its transportation system, it ordered 1,000 freight engines of the 0-10-0 type, with a service weight of 132 tons from Nydquist and Holm.



LOCOMOTIVE ERECTING SHOP, NYDQUIST & HOLM, TROLLHATTAN, SWEDEN

To execute this order within the stipulated period, four and a half years, the shops had to be extended considerably. In 1921 an engine shop, a forge, an assembling department, and storehouses with a total area of 17,200 square metres were erected. The entire area of the workshops at present amounts to 160,000 square metres, about 30 per cent of which is actually covered by buildings. In addition to extending its workshops, the company has bought 200 working machines, many of them of American make, the intention being to increase the capacity of production from 50 to 250 locomotives a year. For a capacity of 250 engines a year the number of employes is expected to be 3,500 persons, though there are only about 2,500 men employed there at the present time.

The delivery of the Russian locomotives began in August, 1921, and before the close of the year fifty engines of the contracted type had been completed. This year 200 will be delivered, and in 1923, 1924 and 1925 the number will be raised to 250.

The Trollhattan Machine Shop was founded in 1847 by the engineers Nydquist, Holm and Lidström, chiefly for the manufacture of water-turbines, steam engines, threshing mills and other agricultural machinery.

In the '50s the first locomobile was constructed and in 1865 the first locomotive left the shop. The manufacture of locomotives was developed more and more and gradually became the specialty of the workshop. Thus the hundredth locomotive was delivered in 1878, the five hundredth in 1897 and the thousandth in 1912. Besides being delivered to Swedish railways, locomotives have been delivered to Norway, Denmark and Finland.

Besides the construction of locomotives, a large number of pump stations for waterworks, gas engines, with the necessary gas works, tool machines, pneumatic hammers, compressors and also a number of special machines for the manufacture of locomotives, rotating snow-plows and apparatus for impregnating sleepers have been turned out.

During late years the manufacture of turbines has been carried on on a large scale. From 1909 to 1918 have been delivered, inter alia, for the account of the Swedish State to the electric power stations at Trollhattan and Porjus 11 turbines varying between 12,500 and 18,000 h. p. A number of turbines have also been delivered to various power establishments in Norway and Finland.

LOCOMOTIVE SHOPS NYDQUIST & HOLM ERECTED IN 1921

In 1918 the firm was reconstructed into a limited company, and in connection therewith the workshops were considerably extended.

The Nydquist and Holm works are situated on the Trollhattan Canal, seventy kilometres from Gothenburg harbor, and this canal, which was widened in 1916, permits vessels of about 2,500 loading capacity to load at the Nydquist and Holm quay. This quay has been fitted with a special crane of eighty tons lifting power for loading locomotives. The shops get their power from the Swedish Government's water power station at Trollhattan, which develops 165,000 horse power.

Recently the Soviet reduced the number of locomotives ordered from Nydquist and Holm, following some negotiations with regard to payments, which are made in gold. Evidently the diminishing gold supply of Russia is forcing the Soviets to make heavy retrenchments in its plans to rehabilitate the Russian railroad system. It seems to be a question as to which will be finished first, the Swedish locomotives for Russia, or the Russian gold supply. The Swedes hope it will be the former.

Construction of Locomotives in Spain

A recent article in the *Revista Minera, Metalurgica y de Ingenieria* brings up the question of Spain's great need of rolling stock for her railways, especially locomotives, and the desirability of supplying these by the national industries. It is pointed out that the expenditures of the Spanish Railways in traction and material represent more than half of the total cost of the operation of the railroads, the cost of fuel, conducting operation and repairs being especially heavy. It is estimated that about 800 new locomotives are needed, as the majority of the old ones are practically beyond the possibilities of being repaired.

The article regrets that the building of these locomotives will go to foreign manufacturers while the work might be done by Spanish industries if they were equipped with the proper facilities. It then goes on to urge the nationalization of locomotive construction in Spain, not only as of financial advantage to the country, but as a policy of economic independence, for any country with political and economic self-sufficiency should control so essential an element of its economic life as adequate transportation facilities and material.

It is thought that there is some special type of locomotive that is best suited to the Spanish railroads, but as to what it should be only a vague outline is given. A vigorous critism is launched against the locomotive having a weight of 33,000 lbs. per axle and a total of about 4,000 lbs. per lineal foot, and the use of heavier locomotives with 55,000 lbs. on each axle and weighing 6,7000 lbs. per lineal foot is advocated for eventual adoption. But in view of the impossibility of immediate reinforcement of bridges, roadbed and car couplings, it would be best to adopt present types to actual conditions. Present traffic conditions indicate that the best results would be obtained with weights of from 120,000 to 180,000 lbs. on drivers and with a limitation to four coupled axles. In order that the locomotives might draw passenger trains at the rate of approximately 50 miles per hour, they should be bogie-engines, which would give a total weight of about 85 tons with 1,700 h.p.

The fire-box should be as large as possible compatible with the gauge and the ability of the firemen to place the fuel and should be capable of using coal of a medium calorific power; they should develop a superheat of 300°. Under which conditions it would not be necessary to raise the pressure to more than 195 or 225 lbs. per sq. in., and for express trains they should be compounded or with three cylinders with cranks set at 120°.

Finally, it is advocated, as an indispensable factor in the nationalization of the locomotive construction industry, that there be close co-operation between the railways and the constructors and the intervention of the State. It is pointed out that up to the present the railways have not shown any marked tendency towards favoring the nationalization of this industry, probably in the fear that national construction would be more expensive than the foreign product; in addition to which, they have made no effort to standardize.

The Spanish government has no fixed policy in this regard, but it is urged that it should follow the policy of France and compel the railways to buy their equipment and material in Spain, by establishing an agreement with industrial enterprises, with State supervision in the regulation of prices.

International Railway Conference at Berne

Invitations have been addressed by the Federal Council to the States which are members of the International Union for Railway Transportation, as well as to some States which are not members—notably Spain, Esthonia, Finland, Portugal, Czechoslovakia—and to the Saar Commission to meet at Berne on May 1, 1923. This conference, which will discuss various plans of revision, was originally called for the spring of 1915, but owing to the war a postponement was necessary.

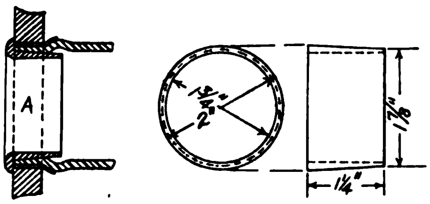
The Federal Council has submitted to the interested governments a number of projects concerning the proposed work of the conference, including revision of the international convention on freight, traffic and amendments to the provisions governing the transportation of passengers and baggage. The States were also requested to inform the Federal Council of any amendments which they desired to propose.

Railway Shop Kinks

Some Special Tools in Use in the Richmond Shops of the Chesapeake & Ohio R. R.

Method of Applying Steel Thimbles to Tubes

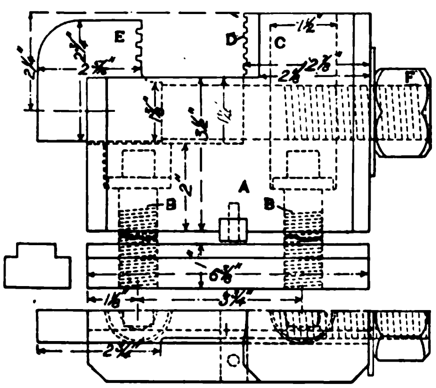
It frequently happens that the threading on the tubes of a locomotive boiler is either burned or worn off before it is time for the engine to be sent to the shop for general repairs. Or it may be that it is worn out while the balance of the tube is in good condition, and if the end could be protected a longer service could be obtained.



STEEL THIMBLE FOR PROTECTING BOILER TUBES

The Chesapeake & Ohio have introduced such a protection which is very simple and easily applied. The face of the tube is faced off flush with the tube sheet and rolled out against the ferrule as shown. The soft steel thimble *A* is then inserted, rolled out against the inside of the tube and beaded over in the ordinary way.

Two sizes of thimbles are in use: One for 2 in. and the other for 2¼ in. tubes. The engraving illustrates and gives the dimensions for the thimble for 2¼ in. tubes. The 2 in. thimble differs in that it is 1 3/16 in. long instead of 1¼ in., and has an outside taper of from 1¾ in. to 1⅝ in. in diameter, instead of from 2 in. to 1⅞ in.



HEAVY DUTY CHUCK FOR BORING MILL

By the use of these thimbles the shopping of the engine for replacement of tubes can be postponed until the body of the tube fails or the time limit has been reached.

Heavy Duty Chuck Jaw for Vertical Boring Mill

The heavy work that it is possible to perform in a 42 in. Bullard vertical boring mill necessitates the use of very strong chuck jaws. A jaw of this description is in use at the Richmond shops of the Chesapeake & Ohio R. R.

It consists of a heavy cast iron base *A* which is held down to a strap fitting in a slot in the table by two ⅞ in. bolts that are set up by a socket wrench. These bolts *B*, *B*, are 3½ in. long over all and are cut with a U. S. standard thread for 1¾ in. The projecting upper portion *C* of the base is faced with the steel jaw *D*, *D*. The outer portion is slotted to take the movable jaw *E*. This jaw has a face similar to *D* and is integral with the 1¼ in. bolt upon which the nut *F* is screwed. This bolt is also cut with the U. S. standard thread.

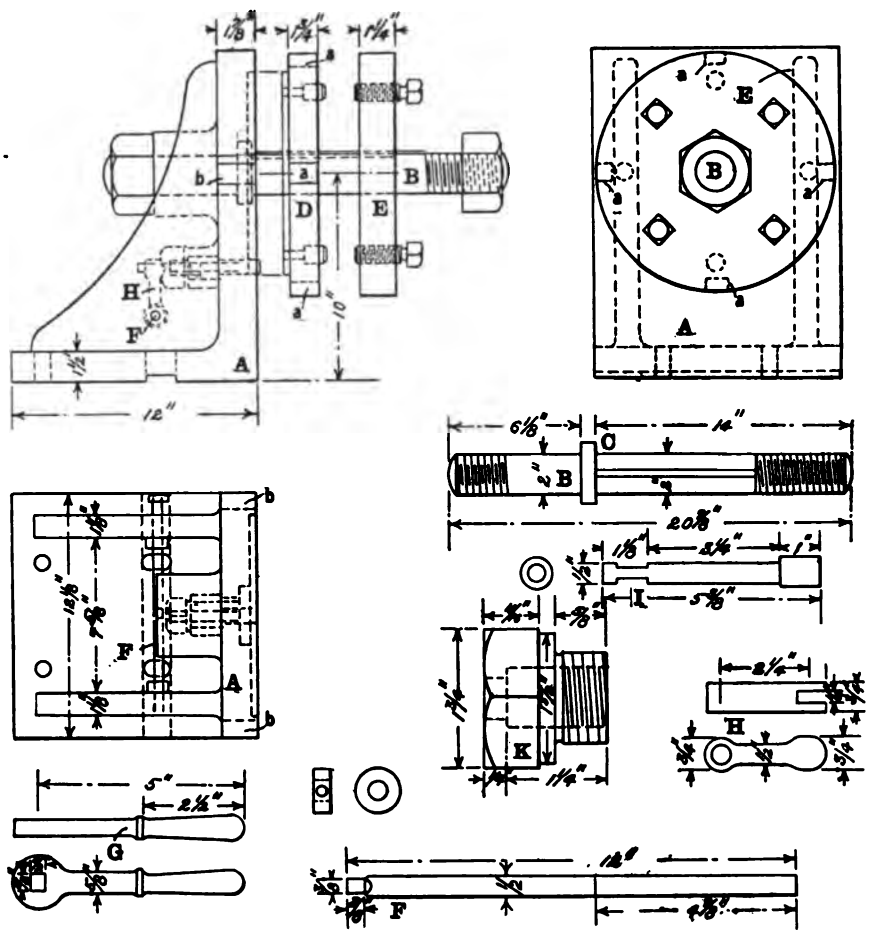
The method of action is readily understood. A slackening of the nut *F* releases and a tightening draws the jaw *E* against the work.

Four of these jaws are usually used for the heavy work for which they are designed. The method of using is to draw the fixed jaw up against the work so as to steady it in the central position, and then fasten it to the table as described. Then the movable jaw is drawn up against it by the nut *F*.

Chuck for Shaping Back End of Main Rod Brasses

This chuck consists of a cast iron bracket *A* which is bolted to the table of the shaper or milling machine on which the work is to be done. This bracket is finished on the bottom and vertical faces and the latter is bored with a counter-bore 10 in. in diameter and ⅜ in. deep as indicated by the dotted lines.

This counter-bore has a second and smaller counter-bore to take the collar *C* of the bolt *B*. The back of the bracket has a boss, as shown, the hole through which serves as a bearing and support for the bolt *B*. This bolt is threaded at each end, and for a distance of 10 in. at the longer end, between the collar and the thread it is fitted with a ⅜ in. by ⅜ in. spline. The bolt may be slipped through the boss and held in position by the nut at the end with its collar *C* bearing against the bottom of the small counter-bore.



CHUCK FOR SHAPING BACK END OF MAIN ROD BRASSES

There are two circular plates *D* and *E* 12 in. in diameter and 1¾ in. thick that have keyways cut to fit over the spline of the bolt *B*. The plate *D* has a projection at the back that sets into the counter-bore of the bracket and at the front carrier form ⅞ in. teats that are dowelled into it and project ⅜ in. from the face. These teats are set on quarters. Opposite these there are four ⅞ in. set screws in the plate *E*. These set screws and teats furnish the bearing points between which the brasses are held.

In addition to the teats in the plate *D* and midway between them there are four ¾ in. holes, which serve to locate and set the plates. At the inside of the bracket there is a spring latch, as indicated by the dotted lines, which engages with the holes in the plate *D*. Some of the details of this latch are given in the engraving. The ½ in. shaft *F* has bearings in the two braces of the brackets and is squared at one end so that it may be turned by the small brass handle *G* which is put upon it. The arm *H* is pinned to the shaft and its jaw straddles the pin shaft *I* at the point *X*.

This pin shaft passes through a hole bored in the small boss in the bracket and is held by a spring, made of 3/32 in. wire and 3½ in. long so that it normally projects slightly beyond the face of the bracket and can engage in the ¾ in. holes in the back face of the plate *D*. The spring has a backing against the shoulder of the large end of the pin *I* and the counter-bore, as indicated by the dotted lines, in the nut *K*.

In addition to the four ¾ in. holes used for setting the plates, there are four ⅞ in. keyways cut in the edge of the plate *D* as indicated at *a a a a*. Corresponding to these there are two ⅞ in. keyways cut at opposite sides of the edge of the bracket *A* as indicated at *b*. For these two suitable square keys, each 3 in. long, are provided.

The method of using the device is as follows:

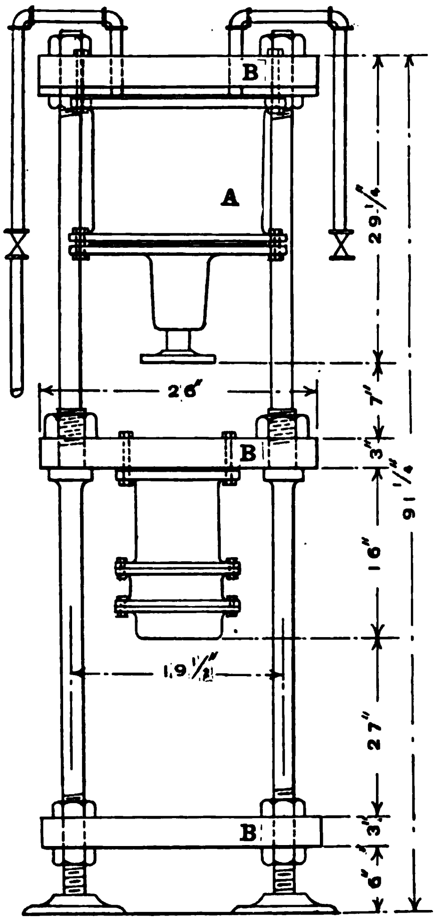
The edges of the brasses are faced off and sweated together. The bolt *B* is slipped into place and the plate *D* put on over it, being pushed home so that the projection of the pin shaft *I* engages in one of the ¾ in. holes. The bolt *B* is then lightly held in place by the nut bearing against the boss of the bracket.

Next the brasses are put over the bolt and the plate *E* brought up against them. The set screws are run in so that all have a bearing when the brasses are set square for the taking of the first cut. The plates are then tightened against the brasses by the nut at the outer end.

In this condition the plate *D* is forced against the collar *C* of the shaft and the two plates, the brasses and bolt are rigidly fastened together, while the whole is held in place by the collar *C* being drawn against the bottom of the small counter-bore in the face of the bracket.

The brasses are thus in place for the taking of the first cut. But before this is done, the two ⅞ in. square keys are shipped into the keyways *a* and *b* and the brasses with the plates and bolts prevented from turning under the stresses imposed by the cut.

When the first cut has been taken, it is necessary to turn the brasses through 90°. This is done by taking the ⅞ in. square keys out and then slackening off on the nut that holds the bolt *B* in place. Then, by turning the shaft *F* the pin shaft is drawn out of engagement with the ¾ in. hole in the plate *D*. This sets the combination of bolt, plates and brasses free so that it can be turned. This is done until the pin *I* engages in the next hole in the plate *D* which squares the brasses for the next cut. The bolt *B* is again tightened; the keys put into place and the work is ready for the next cut. When this is done the process is repeated until all four faces of the brasses have been finished.



VERTICAL GREASE PRESS

Vertical Grease Press

It is a well known necessity or at least a desirability that the grease used in rod cups and elsewhere should be in the form of small cylinders so as to be readily available for use. The oil house of the Chesapeake & Ohio R. R. at Richmond, Va., is possessed of a homemade press that does the work of converting the bulk grease into the shape needed for use.

Again the discarded air brake cylinder comes to the front as a motive power.

In this case the air brake cylinder *A* is 16 in. in diameter with a stroke of 12 in. Other discarded material entering into the construction of the press are three old 36 in. scrap Paige plate wheels, which are used for the plates *B*, *B*, *B*. The cast iron centers of these wheels were faced down to a thickness of 2 in., when the old plates were riveted on and turned to a diameter of 26 in. Then four of the original holes in the plates were reamed to a diameter of 2 in. to take the supporting rods. This with the exception of on the middle platen where they were reamed to a diameter of 2¼ in.

The only work done on the four upright rods was the blacksmithing necessary to put on the collar and upset for the 2¼ in. thread which with the nut holds the center platen in place, and the cutting of the threads at the center and ends. The top and bottom platens are held above and below by nuts and the central one rests on the collars on the rods. At the bottom the rods are screwed into base castings similar to those used in the construction of the 20-ton press illustrated in the October issue of Railway & Locomotive Engineering.

The old air brake cylinder is bolted to the lower side of the upper platen and the push rod of its piston is fitted with a large flat push plate 6½ in. in diameter. The grease cylinder is bolted to the bottom of the central platen in which there is a hole corresponding to the diameter of the cylinder or 6⅝ in.

The head at the lower end of the grease cylinder has a hole of the diameter to which it is desired to form the grease.

The method of operation is to put the bulk grease in the grease cylinder through its upper end. Air is then admitted to the top of the cylinder through the ½ in. air inlet pipe. This, with 90 lbs. air pressure, puts a load of about 18,000 lbs. on the grease, forcing it out through the small hole in the bottom of the lower cylinder. When a charge of grease has been formed, the compressed air is shut off and the valve in the outlet pipe is opened, when the retracting spring inside of the air cylinder will force the piston and its connections into the upper position.

Device for Turning the Ends of Lifting Shafts in a Small Lathe

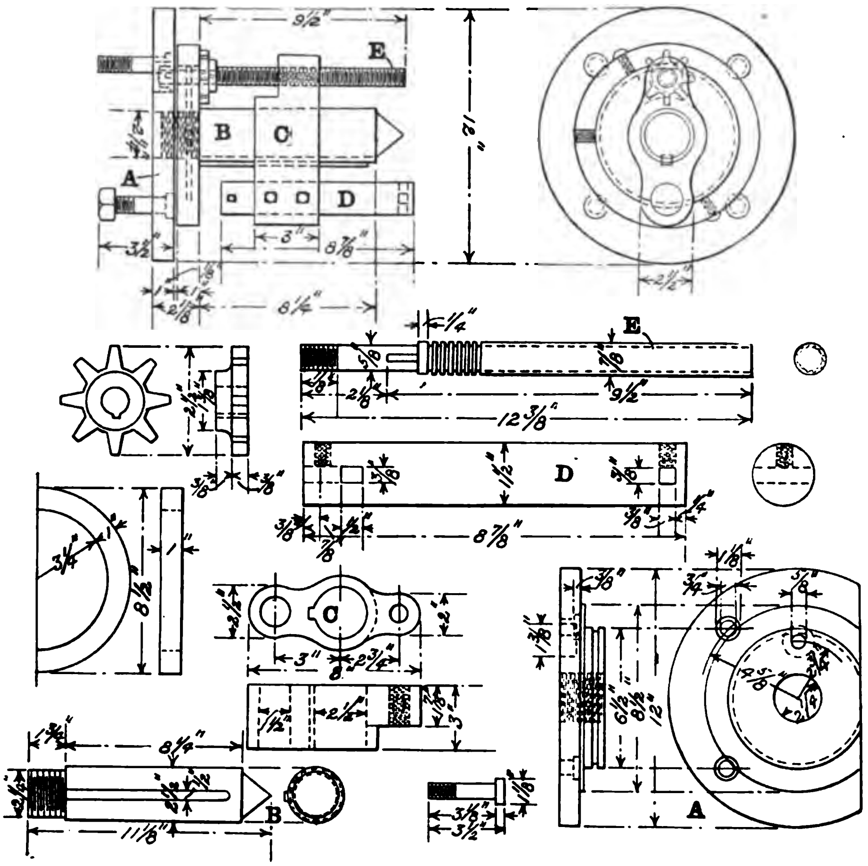
The turning of the bearings at the ends of the lifting shafts for the Stephenson link motion is usually an awkward job. On a lathe large enough to permit the arms to swing, it is usually necessary to give the cutting tool a great deal of overhang. Besides it seems a misapplication of facilities to use a lathe with a swing of from 30 in. to 40 in. to turn bearings 3 in. in diameter.

The device here shown is also in use at the Richmond shops of the Chesapeake & Ohio Railroad, and makes the doing of this job in a small lathe possible by the very simple expedient of revolving the tool about the stationary shaft.

The two illustrations at the top of the engraving represent side and front elevations of the assembled device.

The base of the device is the plate *A* which is centered and bolted to the face plate of the lathe. Into the center of this plate the center *B* is screwed. stock of the lathe with its arms resting against the bed to prevent turning. As the lathe turns the device turns with the spindle and as the rays of the star come in contact with some fixed point, it turns the feed screw and moves the tool post out towards the work and thus carries the cut.

As the whole device is only 12 in. in diameter over all, a lifting shaft with its long arms can have its bearings turned in a lathe having that amount of swing, instead of the lathes generally used.



DEVICE FOR TURNING THE ENDS OF LIFTING SHAFTS IN A SMALL LATHE

This center carries a ½ in. square spline for nearly the whole length of its cylindrical portion. At a distance of 2¾ in. from the center the feed screw is set. This screw is held in place by a nut and can turn in a bearing bored in the plate. It carries a star feed wheel which is keyed to it at the point where the key-way is shown.

The tool post *C* is screwed on the feed screw and slides on to the center *B* over the spline. A round tool holder *D* is set in the opening in the post and is held fast by two set screws, and can be adjusted so as to have any desired overhang so as to reach to the end of the bearing. The tool itself is put in a hole in the end of the holder and is fastened by a set screw. It is here that the adjustment is made for the depth of the cut by moving the tool in or out of the holder.

In operation the lifting shaft is placed

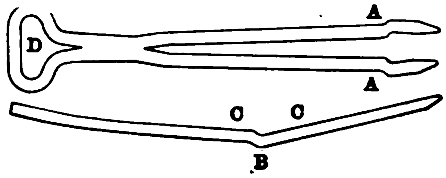
Self-Locking Brakeshoe Key

The self-locking brakeshoe key here shown has been recently brought out by E. Emery, of the Oliver Building, Pittsburgh, Pa. Unlike the ordinary key, which is made of a flat strip, it is made of 3/16 in. by 5/16 in. steel bent to the shape shown in the front elevation.

The two ends are pointed, as shown, so that they readily enter the lugs of the shoe and head. The shoulders at *AA* open out below the lower lug on the brake head, and will thus prevent any tendency of the key to work upward. At the same time the loop *D* at the head of the key makes it possible to draw the key while preventing it from working down when in service.

There is an offset at *B* which allows for the maximum and minimum slot between the brake head and shoe and serves, at the same time, to pull the shoe snugly against the head. It also gives two points for a bearing surface of the key against the

One of its advantages is that it can be easily pried up until the shoulders at *A* are compressed in the slot of the brake head, when it can be removed and be used



SELF-LOCKING BRAKESHOE KEY

again, as it is not subjected to the deformation by hammering that falls to the lot of the ordinary key.

Pennsylvania Describes Employe Representation

In response to many requests for detailed information on the methods jointly adopted by the management and employes of the Pennsylvania System for the peaceful adjustment of all matters in dispute between them the Pennsylvania Railroad has just published a brief exposition of the origin, developments and achievements of the Pennsylvania plan. The policy and practice of the Pennsylvania System in its relations with its employes, according to the pamphlet, may be summarized in one sentence:

"To give all employes an opportunity to have a voice in the management in all matters affecting their wages, working conditions and welfare, and in other matters of mutual concern affecting the welfare of the company and of the public which the company serves."

When the negotiations for the creation of the Pennsylvania plan were first begun General Atterbury, vice-president, said:

"What we want is committees of employes whose orders come from the bottom, from the men at work on this railroad, and are not handed down from the top by some people we know nothing about. We shall be better off by far if we have our agreements and negotiations between ourselves—then we understand them."

Copies of the pamphlet may be had upon request to Room 119, Broad Street Station, Philadelphia.

Piling Up Debts

There are only two ways the railroads can obtain the money for extending and improving their machinery for the public service—either by laying aside a portion of their earnings (if they have any) after paying operating expenses, taxes, interest on funded debt and rentals, or by borrowing the money and distributing the cost over a number of years.

In recent years, they have generally been driven to adopt the latter plan because they have had little left over from earnings, and improvements and extensions are now financed almost entirely from borrowed capital.—Chas. H. Markham, president, Il-

Snap Shots—By the Wanderer

Testimony as Is Testimony

Of course it is preposterous to suspect a dignified state railway commission of being guilty of such a performance as the organization of a frame-up. That may be all very well to lay at the door of a low-order detective or a police bureau that is bound to produce a culprit and convict him to save their face. But a state railway commission, oh, no; never. Perish the thought. And yet.

Of course no member of a railway commission would claim infallibility for himself, however modestly he might disclaim the imputation that he was really so on the part of another. But yet—

Well, of course, the commission may be ignorant. Mind, I say, "may be"; not, "is." Far be it from me to suggest for a moment that a state railway commission does not know all about the job, in fact, all about every case that ever has, is or will be, brought before it. Else, if not knowing in advance, why make up its mind in advance, and why so seldom, if ever, reverse its own decisions and opinions? You see, these are puzzles to a layman. If it isn't a frame-up, then why use the evidence they do and in the way they do? If they are not infallible, why play the part, or try to? If they are not ignorant, why use the witnesses they do? If it is a frame-up, how can they stand the frequent exposure? If they are infallible, what is the use of hearings and trials? If they are ignorant—ah, there's the rub, for there is no positiveness like the positiveness of ignorance, and few there be who can equal the positiveness of the average railroad commission. This may not not be good logic, but it is, at least, a broad-minded charity.

Of course, a moral needs a point, and a substantial fact makes a good one. So here's a point.

A certain railway was attempting to persuade a certain state railroad commission to grant certain privileges. The commission seemed to be playing to the galleries that were filled with the dear public, snuggling up under the protection of the broad-minded commission. So the commission, bent on gallery appaluse, or, as Hamlet says, on splitting "the ears of the groundlings, who, for the most part, are capable of nothing but inexplicable dumb show and noise," and being more than loath to grant the request, hired lawyers and an expert to prove the railroad altogether in the wrong and so protect the D. P.

The expert deposed and solemnly swore that he had practically no training as a mechanical engineer; that he had never made a cricital examination of the wear of rails; that he did not know what the reciprocating parts of a locomotive were; that he knew nothing about the methods pursued in the determination of the counterbalance in the driving wheels; that he had never heard of such a thing as the cold rolling of rails; that he knew nothing about the thrust put upon a rail by the wheel on a curve, and that he never heard of an engine frame.

No, no, no, of course, he didn't testify like that on his direct examination. In that he qualified as an expert and as an expert he proceeded to testify:

That the side rods of a mogul or consolidation engine were made solid from end to end, and that they were the sole and only means of holding the wheels in alignment; that speed had nothing whatever to do with the hammer-blow effect of the counterbalance on the rail; that slow orders were issued where bridges were being repaired or other work done, so as to give the workmen time to get out of the way of an approaching train.

And all this from a man who was put upon the stand by a state railway commission as a mechanical expert to tell the court how locomotives and cars acted upon the track and the interaction of the wheels and rails. He was decidedly hazy on the subject of the counterbalance. In answer to a question: "Isn't there more impact from the driving wheel of the locomotive handling 50 cars than there would be from a locomotive handling one car?" he replied, in his direct examination, "Yes, sir."

Then, later, he said, apropos of the counterbalance: "These is another thing in regard to the speed of the train. The passenger locomotives are, you might say, compensated for a given speed; that is, the compensation bar in the drivers is set up for a good high speed, so that there is rarely a blow delivered unless they are running at a speed in excess of their compensation. The freight engines are compensated for considerably lower speed, and if those freight engines were pushed to the speed of the passenger engines there would be a considerable damage done to the track, owing to the speed; but the speed of your engines, unless it goes very much in excess of the amount for which the engine is compensated, has very little effect upon your track."

His haziness in regard to this and other matters may be seen from the following extracts from his testimony under cross-examination.

Regarding the pressure of the wheel on the rail, he was asked: "And the centrifugal forces increase the lateral"? To which he replied: "Increase the lateral; yes, sir. At the same time we must remember that those rails are compensated for speed, and the outer rail is elevated for a certain speed; the passenger engine is compensated for a certain speed, and it is only when the outer rail is not elevated sufficiently to take up the speed, or cannot be, and when the engine is not compensated for the high speed at which it comes that the speed becomes an element of danger or really of wear.

Again:

Q. In your testimony on direct examination, do I understand you correctly, that an engine hauling one car at a given speed over a track would not do as much damage to the track as the same engine with 50 cars behind?

A. Yes, sir; that is, I suppose you mean in this question, leaving out any effect of the cars themselves on the track back of it.

When asked as to the dynamic effect of a locomotive on the track he replied: "I don't know what you refer to by the dynamic *effort* on the track." Here are some gems in regard to counterbalance that will be new to the mechanical world:

Q. What is the relation between counterbalance and the reciprocating parts?

A. I don't know what you mean by the reciprocating parts.

Q. How did you determine the weight of the counterbalance and how is it determined?

A. I do not know the mechanical process; I simply know the pressure which would be obtained from placing your counterpoise; that is, if you compensate or place your counterpoise for a 40-mile-hour speed, you would place it in a different position than you would if you were compensating for a 30-mile or 60-mile-hour speed.

Q. You mean the engines are counterbalanced for speed?

A. Yes, sir.

The reader will please remember that by "compensation" the witness means counterbalance.

Q. Now, then, given the same weight, same track conditions, how does stress on the track vary or speeds?

A. The difference of the stress in the track would be entirely measured by whether the compensation of the engine was exceeded in the one speed and not in the other, or whether when the engine struck the curve the compensation of the track was made for one speed or for the other speed outside of that, supposing, of course, the track was in good condition and was not humped or hilly, and would throw them, there would be no difference in stress.

Q. You mean that stress, given the same track, given the same engine, given the same weight, wouldn't vary, whether the train was running five miles or fifty miles?

A. It would not vary unless it was running in excess or below its compensation.

Q. What do you mean by "compensation"?

A. I mean that each set of drivers have, as we all know, the connecting rod to the cylinder, and have the connecting rod between the drivers that make a weight which is all on one side of the wheel; in order to compensate that a counterpoise is inserted between the spokes of the wheel of the engine from the other side, so as to impact it and make the wheels move smoothly. Now, owing to the difference between the centers of gravity and your counterpoise balance and of your connecting rods and piston rods, the engine must be compensated for a given speed, for the reason that if that speed is exceeded the distance from the center of revolution will produce a greater strain in regard to the counterpoise weight, it will produce a strain due to the connecting rods, because it is moving at a rate under its compensation. Now, if you exceed your compensation there will be a stress on the track to the extent of that excess. That is what I mean by compensation.

Q. And that is your theory of compensation?

A. There is no question about it; that is what causes the rocking of your engines at high speed and causes a limit to be put to the speed of your engines so as your engines won't stand it.

Q. What is meant by the cold rolling of rails?

A. I don't know; I never heard of it.

Q. You say in your testimony that freight cars run on an inferior quality of wheels as compared with passenger. What do you mean?

A. I mean that the freight wheel is not the same diameter as a passenger wheel, nor is it as good a wheel.

Q. In what way?

A. It is a different wheel, costs less money and is of less good construction.

Q. What is the difference in structure?

A. In dollars?

Q. No; in quality.

A. I don't know.

Q. You are making the statement that the stress on the track would increase as the diameter of the wheel decreases?

A. Yes, sir.

Q. What basis have you for any such statement and, if so, what is the relation?

A. I do not know what the relation is, sir; but the statement is from, you might say, a mental computation, reducing the size of the wheel until the comparison becomes so merged that it can readily be seen; that is, if you would take a six-inch wheel and put it under your freight cars and run your freight cars on that you would readily find that the pressure of your track, the tractive effect, would be marked.

Q. Now, does that same thing apply to the driver on any locomotive engine?

A. No, sir; we are talking about car wheels. There is no blow struck by the wheel of an engine unless there is inequality in it, such as a freight wheel, unless the engine is running out of its counterpoise.

Q. You spoke of the piston rod on the engine. What does it connect with?

A. The drivers.

Q. Is that all?

A. The cylinder, of course, itself.

Q. How does it connect with the drivers?

A. By the connection between drivers.

Q. Well, how?

A. I don't know what you mean; it has to transmit the power from the cylinder.

Q. I am asking you to tell the commission how a piston rod connects with the driving wheel driver, if you know?

A. I don't know; I don't know what method is used in making the connection, whether it is by the stationary pivot on the wheel and it is fastened over that or it is by a bolt or rivet, or how the connection is made; it is there. I did not go into the mechanical devices necessary to make the connection.

Such were the qualifications of a witness that the state put upon the stand to testify as to matters pertaining to locomotives. Was it ignorance or a desire to deceive? I can parallel it with another state witness who was put on the stand to prove that a railroad's valuation of its locomotive was too high when reduced to a cent per pound basis. To do this, he produced a contract in which the price and weight of a certain locomotive was given. It was all right, except that the weights given were in "working order."

This added the weight of coal and water in the tender and water in the boiler, which, by raising the weight, naturally cut down the price per pound. It came pretty near getting through, but didn't.

In language of the street: "And what do you think of that?"

All this pertains to the natural but sometimes irritating phenomenon of the irreversability of state commission decisions. To start with, few men are big enough to acknowledge themselves mistaken. And the few become nearly zero when applied to the genus homo of the species politician. So, when a decision has been rendered and it is questioned and disputed by a railroad company the commission straightway retains a lawyer and hires witnesses to prove to it (the commission) that it is right. Naturally, it believes its own witnesses rather than those of the railroad, and is more impressed with the arguments of its own attorney than by those of the opposing counsel, and so sustains its own decisions. And why shouldn't it? But somehow it does not seem quite right—such a proceeding as that.

Is it fair? Can it be honest? But why should we bother to be fair and honest

Government Ownership in Canada

"Canada has a population of less than 9,000,000 people and our national railways are costing us over $100,000,000 per annum," were the words of Mr. J. L. Payne, former comptroller of statistics in the Canadian Department of Railways.

"Between 1917 and 1920 the volume of business on this state unit increased but 3.9 per cent, yet the number of employes was increased by 60.3 per cent. At the same time it got 35.1 per cent less service per employe. In fact, during the first two years of public ownership there was a decline of 43.3 per cent in efficiency by the ton and passenger mile test, than which no more satisfactory or just could be applied.

"Four things, it might be said, have been established beyond cavil. We have (1) brought on ourselves an economic policy of exceeding gravity; (2) very heavy losses have been incurred; (3) these losses must be met by increased taxation; and (4) no solution of our problem appears to be in sight that would be accepted by our Parliament as at present constituted.

"To make matters worse, the burden is unequally distributed. The West has the railway mileage and Ontario and Quebec pay four-fifths of the taxation. At this juncture it is simply a question of how long the country can stand the losses."

Suspension of Hydrostatic Tests of Tanks of Tank Cars and Safety Valve Tests

Mr. V. R. Hawthorne, secretary of the Mechanical Division of the American Railway Association, has informed the members that upon recommendation from the Committee on Tank Cars, that part of Sections 23 and 24 of the Standard Specifications for Tank Cars, Classes I, II, III and IV, covering the requirements of testing of tanks hydraulically and testing of safety valves, has been suspended as to tanks for which such tests shall become due prior to January 1, 1922, except when such cars are shopped for repairs.

The requirements of Section 23 of each of the Specifications named, that new tanks shall be tested before being put into service, and that tanks damaged to the extent of requiring patching or renewal of one or more sheets, or extensive reriveting or recalking of seams, shall be retested before being returned to service, are not suspended.

The requirements of Section 24 of each of the Specifications named, that safety valves on new cars shall be tested and adjusted before the cars are placed in service, are not suspended.

Later, the committee granted permission to place in service any valves now on hand of that design prior to July 1, 1923. All patterns, however, should be changed at once so that future castings will comply with the requirements as shown in Supplement No. 1 to the Tank Car Specifica-

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The Stability of Locomotives

There is an old saying about the difficulty of deciding when doctors disagree. And there is a case of apparently radical disagreement between practitioners in America and Europe regarding the steadiness, or, as some call it, the stability of locomotives when running at a high speed.

A number of years ago the Pennsylvania Railroad conducted an elaborate series of investigations on the West Jersey & Seashore Railroad over a specially constructed section of track in order to determine the most suitable type of electric locomotive to build for use in the New York terminal. Later, Mr. George L. Fowler made a similar investigation on the Canadian Pacific, though for a different purpose, but obtained results that checked almost exactly with those of the Pennsylvania. The result of the work in both instances was to show that a locomotive with an unsymmetrical wheel base was steadier than one with a symmetrical wheel base. And now comes Col. L. B. Billington, chief mechanical engineer of the London, Brighton & South Coast Railway of England, with a series of tests, from which he has arrived at the conclusion that the engine with the symmetrical wheel base is the steadier.

Perhaps a word of explanation as to what is meant may not be out of place. By a symmetrical wheel base is meant an engine where there are an equal number of truck wheels in front of and following the drivers, as in a 2-8-2 or Mikado locomotive. Whereas, a consolidation, or 2-8-0, locomotive has an unsymmetrical wheel base.

There may be two explanations of this difference of opinion between the American and English investigators. One may be because of the difference in the methods of conducting the investigation and the other because of difference in track construction.

As to the first, both American investigators worked on the track. They measured the intensity of the lateral blow or impact delivered by the locomotive against the rail, this blow being that of the locomotive as a whole and disregarding the blows delivered by individual wheels. The English investigator measured the amplitude of the lateral movement of the engine relatively to the track, the measurements being taken at each end of the machine.

As for speeds, there were no differences between the two except that the English tests were made at or about fifty miles an hour, while the American were made at thirty, forty, fifty and sixty miles an hour, the speed having no effect on the generalization of the results.

The second difference in the general conditions is that of track construction. The English track is laid with the joints of the two rails opposite each other. The American track is laid with the joints staggered.

On certain sections of the Belgian State Railways, where portions are laid in the American way, it has been found that on the European type of track the locomotives of all classes have a tendency to gallop; whereas, on the American laid tracks, with staggered joints, the engines have a tendency to nose.

The difference, then, in the findings of the two sets of investigators may be explained by either one of these differences of conditions; for, under identical conditions identical results must be obtained.

As to the difference in method of approaching the subject the two results may after all check.

The Americans measured the intensity of the lateral blow delivered to the rail. The Englishman measured the amplitude of the lateral motion of the engine. It is quite possible that a movement of the engine that was brought to a sudden stop might deliver a heavier blow to the rail, when measured in pounds of pressure than a swing of greater amplitude brought to a stop more gradually.

The two may be likened to the blow of a hammer on two springs. By one the blow is stopped after a deflection of one inch; by the other, after a deflection of two inches. The energy expended is the same in both cases but the pressure exerted on its support by the spring of long deflection is but half of that of the spring with the short deflection.

Hence, while the English engine with a symmetrical wheel base may have shown a lesser amplitude of vibration than its fellows, it may have followed the example of its American brothers and delivered a heavier blow against the rail.

As to whether the arrangement of the rail joints could have completely reversed matters is another question that can only be answered by a trial on the two kinds of track. That track conditions have a very marked effect on this matter the Americans fully determined, and the action of engines on the Belgian tracks emphasizes the matter. We know that very serious blows may be caused by distortion of track, but as to just what minor differences, such as may occur from tie to tie may produce, we know very little. And can only infer that they have an effect without knowing what it is.

But here we have reliable investigations, flatly contradicting each other in the generalization. One generalization must be wrong when the proposition is reduced to its final terms. It would seem to be well worth while to find out which one is in error.

Accidents

Louis Brandeis created the sensation of his life when, a few years ago, he declared that the railroads could save a million dollars a day by taking care. He may or may not have been right, but it does seem as though a fair percentage of such a saving would be made if everybody would take care.

The Interstate Commerce Commission requires the railroads to file a report of every accident that causes a personal injury or a money loss of $150.00 or more. These reports are analyzed, carded, classified and are used for making up the statistics published by the commission. These published statistics, however carefully studied, can only tell a very small part of the story; for it is only by going over these reports in detail that the investigator can fully—no, not fully—can even partially grasp the full significance of what is going on.

Without going into detailed accuracy as to figures, but merely grouping them roughly into personal and property accidents, it will be found that about one-third are property and two-thirds personal injury accidents. There are, of course, some personal injuries for which the person injured is in no way responsible, but these form such a small percentage of the whole as to be negligible. This is especially true of those killed. If we eliminate those killed as trespassers and in automobiles, that are struck by trains, there are but an insignificant number left.

There are very few roads that do not report automobiles struck by trains every month. And the recklessness and carelessness of the drivers is amazing. They apparently rarely think of stopping, looking and listening. They drive upon the tracks regardless of blowing whistles and ringing bells. They disregard shouts of warning and the frantic gesticulations of crossing watchmen. They drive through lowered crossing gates and even dodge beneath them if there is room. They let their frantic hurry to save a few seconds imperil their own and the lives of their friends. And death takes a goodly tally, besides those that are maimed or temporarily injured.

Now, if so many are caught what would be the record of narrow escapes?

It is gruesome reading that, of the "automobile struck by train" accidents, and leads one to wonder whether the applicant for a chauffeur's license ought not to be subjected to a psychological test to determine his fitness to be entrusted with the lives of his own and his fellow-men. It is to be feared that many would be found wanting. Age, sex nor social condition seems to make no distinction in these reckless incompetents. And so long as almost anyone can secure a license, there will continue these races with express trains and death for the crossing. It may be that the fools are not all dead yet, but the automobile is certainly a great contributing element in the decimation of their numbers.

Then, there are the great mass of minor accidents, sprains and bruises, that are so very largely so, that they may be said to be almost wholly due to personal carelessness.

Humans, by their cultivation and civilization, that so largely eliminated the necessity of being constantly on the guard, seem to have lost, to a great extent, that instinctive watchfulness belonging to the brute. So they fail to "watch their step," with results that send the personal injury cases up into the thousands every month. Perhaps line upon line and precept upon precept may make a change in human thoughtfulness, but man is weak and one is inclined to be pessimistic.

However, without having the actual figures, the impression made, after an examination of thousands of these reports, is that if the reckless chauffeurs and trespassers could be put out of business and all others would "watch their step" and be careful in every respect, ninety per cent of the personal injury cases now reported by the railroads would be wiped away, and the death list would almost vanish.

Now, as to property accidents! Again, what is stated is an impression, not a statement of facts that have been counted. This impression given by the reports is that about sixty per cent of the property accidents are due to carelessness and neglect. Brakes are not set on standing cars; switches are thrown between the before signals are properly understood; riders, in their hurry, do not properly control the cars they are on; flagmen are slow in getting out and back; and there is carelessness in cutting and coupling cars. The result is damage galore and how much that falls below the $150.00 limit or is a chance escape no one knows.

Then there are only the few unavoidable accidents left. Unavoidable because we do not know just how to prevent them. Here are the rails with hidden flaws that break; the wheels with a seam beneath the tread that lose a flange; the triple valve that passes every inspection and test but which gathers to itself some dust, and becomes a dynamiter upon the road, or axles that are breaking by a progressive fracture that cannot be detected. These are the things that go to make up the unavoidable accidents; unavoidable as yet. And their cost is great. A defective triple, a sticking brake, an overheated wheel that bursts, a derailed train, may send the damage costs well up into the five figure zone. These are things that we have to face daily and hourly, and which promise to be ever present for some time to come.

But after all, the lesson taught by these reports, is one of the necessity for care. Care here, there, everywhere. Care of the person, of material, of the mind. The "safety first" that has been shouted from the housetops, the folders and the bulletin boards is no altruistic propaganda. It is, in a final analysis, a simple cold-blooded business proposition for the saving of property, the avoidance of damage claims and the conservation of human energy, and as such it should be preached more loudly and with more vigor than ever before. For before it lies the possibility of eliminating, probably, ninety per cent of all the railroad accidents that are now reported to the Interstate Commerce Commission, and the time taken to make them out and the space required to store them could be more profitably employed in other ways.

Morale and the Men Above

Much has been written and more said of the good old days when men took more pride in the railroad that they worked for than they seem to do at present. And then there is an old adage of "like master like man" that sifts the characteristics of the general manager down through all intermediate steps to the office boy.

Both of these points are brought to the fore in a few paragraphs of Edward Hungerford's Story of the Rome, Watertown and Ogdensburgh Railroad, and this is the way he puts it:

"The days of the final decade of the Rome, Watertown & Ogdensburgh were, most of them however, good days, indeed. Fondly do the men of that era, getting, alas, fewer each year, speak of the time when the Rome road had its corporate a corporate personality. For the R. W. & O. did have in those last days those elusive qualities, that even the so-called inanimate corporation can sometimes have —a heart and a soul. Yet, in every case, attributes such as these must come from above, from the men in real charge of the property. The courtesy of the ticket agent, the friendliness of the conductor are the reflection of the courtesy and the friendliness of the men above him. It is enough to say that H. M. Britton was at all times both courteous and friendly. He was a tremendous inspiration to the men with, and below him.

"In the doleful days of the Sloan administration the R. W. & O. began to deteriorate in its morale with a tremendous rapidity. In the days after the coming of Parsons and of Britton it began slowly, but very surely, to regain this quality so precious and so essential to the successful operation of any railroad. The property began to pick up amazingly. At first it was, indeed, a heart-breaking task. As we have seen, at the end of the Sloan régime little but a shell remained of a once proud and prosperous railroad. The road needed ties and rails, bridges, shops power, rolling stock—everything. More than these even it needed the future confidence of its employes. It needed men with ideas and men with vision. From its new owners gradually came all of these things.

Yet before the things material came the things spiritual, if you will let me put it that way. Brittion gained the confidence of his men. He played the game and he played it fairly. And no one knows better when it's being played fairly by the big bosses at headquarters, than does your keen-witted railroader of the rank and file. Perhaps, the best testimony of the bigness of H. M. Britton came not long ago, from one of the men who had worked under him—a veteran engineer, today retired and living at his home in St. Lawrence County.

"'We didn't get much money, I'll grant you,' says this man, 'but somehow we didn't seem to need much. And yet I don't know but what we had as much to live on as we do now. But that didn't make any difference. We were interested in the road and we were all helping to put it in the position that we felt it ought to be in. In those earliest days, you know, our engines used to have a lot of brass work. We used to spend hours over them, keeping them in shape, polishing them and scrubbing them. And when we had no polishing or scrubbing to do, we'd go down to the yard and just sit in them. They belonged to us. The company may have paid for them, but we owned them.'

"So was it. 'Charley' Vogel, running the local freight from Watertown to Norwood, down one day and back the next, in 'opposition' to 'Than' Peterson used to boast that he could eat his lunch from the running-board of his cleanly engine; which

Moses Taylor, No. 35. Ed Geer, his fireman, was as hard a worker as the skipper. This frame of mind was characteristic of all ranks and of all classes. Indeed, the company may have paid for the road, but the men did own it. And they owned it in a sense that cannot easily be understood today—in the confusion of national agreements and decisions by the Labor Board out at Chicago and a vast and pathetic multiplicity of red-tape between the railroad worker and his boss.

"Take Ben Batchelder: We saw him a moment ago with John O'Sullivan working a thirty-six hour day to clean up a circus wreck just outside of Potsdam. That was Ben Batchelder's way always. Incidentally, it was just one of his days. One time, in midwinter, during a fortnight of constant heavy snow, when Ben had become Master Mechanic at Watertown, the despatcher called him on the 'phone and asked for a locomotive to operate a snowplow. Ben replied that all the locomotives were frozen and that it would be slow work thawing them out, and making them ready for service.

"'Then why don't you take them into the house and thaw them out?' shouted the despatcher.

"'There's no roof on the house, and I'm too busy today to put one on,' was the quick retort.

"Faith and loyalty—we did not call it morale in those days, but it was, just the same. Here was Conductor William Schram with a brisk little job, handling the way freight on the old Cape branch. He had just spent three days bringing a big Russell plow through from the Cape to Watertown. On getting into Watertown it was needed to open up the road between that city and Philadelphia. Schram had been on duty three days without rest. Another conductor was called to relieve him. William Schram protested. He said that he did not feel that he could desert the road when it was in a fix."

National Agreements

"The national agreements in theory are splendid ideas. In practice, they are impractical. For instance, if there is an irritating question that arises on the Pere Marquette Railway in connection with these agreements, and another entirely different irritating question that arises on the Southern Railway 500 miles or more away, and still another such situation on the Santa Fe Railway perhaps a thousand miles away, the Pere Marquette, the Southern and the Santa Fe Railroads find themselves not with one situation each to deal with, but with three such situations. The troubles are cumulative. What misunderstandings might be considered as minor in this way become major grievances."—F. H. Alfred, president, Pere Marquette

Functions of Side Bearings and Center Plates on Freight Cars

The following statement regarding this subject was made by the late R. P. C. Sanderson, formerly superintendent of motive power of the Virginian and the Seaboard Air Line:

So far as freight cars are concerned, and with especial reference to the safety of cars on ordinary track, a clearance between the side bearings is absolutely essential on rigid cars and most desirable on flexible cars. Absolutely essential with Diamond or rigid side frame trucks. Most desirable with pedestal trucks having small movement at the boxes, and not especially necessary with equalized trucks.

Low joints and track inequalities are everyday occurrences on most American railways, where the cost of maintenance has to be regulated in a given ratio to the gross earnings, especially so now that earnings have been reduced by enforced reductions of rates and increased operating expenses, due to legislative action.

When passing over such inequalities, a rigid car body cannot adjust itself thereto, and unequal loads are thrown on the different side bearings if all are in contact, which will frequently cause derailments, as the load on the outside bearing of the leading truck is often insufficient to prevent the wheel mounting.

The only practical remedy for this defect, outside of the use of equalized trucks, or trucks having considerable pedestal movement, is in allowing sufficient side bearing clearance so that the trucks can adjust themselves to the track inequalities under the body while maintaining a reasonably equal division of the load on all wheels.

The amount of side bearing clearance required must depend on the average condition of the surface of the track, but usually 3/8 inch to each side bearing is sufficient, and less than this can be used, depending on the average condition of the surface of the track.

Rigid bolsters are essential to the maintenance of side bearing clearances, and such are commonly found in all-steel underframe cars.

It is not believed to be worth while to spend much time investigating conditions for wooden underframe cars, as it is reasonably certain that the freight car of the future will be built with strong rigid underframes.

The functions of the side bearings where a clearance is provided, for reasons above mentioned, are twofold:

First. To stop the oscillations of the body on the center plate in running over rough track or when passing over curves when the horizontal effect of the centrifugal force has a tendency to make the body roll.

Second. To permit a rotary movement of the truck under the body when the side bearings are in contact.

it is important that the center plate should have a flat bearing surface of sufficient diameter, in proportion to the load it carries and the height of the center of gravity of this load, to have sufficient self-righting qualities, so that the body will only lurch on the side bearing under rather extreme conditions of bad track and centrifugal lateral thrust and will tend to right itself to a vertical position by the action of the center plate.

It is evident that the most effective position of the side bearing, with reference to the center plate, will be where it is placed directly over the journals as the leverage will be as great as the truck clearance will permit to resist the lurching of the body with the least pressure on the side bearings. It is further evident that in this position, assuming that a given resistance is necessary to stop the side lurch of the body, or to hold the body upright, the work done is a function of the lever arm, so that with a wider spread of side bearing there will be less pressure; with a less spread of side bearing, there will be a greater pressure to accomplish the same purpose.

This has a direct effect on the resistance to curving of the truck under the body, due to friction, as the friction is proportional to the pressure as well as to the movement.

With a properly designed self-righting center plate, the best results will be accomplished by placing the side bearing as far out as possible, as the pressure will be less and as the movement of the trucks during the period when the side bearings will be in contact will be comparatively small, it is believed that with side bearings properly arranged for easy adjustment for clearance and provided with a simple means of lubrication, anti-friction side bearings would be found to be unnecessary.

Experience has shown that any form of roller, ball or other anti-friction side bearings will fail where side bearing clearance is provided (and such clearance is as necessary with anti-friction side bearings as with plain side bearings) on account of the impact blows when the side bearings come in contact.

The base of the stability for the entire car is the spacing of the rails, but since all pressure on the rails must be transmitted through the journals outside the wheels, the best position for the side bearings is directly over the center of the journals. The next best position would be with the side bearings directly over the rails, in either case, transmitting the pressure through the springs to the frame, by compression of the bolster and relieving it of all bending strains due to side bearing pressures.

Side bearing designed for use with Virginian Railway freight cars, have the bottom side bearing arranged for adjustment as to height, by means of liners and the top side bearing being provided with a grease cup, similar to that used on the

Pressed Steel Domes for Locomotives

Ample Strength and Economy in Formation Developed by the Baldwin Locomotive Works

The Baldwin Locomotive Works have developed a standard steam dome for locomotive boilers that combines the essential requisites of ample strength and economy in formation. It is of pressed steel, made from a flat plate by stamping in the usual manner. The apearance of the output is clearly shown by the reproductions of the photographs.

PRESSED STEEL DOMES MADE BY BALDWIN LOCOMOTIVE WORKS.

Dies have been made for seven diameters and four heights of domes, as shown in the annexed table. Owing to the differences in the amount of work put upon the plate and differences in the finished diameters the plates used are of different thicknesses.

Boiler Diam. Ins.	Standard Dome Inches.										Least at L.	Rivets in Base		On Flat	
	Dia.	H	L	C	R	R	O	A	B	D		No.	Diam	X	X
22-26	15 1/2	19 5/8	25 1/2	11 3/4	1 1/2	- -	15 1/2	- -	- -	1 5/8	- -	32	7/8	12 3/4	11 3/4
28-36	19	22	29 1/2	14 1/2	2	1	15	- -	- -	1 5/8	- -	36	7/8	15 1/8	13 3/4
38-44	22	24	37	18	2	2	15	1 7/8	1 7/8	1 5/8	36	72	7/8	18 1/2	17
46-54	25	26	42	20 1/4	2	3 5/8	15	2 1/4	2 1/4	1 5/8	40 1/2	88	7/8	21 1/2	19 3/4
56-68	29	26	49 1/4	22 1/2	2	3 5/8	19 1/2	2 1/4	2 1/4	1 5/8	46	96	1	26	21
70-84	33	26	52 1/2	24 1/4	2	4 1/2	21 1/2	3	2 1/2	1 5/8	50	96	1	28	23 1/2
86- +	36	26	55	25 3/4	2	4 1/2	24	3	2 1/2	1 11/16	52 1/2	96	1 1/8	28 3/4	24 9/16

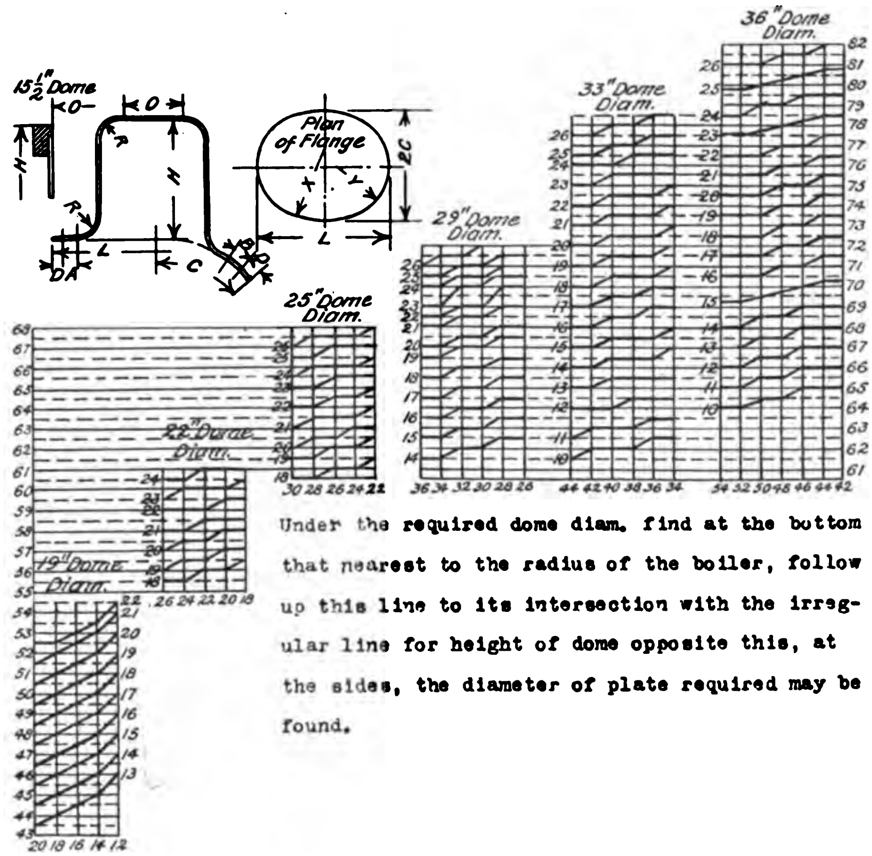
TABULATION OF DIMENSIONS OF PRESSED STEEL DOMES AS MADE BY THE BALDWIN LOCOMOTIVE WORKS.

For any dome 15½ in. in diameter and 19 in. or less in height a plate 48 in. in diameter and ¾ in. thick is used. For domes 19 in, and 22 in. diameter the sheet is 13/16 in. thick and for domes of 25 in., 29 in., 33 in. and 36 in. diameter sheets 1⅛ in. thick are used.

The diameter of the plate to be used varies with the diameter and height of the dome, and the method of determining it is shown in the accompanying series of diagrams.

In these diagrams the figure next to the irregular line indicates the height of dome. The figures along the bottom indicate the boiler diameters, while the larger figures at the extreme left and right indicate the diameter of the plate to be used.

In order to determine this later, find the figure at the bottom of the proper dome diameter, the figure nearest to the diameter of the boiler on which it is to be used. Follow the vertical line above it until it intersects the irregular line leading off from the height of the dome at the left of the diagram. Then follow the horizontal line at which this intersection takes place to the figures at the left or right of the diagram for the diameter of the plate to be used; the thickness of which has been specified above.



METHOD OF DETERMINING OR FINDING SIZES OF PLATES FOR PRESSED STEEL DOMES (BALDWIN LOCOMOTIVE WORKS).

30th Annual Convention of the Traveling Engineers Ass'n.

Reports Presented Covering Flange Oilers—Operation and Maintenance of Oil Burning Locomotives—Mechanical Firing of Locomotives—Relation of Air Brake Defects to Traffic Delays and Fuel Consumption, Etc.

The thirtieth annual convention of the Traveling Engineers' Association opened at the Hotel Sherman, Chicago, Ill., October 31, and lasted four days. President J. H. De Salis, master mechanic of the New York Central at East Syracuse, New York, presided.

The committee reports and papers were of the usual highly practical standard of this association, and brought out discussions full of interesting experiences which will be published in full in the annual volume issued by the secretary of the association.

Flange Oilers

An excellent report on Flange Oilers was presented by a committee of which N. Suhrie was chairman and which is here reproduced in full.

When the first wheels were made with flanges, it was evident that the friction between the flange and rail was a factor to be taken into account, and means would have to be provided to eliminate same if possible. To do this, various schemes were tried, and it was found that by lubricating the flange of the wheel or inside head of the rail fairly satisfactory results were obtained.

This at first was accomplished manually, and from the gratifying results obtained, numerous methods have been devised whereby the lubricating of the flange is done mechanically.

At the present time, in any of our cities having trolley cars, it is a common sight to see the outside rail on a curve being greased by a man with a piece of waste fastened to a stick.

The excessive flange wear on our locomotives and cars and the rail wear, especially on curves, together with the derailments attributed to flange friction, has been a very annoying question to the various railroads for years, and incidentally has taken quite a large slice from the net profits.

To overcome the above mentioned friction, the following devices have been designed:

1. A piece of waste attached to the frame of the locomotive with a piece of wire in a position so that it would come in contact with the driver wheel flange. When the engineer was oiling around, he would drop some oil onto the waste, a small portion of which would reach the flange. The crudeness of this method was wasteful in the use of oil, but some small benefit was derived.

2. The next advance was a crude tin can mounted on a bracket attached to the locomotive frame. From this can a pipe with a wick in the end was projected to a position over the driver wheel flange. After the can had been filled with black oil, the wicking was supposed to form a circuit between the oil in the can and the driver wheel flange. This helped a little, but in the majority of cases this caused the driving wheels to slip to such an extent that the method was impracticable.

3. From the above devices an arrangement was made with a flexibly mounted shoe that was supposed to be in contact with the flange. The use of this flexible shoe developed two noticeable facts: It was hard to keep the shoe in position and the oil was carried on the tread due to the lateral motion.

4. A stick of graphite held by a clamp from the frame in such a positon as to rub on the flange. The same difficulty was experienced as with the flexible shoe.

5. A reservoir of oil with a needle point resting against the flange and closed except when the wheels were working laterally. The slightest move laterally opened a valve and allowed the oil to run on the flange.

6. Hard grease to bear against the flange; but with this scheme the hard grease gathered dirt and sand and made an abrasive, causing rapid flange wear.

7. An oil receptacle with a pin valve fastened to a pendulum that was actuated by the motion of the locomotive and allowed the oil to be dropped on the flange.

8. An oil receptacle with the exhaust steam from the compressor forcing the oil through a jet onto the flange. The exhaust steam from the compressor without any oil other than that used for lubrication of steam end of air compressor was tried, but without success.

9. In 1904 the hydrostatic oil, so termed because it works on the condensation displacement principle, was developed, and it has been generally conceded from previous tests that a successful flange lubricator is one that can be operated or controlled from the cab of the locomotive, and can be started or stopped at the will or judgment of the engineer. This is correct as far as it goes, but it stops just short of the ideal flange oiler. The engineers and firemen of our large modern locomotives have too many other duties

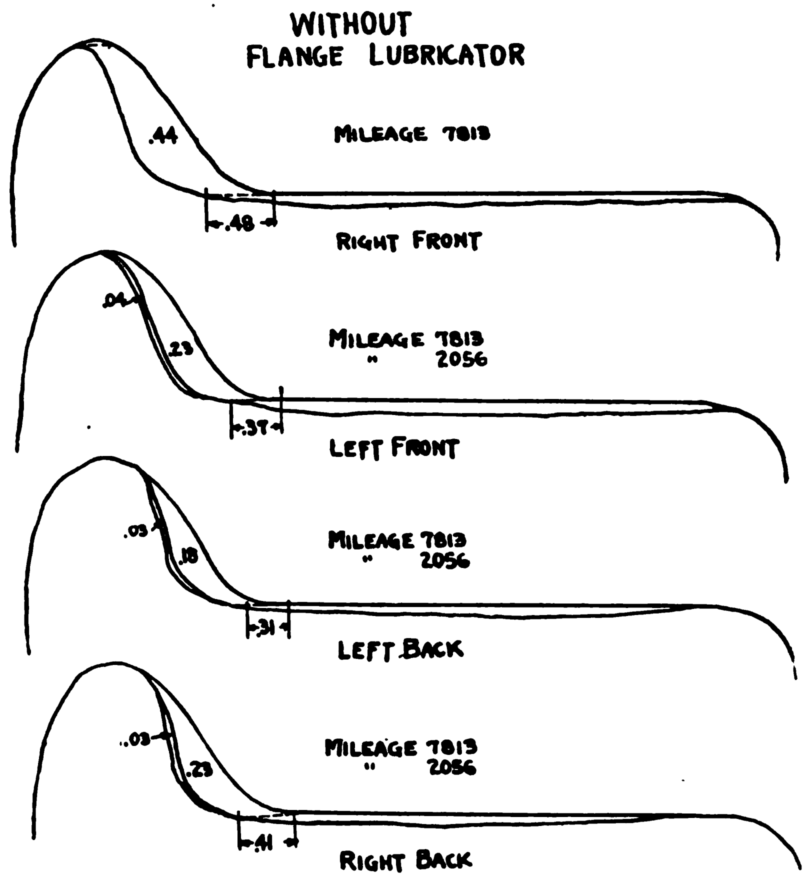


FIG. 1

to perform, and it would be impracticable to add another device for them to operate. Therefore an automatic oiler with a feed that would vary with the speed, or could be shut off at the will or judgment of the engineer, would be the practical oiler as we see it.

We might ask: "Why this persistence in developing a flange oiler, and why do we need it at all?"

This about completes the various schemes used to date; therefore the loss of metal due to the friction between the flange and rail will be taken up.

Let us assume that we have before us a section of locomotive driver wheel tire that has the flange and tread in a perfect contour. It is an established fact that by removing 1/32 in. from the throat of the flange, 1/16 in. metal would have to be removed from the tread of the wheel to restore contour, or ⅛ in. from throat equals ¼ in. from tread.

On many roads this represents considerable mileage lost. If this expense could be eliminated the cost of maintenance per locomotive mile would be greatly reduced.

The application of flange lubricator works in with one of the foremost subjects of today, namely, "Safety First." When you consider the heavy power, the high speed and the many sharp curves, the wonder is how small flanges will keep locomotives and cars on the track. In many places the statement is made that locomotives and cars tried to take a short-cut across the curves instead of following the track, whereas with flange lubrication this is not heard, for the reason that with a small amount of lubrication to the flange or inside head of the rail a considerable portion of the derailments would be eliminated.

It is a known fact that where there is excessive wheel flange wear there is also excessive rail wear.

Let us now investigate and see if the flange oiler is not also a factor in fuel economy. The more friction between wheel flanges and rail the more train resistance is developed, and the higher the train resistance the greater the fuel consumption. This was not proven by actual pounds pull per ton, but from the fact that with flange lubrication and drifting down over the curves on certain stretches, more braking was necessary than when not using flange lubrication.

On switching and shifting locomotives the greatest benefit will be derived, as they are continually going over crossovers and curves.

A personal examination of the rails on both curves and tangent tracks after a locomotive and train passed over with the locomotive equipped with one of the best lubricators showed that a thin film of oil was very noticeable on the inside of the head of the rail. When a heavy asphaltum oil is used, the deposit is enough to soil a white hankerchief if rubbed on inside of rails; therefore, as the average resistance in pounds per ton of a train on a 2-degree curve is about .58 pounds without lubrication, this figure would be somewhat reduced with lubrication on the flanges.

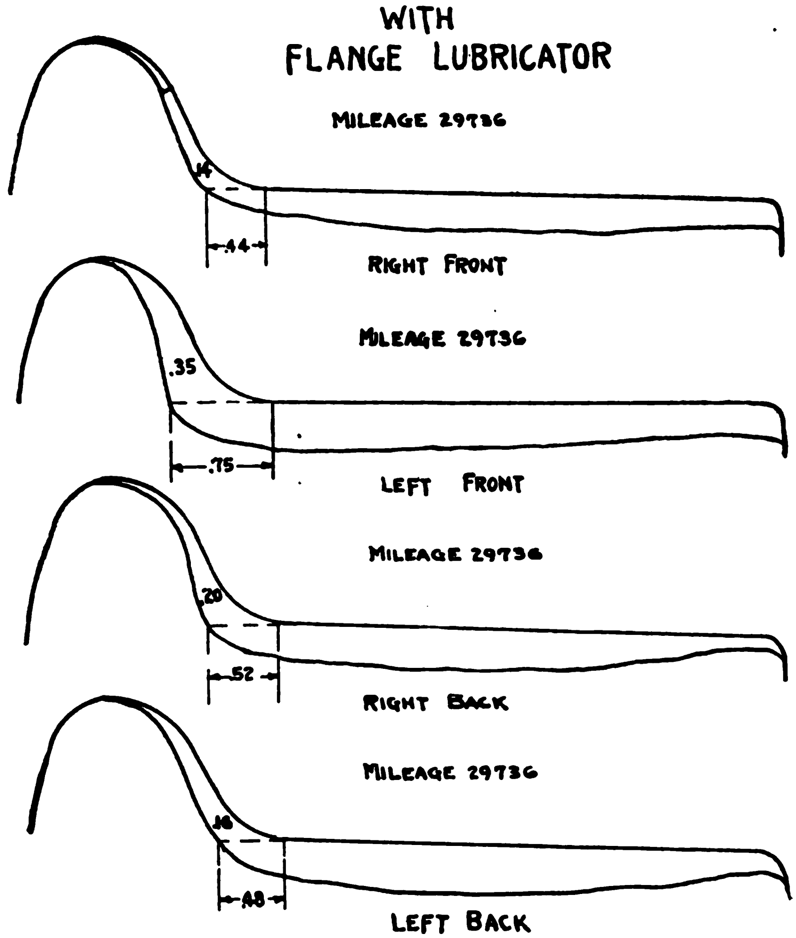


FIG. 2

Letters written to twenty-one railroads to ascertain the effect and opinion of flange lubrication reducing flange and rail wear, brought the following replies:

Six roads reported they noticed a reduction of flange wear, and the remaining fifteen did not reply to this question, whereas ten of the roads claimed the rail wear was reduced, and three could not notice any difference and eight did not reply. One road advised that the difference in train resistance was very noticeable.

An extensive test was made with and without flange lubrication on one of the larger roads covering a period of two years, the first year with and the second year without flange lubricators. The locomotives equipped were run over the same section or stretch of track and everything was directly comparable. It was established on this test when using flange lubrication that the flange wear on the driving wheel tires was reduced 72 per cent, while the wear on the rail per 100,000 gross tons was reduced about 87 per cent. The cost of driving wheel tires per 10,000 miles was decreased 29 per cent, engine truck wheels 42 per cent, and tender truck wheels 49 per cent with flange lubrication.

Fig. No. 1 shows that without flange lubrication the flange wear was excessive when compared to the tread wear.

Fig. No. 2 illustrates that flange lubrication decreased the flange wear, thus allowing the tread to wear, and in a number of cases be the condemning factor. The mileage made by these tires for the flange wear shown is about four times that made by the tires in Fig. No. 1. The flange wear in Fig. 1 was greater than in Fig. No. 2.

Fig. No. 3 is a composite diagram of the driving tires of several consolidation locomotives with and without flange lubrication. This comparison readily shows the decrease in flange wear when using a flange lubricator.

Fig. No. 4 gives comparative rail wear at the same location and over the same period of time with and without flange lubrication. It will be noted that the wear on the rail with lubrication was about 17 per cent of that on the ones without lubrication.

The derailments on a portion of this stretch over which the above tests were made showed a decided decrease when flange lubrication was used.

From actual records taken without flange lubrication, it was found that 80 per cent of the rolled steel wheels under cars and tenders were removed for flange wear.

On the Norfolk & Western Railroad without flange lubrication, the front tires of a locomotive averaged 16,000 miles, whereas when equipped with a flange lubricator they averaged 33,000 miles, or an increase of 106 per cent.

The St. Louis & San Francisco Railroad showed a net saving of $84.03 per year per consolidation locomotive.

The Queen & Crescent Railroad increased their mileage between turning tires from 23,000 miles before using lubrication to 44,000 miles after using lubrication on the flanges. On their Pacific type locomotives the mileage between turning tires was increased from 40,000 to 92,000 miles.

On a 2-8-0 Southern Pacific locomotive the life of the driving tires was prolonged 375 per cent when equipped with flange lubricators, the tender truck wheels 436 per cent, and rail wear on curve 250 per cent.

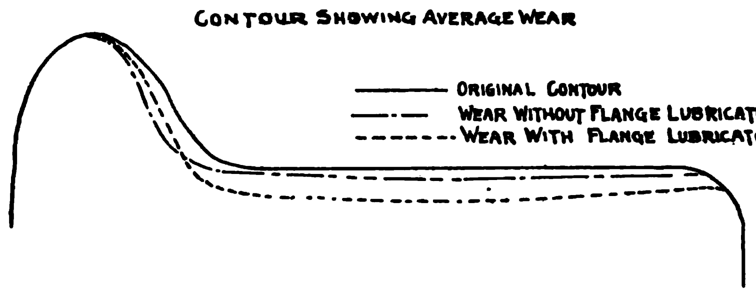


FIG. 3

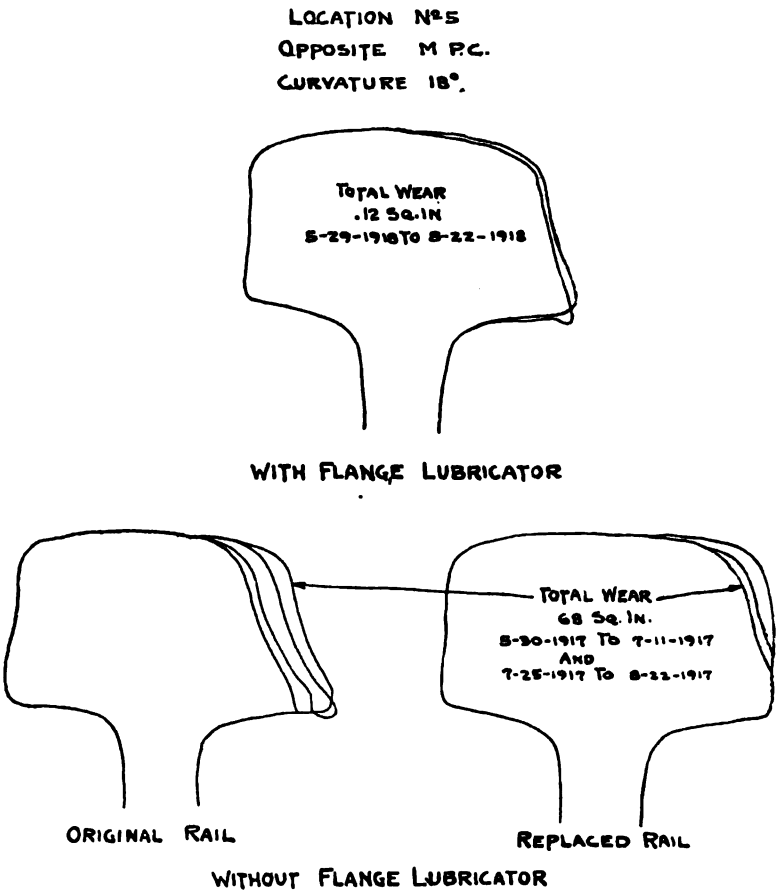


FIG 4

This test was conducted where the ruling grade is 3.8 per cent and maximum curve over 10 degs.

The wide range of opinions of the effectiveness of the flange oiler to prevent flange wear indicates that there are certain divisions and certain railroads where their application is justified and where results show a real saving. However, the tractive power with relation to weight on drivers on certain classes of modern locomotives has been reduced to a point where the application of a flange oiler would result in a waste of fuel, due to locomotive slipping, greater than the saving effected by elimination of flange wear by the use of a flange oiler.

The question of flange lubrication is one to be decided by Motive Power Officers, who are familiar with the physical characteristics of the railroad and the class of locomotive to be used in their respective territory, but in order to obtain best results, all the locomotives on the division or district should be equipped with flange lubricators.

Flange oilers will do certain things, but will not prevent flange wear if we permit locomotives to run "sideways"; in other words, great care should be exercised in having locomotives properly trammed.

In conclusion, we will state it is the finding of this committee that with the proper flange lubricator and when using a heavy asphaltum oil the flange wear on the locomotive, tender and cars and rail wear will be sufficiently checked to warrant the use of flange lubricators, but that, no matter what flange lubricator is used, it must be maintained and receive the co-operation of everybody concerned.

The Operation and Maintenance of Oil Burning Locomotives

J. N. Clark, chairman of the committee on the above subject, presented a report which stated that there are forty-one railroads in twenty-one states burning oil for fuel. Some, however, are burning oil on only parts of their lines.

The fuel in general use is commercially known as fuel oil, which is topped petroleum; that is, the residue after the more valuable and volatile constituents have been removed by distillation, leaving a heavier and safer oil for burning purposes. Prior to 1914 a great deal of the fuel used was crude petroleum, but on account of the value of the lighter oils they are removed by distillation, although at present there are certain localities where crude petroleum is still used for locomotive fuel.

There are two recognized systems of drafting oil-burning locomotives, namely, the horizontal and vertical draft. In the vertical system, the main supply of air is admitted in a vertical plane through the bottom of the fire-pan near the flash-wall, auxiliary air being admitted around the burner. In the horizontal system, the air is admitted, as the name implies, horizontally through the fire-door and below the burner. There are many modifications and combinations of these two systems in use which are apparently giving good results. In some bad water districts admission of any large amount of air through the fire-door has been found detrimental to boiler maintenance. The fire-pan should be designed to give large fire-box volume. This can be accomplished by extending the fire-pan quite a distance below the mud-ring, where the design of the engine will permit. The area of air openings for admitting air to the fire-box varies from 22 per cent to 42 per cent of the tube area (area of superheater units being deducted).

Many systems and type of burners have been experimented with in burning oil under locomotives. The most satisfactory system is the steam atomized, using the Drooling type outside mixing burner.

This burner is simple and efficient and requires very little attention. Oil flows from tender by gravity, dropping from the mouth of the burner onto steam spray, where it is atomized and carried back against an incandescent flash-wall which further aids in atomizing and burning the oil. This brick flash-wall is located about five feet from the burner tip. Although some mechanical or internal mixing burners may produce a slight increase in efficiency, this increase in efficiency would be probably offset by the initial cost and maintenance of these burners. Furthermore, the greatest field for improvement in efficiency lies in fire-box condition, such as design and distribution of air, rather than the burner itself.

OPERATION

In the operation of an oil-burning locomotive great attention should be given to avoiding sudden and great changes in fire-box temperatures. The fireman, by inattention in letting the steam drop back and then forcing the fire to bring the steam up again, not only wastes fuel, but works a great hardship on the boiler. Owing to the rapidity with which the temperature can be dropped by cutting down the fire to a small tongue of flame, it is of utmost importance to have the engine crew give special attention to the use of the dampers and handling of injectors or feed water heaters and the blower to prevent abuse of the boiler. In starting a train, the locomotive burning oil can develop its maximum power without fear of holes being torn in the fire by heavy exhaust at long cut-offs, as in a coal-burning engine, this feature will adversely affect fuel economy by producing uneconomical acceleration.

The fuel oil should be heated to about 100 degrees in the tank to give the best results, although with the use of very heavy oils it has been necessary to heat the oil to 150 or 180 degrees. Both the indirect method with the coil and the direct method of heating oil, where live steam is turned directly into the tank, are in use. Heating of the oil is for the purpose of making it flow freely to the burner and increasing the fluidity to aid atomization, as the extent to which an oil may be atomized does not alone depend upon the burner, but upon the viscosity of the oil as well. Excessive heating damages the oil by driving off the lighter gases and breaking down the coil, which causes the asphaltum to separate from the lighter oil. Overheating the oil makes it difficult to regulate the fire at the burner, the oil gases making the flow to the burner irregular. This results in fire fluctuating and makes it difficult to carry a light fire when drifting or standing.

Frequent sanding of the flues to prevent accumulation of soot promotes economy. Sanding should be done where there is no hazard of starting fires and when the engine is working under heavy conditions at a long cut-off. The intervals between sanding depends upon conditions of operation.

The operation of the firing valve and atomizer require close attention to take care of the varying boiler load, due to changing cut-off. Careful attention in the use of the atomizer and firing valve will eliminate black smoke, except where mechanical defects interfere. Heavy black smoke is not only a direct fuel loss, but rapidly deposits soot on the flues which interferes with the heat transfer to the boiler, as soot is one of the best known non-conductors of heat. A clear stack is deceiving. It may mean only a small amount of air, or it may mean as much as 300 per cent excess. A clear stack is ideal when the gas analysis at the same time shows high percentage of carbon dioxide, very low percentage of free oxygen and no carbon monoxide. Under operating conditions, it is good practice to regulate the supply of air until a very light brown haze is shown at the stack, which will reduce the amount of excess air and thereby produce economy in the use of fuel. The presence of smoke does not always mean insufficient air. Poor atomization, poor mixture of air and oil, unconsumed oil striking cooling surface and poorly designed or bricked fire-pan frequently cause smoke when air supply to combustion may be far in excess of that required.

MAINTENANCE

The maintenance of oil-burning locomotives depends mainly on taking care of those parts that are peculiar to this type of locomotive, such as oil tank and piping, care of burner and brick work and the prevention of localization of high temperatures in the fire-box.

Burners should have sufficient air admitted around them to prevent them from becoming heated to a temperature causing carbonization of the fuel at the mouth of the burner, resulting in deflecting the oil spray. The best results have been obtained with a burner located at a point from six to nine inches above the floor of the fire-pan. The size of the burner is governed by the size of the locomotive. Burners should have a proper alignment with fire-pan to strike the center of flash-wall and should be inspected frequently, by inserting a hack-saw blade in the oil port of burner to insure that there is no foreign matter to prevent maximum capacity of fuel being delivered when required.

The fire-pan should be free from all air leaks, except the air openings provided in the fire-pan for the combustion of fuel. Every effort should be made to keep the fire-pan free from leaks, as air entering through these openings does not aid combustion of unburned gases, and also has a chilling effect upon the gases of combustion and the heating surfaces. These leaks, in many cases, cause the brick work to become loose. Permitting the brick to fall into the bottom of the fire-pan deflects the oil spray. The maintenance of brick work in the fire-pan is influenced by the shape and quality of brick.

Fire clay, asbestos and fine sand should be used in lining brick work of the fire-box and fire-pan. These should be mixed in proportion of two parts clay, one part of sand and one of asbestos, and stirred to the consistency of a thin paste. The brick should be placed as closely together as possible. Large quantities of fire clay mixture should not be used at any one point or depended upon entirely as heat-resistance surface. After the brick setting has been completed, all exposed surfaces should be coated with a solution of soda ash and water, mixed until it will flow freely. This makes a very satisfactory glaze and a fire-resisting surface.

Much can be accomplished in maintaining the brick work by having the fire-pan properly braced, eliminating vibration. The height of the brick work varies from six inches above the mud-ring to the fourth row of stay-bolts on the side-sheets. The thickness of the flash-wall should be considered to protect the door-sheet, as with the sloping back head boiler the heat is severely impinged on the door-sheet and back end of crown-sheet if the flash-wall is not properly designed and maintained. Should any carbon be found on the flash-wall, this should be removed to permit the oil spray to come in contact with a reasonably clean wall.

The formation of carbon is due to oil striking the brick work or some obstruction in the fire-pan before it had time to burn. The oil adheres to the brick work or obstruction, the light gases vaporize and burn, the carbon remaining and adhering to the surface as a solid mass. This may occur with faulty atomization, on account of the oil not being properly broken up, or too much air chilling the fuel before it has had time to burn. There is a noticeable increase in the amount of carbon formed when very heavy asphaltic base oils are used. This is probably due to the fact that these are heavy, slow-burning oils. Other things being equal, they require a longer time in which to be consumed. Decreasing openings of fire-pan thereby increases the velocity of air entering the fire-pan and reduces carbon formation, as it has the effect of hastening combustion.

Both small and superheater flues should be inspected frequently, as there is possibility for sand collecting in the large flues when leaks exist in the front end. When these conditions are found, the flues should be cleaned by inserting a pipe of quarter-inch diameter into the large flue under the superheater units to insure the removal of all sand that lies on the bottom of the flue. Any restriction in the flues will affect superheating and evaporating efficiency.

The front end arrangement of an oil-burning locomotive is quite similar to that of a coal-burning locomotive, with the exception of the absence of the deflector plate and the necessary netting required to prevent cinders from emitting from the stack. The absence of netting permits of a freer flow of gases and less gas restriction in the front end of oil-burning locomotives. Providing that an oil-burning engine is properly drafted and the firebox properly bricked to prevent the localization of high temperatures, the cost of maintenance is about the same as that of a coal-burning engine.

ECONOMICAL ADVANTAGES OF AN OIL-BURNING LOCOMOTIVE

In comparing the operation of an oil-burning locomotive with a coal-burner, the locomotive burning oil has a number of distinct advantages:

1. Reduction in amount of smoke.
2. Absence of cinders.
3. Largest type of power can be operated without the mechanical stoker.
4. Less loss of fuel at the stack.
5. Hazard of starting fires along right-of-way reduced.
6. With careful handling the steam can be kept closer to the maximum boiler pressure without frequent or prolonged openings of the pop valve.
7. From a safe operating standpoint, it permits the fireman at all times to be in a position to observe signal indications and operating rules.
8. The use of oil permits a more accurate check of the fuel consumption, which is of great value in compiling individual performance of engineers, firemen and locomotives.
9. Quicker turning of the power may be accomplished with the use of oil; also a reduction of terminal charges due to the reduction in hostler service and ash-pit service being practically dispensed with.
10. Better system and lower cost of distribution through the use of pipe lines is an economic factor in favor of the use of oil as a fuel. The use of oil is also conducive to longer locomotive runs, as for equal heat value oil occupies much less space than coal. Furthermore, oil when stored does not lose its calorific value as does coal, nor are there any difficulties arising from disintegration such as may be found when coal is stored.

Mechanical Firing of Locomotives

To What Extent Is the Mechanical Firing of Locomotives Reducing the Cost of Train Operation? was the subject of a report by a committee of which James Fahey was chairman, which follows:

Every item of expense connected with the operation of a railroad enters directly or indirectly into the cost of producing a transportation unit.

While the subject of the paper confines your committee to train operation, yet many factors enter into this proposition that are not always taken into account. In considering the effect on operating costs of any particular or specific apparatus as applied to a locomotive, we must necessarily confine ourselves to such items of cost chargeable against train operation as are directly affected by the appliance in question.

Insofar as the locomotive stoker is concerned, the outstanding features are naturally those which have been particularly stressed by stoker manufacturers and stoker representatives, viz., possible increase in tonnage or decrease in time between terminals, or both, together with the possibility of handling a fuel of a lower B. t. u. value and a correspondingly lower cost.

As an offset against the above, which directly affects cost of train operation, there has been charged the increase in coal consumption per 1,000 G. T. M., which has always been considered as going hand in hand with stoker operation. In this paper it is the desire of your committee to confine themselves to facts and not to theories, and while some of the theories which were based on the performance of the first mechanical stokers as developed, have been borne out in actual operation, yet in the later development of the stoker it has been found that some of these theories were based on wrong premises and have in practice been found as leading to wrong conclusions. We refer now particularly to the theoretical increase in coal consumption when comparing stoker with hand firing. It is unfortunate that in the early development of the stoker the only successful machine was one having a relatively high point of delivery, and, consequently, when the locomotive was being forced to its maximum the lighter particles of coal were carried over the arch, where arches were used, thereby resulting in an excessive stack or spark loss. This particular feature was strongly impressed on the railroad world in general by some tests conducted in the testing plant at the University of Illinois, in which it was found that the spark loss for the stoker-fired locomotive ran as high as 17 per cent of the total coal fired as against 4.6 per cent for the same locomotive when hand fired.

In some recently conducted road tests it was found that this condition no longer prevails. It was shown that where the same attention was given the stoker as in hand firing, the fuel consumption per 1,000 G. T. M. per hour was generally lower on the stoker-fired locomotive. This difference in fuel consumption was no doubt due to the higher average temperatures obtainable in stoker firing, due to the elimination of the periodical inrush of cold air, and the more perfect combustion possible through carrying a lighter fire as well as the more regular and uniform fuel feed.

In proof of the above statement we direct your attention to the following data obtained as the result of a careful test conducted on a trunk line road, not for the purpose of determining the relative fuel consumption per 1,000 G. T. M. between stoker and hand-fired engines, but to determine the difference between assigned and pool service:

FUEL PERFORMANCE OF U. S. R. A. LIGHT MIKADO TYPE LOCOMOTIVES EQUIPPED WITH STOKERS

February, 1922.	Assigned Service	Pool Service
Engine No.	652	656
Engine Miles	3,150	3,703
Gross Ton Miles....	4,514,835	4,496,685
Pounds Coal between Terminals	476,710	605,530
Pounds per 1,000 G. T. M..........	105.59	.66

This test will be found of great interest in the other direction, however, as will be shown later.

The test shown above extended over a period of sixty days. The two locomotives were identical in every respect, and operated in the same class of service, viz., fast freight. Locomotive No. 652 was operated by the same crew throughout the entire test, while Locomotive No. 656 was handled by four crews alternating. Note that during the first thirty days the assigned locomotive made 18,150 more ton-miles and 553 less engine-miles than the pooled engine, and consumed 128,820 pounds less coal or a difference of 27.5 per cent calculated on a 1,000 G. T. M. basis.

A daily check of the fuel performance was kept, consequently at the end of the first month it was possible to make an immediate comparison which showed up the above difference in coal consumption. Steps were therefore taken by the supervising officers to bring the performance of the pool crew to that of the assigned crew by teaching and getting the men interested, and the result of this action is reflected in Table No. 2:

March, 1922.	Assigned Service	Pool Service
Engine No.	652	556
Engine Miles	3,750	6,144
Gross Ton Miles....	5,129,449	7,723,177
Pounds Coal between Terminals	580,862	913,279
Pounds per 1,000 G. T. M..........	113.24	118.25

While this table shows an increase of 7.3 per cent in fuel for the assigned engine, this increase, however, was due almost entirely to weather conditions. The table shows, however, that the active supervision over the pool crews, together with their co-operation, resulted in a decrease of 13.8 per cent. As the weather conditions affected both alike, it is reasonable to assume that had the pool crews been allowed to go on during the month of March as in February, the coal consumption for Engine No. 656 would have been affected the same as in the case of Engine No. 652, i. e., increased 7.3 per cent, which would have made it approximately 144.49 pounds per 1,000 G. T. M. instead of 118.25 pounds.

This test proves conclusively: First, that the excess in fuel consumption of the pooled over the assigned engine was not due to the stoker or the locomotive, but altogether to the manner in which it was handled by the four crews; and, second, that intelligent supervision will bring the same results in case of stoker as in hand firing.

Therefore we can eliminate the theoretical increased fuel consumption from our problem, and consider only the effect of the stoker on train operation insofar as increase in tonnage or decrease in time is concerned.

Economical train operation means the movement of the greatest possible tonnage over a division in the shortest possible time. The loading and time factors are the all-governing ones and must be carefully worked out by the operating department, as an error of 19 per cent either way, i. e., overloading or underloading, spells a material increase in operating expense. The importance of correct loading is clearly brought out by Mr. Wm. Elmer of the Pennsylvania System in a paper entitled "Avoidable Waste in the Operation of Locomotives and Cars," presented before the meeting of the Railroad Division of the American Society of Mechanical Engineers, December 3, 1921. This is the most comprehensive paper on this subject that has been brought before the railroad world and worth the careful study of all engaged in train operation.

The question will now arise: What has the stoker to do with correct loading? The answer is: Everything. Where the coal consumption per hour approaches the physical limitations of the fireman, it is only through the application of the stoker that a uniform maximum steam pressure is possible at all times, and it is only through the maintenance of the maximum steam pressure that the desired speed can be sustained.

The physical endurance of firemen is governed, first, by the amount of manual labor called for, and, second, the conditions under which he works. The first is governed by the amount of characteristics of the fuel fired; the second, the length of time during which he must put forth his maximum effort continuously, which means the length of the grades, and climatic or temperature conditions obtaining.

It is needless to say that it requires more coal of a low B. T. U. value to generate a certain amount of steam per pound of coal fired. It is also evident that where coal runs high in ash, necessitating frequent grate shaking, or is composed of large lumps that must be broken by the fireman, or is of a caking nature, requiring the frequent application of the hook or fire rake, the work of the fireman is often harder on a locomotive developing but 45,000 pounds tractive effort than on one of 60,000 pounds tractive effort, but furnished with a better grade of coal; therefore, it is the conditions under which the fireman works that must be considered as well as the size of the locomotive.

Opinions vary as to the size of the locomotive to which the application of stokers seems justified; this is because the conditions mentioned above are not the same on all railroads or even on all divisions of the same railroad, and as men speak of things as they find them, it is but natural that there should be a difference of opinion. A careful study of the problem, however (and we would suggest a study of the paper by Mr. Elmer previously referred to), will show that there are few (if any) instances where operating costs cannot be reduced by the application of mechanical stokers to locomotives developing even as low as 45,000 pounds tractive power.

Let us take a few concrete examples. A certain railroad in the Southwest, where temperature ranges are high, operated consolidation type locomotives of 45,000 pounds tractive power, 49.5 square feet grate area, over two divisions, one being 117 miles long of practically 1 per cent continuous grade, the other 124 miles long with 1 per cent broken grades, the longest continuous grade being forty miles straight away. The rating of the locomotives when worked to their capacity was 1,500 gross tons. However, owing to the physical limitations of the firemen—and they are real men, all of them—it was found necessary to reduce the tonnage over the first district to 1,150 gross tons and over the second to 1,250 tons in order to get the trains over the road within the sixteen hour period. Stokers were afterward applied to these locomotives and the tonnage raised to the locomotive capacity, i. e., 1,500 gross, or an increase in the first instance of 30 per cent and in the second of 20 per cent. As the wages remained the same, this change resulted in a corresponding direct decrease in operating cost. In this instance it was not a question of the size of the locomotives so much as a question of climatic conditions and physical characteristics of the railroad.

We now cite a case where the locomotives were so large that when worked to their capacity the firemen were unable to supply the coal as fast as the engine could burn it. These were of the 2-10-2 type, 67,000 pounds tractive power, 80 square feet grate area, operated over a choppy division 100 miles long having short grades of 1½ per cent. The tonnage behind these engines when hand fired was 2,250 gross tons. Stokers were applied and the tonnage increased to 2,650 gross or 12.76 per cent. The wages and other costs remaining the same, this resulted in a decrease in cost of train operation of 12.76 per cent.

In some very exhaustive tests conducted in the Dominion of Canada during the months of May and June, 1921, with Mikado type locomotives, 53,000 pounds tractive power and 56.5 square feet of grate area, it was found that the maximum drawbar horsepower that could be developed hand firing on the maximum grade was 996, while the same type of locomotive stoker fired gave a drawbar horsepower output of 1,227, an increase of 22 per cent. As a result of this test, the Mechanical Engineer made the following recommendation:

"In connection with the savings to be made by the use of the stoker, by hauling additional tonnage or handling present loads at higher speeds, please see separate report on tonnage rating for this district, in which an increase of 15 per cent is recommended on the time freight load eastbound. This represents 400 tons per train, of which approximately two-thirds would be load and one-third tare, or 266 tons would earn revenue. At a rate of only ½ cent per ton-mile, this would represent $171.00 per train, and if the engine averaged twelve trips per month, this would mean $24,000.00 per annum, which would amply justify the cost of installation, without taking into account the additional service possible from the locomotive owing to being able to double the road if required, on account of the crew being in a condition to work a second shift when the physical labor of firing is eliminated."

In connection with this, we would advise that while the theoretical increase as recommended by the Mechanical Engineer was not handled, yet an increase of 300 gross tons over the normal hand-fired rating was handled by the locomotive stoker-fired, maintaining the same average speed as was maintained by the hand-fired engines with the lighter tonnage.

Leaving Canada and getting back home, however, on the road represented by your chairman, there is a seasonal fruit rush which calls into service every available man and locomotive to such an extent as to make it necessary to double the road (150-mile division) wherever the condition of the locomotive, the crew, and the hours of service make it possible. When this rush is on, we find no difficulty in getting the men to double back on stoker-fired locomotives even though they have a stoker-fired engine in but one direction. Threfore, it is clear that if we did not have stoker-fired engines it would mean either more men, which would often result in the payment of the arbitrary held from home terminal, or in holding the engines for the crew's rest, or in an increase in the number of engines assigned to this service, which would mean an increased number of idle engines during the slack period. An idle engine costs money even if standing dead behind the roundhouse, as it represents an investment on which the interest will run $10.00 to $15.00 per day

The above simply represents the definite decrease in cost of train operation as developed on different railroads through the application of stokers to locomotives of different dimensions.

There is, however, another decrease in cost of train operation which can be absolutely attributed to the application of the stoker, but which varies with the seasons and climatic conditions of the States transversed by the railroads. We refer now to the necessity of sending out relief firemen to take the place of others who on account of the extreme heat or through other causes have become physically exhausted. While this may appear as a small matter, yet records indicate that on some roads the loss chargeable to this one item amounts to considerable; as, for instance, your committee has records of one railroad located in the Mississippi Valley having one division 156 miles long, operated by locomotives developing 39,000 pounds tractive power, and during the summer months it is necessary to have relief firemen stationed at intermediate points fifty miles apart, and as a rule one or more firemen are relieved daily. As under the schedule, 100 miles or less constitutes a day's work, it follows that in a case of this kind the labor cost insofar as firemen are concerned, is doubled. This in itself would not amount to so much, provided there is no attendant train delay, but where it is necessary to tie up a train at some intermediate station until a fireman has been deadheaded from a terminal, it results not only in an increased labor cost, but it upsets the dispatcher's entire schedule, delaying not only the train in question, but often other opposing trains.

In the article by Mr. Elmer, previously referred to, the statement is made that the 32,080 locomotives in freight service in the United States during the year 1920 earned for the railroads an average of $135,000.00 per locomotive per year, although each engine made on an average but 59.3 miles per day or 1,800 miles per month, showing that the average freight engine earned for its owners $370.00 per day or $6.25 per mile run, which is at the rate of $15.40 per hour or 26 cents per minute. It therefore follows that for every hour's delay to a train en route a railroad sustains a direct los of $15.40. When this is added to the direct wage loss resulting through the necessity of relieving exhausted firemen, a total loss that could under such circumstances be entirely eliminated through the application of stokers, it shows another means where the cost of train operation could be materially reduced, aside from the direct savings effected through tonnage increase.

Going back to the Canadian test previously referred to, it was found that the maximum speed on the grades possible with the hand-fired locomotive was 12.32 miles per hour, while with the stoker-fired engine handling the same tonnage a speed of 15.61 miles per hour was maintained, or an increase in speed which is equivalent to the same increase in ton-miles per hour of 25 per cent.

Coupling this with the data furnished in Mr. Elmer's article and assuming that of the 32,080 locomotives referred to, 8,000 were stoker fired, it is logical to assume that the average mileage for all locomotives was pulled down to the low rate of 59.3 miles per day by the hand-fired locomotives; or, to put it another way, had the locomotives been stoker fired we would have had a right to expect 71.6 miles as the daily average, which would have resulted in an hourly earning of $19.25. Wages, etc., remaining the same, any increase in the earning capacity of the locomotive should result in a corresponding decrease in operating cost.

In this connection, however, it might be well to say something with reference to the increase in fuel consumption due to the increase in speed made possible through the application of the mechanical stoker. In some very exhaustive tests conducted on the Southern Pacific System, where oil is used as fuel and consquently accurate data was obtainable, it was found that the fuel consumption based on ton miles or train miles increased practically as the square of the speed. It is on account of the speed factor not being considered that in many instances the mechanical stoker has been charged with an increase in fuel consumption over hand firing. Ton miles or train miles or locomotive miles is a mighty poor yardstick by which to measure train or locomotive operation. The time element should always be taken into consideration and where this factor is considered and coal consumption as well as other operating costs are based on the ton miles per hour, it will be found that the stoker can show economies over the best hand firing.

In the beginning of this paper we referred to one possible reduction in operating costs through the possibility of burning a cheaper grade of fuel. During the last months in 1921 slack coal, or what is termed screenings, became a drug on the market and could be purchased at $1.20 per ton less than the mine-run coal produced at the same mines. A saving of $1.20 per ton held out a very attractive proposition to the railroads, but it was found that in hand-firing practice it could only be handled successfully in switch engines, as in road service the firemen experienced difficulty in maintaining full steam pressure at all times in either passenger or freight service. Tests were then conducted, however, in order to determine whether or not the coal could be successfully used in connection with mechanical stokers, and it was found that with some types of stokers practically the same locomotive horsepower output could be obtained per pound of screenings as per pound of mine-run, and therefore on such roads as were equipped to handle both mine-run and screenings at their coaling stations, screenings were used in the stoker-fired locomotives, resulting in a net saving in fuel cost of 7.6 cents per locomotive mile, more than enough to offset the wages of the fireman. From this it follows that through the application of stokers another saving is made possible in that while screenings at a lower price than mine-run may not always be available, yet by having the locomotives stoker equipped it is possible to take advantage of the varying market..

The above refers altogether to possible operating economies in freight service. There is plenty of evidence to show that under competitive passenger train operation a corresponding decrease in cost is not only possible, but is being obtained daily on quite a number of railroads. With the increase in size and number of coaches per train, the locomotive is taxed to the utmost. Competition is keen. Trains must be kept on time. If one locomotive can't handle the train and make the schedule, two must be used.

We will close the paper by giving one concrete example; discussion on the floor will doubtless bring up many.

These observations were taken from engines No. 550 and No. 551 pulling the Dixie Flyer between Nashville and Chattanooga, Tenn. In February and March the train consisted of one baggage car, two coaches, one dining car and five sleepers—all steel. The average pounds of coal per car mile for the two months was 10.46.

The train for April and up to May 20 consisted of twelve heavy steel cars (including seven sleepers). Fuel consumption for April and up to May 20 averaged 12.13 pounds per car mile.

These engines are stoker fired and have a grate area of 70.3 square feet. The distance is 151 miles and we have four hours and ten minutes to make it in. However, the management requires that when necessary to go in on time, this mileage must be made in three hours and thirty-five minutes.

There are any number of grades from seven to twelve miles long that run from 1.5 per cent to 1.7 per cent and one grade three miles long that is about 2.5 per cent. On account of several speed limit restrictions, this train has to reduce speed to thirty miles per hour at the foot of several grades and then accelerate to maximum as quickly as possible so as to keep on time. The rate of acceleration as shown by stop watch on the 1.5 per cent grade was from thirty miles per hour to forty-five miles per hour in a distance of five miles. This called for a steam rate per minute necessitating a coal consumption far beyond the physical capacity of any fireman; or, in other words, had this engine not been equipped with a mechanical stoker such a rate of acceleration would not have been possible, and as a result either the time would not have been made, thus reflecting on the service, or else a helper on this grade would have been necessary.

Up to and including May 20 this train has arrived at both terminals on time, although it has departed any number of times as much as forty minutes late. Without stoker this performance could not have been made.

Air Brake Defects on the Road and Their Relation to Traffic Delay and Fuel Consumption

A committee of which B. J. Feeny was chairman reported on the above subject in a paper from which we extract the following:

Of the many difficulties that enter into the problem of train operation on our great American railroads today, the following may be selected as the most prominent factors, namely: First, time; second, train control; third, safety. As a general proposition these factors are recognized as to their importance in the order given.

Starting and stopping of trains are complimentary factors in the problem of time-saving; therefore, it is evident that the best results can be obtained where both factors are given due consideration.

Unfortunately, the brake is usually looked upon as a safety device only, and because of the prevalence of this idea its maintenance does not receive the consideration it merits.

Insufficient consideration is given to the importance of correcting defects before trains leave the terminal. It is far better from every standpoint to spend a few minutes in the yard correcting defects than it is to spend hours in delays on the road due to the defects referred to.

The business of the railroad is to move trains. Therefore the value of its right-of-way properties is in direct proportion to their capacity for the movement of trains. Trains cannot be moved unless they can be controlled. The effectiveness of the control will determine the speed and number of trains. It will determine the number of cars which may be successfully operated in each train, as well as their weight and variation in weight from the empty to their loaded condition.

A practically perfect brake must be automatic, durable, always ready and flexible; the latter requirement involves the elements of power, time and amount of reduction made.

BRAKE PIPE LEAKAGE

The importance of brake pipe leakage in connection with proper operation of the brakes and fuel consumption, is generally underestimated. Efforts are made to reduce the leakage somewhat, but its effect when the brake valve is moved to lap position is lost sight of. When the engineman makes a brake pipe reduction and places the brake valve on lap, he is powerless to prevent the effect of brake pipe leakage on the train.

It is important that this point receive more attention on long and heavy trains than on the shorter ones, not only for the trouble it may cause during the application of the brake, but also to decrease compressor wear, steam consumption, lessening the ability to release all brakes in the train and also lengthening the time in which they can be released.

It is customary to determine the amount of air lost from the brake pipe through leakage by making a ten-pound reduction, lapping the brake valve and noting the rate of drop of brake pipe pressure. Then, knowing the volume of the brake pipe, it is possible to calculate the cubic feet of free air lost from the brake pipe during the first minute, after the brake valve is placed in lap position. This figure is commonly accepted as a measure of the relative condition of trains on the road with respect to leakage from the air brake system.

However, an extended investigation of long freight trains has developed the fact that the information so obtained may be in reality of little value and rather misleading than otherwise.

Trains are frequently encountered on which the brake pipe leakage, as noted above, may not be excessive, the indication being that the locomotive compressor capacity is ample to supply the air required for maintaining the pressure in the brake system, but subsequent observation on the road demonstrate that the compressor capacity is nearly or quite insufficient to supply the air lost.

Attempts to measure the amount of air leaking from the entire system (including brake pipe and auxiliary reservoirs by charging the brakes to seventy pounds and then placing the brake valve handle in lap position does not give satisfactory results, because where there is considerable leakage some brakes will apply when the brake valve is placed in lap position without making a brake pipe reduction, and the leakage then observed is the result of the leakage from the brake pipe and from those reservoirs only on cars where brakes do not apply. This uncertainty makes tests of this character of no value.

In order to avoid the difficulties encountered in attempting to observe the leakage from the system of noting the drop in pressure on the brake pipe gauge on the locomotive, or at the end of the train, such leakage is now determined by measuring the amount of air passing into the brake pipe to supply the leakage which exists, and which the compressor must be able to take care of. In other words, instead of measuring the effect of leakage from the air brake system by observing the drop in brake pipe pressure, which may oftentimes be a false indication, it should be determined by observing the amount of compressed air required to supply such leakage.

The permissible amount of leakage from the entire brake system is a question each individual road will have to decide, being governed by the available supply and the service required. It is a well-known fact that we cannot expect and do not have compressors on our locomotives that are at all times 100 per cent efficient. Neither can they be maintained so. Consequently, we have to take as a basis what can reasonably be expected from the compressor. Too much leakage must not be allowed or an undesirably large compressor capacity or high degree of compressor maintenance will be necessary. An exceedingly low amount of leakage must not be insisted upon or traffic will be interfered with on account of the time required to stop the leaks.

It may therefore be said that the whole question of brake pipe leakage resolves itself into what quantity of air may be permitted to escape from the brake system and still permit charging, maintaining and replenishing the brake system in such time as will not impose limitation on traffic in the way of delays, getting trains ready in the yard, and operating them on the road. For instance, five pounds from the brake system, which would mean about twenty pounds from the brake pipe volume alone, will not materially interfere with the operation of the brakes, that is to say, their application and release, yet five pounds of air leakage from a 100-car train will amount to sixty-five cubic feet of free air per minute.

This amount of air leaking from the system of a 100-car train in one minute would not interfere with the operation of the brakes as far as application is concerned, but it might seriously interfere with the release of the brakes, since it reduces the ability by sixty-five cubic feet of air per minute to raise the pressure in the brake pipe at the rate required to insure release. In fact, the compressor may have but little (if any) margin above that required to nearly replenish the leakage. In other words, it is clear that if the leakage is kept down to a point where the compressor, the brake valve passages and the brake pipe resistance, and not the leakage, are the chief governing factors of the rise of the pressure in the system, there is no need to fear the effect of brake pipe leakage on the operation of the triple valves in the brake system. The time required to release the brakes on a freight train is a variable quantity, owing to the many changing conditions; for this reason no definite time can be given. It can be said, however, that the time required is usually underestimated, and the time the brake valve is left in release position is overestimated. Instruct an engineman, when releasing brakes, to place the brake valve in release position and leave it there fifteen seconds, and it will usually be found nearer ten seconds than fifteen. The natural tendency to hasten the movement of the train makes the time seem longer than it really is, and an effort is made to start the train before all brakes have had time to release, resulting in placing great strains on the draft gear, frequently severe enough to cause parting of the train. At how low speed brakes can be released without liability of damage depends on how heavily they are then applied, the amount of excess pressure, the length of the train, whether slack is in or out, and whether track conditions are favorable for releasing.

Where retaining valves are in use, it is practicable to release at somewhat lower speeds than where they are not. While the head brakes always start to release before the rear ones, the retaining valves cause a much slower fall of brake cylinder pressure than when they are not in use, and this causes the slack to run out more smoothly.

The most favorable conditions for releasing brakes are: Train standing, maximum excess pressure and brakes almost fully applied. The difficult release is when the brake pipe pressure is very low, as where the engine has been cut off for some time, after a burst hose, train parting or an emergency application, because of the large amount of air required to raise the pressure in the brake pipe, also in the auxiliary reservoirs of all early releasing brakes, above the pressure in the auxiliary reservoirs of the late releasing brakes, particularly those at the rear.

To insure release, a quick and considerable rise of brake pipe above auxiliary reservoir pressure must be had. Furthermore, in trying to get this to the rear, after a light application, the head brakes are sure to be overcharged, above the adjustment of the feed valve, as to insure that some will reapply. Where a light application is made it should be increased before attempting to release.

No attempt should be made to release the brakes on a long freight train while running following an emergency application, no matter how high the speed may be. In case the brakes are applied from the train, place the automatic brake valve in emergency position, shut off steam and ascertain the cause; a hose may have burst, the train may have parted, or the conductor's valve may have been opened.

Length of train is also important from the air compressor standpoint, as with two trains having the same rate of leakage and one double the number of cars than the other, one will require twice the air to supply its leakage. In other words, five pounds leakage per minute with 100 cars requires the same amount of air to supply the leakage as does ten pounds per minute with fifty cars; and, inasmuch as all air lost by leakage is a continuous drain on the compressor capacity it is essential that it be measured accurately in order to insure that the compressor capacity is great enough to handle the train.

It may be of interest here to state that it requires to apply the brakes on a 100-car train of ten-inch equipment with a full service application approximately 205 cubic feet of free air. Assuming the average leakage from the brake system at forty cubic feet of free air per minute, then every five minutes as much air is consumed by leakage as is required to apply the brakes with a full service application. And if this train of 100 cars be kept charged while on the road twelve hours, it will consume in leakage alone about 28,800 cubic feet of free air, or enough to apply the brakes with a full service application 144 times. From this we can see that the actual amount of air used in operating the brakes as compared with that wasted by leakage is very small indeed. Furthermore, when we begin to appreciate more fully the expense entailed due to unnecessary fuel consumption, compressor wear, poor train control and delay to train movement on account of air leakage from the brake system, then, and then only, will proper attention be given to overcome this leakage. We avoid the cost of a good tight pipe job, of close inspection and competent repairing, but burn more coal and waste much time. We must do more than make rules about these things. We must have the right kind of men, enough of them and encourage them by giving them the right kind of tools, the materials and proper place to do work. No man can turn out a decent job with only a pipe wrench, a paint brush and lack of proper material and conveniences.

Tribute to W. O. Thompson

At the request of the Executive Committee, W. O. Thompson, who was largely responsible for the founding of the Association, presented a brief resumé of its history, in which he referred to a conversation between a master mechanic and a representative of the Westinghouse Air Brake Company in regard to the good work accomplished at the Master Mechanics and Master Carbuilders conventions of 1892. A traveling engineer of one of the roads running into Chicago hearing the conversation was led to believe that if the work of the Master Mechanics and Master Carbuilders Associations was of such inestimable value, that an organization of traveling engineers would be of equal value, not only to the traveling engineers themselves, but also to the railroads. Accordingly, the listener started out to form an association, and finally succeeded in interesting 14 traveling engineers in favor of the idea. These met at a preliminary meeting in Chicago, November 14, 1892, and formed a temporary organization.

A permanent organization was formed at a meeting in the offices of Railway and Locomotive Engineering, New York, held January 9, 1893, at which time there was an enrolled membership of 53.

At the present time the membership totals 1,536. During the thirty years of its existence there has never been a decrease in membership. Five hundred and seventy-five members have been selected for higher positions on railroads or in business, nearly all of whom give their moral and financial support to the association by continuing as members.

At the close of Mr. Thompson's paper, a remarkably high tribute was paid to him by the members and their friends for his long continued service in behalf of the association. D. L. Eubank of the Galena Signal Oil Company unveiled and presented Mr. Thompson's portrait, in oil, to the association, and the association voted that the portrait be hung in the convention hall at all future meetings. The presentation and action of the association was a complete surprise to Mr. Thompson. On behalf of the membership, tributes were paid Mr. Thompson, who has been secretary of the association since it was founded, and who is the only surviving charter member, by L. D. Gillet of the Dominion Railway Commission of Canada, D. R. McBain, the Railway Equipment Manufacturers' Association, and others.

Other Reports

Reports were also presented covering a "Comprehensive Standard Method of Employing, Educating and Examining Engineers and Firemen" by a committee of which J. B. Hurley was chairman; and also on the "Benefits to Be Derived from the Use of Radiolite for the Illumination of Gauges, Etc., in the Locomotive Cab." N. Suhrie was chairman of the committee that presented the report on the latter subject, which closed with the statement:

"We feel that there are many uses for radiolite around the railroad and in the industrial world, but are inclined to believe that since the application of electric equipment to locomotives it will be difficult for radiolite to displace electricity in the cabs of our steam locomotives, for the reason that there is enough uncontrolled light around a steam locomotive to interfere with radiolite illumination, and its application would only add one more article of expense to locomotive maintenance."

Condition of Equipment.—Reports from the Car Service Division of the American Railway Association show that fewer cars are now in need of repairs than at any time since March 15, 1921.

A total of 270,045 freight cars, or 11.9 per cent. of the cars on line, were in need of repairs on October 15, the latest date available. This is a reduction of 54,538 compared with the number on July 1 last, the date upon which the strike of railroad shopmen began.

On October 15, last year, there were 354,996 freight cars, or 15.5 per cent. of the cars on line, in need of repairs.

Steam Railroad Electrification

By S. B. Cooper, Chief Engineer*

Westinghouse Electric and Manufacturing Company

Much has been said regarding the results obtained on particular installations by means of electrification. There have been heated discussions held regarding the relative merits of steam and electric locomotives as machines. Volumes have been written on the subject "System" of Electrification—alternating versus Direct Current, Low versus High Voltage, Overhead Trolley versus Third Rail.

Let us approach the subject of electrification from a little different angle. Let us begin with certain fundamental assumptions, accepting them temporarily at least as facts, and thus avoid traveling over old ground.

Let us assume first, that electrification *has* accomplished much in the particular installations of which you have all heard. Second, that we are in complete agreement that steam and electric locomotives are both remarkable machines, highly developed, both undergoing constant improvement and both destined to accomplish great results in their respective fields. Third, that electrical operation may be satisfactorily accomplished in a number of ways, differing in detail, each having its ardent advocates and opponents, but after all, each successful in actual service under existing conditions to a remarkable degree.

With this background established, then, what can be said for and against electrification?

The only possible objection to electrification is the large investment required.

This objection can be sustained only if it can be shown that electrification fails to effect economies sufficient to pay a satisfactory return or that the same capacity for moving traffic could be obtained at lower cost by other means. Each particular case must be considered on its merits and all of the factors considered. Obviously only those roads or parts of roads will be electrified where it can be shown that one of two conditions exist:

(1) Either a given limitation can only be overcome by electrification, as in the case of long tunnels, etc., or

(2) A given traffic capacity can be obtained by electrification with sufficient operating economy over steam to justify the extra investment.

Fifteen or twenty years ago, when electrification first came up for general discussion, enthusiastic predictions were made by some electrical men that the steam railroad was about to be retired, much the same as many auto-bus enthusiasts today say that the auto-bus will supplant the electric street car. As time went on and the electrical engineers acquired a better knowledge of railroad methods and problems, and as the railroad operators learned more of the possibilities of electrical operation, we have come to a firmer common ground of understanding and a more respectful attitude toward each other's viewpoint. No one today would be so rash as to predict the early retirement of the steam locomotive, or the prospect of the immediate electrification of a very large part of the railroad mileage of the country. There is, however, a very general acceptance of the fact that electrification is firmly established in certain fields. That the use of electric power offers to the transportation industry a new tool—a tool that permits, because of its characteristics, new operating methods and the ultimate accomplishment of results apparently impossible with previous means.

These fields may be outlined as follows:

(1) Congested terminals in large cities, often involving tunnel approaches.
(2) Heavy suburban service.
(3) Heavy grade divisions carrying dense traffic and under existing operating methods limiting the carrying capacity of a whole system.
(4) Sections remote from suitable fuel supplies and where abundant hydro-electric power is available.

The industrial expansion of this country has been phenomenal. No one doubts that this expansion will continue. For reasons too familiar to require discussion here, the railroads of the country have not kept pace with the growth of our population or our industrial and agricultural activity. While the immediate future may appear doubtful, adequate transportation is too vitally necessary to our national welfare to permit politics, labor disturbances, financial depressions or other agencies to interfere with the ultimate progress and prosperity of the railroads of the country. If this is true may we not logically look for an increasing demand and an absolute necessity for increased traffic capacity? In looking for ways and means of increasing this traffic capacity most economically, we must realize that changes and continued improvements in operating methods are inevitable. Shippers and consignees will find means of more promptly loading and unloading cars, perhaps involving a pick-up and delivery service. The railroads will find means of handling trains between major terminals without delays and reclassification at intermediate points. They will find means of moving these trains in larger units and at higher speeds than now customary.

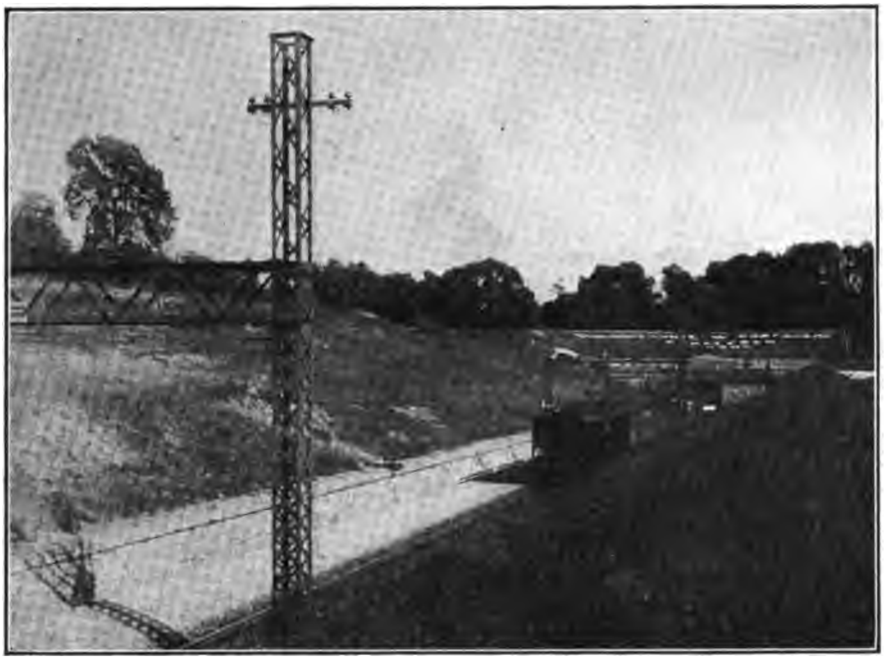
It does not seem unreasonable to expect that train sizes will be limited only by the strength of the draft gear and speeds only by alignment and car journal performance. As the need for larger trains and

THE OLYMPIAN DRAWN BY BALDWIN-WESTINGHOUSE LOCOMOTIVE LEAVING BUTTE, MONTANA, STATION

*A paper read before the Western Railway Club.

higher speeds increase, who can say that means will not be found to overcome these limitations?

In the electric locomotive we have available a motive power unit able to produce, under the control of one operator, as great a tractive effort as the strength of the cars will permit at any speed considered safe for the alignment of the road and for the satisfactory operation of the car journals. Experience with electric locomotives to date has proven that they are extrordinarily reliable, relatively cheap to maintain, and available for service a very large percentage of the time. When properly designed for the service to be performed, and when operated within their rated capacity, the routine inspection and running adjustments can be made in a very short time and the percentage of time in the hands of the mechanical department is very small. I just recently heard of an example that will illustrate my meaning. An electric heavy interurban railroad operates two sixty-ton locomotives in coal hauling service. They are coupled together and operated as a unit, and for months past have been in service 24 hours a day, except for four hours once a week when they are inspected and the necessary renewals and adjustments made.


ELECTRIC LOCOMOTIVE AND TRAIN EMERGING FROM ST. CLAIR TUNNEL

The freedom from the necessity for stopping for coal and water is in itself a great advantage on a busy track, particularly where heavy trains are operated with more than one engine per train. The absence of boilers to be washed and fires to be cleaned makes through runs over two or more divisions possible. The higher speed available with electric motive power increases the possible length of operating districts, and often the elimination of intermediate terminals.

Regenerative braking has proven itself an immense advantage in heavy grade operation. The saving in power, wheel and brake shoe wear, delays and damage due to stops to cool wheels, while attractive in themselves, are all overshadowed by the increased reliability and safety of operation. Air brakes are held in reserve for use in emergency and for coming to a complete stop.

Electrification has revolutionized tunnel operation. In the Elkhorn tunnel of the Norfolk and Western Railroad, bad rail conditions due to condensation and the difficulties due to smoke and gases, steam operated trains commonly took 30 to 40 minutes to clear. The electrically operated trains now clear in about 2½ minutes, and so far as the operation of trains is concerned, the tunnel may be considered as non-existent. The same relief has been experienced in the operation of the Hoosac tunnel of the Boston & Maine, the Sarnia tunnel of the Grand Trunk, the Detroit tunnel of the Michigan Central and others.

In suburban service the multiple unit trains offer the marked advantages of higher schedule speeds due to higher accelerating and braking rates, more uniform schedules due to the maintenance of a constant ratio of motive power to train size, and increased facility of handling due to double end operation. And analysis of steam suburban service shows generally two operations for the electric motor car train—one in and one out.

The steam train requires several engine and train moves. It has been the practically universal experience of roads that have electrified their suburban districts that the faster, cleaner, more reliable service has attracted greater patronage and built up income. Hence, electric operation opens up an opportunity to transform a necessary service from a burden to a source of added income.

Another field that offers attractive possibilities, if electrified, is that of branches and feeder lines in growing and productive territory. Such lines may be electrified following interurban practice, thus forestalling other electric line or auto-bus competition, and by means of improved service, building up a very profitable traffic. There are undoubtedly a great many such lines in the country. The experience with the "Safety Car" on city systems has indicated the marked effect on traffic of frequent rapid service. The amount of business now being handled by gasoline busses and trucks is surely sufficient indication of the existence of business that might be profitably handled by the railroads if they would provide the proper equipment and facilities for its accommodation.

In concluding, I would like to emphasize a feature that seems of vital importance. In the electrification of other industries, economies in fuel, labor, maintenance, sanitation, etc., while in many cases important in themselves, have been subordinate to the advantage of increased production.

Statistics show that our freight traffic doubles in about twelve years. Our transportation machine has had great difficulty in producing 450 billion ton-miles in recent years. What is it going to do under a load of 900 billion ton-miles by 1930 or '32? Electrification is bound to be a big factor in the solution of the problem and therefore justifies the co-operative study and development of both the railroad engineers and the manufacturers.

Cause of Rail Breakage

Some time ago Messrs. George Charpy and Jean Durand presented a paper before the Academy of Sciences in Paris on the subject of rail breakages, which we reproduce herewith.

A number of observers have already pointed out that one of the most frequent causes of rail breakages when they show no local defects due to improper manufacture, consists in the formation of very fine fissures which are developed in time beneath the rolling surface.

It has also been recommended that a minute examination should be made of the track so that rails, showing any indication of a change in their homogeneity, could be removed.

In undertaking the study of this question we have approached it from a different angle. In short, we have set ourselves to determine the method of the formation of these fissures and to try to reproduce them artificially in order to see if it would not be possible to arrive at some remedy that would be less expensive and more certain than the removal of rails that showed signs of change pure and simple.

In the course of these investigations we found, in the first place, that the phenomena is quite general and the manifestations are not limited to railway rails. They have been found in a large number of cases, presenting a common characteristic when the steel is subjected to a heavy cold hammering that is limited to a surface layer. Under these conditions this layer seems to be subjected to tension stresses of the same nature as those produced by the difference in the expansions that occur between a mass of clay and its shell, and which are the cause of breaking by cracking. The check cracking of steel occurs when the metal is so cold hammered or rolled upon its surface that it can break without undergoing any appreciable elongation.

From the preceding it it easy to see that the phenomena would be particularly marked in metals of variegated structure. In the case of white cast iron especially a heavy rolling action is quite sufficient to cover the whole surface with a network of fine cracks similar to those which have been found on rails. The same thing (that is a network of cracks as the result of rolling) can be reproduced in rapidly hardened tool steels such as the nickel-chrome or metals of varying hardness or with cemented steels that have been hardened in water without annealing. Several examples of this being found.

The cracks, which are often very fine can be accentuated by an acid treatment. It even appears that in some cases the acid develops these cracks which only existed in the metal in a latent condition and could only be detected by a minute microscopic examination. The network of cracks would then be produced when the strength of the superficial layer was sufficiently weakened by the thinning occasioned by the action of the acid.

Other methods of cold hammering other than by rolling will produce similar results. A single striking example will alone be quoted. It consists in cold hammering the surface of a very hard metal, by making an impression upon it with a ball after the manner of determining the hardness in a Brinnell test. Under these conditions we sometimes find the fine cracks when the impression is examined under the microscope. But, even when the metal appears to be perfectly intact, it is quite sufficient to make an attack upon it with acid, as already described, in order to see the radical cracks form, distinctly and usually arranged in a regular star shape. The length of these cracks would indicate the distance to which the cold hammering produced by the ball can make itself felt beyond the edge of the impression itself. This experiment can be most readily performed with rapidly hardened tool steel.

In steels of average quality of structural variation such as that used for rails having a tensile strength of from 90,000 lbs. to 100,000 lbs. per sq. in., the total superficial cold hammering is much more difficult to obtain. This result cannot be reproduced. In order, then, to reproduce the phenomena observed on railway tracks, we have used a method, suggested some time ago by Duguet, whose action lies between the rolling action of a train and that of a rolling mill. The test is, also, more easily conducted if cylinders exactly like those of a rolling mill are used and made of a semi-hard steel of the same structure as that used for the manufacture of rails. Now, on a large number of such cylinders, we have found, after a certain length of time in service, that cracks were developed exactly like those that are produced in rails as shown by the examples offered. We have also observed the same phenomena on the trunnions of the rolls of a rolling mill for steel.

Another example can be cited which, at first sight, may seem to be quite different from those already instanced; it is that of the erosion of the rifling of cannon, which has been made the subject of numerous studies by Professors Howe and Fay. If the surface of the rifling is examined as soon as the erosions appear, the presence of a network of cracks quite similar to those which we have found in rails and mill rolls, will be clearly seen, and these seem to have been produced by a sort of cold rolling by the rubbing of the bands of the projectiles on the rifling grooves.

This example as well as that of the mill rolls leads to the belief that the formation of such a network of cracks is facilitated by a temperature that is somewhat above the normal. This ought not astonish us, because we have known for a long time that cold rolling is particularly dangerous at temperatures where the metal is discolored by oxidation, that is cold rolling at a blue heat. In the case of rails this condition will be brought about in the skidding of the wheels caused by a sudden application of the brakes, where we know that a very high temperature may be developed.

All that has been said goes to show that for a steel of medium hardness, the cold rolling needed to lead up to the formation of a network of cracks cannot be produced instantly, but requires a series of repeated actions, resulting in a gradual hardening of the surface. Available statistics substantiate this point of view; for, if, from the very reliable reports submitted to us by one of our great railways, we draw a curve showing the number of rail breakages in terms of length of service, it will be seen that it will show a sudden change of direction at the end of about ten years, beyond which the number of breakages, which were very few before the end of that period, increase rapidly. There then appears a progressive aging of the rails, for which, at least in the cases cited, ten years appear to be the critical age, and this fact makes possible the suggestion of a remedy.

The hardening caused by the cold rolling can, in fact, be nullified at any time by a proper annealing. If this annealing is done before the network of cracks is formed the change produced is completely annulled; the effect of aging is done away with and to use the same simile, a rejuvenation of the metal is brought about that puts it back into essentially its original condition. This conclusion can be confirmed by a quick experiment with the impression of a ball made upon a piece of steel cited above. If, after having made the impression with the ball, the metal is annealed, an attack can be made upon it with acid to a considerable depth without developing the slightest indication of a crack.

In the case of rails this superficial annealing is comparatively easily done. A heating apparatus has been designed, which is mounted on wheels and which is intended to produce a superficial tempering. The same apparatus can be even more readily used for annealing. Thus by annealing before the critical age of ten years has been reached, there is hope of reducing by a considerable proportion the number of rail breakages caused by such a network of cracks.

Without insisting too strenuously upon this idea, to which we expect to return, we would like to refer a little further to its general character. Wherever a piece of metal is subjected to a change, which is gradually developed in service, as the result of cold rolling or hammering, of which we have many examples besides those of rails, such as chains, bolts, piston rods and the like, it can be met by annealing at convenient intervals. That is to say, the "heat cure" will enable us to add considerably to the length of life of certain metallic parts and thus brings to the front a source of metal saving that deserves attention.

Fewer Freight Cars Need Repairs

Reports just received by the Car Service Division of the American Railway Association show that 32,929 fewer freight cars were in need of repairs on October 1 than on July 1 last, when the strike of railway shopmen began.

The total number in need of repairs on October 1 was 291,654, or 12.8 per cent of the cars on line. This was a decrease of 12,894 cars compared with the number in need of repairs on September 15, at which time the total was 304,548, or 13.4 per cent.

On October 1 last year 364,372, or 15.8 per cent, were in need of repairs.

Of the total number in need of shop work, 230,565 require heavy repairs, while 61,089 require only light repairs. This is a decrease compared with September 15 last of 11,114 in the number requiring heavy repairs, and a decrease of 1,750 in the number needing light repairs.

Every district reported a decrease in the number of cars in need of repairs on October 1 compared with September 15.

Railroad Equipment Notes

Locomotives

The Pacific State Lumber Co. has placed ar order with the Baldwin Locomotive Works for one locomotive of the Mikado type.

The Montour Railroad is reported to be in the market for four locomotives.

The Toledo Terminal contemplates buying 3 switching locomotives.

The Denver & Rio Grande is inquiring for 10 Mountain type locomotives.

The Chicago, St. Paul, Minneapolis & Omaha Railway is reported to be in the market for 15 locomotives.

The Lehigh Valley Railroad has placed an order with the American Locomotive Co. for 15 Mikado type locomotives weighing 334,000 lbs.; cylinders 26 x 32 in.

The Pere Marquette Railway is in the market for 22 switching locomotives of the 0-8-0 type.

The Minarets & Western has ordered 5 Mikado type locomotives from the American Locomotive Co. Of these, 3 locomotives will have 24½ x 28 in. cylinders and a total weight in working order of 250,000 lbs., and 2 locomotives will have 20 x 24 in. cylinders and a total weight in working order of 190,000 lbs.

Chicago, Rock Island & Pacific Railway has placed an order with the American Locomotive Co. for 10 Mountain type locomotives, weighing 369,000 lbs., cylinders 28 x 28 in., and 30 Mikado type locomotives weighing 332,000 lbs., cylinders 28 x 30 in.

The Richmond, Fredericksburg & Potomac is inquiring for two 8-wheel switching locomotives.

The Grand Trunk is inquiring for ten 6-wheel switching locomotives and ten 8-wheel switching locomotives.

The Korean Central Railway is reported to have placed an order with the Baldwin Locomotive Works for two locomotives of the Prairie type.

The Maine Central has ordered eight 4-6-0 type locomotives from the Lima Locomotive Works.

The Chicago, Milwaukee & St. Paul is inquiring for 100 Mikado type locomotives.

The Northern Pacific Railway, previously mentioned as being in the market for additional motive power, has issued inquiries for 20 locomotives of the Pacific type, 20 of the Mikado type, 4 of the Mallet type and 15 switchers.

The Western Pacific Railroad is considering the purchase of 5 locomotives of the Mikado type.

The Baltimore & Ohio Railroad has placed an order with the General Electric Co. for two 120-ton, 600-volt electric locomotives.

The Tennessee Central contemplates buying 4 Mountain type or Pacific type locomotives.

The Great Northern is said to be preparing to issue an inquiry for 50 or more locomotives of various types.

The Norfolk & Western Railroad has purchased four double cab electric locomotives similar to those now in use on the Elkhorn Grade electrification.

The Chicago & North Western Railway is said to be contemplating the purchase of 50 locomotives in addition to the 50 recently ordered.

The Chesapeake & Ohio Railway is reported to be in the market for 6 Pacific type locomotives and two of the Mountain type in addition to the order of 50 recently placed.

The Pennsylvania will build 3 electric locomotives in its Altoona shops.

The Southern Pacific, Texas Lines, is inquiring for 9 Pacific type locomotives.

The Illinois Central is inquiring for about 75 locomotives.

The Minneapolis & St. Louis contemplates the purchase of from 25 to 30 locomotives.

The Green Bay & Western Railroad has placed an order with American Locomotive Co. for two locomotives.

The Erie has ordered 10 Mikado type and 20 Pacific type locomotives from the Baldwin Locomotive Works. This is in addition to the 30 Mikado type ordered from the same builder.

The Atchison, Topeka & Santa Fe has ordered 26 Santa Fe type, 8 Mountain type, 15 Mikado type, and 10 Pacific type locomotives from the Baldwin Locomotive Works.

The Lehigh Valley has ordered 15 Mikado type from the American Locomotive Company and 15 Mikado type from the Baldwin Locomotives Works.

The Central of New Jersey is inquiring for 10 Mikado type locomotives and expects to order additional motive power later.

The United Fruit Company has ordered one Mikado type and one 6-wheel switching locomotive from the Baldwin Locomotive Works.

Freight Cars

The Maine Central has ordered 350 single-sheathed box and 100 open rack cars of 40 tons' capacity, 10 dairy products cars from the Keith Car & Manufacturing Company, and 50 all-steel self-clearing gondola cars of 50 tons' capacity from the Standard Steel Car Company.

The Atlantic Coast Line R. R. is reported to have placed an order with the American Car & Foundry Company for 1,000 hopper cars of 50-ton capacity.

The New York Central R. R. is reported to have placed an order with the Streator Car Company for repairs to 500 box cars.

The Western Pacific is inquiring for 800 general service gondola cars of 70 tons' capacity and 500 stock cars of 50 tons' capacity.

The Lehigh & New England has ordered 100 gondola cars of 50 tons' capacity from the Magor Car Corporation.

The Louisville & Nashville R. R. has entered the market for 2,000 hopper and 1,000 box cars.

The Virginia Ry. is in the market for 500 or more flat bottom gondola cars and 500 or more steel gondola cars.

The Kingan Refrigerator Line, Indianapolis, Ind., contemplates coming in the market for 100 refrigerator cars.

The Beaumont Export & Import Co., Beaumont, Texas, is inquiring for 40 refrigerator cars for export to Mexico.

The Detroit, Toledo & Ironton R. R. is reported to have ordered 500 coal cars from the Standard Steel Car Company and 500 from the Cambria Steel Company.

The Pennsylvania Coal & Coke Corp. has placed an order with the American Car & Foundry Company for 1,000 hopper cars of 50-ton capacity.

The Live Poultry Transit Company, Chicago, will build 100 poultry cars in its own shops.

The Chicago, Milwaukee & St. Paul is inquiring for 3,000 gondola cars, 1,500 box cars and 500 automobile cars.

The Pere Marquette Ry. is reported being in the market for 1,500 box and 500 hopper cars, also for 500 gondola cars.

The Atchison, Topeka & Santa Fe Ry. is reported to have placed orders for 5,000 cars as follows: 1,000 40-ton automobile cars, 1,000 refrigerator cars, and 500 double-deck stock cars to the Pullman Company; 500 40-ton box cars, 500 40-ton coal cars, and 1,000 40-ton refrigerator cars to the American Car & Foundry Company; and 500 40-ton box cars to the Standard Steel Car Company. This carrier has also ordered 50 caboose cars from the American Car & Foundry Company.

The Sinclair Refining Company, Chicago, Ill., has ordered 5 tank cars of 6,000-gal. capacity and 5 8,000-gal. capacity from the American Car and Foundry Company.

The Transcontinental Oil Company has placed an order with the American Car & Foundry Company for 75 tank cars of 8,000-gal capacity and 75 of 10,000-gal. capacity.

The New York Central R. R. has placed an order with the Streator Car Company for repairs to 200 stock cars.

The New Orleans Great Northern R. R. is said to have placed an order with the Southern Car Company for 200 flat cars.

The Grand Trunk is having repairs made to 1,000 box cars at the shops of the National Steel Car Corporation, Hamilton, Ont., Canada.

John A. Roebling's Sons, Trenton, N. J., have ordered 2 hopper cars of 55 tons' capacity from the Pressed Steel Car Company.

The Chicago, Rock Island & Pacific has

awarded a contract to the Western Steel Car & Foundry Company for repairs to 100 furniture cars, 100 wooden box cars and 200 steel frame box cars.

The Fruit Growers' Express, reported as building 1,000 refrigerator cars in its own shops at Indiana Harbor, Ind., have ordered 1,000 steel underframes from the General American Car Company.

The New York, Chicago & St. Louis has ordered 300 steel underframes from the Illinois Car Manufacturing Company.

The West Penn. Power Co. of Pittsburgh, Pa., has placed an order with the American Car & Foundry Company for 60 hopper cars of 55 tons' capacity.

The Grey Steel Products Company, of New York, is reported to have placed an order with the Pressed Steel Car Company for two steel hopper cars.

The Cudahy Packing Company, Chicago, will build 200 refrigerator cars in its shops at East Chicago. The cars are to be built in lots of 50.

The Pere Marquette Ry. is in the market for repairs to 1,000 wooden box cars.

The Western Pacific has ordered 100 automobile cars from the Mount Vernon Car Manufacturing Company.

The Arms Yaeger Company has placed an order with the Pullman Company for fourteen horse cars.

The Delaware & Hudson Company is said to be in the market for 1,000 gondola cars.

The Norfolk Southern has ordered 240 steel underframes from the Virginia Bridge & Iron Company.

The United Fruit Company has ordered from the Magor Car Corp. 25 cane cars for the Tela R. R.

The Atlantic Coast Line has ordered 500 steel underframes for box cars from the Standard Tank Car Company.

The Northern Pacific Ry. has issued inquiries for 3,000 box cars.

The Hocking Valley has equally divided an order for repairs to 500 composite gondola cars between the shops of the Pressed Car Company and the Greenville Steel Car Company.

The Atchison, Topeka & Santa Fe is reported to have placed an order with the American Car & Foundry Company for 50 caboose cars.

The Chicago & North Western Ry. have ordered 800 50-ton gondola cars and 200 55-ton cars from the General American Car Company.

The Cincinnati, Indianapolis & Western R. R. has ordered 209 gondola cars from the American Car & Foundry Company.

The Chicago & North Western has ordered 800 gondola cars and 200 flat cars from the General American Car Company.

The Atlantic Coast Line has ordered 2,000 box cars of 40 tons' capacity from the Standard Tank Car Company.

The Chicago & Alton R. R. has placed an order with the Illinois Car Company for repairs to 200 gondola cars, and has Manufacturing Company for repairs to 200 steel gondola cars.

The New York, Ontario & Western Ry. is in the market for 100 steel underframes.

The Lehigh & New England is inquiring for 100 55-ton hopper cars.

The Old Time Molasses Company, Inc., has placed an order with the American Car & Foundry Company for 72 tank cars of 10,000-gal. capacity.

The East Jersey Railroad & Terminal Company has placed an order with the American Car & Foundry Company for 25 tank cars of 10,000-gal. capacity.

The Pennsylvania Railroad is reported to have plans under way for converting about 10,000 50-ton cars into 70-ton cars, and will be in the market for a large number of car trucks.

The Union Pacific R. R. is reported to have placed an order with the Mt. Vernon Car Manufacturing Company for 50 caboose cars.

The Buffalo, Rochester & Pittsburgh Ry. is in the market for 1,000 gondola cars.

F. M. Pease, Chicago, Ill., has ordered 100 Tank cars of 8,000-gal. capacity from the Pennsylvania Tank Car Company.

The Baltimore & Ohio R. R. has ordered 1,000 gondola cars of 55 tons' capacity from the American Car & Foundry Company.

The Atchison, Topeka & Santa Fe Ry. is reported to have placed an order for 5,000 freight cars.

The National Refining Corporation, Hoboken, N. J., is inquiring for from 5 to 25 tank cars of 40 tons' capacity; also for the same number of cars of 50 tons' capacity.

The Pennsylvania will build 100 steel caboose cars in the Altoona shops.

The Central of Georgia is inquiring for 10 steel underframes for caboose cars.

The Chicago, Rock Island & Pacific Ry. has issued inquiries for 500 box cars and 500 coal cars.

The Chicago, Milwaukee & St. Paul Ry. is reported to be in the market for repairs to 500 stock cars.

The Erie Railroad has given a contract to the Magor Car Company for making repairs to 500 cars; most of these are gondola cars.

The Tennessee Coal, Iron & Railroad Company has ordered 195 miscellaneous cars from the Chickasaw Ship Building Company.

The Chicago Great Western R. R. has placed an order with the Pullman Company for 500 box cars.

The Northern Pacific is inquiring for from 300 to 500 gondola cars.

The Cudahy Packing Company, Chicago, is inquiring for 200 40-ton refrigerator cars.

The Interstate Railroad has placed an order with the Pressed Steel Car Company for 1,000 hopper cars of 55 tons' capacity.

100 tank cars.

The New York, New Haven & Hartford is inquiring for 2 transformer cars.

The Pere Marquette expects to come in the market soon for 500 hopper cars and 1,500 box cars.

The Chicago Great Western has awarded a contract to the Pullman Company for 500 box cars.

The Erie Railroad is said to be in the market for 1,000 hopper cars of 70 tons' capacity.

The Chesapeake & Ohio Ry. is in the market for 50 caboose cars.

Passenger Cars

The Chicago & Northwestern Ry. is said to be considering the purchase of 36 standard coaches, two diners, two cafe parlor cars and 10 baggage cars.

The Central of Georgia Ry. is reported to be in the market for 30 passenger coaches, 10 baggage and express cars, and five com.

The Central of New Jersey has ordered 30 all-steel coaches from the Standard Steel Car Company, 20 all-steel coaches, 10 steel baggage cars and 5 steel combination passenger and baggage cars from the American Car & Foundry Company, and is inquiring for repairs to 100 passenger cars.

The Baltimore & Ohio is inquiring for 30 baggage cars.

The Central of Georgia is inquiring for 50 coaches, 10 baggage express cars and 5 combination passenger and baggage cars.

The Maine Central is inquiring for 7 steel combination baggage and mail cars from the Osgood Bradley Car Company.

The Cuba Railroad is building one business car in its shops at Camaguey, Cuba.

The Arms Yaeger Company has placed an order with the Pullman Company for 14 horse cars.

The Chicago, Rock Island & Pacific has issued inquiries for these cars: 500 coal cars, 500 automobile cars, 250 flat cars, 250 ballast cars, 250 refrigerator cars and 250 stock cars.

The Chicago, Rock Island & Pacific is issuing inquiries for 50 all-steel suburban passenger cars and 50 70-ft. steel suburban cars.

The Chicago, Rock Island & Pacific has awarded a contract to the Pullman Company for repairs to 5 dining cars.

The Bethlehem-Chile Iron Mines Company has ordered 25 hopper bottom ore cars of 50 tons' capacity from the Magor Car Corporation.

The Baltimore & Ohio has ordered 30 baggage cars from the American Car & Foundry Company.

New York Central—Car builders are asking for prices on specialties for 20 70-ft. steel coaches and 80 60-ft. steel baggage cars for the New York Central Lines.

The Long Island is inquiring for 40 motor cars, 20 electric trailer cars, 20

10 coaches for steam service and 2 combination baggage and mail cars for steam service.

Buildings, Structures, Etc.

The Canadian Pacific has awarded contracts for the extension of 12 stalls of the locomotive house at Calgary, Alta., Canada, to T. Jamieson & MacKenzie, Ltd., of Calgary, and to the Hamilton Bridge Company of Hamilton, Ont., for the construction of two 90-feet turntables to be installed at Brandon, Man., and North Bend, B. C., Canada.

The Missouri Pacific has awarded to the Ogle Construction Company, Chicago, Ill., a contract for the construction of a 300-ton reinforced concrete coaling station at Bala Knob, Ark.

The New York Central & Hudson River is planning additions to its locomotive and boiler shops at Lock Haven, Pa., estimated to cost about $250,000.

The Lehigh Valley R. R. is reported to have plans under way for the construction of a new one-story locomitive repair shop at Jersey City, N. J., to cost about $25,000.

The Long Island has plans under way for the electrification of its Montauk division to Babylon, L. I., estimated to cost about $3,500,000, including power equipment.

The Chicago, Rock Island & Pacific Ry. has awarded a contract to the International Filter Co. of Chicago, for the construction of a water-treating plant at Peoria, Ill.

The Michigan Central R. R. has plans under way for the construction of new car repair shops and power house at Bay City, Mich.

The Missouri Pacific R. R. is reported to have awarded a contract to the Jerome Moss & Co. of Chicago for the construction of a car repair shop at Kansas City, Mo.

The Pennsylvania Railroad is reported to be planning the electrification of its four-track line from Altoona to Johnstown, and also the construction of a new power house, the project estimated to cost about $10,000,000.

The Mobile & Ohio R. R. is planning the erection of a car repair shop and addition to engine house at Tuscaloosa, Ala.

The Atlantic Coast Line R. R. is planning the construction of a new engine and repair shop at Southover Junction, Savannah, Ga., to cost about $100,000.

New Haven Orders Electric Locomotives

The New York, New Haven & Hartford Railroad has recently placed an order with the Westinghouse Electric & Manufacturing Company for five 181-ton electric locomotives. The new locomotives will practically duplicate the ones which are now proving so successful in high-speed passenger service, being equipped for operation on either alternating or direct current. With the direct-current equipment the locomotives will be able to operate over the direct-current installation in the Grand Central Station, New York.

Norfolk & Western Buys Four Electric Locomotives

The Norfolk & Western Railroad has placed an order through their consulting engineers for four double cab electric locomotives similar to those now in use on the Elkhorn Grade Electrification. These locomotives will be equipped for operation over the alternating current installation. The capacity of the new locomotive will be somewhat greater than those now in operation, but will still maintain the special feature of split phase operation and will be of the jack shaft and side rod type of locomotive weighing approximately 382 tons. This recent addition to the rolling stock is a result of the increased heavy freight traffic on the electrified section of the Norfolk & Western.

Pennsylvania's New Enginehouse

The Pennsylvania System has just completed and placed in service at Pitcairn, Pa., a modern 34-stall enginehouse with turntable at a cost of $1,385,000. Located on the main line of the Central Region, it will be one of the key enginehouses of the System in expediting the prompt dispatching of through trains. Nearly 200 engines are handled daily by the force of 700 men. In addition to preparing the engines for service, which includes inspection, cleaning the fires, refilling the boilers, coaling the tenders, etc., the heaviest of running repairs will be made at Pitcairn. Among the important facilities at the new enginehouse is the turntable, 110 feet long and electrically operated, which connects with each of the 34 stalls. It is of sufficient capacity to turn the largest engine in Pennsylvania service. Each stall is 140 feet long and so constructed that it can be completely enclosed. Steam heat permits the employes to work in comfort during cold weather.

Urge More Rigid Locomotive Inspection

On October 11, counsel representing the Brotherhood of Locomotive Engineers and the Brotherhood of Locomtive Firemen and Enginemen at a conference with President Harding, urged a more rigid enforcement of the safety appliance and locomotive inspection laws. Representation was made that rolling equipment was in such condition that it was a menace to the traveling public and that safety laws were being disregarded, and that the President should compel the roads to observe the requirements of the laws.

Reopening of Interstate Commerce Commission Hearing on Power Brakes

Secretary George S. McGinty, of the Interstate Commerce Commission, has issued a notice, under the date of October 16, that the proceedings in the Investigation of Power Brakes and Appliances for Operating Power Brake Systems is assigned for further hearing November 8, 1922, ten o'clock A. M., at the office of the Interstate Commerce Commission, Washington, D. C., before Examiners Mullen and Borland.

Heaviest Merchandise Loadings in Railroad History

In the week ending September 30, the American Railway Association reports that 589,098 cars were loaded with merchandise and miscellaneous freight. This is the greatest number in the history of roads. It was 36,735 in excess of the same week last year, and 39,061 cars more than the corresponding week in 1920, in which year the volume of all traffic handled by the railroads was the heaviest in their history. Loadings of all commodities, according to the latest figures available, are at the present time within 3 per cent of the record loadings of 1920.

Railway Oil Fuel

According to the monthly report of the Interstate Commerce Commission on freight and passenger train service compiled from the reports of the Class I railways, the fuel oil consumed by the railroads in July of this year amounts to 120,626,000 gallons, an increase of 5,715,000 gallons compared with the same month a year ago.

In the first seven months of this year the railroads have consumed 831,923,000 gallons of oil, an increase of 20,204,000 gallons over the amount used in the seven months' period last year.

Factory and Railway Wages Compared

The Industrial Commission of New York in its monthly bulletin says that the earnings of factory workers in that state averaged $24.77 weekly, or very nearly $100 a month, in July of last year.

According to the monthly report of the Interstate Commerce Commission on railway wage statistics, the average wage for all classes of railway employees in the same month was $131.88.

Railways as Buyers

The railways purchase directly one-quarter of the total output of coal in the United States and one-ninth of the total petroleum production. Directly and indirectly they buy from 30 to 40 per cent of the iron and steel output, 25 per cent of the lumber produced, from 15 to 20 per cent of the copper and brass output.

Items of Personal Interest

N. H. Nuff has been appointed night roundhouse foreman of the Atchison, Topeko & Santa Fe, at Tulsa, Okla., succeeding W. R. Hunt who is now night roundhouse foreman at Emporia, Kans.

The following appointments have recently been made on the Chicago & Alton at Bloomington, Ill.: William P. Kershner, master mechanic; C. Seager, general roundhouse foreman; L. Autenbaugh, day roundhouse foreman; William Wunderlee, night roundhouse foreman. Other appointments on this road are: George W. Ray, master mechanic at Slater, Mo.; A. C. Brunning, road foreman of engines, Southern Division, Springfield, Ill.; Jesse Siegfried, road foreman of engines, Roodhouse, Ill.

H. Jefferson has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe with headquarters at Amarillo, Texas.

W. W. Payne has been appointed road foreman of engines of the Seaboard Air Line with headquarters at Jacksonville, Fla., succeeding W. W. Shoemaker, who has been assigned to duties elsewhere. H. M. Agin has been appointed assistant road foreman of engines of the same road at Waldo, Fla.

O. M. Foster has been appointed district superintendent of motive power of the New York Central with headquarters at Collinwood, Ohio, and W. R. Lye has been appointed district superintendent of motive power at Elkhart, Ind.

T. C. Raycroft has been appointed master mechanic of the Seaboard Air Line at Hamlet, N. C.

J. A. Buechler has been appointed macter mechanic of the Detroit, Bay City and Western at Bay City, Mich.

B. F. Kuhn has been appointed assistant superintendent of motive power of the New York Central at Cleveland, Ohio. He was formerly district superintendent of motive power at Collingwood, Ohio.

A. McCormick has been appointed master mechanic of the Graysonia, Nashville and Ashdown with headquarters at Nashville, Ark.

E. W. Smith has been appointed general superintendent of motive power of the Southwestern region of the Pennsylvania with headquarters at St. Louis, Mo., succeeding W. C. A. Henry who has been appointed engineer of transportation with headquarters at Philadelphia, Pa.

C. Peterson has been appointed acting master mechanic of the Denver & Salt Lake at Denver, Colo.

J. D. Young has been appointed master mechanic and David Evans has been appointed road foreman of engines of the Central of New Jersey, both with head-

W. C. Sherman has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe with headquarters at Canadian, Texas.

John J. Hanlin has been appointed superintendent of motive power of the Seaboard Air with headquarters at Portsmouth, Va.

B. F. Bardo has been appointed superintendent of electric transmission of the New York, New Haven & Hartford with headquarters at Cos Cob, Conn.

Charles E. Fisher has been appointed service engineer of the Franklin Railway Supply Company, New York. He was formerly assistant engineer, test department of the New York, New Haven & Hartford at Boston, Mass.

New appointments in the College of Engineering, University of Illinois, Urbana, Illinois, are Milo Smith Ketchum as Dean of the College of Engineering and Director of the Engineering Experiment Station; Robert Edwin Kennedy as superintendent of the Foundry Laboratory; Howard Edward Degler as instructor in mechanical engineering; and William N. Espy as assistant instructor of mechanical engineering.

W. H. Woodin, president of the American Car & Foundry Company, New York, was appointed fuel administrator of the State of New York by Governor Miller. Mr. Woodin succeeded the governor's advisory coal commission. He will serve without compensation.

F. A. Tarrey, general superintendent of motive power of the Chicago, Burlington & Quincy, retired from service November 1. Mr. Tarrey had served with the road for a period of 48 years.

W. J. O'Brien, master mechanic of the Kanawha & Michigan, with headquarters at Middleport, Ohio, has been appointed master mechanic of the Toledo & Ohio Central, with headquarters at Bucyrus, Ohio, succeeding C. Bowersax, who has resigned to engage in other business.

J. E. Friend, assistant master mechanic of the Fort Worth division of the Texas & Pacific, with headquarters at Marshall, Texas, has been promoted to master mechanic of the Louisiana division, with headquarters at Alexandria, La. He will be succeeded by D. L. Ringer, general foreman at Baird, Texas.

C. E. Skinner, assistant director of engineering of the Westinghouse Electric & Manufacturing Company, has sailed to attend the meeting of the Rating Committee of the International Electro-Technical Commission to be held in Geneva, Switzerland, beginning November 18.

Mr. Skinner is known throughout the electrical world for his extensive research work, especially on insulation, and his effect on the development of electrical machine design. He organized and has directed the research work of the Westinghouse Company until his recent promotion to the position of assistant Director of engineering. He has contributed frequently to the literature of the industry, and is well known abroad for his researches as well as in this country. In 1915 he was a special representative of the American Institute of Electrical Engineers, of which he is a fellow, at the conference on electrical standards held in London, and he is now a member of the committee representing the Institute on the International Electrotechnical Commission. He was chairman of the American delegates to the Brussels meeting in 1920.

The Independent Pneumatic Tool Co., 600 West Jackson boulevard, Chicago, announces that Harry J. Reefe, formerly manager of the order department, has just been appointed to the position of purchasing agent to succeed Thomas J. Keegan, who has resigned.

The Railway Equipment Manufacturers Association, which held its annual meeting at Chicago October 31, in conjunction with the annual meeting of the Traveling Engineers Association, elected F. W. Venton president for the ensuing year. Mr. Venton, who was formerly vice-president, is traveling engineer for the railroad sales department of the Crane Company, Chicago.

Oldest Employe of the Oldest Railroad

The oldest employe of the oldest railroad in the United States, L. F. Thompson, of Parkersburg, W. Va., celebrated his ninety-ninth birthday September 22—a distinction held by few who are as active at this age as the present Nestor of the Baltimore & Ohio. He is older than the railroad itself, having been born in 1823 or four years before the City of Baltimore gave birth, in 1827, to the organization with which he has been identified for 65 years. Mr. Thompson was pensioned by the company in 1900, twenty-two years ago.

Factory Extension of National Lock Washer Company

The National Lock Washer Company, Newark, N. J., is building a new two-story brick structure, 84 ft. by 40 ft., at the corner of Pennington and Hermon streets, the top floor of which will be used for office purposes and the ground floor for shipments. The company is also putting up a steel storage building 100 ft. by 60 ft. for additional storage purposes, and is also rearranging the equipment in its fabricating machine shop and making general improvements throughout the en-

Books, Catalogues, Etc.

New Publications

The Welding Encyclopedia; Second Edition, 315 pages; 6 in. by 9 in. Flexible cover. The Welding Engineer Publishing Co., Chicago, Ill.

To one who is not more or less familiar with the art of welding, as it is now carried on in the various branches of industry, the contents of this book would come with somewhat of a surprise. The first 149 pages are occupied with definitions pure and simple of the terms, articles and methods used in welding. In this is included the trade names for all sorts of supplies, it so happening that the first and last definition in this part of the book are of trade names.

Then follows descriptions of electric arc welding, electric resistance welding, oxy-acetylene welding, thermit welding, boiler welding, pipe welding, tank welding and rail joint welding. These descriptions are not merely perfunctory affairs, but they enter into the details of the work and discuss the methods by which it should be done and the precautions to be taken in order to insure success with great thoroughness.

After this there are the rules that have been adopted by various organizations regarding the use of welding especially in connection with the welding of steam boilers. The rules given embody those of the American Society of Mechanical Engineers, the Department of Commerce, Lloyd's Register, the rules of the several states of the Union, the Interstate Commerce Commission, the American Railroad Association, the Underwriters' Laboratories, and the National Board of Fire Underwriters.

The book closes with an essay on the treatment of steel and instructions on the preparation of parts to be welded with illustrations of a wide variety of joints.

Taken as a whole there is little left to be considered in the art of welding that is not embodied within its pages, and it should be of great value as a book of reference for those who have the general oversight of any of this class of work as well as for the workman himself, who wishes to advance himself in the details of his trade.

The Union D'Electricité and the Gennevilliers Station, edited by the Revue Industrielle, Paris; 49 pages; 8½ in. by 11 in.

The object of the Union D'Electricité, as set forth in this pamphlet, is the development of what we would call the super-power plant, and the details of its principal one, the Gennevilliers Station is fully described.

The early work of this character in Paris was done during the war, when Paris was transformed into an immense armament factory. In order to meet the requirements of the hour and save the waste of fuel that would have occurred had every factory been obliged to develop its own power the central power station was the object of a rapid development.

The general idea of the new scheme is to obtain the maximum possible efficiency and reduce the installation expenses. The first is necessitated by the high cost of coal in Paris, which at present amounts to more than 100 francs per ton in the barges. It is assumed that the price will decrease rapidly to 70 francs and after several years it will be in the vicinity of 60 francs. This, at the normal rate of exchange, would be between $11.00 and $12.00.

The Gennevilliers Station, the description and illustrations of which occupy the greater portion of the pamphlet, will have a capacity of 320,000 kilowatts, to which three other stations will be added, having a capacity of 120,000 kilowatts.

New Thermit Locomotive Pamphlet Issued

The Metal & Thermit Corporation, New York, has issued the fourth edition of its Thermit Locomotive Pamphlet No. 21, which is of special interest to all railroad Superintendents of Motive Power, General Foremen, Blacksmith Foremen and Thermit Welders. The new pamphlet contains many revisions since the last edition was published, chief among which are instructions for applying important improvements in practice in Thermit welding, which have been developed by exhaustive research. The drawings and instructions illustrating and describing making Thermit welds in various parts of locomotive farmes and other locomotive and railroad equipment have been completely revised since the publication of the last edition to conform to the improved practice.

Railway and Locomotive Historical Society

The Railway and Locomotive Historical Society has issued Bulletin No. 3, a pamphlet of 54 pages. The subjects of the articles inclue: Story of the Old Woburn Branch, by James M. Kimball; Single Driving Wheel Locomotives, by J. W. Merrill; Some Famous Runs and Some Famous Engines, by Charles E. Fisher; The Capture of the "General," by H. P. Yeaton; The Maine Central Railroad and Its Leased Lines, by Charles S. Given. There are reminiscent communications from J. E. Alger and G. M. Basford. In his communication Mr. Basford refers to the little old engines of 45 years ago, that ran between Boston and Providence and states: "I believe that those little engines did more work per pound of metal than the big engines of today."

Reference is also made to the forthcoming exhibition of early locomotive photographs and other historical material, which was held at the Boston Public Library during the last week in October. Copies of the Bulletin may be procured from Herbert Fisher, Box 426, Taunton, Mass., or J. W. Merrill, 40 Kilby Street, Boston, Mass.

Train Lighting Equipment Catalogue

The Safety Car Heating & Lighting Company has recently issued two new catalogues descriptive of Safety train lighting equipment, under the titles of "Operation of Underframe Car Lighting Equipment," and "Pintsch Gas Car Lighting Fixtures." Both are profusely illustrated and should prove of interest to those engaged in train lighting work.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

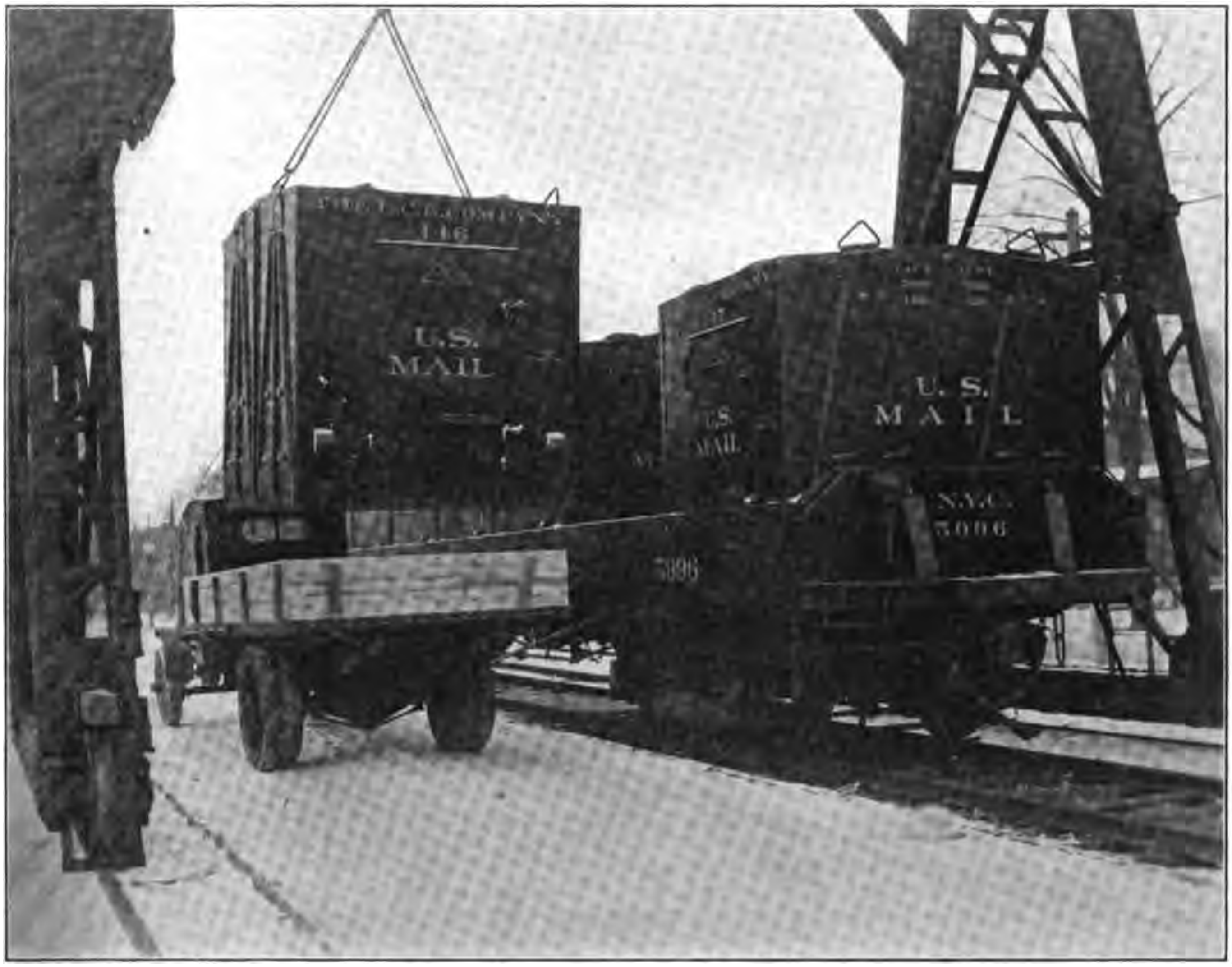
Vol. XXXV | 114 Liberty Street, New York, December, 1922 | No. 12

Container Car Freight Service on the New York Central

In the December, 1921, issue of RAILWAY AND LOCOMOTIVE ENGINEERING there appeared an article under the title of Avoidable Waste in Car Operation, a description of the container cars which were introduced in mail service on the New York Central. A new system of freight ship-

manual labor to a minimum was described in detail by F. S. Gallagher, engineer of rolling stock, before the Society of Terminal Engineers at New York, Oct. 10, 1922, from which we extract the following:

The "containers" have been used regularly in carrying United States mail for whatever to valuable consignments; have reduced necessity of sacking mail and have greatly expedited inter-city deliveries. The "containers" permit a shipper to stow consignments on his own shipping platform and eliminate need of costly boxing and crating.



TRANSFERRING CONTAINER FROM CAR TO MOTOR TRUCK ON THE NEW YORK CENTRAL cars in carrying express and mail matter have now been followed by the establishment of crane equipment for regular "container" service in carrying less-than-carload freight between 33rd Street Station, New York City, and Carroll Street Station, Buffalo, N. Y., the "container" cars leaving each terminal Tuesdays and Saturdays. Special rates have been established under tariffs published with the approval of the Interstate Commerce Commission. These provide rates for a minimum of 3,000 pounds up to the maximum capacity of a 7,000-pound load for each container.

Mr. Gallagher, in describing the new system before the Terminal Engineers' Society, said in part:

"Although the container system of handling less-than-carload freight is too young in years to furnish definite or concrete figures as to costs, we are able to show success in economy and safety effected through the new method. The accomplishment of a means of loading or unloading a car of less-than-carload lots of freight within a few minutes alone carries far-reaching potential benefits, when we take into consideration the railroad equipment of the country and the inability of the railroads to control this equipment during the peak load of business. In times of heaviest demands, it is known that shippers, while waiting for a change in the market, gladly pay the regulation demurrage charges rather than unload the car in which their goods were shipped, using the car as a temporary storage place, and tying up equipment that is badly needed. This condition was very prominently brought out during the war when goods were shipped, especially in this eastern district, to consignees who either could not or did not want to unload the freight, but instead took advantage of the demurrage provisions, which was at an expense to the railroad company for car revenue which they would have had if the car had been unloaded promptly and returned to service, and at the expense of the public at large because of the inability of the railroads to handle greater tonnage because of the lack of equipment.

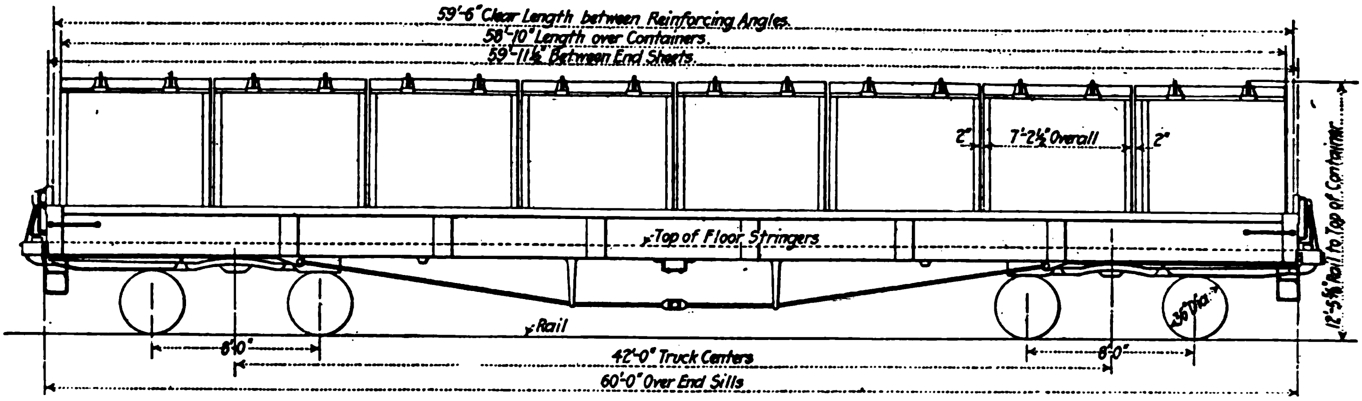
"This condition with the use of the less-than-carload containers should be greatly reduced, if not altogether eliminated, because of the fact that the containers can be removed from the car, immediately taken to the shipper's warehouse, and while there might at some day be a demurrage charge for holding the containers, it would not keep the rolling stock out of service. In other words, the container method of handling freight permits the enforcement of quick unloading, and of course the quick unloading means the quick return to service of the car. During periods when there is a shortage of cars, the quick unloading of the freight car is a benefit to all concerned—the railroads, the shipper and the public.

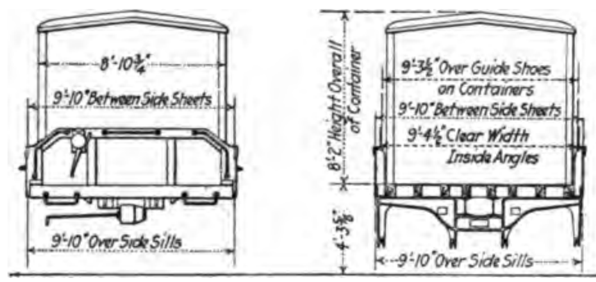
"The saving in labor and time may be seen by noting, in detail, the number of times that less-than-carload lots of freight must be handled from the shipper to the consignee. Let us follow one package from start to destination: First, it is carried from the packing room to the warehouse platform; second, from the warehouse platform to the wagon by hand truck; third, from the hand truck into the wagon. This is man-handling. The wagon then proceeds to the freight house, where at the platform occurs the next man-handling. The fourth man lift is from the wagon to the freight house platform, and the fifth from the platform to the hand truck. The individual package must be weighed, proper records made, and then taken into the car, making the sixth movement. A seventh handling is the stowing into the freight car, after which is attached the seal, which is broken at destination. The eighth handling is by the unloader lifting the freight to the floor of the car for the hand trucker; the ninth, the hand trucker with the package stopping while record is being made of the shipment going out of the car. The trucker then carries this freight to a designated place in the freight house and it is left there.

"The consignee is notified that the goods for him have arrived, sends his wagon to the freight house, and notifies the delivery clerk. The delivery clerk points out the shipment to the hand trucker, who takes it to the wagon for loading, which is the tenth handling. When the package is delivered by the hand trucker to the wagon platform, it is dumped at the tail gate of the wagon, making the eleventh handling, and must be handled the twelfth time to place it into the wagon. At the consignee's receiving platform, the goods must be unloaded from the wagon, making the thirteenth time that this package has been handled.

"Now assuming that a carload of less-than-carload freight were 20,000 pounds, this means that it must be man-lifted thirteen times, or man-power must be provided to lift 260,000 pounds in order to transfer one carload of 20,000 pounds of freight. This does not include the numerous checkings and records that must be made of this freight, which in itself is a big item of expense.

"By the new system, the container is delivered to the shipper, who, if properly equipped, will have a light overhead crane or some other means of carrying the container into his warehouse, so that one handling of the original package into the container is all that is necessary. The expense of crating is eliminated. When the goods are in the container, the door is closed, and if the shipper desires, he can put his own lock on it. The railroad company would also seal the container with





GENERAL ARRANGEMENT OF IMPROVED TYPE OF MAIL CONTAINER CAR the regular seal used on car doors.

"Being loaded with one handling of the freight, the container is lifted by hoist from the floor of the shipper's warehouse to the motor truck and is lifted by hoist from the truck to the car.

"Particular attention is directed to the security of the shipment when placed on the car. The bottom of the door of the container sets in behind the side of the car, making it possible to get into the container while on the car, and the container is big enough so that it cannot easily be taken from the car without proper lifting facilities.

"At destination, the operation described is reversed. The container is lifted by crane from the car onto the motor truck and then from truck to the consignee's platform, where it is unloaded and may be ready for a return shipment, or it may be picked up by truck for the use of some other shipper. While the container is being unloaded, the motor truck, as well as the railroad car, is released for service.

"The containers are 7 feet wide, 9 feet long, and 8 feet high, and they have a carrying capacity of 7,000 pounds. This keeps the gross weight within the carrying capacity of a five-ton truck. The containers are made of steel throughout, except the floors, which are of laminated wood. They are well braced, and there is very little chance of damage with ordinary handling." Each weighs 3,020 lbs., and has capacity for 438 cubical feet.

The Cost of Stopping a Freight Train

An Analysis of a Method Followed in Making an Estimation

To ask what it costs to stop a freight train and accelerate it to the speed from which the stopping started is about like asking the size of a piece of chalk. It depends. It depends on the track—whether straight, curved or on a grade; the length and weight of the train, the locomotive and even on the weather.

It would be so exceedingly difficult to actually make a test, that possibly the nearest approach to the answering of the question is to assume conditions and work out a theoretical case that is as close to practical operation as possible.

The problem is an attractive one, even though it may resemble the setting up of a man of straw.

With this apology for rushing in, where experts might fear to tread, an offering may be made.

Let us assume that the track is level, straight and in good condition. For a train, we will take one of 75 cars weighing 11,121,000 pounds, hauled by an engine with 29½ in. by 32 in. cylinders and having drivers 63 in. in diameter, and with a boiler pressure of 200 lbs. per sq. in. Such an engine would weigh about 398,000 lbs. of which 306,000 lbs. would be on the drivers, while the tender would weigh about 223,000 lbs., making a total of 621,000 lbs. All this is necessary because it is this weight that must be stopped as well as accelerated to speed again.

Then there must be an assumption as to train resistance which if we put it at 6 lbs. per ton for the cars and 8 lbs. per ton for that of the locomotive and tender gives us a total resistance of 35,605 lbs. which is regarded as constant.

In order to include as many of the variables entering into the cost as possible, we will assume, for the engine, a rate of evaporation of 5 lbs. of water per pound of coal, which costs $3.00 per ton. For the steam at a pressure of 200 lbs. per sq. in., the weight will be 47 lbs. per cu. ft. Further it will be assumed that full boiler pressure is maintained in the cylinders up to the point of cut-off. For an acceleration to different speeds, different points of cut-off will be used as the speed increases. For example the reverse lever would be set to cut-off at 89 per cent. of the stroke from the start to a speed of 5 miles per hour. From that to 10 miles per hour two points of cut-off are assumed; one at 89 per cent. and the other at 80 per cent. of the stroke. The former would probably tax the boiler pretty well up to its limit, while the latter would more nearly approach that used in service, but would require a longer time and greater distance in which to accelerate to speed.

Similar assumptions are made for the acceleration from 10 to 15 miles per hour, where estimates are based on cut-offs of 87 and 70 per cent. respectively.

In this estimate it is assumed that the train is running at speeds of 5, 10 and 15 miles an hour; that it is stopped and again accelerated to the speed from which it has been stopped.

In making the stop consideration has been paid to the possibilities of practical brake applications. That is we have taken about a 6 lb. brake-pipe reduction which will give about 15 lbs. brake cylinder pressure, and this developed on each of the 75 cars and the tender with an assumed coefficient of friction of .20 for the brakeshoes will give an actual brakeshoe resistance of about 1.312 per cent. of the weight of the train.

The reason for using this low reduction is that it is desired to make a single reduction stop and a greater reduction would probably cause train trouble.

There are two further brake assumptions which are, first, that it will take 12 seconds for the serial propagation of the appliaction from the engine to the rear car and, second, that, after the train has stopped, it will require 60 seconds in which to release the brakes so that the train can start.

The problem, then, becomes that of calculating the time and distance required to stop and accelerate to speed with the cost; and also the same as involved in running that same distance at the original speed.

It appears that there are five items of cost in this: Wages, brakeshoes, water, coal and wear and tear.

The method of determining these costs can be best followed by a reference to the accompanying table.

The first line gives the speeds of the train in feet per second and needs no explanation. Likewise the second line, which is a repetition of the assumption of the points of cut-off at which the engine is to be worked during the period of acceleration.

From the several points of cut-off the mean effective pressures in the cylinders was obtained and from these the tractive efforts as shown in the third line.

We have already assumed a constant train resistance of 35,605 lbs., and by subtracting this from the several gross tractive efforts we obtain the tractive efforts available for acceleration as given in line 4.

Dividing these "available tractive efforts by the total weight of the train, we get the percentage of the weight of the train as represented by the tractive effort available for acceleration, as given in line 5.

We have assumed that it takes 12 seconds for a brake application to reach the last car. As far as brake resistance is concerned this is taken as equivalent to an instantaneous brake application throughout the train at the end of 6 seconds. The train is, therefore, assumed to be drifting for 6 seconds under the influence of its own resistance which is 0.303 per cent. of its weight. Under these conditions the speeds of the train will have been reduced to those given in line 6 at the end of 6 seconds, and will have traversed the distances given in line 7 during that time.

Then the brakes are assumed to start their work, and together with the internal resistance of the train itself will have stopped it in the distances given in line 8 and in the times given in line 9.

If we add the distances in lines 7 and

8 together, we have the distances traversed to the stop; and, by adding 66 to the times in line 9 we will have the time elapsed from the start of stopping to the start; 6 seconds being for the period of drifting and 60 for that of standing to release.

If on the start the tractive effort available for acceleration as given in line 4, is applied to the train it will be brought back to its original speed in the time given in line 10 and in the distance given in line 11.

By adding the time required for stopping and standing to the time in line 10, we will have the time given in line 12 to stop, release brakes and accelerate to speed. And by adding together the distances given in lines 7, 8 and 11, we have the total distance traversed from the start ing and standing being given in line 16.

This covers all of the items of stopping, standing and acceleration except brakeshoe wear.

One more assumption as to locomotive cut-off and that is that one of 58 per cent. of the stroke be used to carry the train over the distances involved at the original speeds.

A process similar to that already used will give us the time required to traverse the distance by dividing line 13 by line 1. This is given in line 17. Knowing the number of wheel revolutions required we readily obtain the steam consumption given in line 18, and from it by dividing by 5 the coal consumption of line 19.

With this we have all of the elements then, assumed that the wear of the shoes is at the rate of .047 lb. per 1,000 feet, by which the brakeshoe wear given in line 23 was calculated.

In order to determine the extra wages paid for the stop those paid the various members of the engine and train crews were taken to be as follows:

Engineer	$1.00 per hour
Fireman	.77 per hour
Conductor	.80 per hour
Two brakemen @ .69.....	1.38 per hour
Total	$3.95 per hour

Then taking the extra time used on this basis we get the extra cost of wages given in line 25. The cost of brakeshoes is taken at 2.7 cents per pound, and gives the

		Speed in Miles Per Hour				
		5	10	10	15	15
1	Speed in feet per second	7.33	14.66	14.66	22.00	22.00
2	Cut-off for acceleration in per cent. of stroke	89.00	89.00	80.00	87.00	70.00
3	Tractive effort in lbs.	75150.00	68510.00	54800.00	61880.00	47780.00
4	" " available for acceleration in lbs.	39545.00	32905.00	19195.00	26275.00	12175.00
5	Ratio of available tractive effort to weight of train in per cent.	.337	.28	.129	.224	.104
6	Speed of train after drifting 6 seconds in feet per second	7.27	14.60	14.60	21.94	21.94
7	Distance drifted in 6 seconds in feet	43.80	87.78	87.78	131.82	131.82
8	" to stop from drifting speed in feet	50.83	204.95	204.95	454.92	454.92
9	Time to stop from drifting speed in seconds	14.00	28.05	28.05	59.50	59.50
10	" to accelerate to speed seconds	65.80	147.63	242.54	249.42	461.77
11	Distance to accelerate to speed feet	241.45	1136.77	2008.85	3002.07	5155.26
12	Time to stop and accelerate to speed, seconds	145.80	241.68	336.59	374.92	586.27
13	Distance to stop and accelerate to speed, feet	336.08	1429.50	2241.85	3588.81	5669.68
14	Steam used to accelerate, lbs.	315.28	1484.58	2394.59	3866.54	5550.38
15	Coal used to stop and accelerate, lbs.	67.06	301.66	483.60	779.58	1116.35
16	" " while drifting and standing, lbs.	4.00	4.74	4.74	6.27	6.27
17	Time to run distance at speed, seconds	45.83	97.46	152.90	163.13	257.71
18	Steam to run distance at speed, lbs.	149.52	635.94	997.21	1596.60	2522.17
19	Coal " " " " " "	29.90	127.19	199.44	319.32	504.43
20	Extra time used to stop, seconds	99.97	144.22	183.69	211.79	328.56
21	" steam " " " lbs.	165.76	848.64	1397.08	2269.94	3028.21
22	" coal " " " "	38.16	174.47	284.16	460.26	611.92
23	Brakeshoe wear lbs.	1.08	7.25	7.25	14.88	14.88
24	Extra cost for wages	.11	.16	.20	.23	36
25	" " " brakeshoes	.03	.20	.20	.40	.40
26	" " " water		.01	.01	.02	.03
27	" " " coal	.06	.26	.43	.69	.92
28	" " " wear and tear	.04	.06	.08	.10	.14
29	" " " stopping	.24	.69	.92	$1.44	$1.87

TABLE OF COSTS FOR STOPPING AND ACCELERATING A TRAIN

of the stop to the recovery of full speed as given in line 13.

Knowing the distance traveled during the period of acceleration and the rates of cut-off used from the start to the attainment of full speed, and assuming full boiler pressure to be maintained to the point of cut off, and that there is a clearance of 1.5 per cent for the cylinder, then, with the steam weighing .47 lb. per cu. ft. it is possible to calculate the steam consumption for the period of acceleration as given in line 13. If the evaporation is at the rate of 5 lbs. of water per pound of coal, and if the consumption during drifting, retardation and standing is at the rate of 3 lbs. per minute, we will have the coal consumption given in lines 15 and 16. The consumption during drift- involved in the stopping, accelerating and running of the train. It only remains, then, to determine the difference between the two performances in order to learn the extra cost of stopping over that of running the train over the distance covered. By subtracting line 17 from line 12, we have the extra time occupied in making the stop as given in line 20. By subtracting line 18 from line 14 we have the extra amount of steam consumed, given in line 21. By subtracting line 19 from line 15 we have the weight of the extra coal consumed as given in line 22.

The distance that the brakeshoes were running in contact with the wheels is obtained by multiplying the distances given in line 8 by 608, or the total number of brakeshoes on the cars and tender. It is, cost in line 26. Water is assumed to cost 8 cents per thousand gallons in the tender, which on the basis of the extra consumption of line 21, gives the cost in line 27. Coal is taken at $3.00 per ton, and gives the cost of line 28. Then there is an assumption of wear and tear based on a life of seventeen years for the rolling stock with cars costing $1,500 each and the locomotive $60,000. This is placed in line 29, and the total of lines 24 to 28 is the calculated cost of stopping a train and again accelerating it to speed with only sufficient delay to release the brakes; a delay that is here placed at the minimum.

It cannot, of course, be claimed that this calculation gives results that cover the actual costs but it is probably a fairly close approximation. There are so many variables in the case that whoever chooses may substitute his own figures for those assumed and so obtain different results. This is shown by the variations resulting from the simple change in the points of cut-off in accelerating from speeds of 5 to 15 miles per hour. Then there might readily be a disagreement as to the time required to apply and release the brakes, and certainly there could never be any such uniformity of pressure and action as has been assumed. All of these would tend to increase the cost of the stop, in time occupied and distance traversed before reaching the initial speed after acceleration. As to what percentage should be added to the total cost of stopping the train, there would probably be as many opinions as there were men expressing them. So it is left to the reader to make his own additions.

But, if the method pursued is admitted to be a correct one, and the results adopted as approximately accurate, they will probably seem low to the majority of those who have thought about the matter. One interesting thing about the totals is that, discarding the continued use of 89 and 87 per cent. cut-off to accelerate to a speed of 15 miles per hour, and referring to the 80 and 70 per cent. columns, we find that the costs rise approximately as the squares of the speeds.

Thus, the stop from ten miles an hour cost four times that from five. On the same ratio the stop from fifteen miles an hour should have cost $1.98 instead of $1.79, which is a little more than eight times the first instead of nine.

There were two reasons for limiting these calculations to stops from a speed of 15 miles an hour. The first one is the rule in effect on a large number of railroads that if the brakes are applied and the speed reduced to 15 or less miles per hour, they must not be released until the train has been brought to a stop.

The second reason is that the engine assumed would have great difficulty and require a long time to accelerate the train assumed to a speed of 20 miles an hour and would probably be quite unable to raise it to 25 or 30 miles an hour on a straight and level track.

The first reason is based on an operative condition met in daily practice and involves a cost that must be repeated many times each day.

If the grade were to be changed to a descending one, the distance required to stop would be increased but the time and distance required to accelerate would be so diminished that the total cost would probably be lessened. On the other hand if the grade were changed to an ascending one, the time to stop would be decreased but the time and distance required to accelerate would be so increased as to probably increase the cost. This would also, probably, be increased still more if any curve resistances were introduced into the calculation.

Employing and Educating Enginemen and Firemen

A Committee, J. B. Hurley, Chairman, Presented the Following Report to the Traveling Engineer's Association

In the past when locomotives were small and always easily handled in case of breakdowns and when the pooling of power had not become as universal as it is today, an entirely different method of employing, educating and examining enginemen naturally obtained than under present conditions.

In the first place, railroading held out attractions greater than other lines of employment, as far as wages, physical labor, etc., were concerned. As a result there were usually more applicants than there were jobs, and consequently it was possible to pick from the applicants the men whom we thought best suited for the position.

The position of locomotive engineer was worth working for and as the first step in this direction as a job was fireman, it followed that there were many applicants for this position. Foreign labor was not as plentiful as it is today and consequently what are now termed laboring jobs, such as wiping, knocking fires, cleaning cinder pits, helping machinists and hostlers, and other jobs about roundhouses were filled by young Americans, and each of the above positions was considered as in line for a job of firing. Entering the roundhouse usually as a wiper, the young man graduated to a position of fire knocker, then to that of hostler helper, and then as a fireman on a switch engine. The result was that during the time he knocked about the roundhouse in the above capacities he absorbed a lot of valuable information covering the construction, care and maintenance of a locomotive.

When he finally became fireman on a regular engine it was expected of him and the engineer to take care of it, and as the locomotives were small, it was seldom more than a two-man job in case of accident to disconnect any broken parts and load same up or to make such temporary repairs as would enable them to get the locomotive to the terminal. They became thoroughly familiar with this part of their work and, consequently, any instructions handed to them were along the above lines and any examination given them necessarily embraced more what to do in case of accident, so as to enable them to bring the engine in, than the actual running of the locomotive or handling of the train, it being taken for granted that a man who was thoroughly familiar with the construction of the machine and had some experience as fireman would be equally as capable of successfully running the engine and handling the train.

Since this time, however, things have changed—the old-time engine as well as the old-time engineer are largely a thing of the past. The engine crews no longer take care of the same breakdowns they used to handle with ease years ago; other conditions have changed likewise, that is, other fields of labor are proving more attractive from a financial point of view than locomotive running. Again, due to the fact that locomotives are increasing in size and capacity with the increase in business, it follows that the firing period to promotion is likewise extended, therefore we are finding it more difficult all the time to obtain satisfactory material from which to make our future engineers.

The human organization has not received the proper attention on most of the railroads, although it is true that successful operation depends in a large part upon the human element. A good organization can and often does accomplish good results with inadequate and poorly maintained equipment, but a poor organization cannot produce other than poor results, even with the equipment entirely adequate and well maintained.

It is our opinion that the labor supply should be developed in the territory served. We are prepared to say why more good men are not attracted to this vocation in late years. As before stated, other fields of labor are proving more attractive from a financial standpoint. Although the pay has been increased and working conditions improved, it is less laborious, large power being mechanically fired, and there are better opportunities to become educated in this particular branch of the service than ever before. Young men leaving school or university and seeking employment for the first time, should be informed by circular or other printed matter where to apply to railroad offices and who to apply to for the particular job for which men are wanted. This should be done by mailing this information to station agents to be posted on bulletin boards at stations. Unless men live at railroad division points, they know little or nothing about the opportunities in railroad service. Systematic development of the labor material available will do much in remedying labor conditions on railroads at the time of year when men are needed. The employing officer should have regular days in his office to confer with applicants for positions, and this information should be given on circulars posted. This officer should be a responsible person and carefully selected. The first impression made on an applicant is usually a lasting impression. Does he ask the applicant to sit down and treat him as he would like to be treated by taking interest enough in him to ask where he lives and when he arrived, what vocation he followed, if any, and where he could be found when needed, and, in the meantime, judging his mental and physical fitness for the job intended for, before giving him the application to fill out? It will be claimed that no one has time to converse with all the men who apply for jobs. This may be true, but might it not be cheaper in the end to have some capable person or organization responsible for handling all applicants with the occasional chance of getting the right man at a time of need, instead of finally having to take whoever comes? First, a kind word of encouragement to the promising man, a word of advice to improve himself by study, a recommendation where to obtain literature by recognized authorities on the subject of firing, and a record or symbol written on the face of his application is all that is needed in the way of a preliminary record.

The best practical training to fit a fireman to meet the variable conditions always present in locomotive operating is on the deck of the engine in the midst of those variable conditions. In other words, the training should be more practical than that which can be obtained by any other method. The real practical training starts when the new man makes his first trip on an engine and under personal instructions by a competent instructor works to keep the engine hot without wasting steam at the pop valve, strives to save coal without starving the fire too much, and tries to prepare the fire to meet a sudden change in working of steam without making black smoke.

The first trips of a new man on the engine are his habit-forming trips. They are more important in their effect on the direction of his habitual attitude toward his work and toward the welfare of the company, and in their effect on his sense of duty and responsibility and on his character than any other number of trips of his life. He should be instructed by the Traveling Firemen or the Traveling Engineer, or sent out with the best crew on the divisions if the Traveling Fireman or the Traveling Engineer are not available.

We believe railroads should establish a system of progressive examinations when a man is employed first as a fireman. He will be given the questions on which he will be examined at the end of the first year; having answered these questions satisfactorily, he will then be given questions for the following year. Having passed this examination, he will be given a third and final set of questions, on which he will be examined before being promoted to engineman.

It is not expected that a man will answer these questions without assistance, and in order that he may understand them properly, there should be established a school of instructions in the use of the air brake and all other locomotive appurtenances. He should also be invited to ask the Master Mechanic, Traveling Engineer or Air Brake Instructors or any other official for such information as may be required on any points in connection with his work. He should not only be invited, but urged to do so, as the more knowledge the fireman possesses the better the results which can be obtained. He will have ample time to study each set of questions, therefore there is no doubt but that with a reasonable amount of study each week the information required to answer satisfactorily the entire list of each series of questions can be easily mastered in the time given.

In connection with the examination, the work done by the fireman during the time of his service will be carefully noted and how it compares with that of other firemen engaged in the same class of service; also his record as to the use of coal, oil, etc., will be taken into consideration. It is hoped that he will give everything in detail the consideration it merits and realize fully that it is by looking after the little things that a man succeeds. It should be borne in mind that it is only by filling well the position that one has that a person is entitled to the confidence that makes a better position possible.

The following describes the method and time of holding these progressive examinations: He will be required to pass written and oral examinations in the manner prescribed by the officials in charge.

If a man passes 80 per cent or more in all examinations he should be given a certificate.

If a man fails to pass the first or second examination, he should be dropped from the service.

At the third examination, if a man should fail to pass 80 per cent of the questions asked, two more trials not less than two months apart will be given him to pass the same examination. If he then fails to pass by a percentage of 80 he shall be dropped from the service.

Firemen passing the third and final series of questions will be promoted in order of their seniority as firemen, except that those who pass on the first trial shall rank when promoted above those who pass on the third trial.

Enginemen employed shall be required to pass the third series of questions before entering the service.

How Rates Decreased Before Regulation

The average charge for hauling a ton of freight one mile in 1865 on the Chicago, Milwaukee & St. Paul Railroad, according to Mr. H. E. Byram, president, was 4.1c. In 1871 it was 2.5c.; in 1881 it was 1.7c.; in 1891 it was down to 1c.

In 1901 it had been reduced to .86c. and in 1916—the year before this country entered the war—it was only .74c., which was a low mark.

In 1921 the full effect of rate increases authorized by the government during Federal control to offset increases in expenses, brought the rate up to 1.27c. per mile.

In connection with these figures Mr. Byram says:

"They show conclusively that when the carriers have a measure of control over their rates and expenses the rates came steadily down."

Meeting of the American Society of Mechanical Engineers

The Forty-third annual meeting of the American Society of Mechanical Engineers will open in New York on December 4, and will last four days.

Three papers on locomotive design and operation will be presented at the Railroad Session which will be held on December 6. The titles of the papers and the authors are as follows: Steam Distribution in the Locomotive, by George H. Hartman, Locomotive Appliance Company; Mechanical Drafting of Locomotives, by F. H. C. Coppus, Coppus Engineering Corporation; Stresses in Locomotive Frames, by R. Eksergian, Baldwin Locomotive Works. James Partington of the American Locomotive Company, the new chairman of the Railroad Division will preside.

On the evening of December 6, the society will hold a joint session with the American Economic Association at which L. F. Loree, president of the Delaware & Hudson will deliver an address, and E. M. Herr, president of the Westinghouse Electric & Manufacturing Company will speak on the Human Element in Industry.

Railway Bills in Congress

According to Senator Cummings of Iowa, chairman of the Senate committee on interstate commerce, there are over 500 bills pending before the committee that would affect railway finances, or railway operation and management in one way or another.

The General Railway Situation*

By Charles H. Markham, President of the Illinois Central Railroad

We have witnessed this year a remarkable change in conditions in the United States. The country recently was passing through one of the most profound business depressions in its history. It has emerged from this depression, and has entered a period of activity in production and commerce such as those which always have followed its panics and depressions in the past.

At the very threshold of this new era, however, we are confronted with a shortage of railroad transportation.

The railways have moved more grain this year than ever before in history. Nevertheless, the farmers complain that, although their big corn crop has not all been harvested, they cannot get enough cars for even the grain that is ready for shipment. Lumber manufacturers find themselves unable to ship the lumber they have produced and for which there is a demand.

The coal mine operators cannot get anywhere near as many cars as they order. Manufacturers of iron and steel show that their output is being restricted because the railways cannot deliver them enough fuel and raw materials. Road building and other construction concerns complain that their business is interfered with by the priority in the use of open top cars being given to coal under an order of the Interstate Commerce Commission. Growers of fruit and vegetables say they are suffering large losses because they cannot get enough refrigerator cars.

Some of these complaints are exaggerated. Some are without justification. But they reflect a nationwide condition, the existence of which cannot be questioned.

In every past time when there was a shortage of transportation it was felt only after the revival and increase of business had been going on for some time and had carried production and commerce to higher levels than ever before. What we call "car shortages" always have represented inadequacy of all railroad facilities. The "car shortages" of 1906 and 1907 did not come until toward the close of a ten year period of industrial and commercial expansion during which the railways had increased by two and one-half times the volume of freight carried by them. The car shortages of the war years did not begin until when, in 1916, the railways were handling 20 per cent more freight than in the previous record years.

The significant fact which challenges our attention regarding the present shortage of transportation, is that it has been met at the very beginning of a period of business revival.

The railways are now moving about as much freight weekly as in 1920, when the highest record was made. In spite of this the "car shortage" recently reported has been the largest ever known, and the demands of shippers continue to increase. In past periods of business revival the increase in freight business has gone on until it has reached a point 35 to 150 per cent higher than ever before. We may well ask ourselves whether, with the railways finding it difficult to surpass the freight carrying record of 1920, they can be expected within a few months or years to handle such an increase in tonnage as past experience shows would be only normal in a period of general revival.

Secretary Hoover recently estimated that every period of shortage of transportation costs the country at least a billion dollars.

Why are we suffering from this shortage of transportation at the very beginning of a business revival? The correct answer must be given to this question, and the public must be convinced that it is correct. Without an informed public opinion the situation cannot be remedied.

The situation is partly due to the coal strike and the shop employes' strike. But it would be a serious mistake to assume that these strikes have caused the present shortage of transportation and that it will disappear when their effects have been removed. The causes of the present shortage of transportation and the still greater shortage there is reason for fearing, go much deeper and farther back.

During the last fifteen years the production and commerce of the country, in spite of occasional reverses, have grown as rapidly in proportion as in previous years. The increase in the freight offered the railways conclusively proves this. But during this time the development of the facilities of the railways has steadily and rapidly declined.

In the five years ending with June 30, 1907, the number of locomotives in service on the railways of the United States increased 18,160. The end of this period coincided with the beginning of the period of restrictive regulation.

Compare this with the increases that have occurred since then. In the five years ending with June 30, 1912, the increase in the number of locomotives in service was only 8,447; in the four and one-half years ending with December 31, 1916, it was only 4,558; and in the five years ending with 1921 the number of locomotives in service actually *decreased* 664.

The locomotives retired were constantly being replaced with more powerful engines, and the increase in the total tractive power, or total pulling capacity of the locomotives in service in the first five years of this period was 640 million pounds. In the next five years it was only 338 million pounds; in the next four and a half years 367 million pounds; and in the five years ended with 1921 only 262 million pounds.

Now take freight cars. In the five years ending with June 30, 1907, the number in service increased over 480,000. In the next five years it increased less than 230,000; in the four and one-half years ended December 31, 1916, it increased only 114,000; and in the five years ended with 1921 the number of freight cars in service actually *declined* 13,621.

The cars retired were constantly replaced with cars of larger capacity, and the increases in the total capacity of the freight cars in service were as follows: Five years ended with 1907, 25 million tons; five years ended with 1912, 16 million tons; four and a half years ended with 1916, 12 million tons; five years ended with 1921, 3½ million tons.

Comparison of the figures for the two five-year periods farthest apart show that the increase in the total tractive power of locomotives was almost 60 per cent less, and the increase in the total capacity of freight cars 85 per cent less in the five years ended with 1921 than in the five years ended with 1907.

The decline in the amount and capacity of the equipment provided has been accompanied by a corresponding decline in other facilities provided. Construction of new lines, which formerly averaged about 5,000 miles a year, has dwindled until during the last five years more mileage has been abandoned than built. The enlargement of terminals, the construction of second and other additional main tracks, the improvement of stations, have been for years coming nearer and nearer to a standstill.

I am a firm believer in the principle of regulation, but I also believe that government regulation as it has been practiced for fifteen years is almost wholly responsible for the decline of railroad development and for the existing shortage of transportation.

For ten years before the war regulation kept down the rates and reduced the net return of the railroads, although wages, prices and the returns earned in other lines of business were increasing. Persons who had money to invest more and more avoided the railroads. The market value of their securities declined, and with it the capital they could raise to expand their facilities.

For months while the managements of

** Abstract from an address delivered before the Railway Business Association in New York on November 10th.*

the railways were struggling desperately to reduce current expenses and even deferring maintenance work that needed to be done, controversies over both rates and wages raged at the same time.

Among the results were large increases in the number of locomotives and cars in bad order, less expansion of facilities than for many years, reductions of rates made by the railways voluntarily or under orders of the Interstate Commerce Commission which, on the basis of the business handled in 1921, amounted to $400,000,000 a year, and reductions of wages authorized by the Railroad Labor Board which resulted in the shop employes' strike.

Reductions of rates were advocated on the ground that they were essential to a revival of general business. Without now arguing the question whether they were desirable or not, it is notable that general business began to revive before any reductions of rates were made.

Clearly it is essential to the welfare of the country that the railways should as rapidly as practicable put their existing facilities in good condition, and that they should for some years rapidly improve and expand their properties.

What is necessary to insure that this will be done? The point cannot be too strongly emphasized that no policy ever will do any good which is not based mainly on the principle that if the railways are to render good and adequate service they must be allowed to earn a sufficient net return to pay the going rate of interest and reasonable dividends on their existing bonds and stocks, and also on such amounts of additional bonds and stocks as they must issue and sell if they are to raise the new capital required to carry out a program of expansion.

The question is not what interest and dividends railways ought to pay. It is what they *must* pay to get capital. During recent years the railways have not been able to meet the competition of other concerns for new capital by offering relatively as high rates for it. Therefore, they have not got their share of it. That is almost the sole reason why railroad expansion has declined.

The Interstate Commerce Commission having, after two years more of investigation, again held reasonable the valuation placed by it upon the railways in 1920, has held it would be fair and in the public interest for them to earn in future an average annual net return of 5¾ per cent on their valuation. In view of past experience in the railroad business and of present economic conditions it is impossible to comprehend how any reasoning mind could conclude that the earning by the railways of any smaller average return than 5¾ per cent over a period of years would enable them to raise the large amounts of new capital which, in the interest of the entire producing, commercial and consuming public, they should raise and invest.

It is a fact, however, which we must not minimize or disregard that a strong and widespread propaganda is being carried on to secure legislation to reduce the net return of the railways to a much lower basis than that which the Commission has held reasonable.

It has been proposed in bills introduced in Congress to restore to the states the same authority to regulate rates that they had before the Transportation Act was passed. This would remand the railways again to the rule of 49 masters. It would result in the states again making state rates lower than the corresponding interstate rates. It would destroy the ability of the Interstate Commerce Commission to so regulate rates as to enable the railways to earn adequate net returns.

In addition, the valuation made by the Interstate Commerce Commission is being attacked by certain labor and political leaders on the ground that it is from $5,000,000,000 to $7,000,000,000 too large.

Basing its estimates mainly upon the wages and prices of materials which prevailed in 1914 the Commission, after eight years' work in carrying out the valuation law, has found that the value of the railways as a whole, while less than the investment shown by their books, is more than $2,000,000,000 greater than the amount of their securities actually outstanding in the hands of the public.

The Commission is composed of eleven men who have been appointed by three different presidents from nine different states. Only one of them ever was a railway officer, and five of them have been members of state commissions. Nothing could be more unreasonable than to assume that such men would be disposed unduly to favor the railways, or that after their years of study of the problem they would be less able to make an intelligent valuation than politicians and labor leaders.

The attack is directed chiefly against the rate-making provisions of the Esch-Cummins Act. The most important of these provisions now in effect is that which directs the Interstate Commerce Commission in fixing rates to consider the need of the country for adequate transportation. Therefore, the principal thing Congress would do by repealing the rate-making provisions would be to say in effect to the Commission that it should not in future consider the need of the country for adequate transportation.

Plainly those who advocate this policy ignore the fact that the greatest present menace to the prosperity of the country is that it has not adequate means of transportation. No more deadly blow to railroad credit, to the ability of the railroads to expand their properties, to the nation's good faith and prosperity, could be struck than by legislation such as they propose.

There is no doubt, however, that further attempts will be made to secure changes relating to the settlement of labor controversies and those relating to rate-making. The public and the railroads long since decided it would be best for all concerned for differences between the railways and their employes which could not be settled by direct negotiations to be settled by arbitration.

The principle of arbitration of railway labor controversies that cannot be settled by direct negotiations is absolutely sound and should and must be maintained. The public should and in the long run will refuse to tolerate such private wars and interferences with service in an industry whose efficient and uninterrupted operation is essential to its welfare.

Most of the troubles of mankind are due to lack of understanding or to misunderstanding. A very large majority of the employes of the railways are good citizens who do their duty as they see it, and who desire to contribute their share toward their country's progress and prosperity.

I have an abiding faith, based upon long experience as a railway officer, that if the managements of the railroads will not only treat the employes fairly, but will also get to them the facts about the railroad business which they are entitled to know, and appeal to and rely upon their intelligence and good sense, a large majority of railway employes will respond in what they say and do in the same spirit.

I have an abiding faith in the fairness and good sense of the American public. The public does not and never did desire to confiscate any investment which has been honestly and sanely made. Our farmers, business men and working men would not give a moment's hearing to demagogues and enemies of social order who propose to solve the railroad problem by scaling down the valuation billions of dollars thus confiscating billions of dollars of legitimate investment if they knew more of the facts about the railroad business and in consequence understood the significance and purpose of such reckless and wholly unprincipled proposals.

That the public has so often been misled regarding railway matters in the past, and that so large a part of it is being misled regarding them now, is largely due to the failure of the railways frankly and persistently to present their case to the public. The problem is so essential to the welfare of all of us, that we should be given the cooperation and support of public men and of the press.

We have relied too long on presenting our case mainly to legislative committees, commissions and courts. In the long run public sentiment always has, and it always will, determine what lawmakers, commissions and courts will do; and until we do what is necessary to make the public understand the railroad situation and the railroad problem we shall never long have a sound policy of regulation.

Most Powerful Passenger Locomotive in the World

A Description of the New Mountain Type on the Denver & Rio Grande Western R. R.

The American Locomotive Company recently delivered ten heavy passenger locomotives of the mountain type to the Denver & Rio Grande Western Railroad. They are said to be the largest passenger locomotives in the world and are intended to handle, on passenger schedule, trains that have heretofore required two engines of other types.

Some of the principal dimensions of the engines are as follows:

Cylinder diameter	28 in.
Piston strike	30 in.
Driving wheel diameter	63 in.
Boiler pressure, per sq. in.	210 lbs.
Tractive effort	66,600 lbs.
Wheel base—	
Driving wheel	17 ft. 3 in.
Engine	39 ft. 10 in.
Engine and tender	82 ft. 2¾ in.
Length over all	95 ft.
Fire box—	
Length inside	120⅛ in.
Width Inside	96¼ in.
Tubes—	
Diameter	2¼ in.
Length	20 ft.
Number	220
Superheating tubes—	
Diameter	5½ in.
Number	58
Heating surface—	
Tubes	2,580 sq. ft.
Superheater tubes	1,662 sq. ft.
Arch tubes	35 sq. ft.
Fire box	333 sq. ft.
Total	4,610 sq. ft.
Superheating surface	1,428 sq. ft.
Grate area	82.2 sq. ft.
Boiler shell, inside diameter first ring	94 3/16 in.
Weight on drivers	257,500 lbs.
Total weight of engine	377,000 lbs.
Total weight of engine and tender	644,600 lbs.

DENVER & RIO GRANDE RAILROAD MOUNTAIN TYPE LOCOMOTIVE. (BUILT BY THE AMERICAN LOCOMOTIVE CO.)

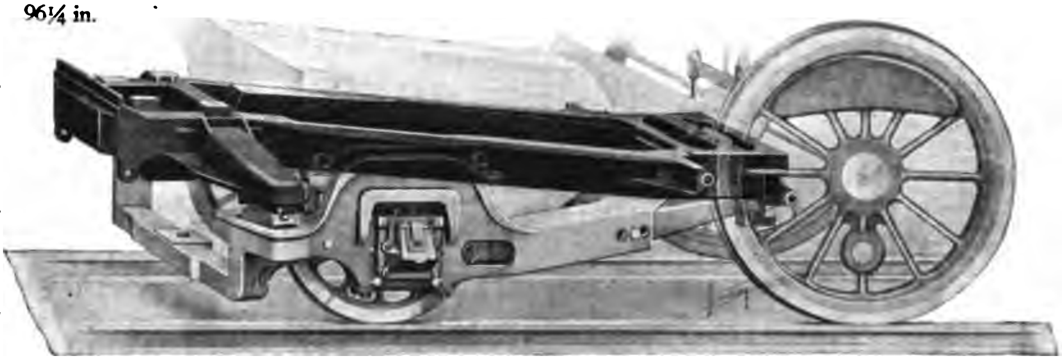
The brick arch is carried by five 5-in. arch tubes and there is a combustion chamber in the boiler 40 inches long.

With the tractive effort as given and the weight on the drivers, the factor of adhesion is 386.

The rigid wheel base is given as 11 ft. 2 in., while the driving wheel base is 17 ft. 3 in. This is effected by giving the trailing driving wheel considerable lateral play in the boxes.

The tender is exceptionally large and heavy, as it has a capacity of 14,000 gallons of water and 22 tons of coal. A large amount, but when working to its maximum capacity the boiler will evaporate 8,000 gallons of water per hour, and burn 5½ tons of coal, for which a mechanical stoker, the Duplex Type, is provided. The horsepower capacity of the boiler is 3,300.

Not only is the engine heavy and long but it is also broad and high; as the total width over all is 11 ft. 2½ in. and its height is 16 ft. This is about 1 ft. each way greater than that permissible by the ordinary clearances.



DELTA TRUCK USED ON MOUNTAIN TYPE LOCOMOTIVE

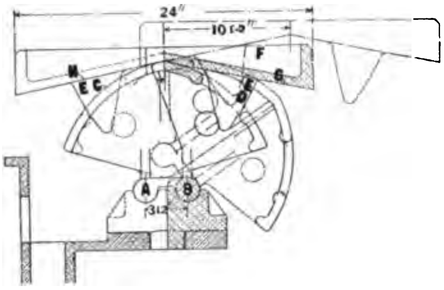
Among the interesting specialties with which this engine is equipped is the Delta truck made by the Commonwealth Steel Company of St. Louis, Mo.

This truck combines in a single casting the radius bar members, journal box guides, end transom and equalizer pivot. It is loaded at three points—two at the rear and the third at the front end center pivot. This, with the equalizing arrangement provided by the use of a separate trailer equalizer, pivoted on the truck frame, makes the truck particularly easy riding.

This is also the only truck that is designed to carry a booster engine, as it has a member at the rear to which the booster engine seat may be applied, and which has only a small amount of vertical movement. In the case of the locomotives under consideration, clearances have been provided so that booster engines may be applied at any future time, should the railroad company so desire. The perspective view of the truck shows the general arrangement and the method by which these points are effected.

The load, as applied to the two points at the rear, is carried by a constant resistance rocker that rests in a pocket on each side of the trailer track frame and supports the cradle directly. This arrangement is peculiar to the Delta truck, and gives a positive centering effect to return the cradle to its central position after curving, and also minimizes the oscillation at the rear end.

This rocker is shown in detail in the special engraving. It consists of a heavy casting with a bearing surface in the form of a gothic arch. When the engine is on a tangent track and the cradle and truck are in line the two supporting points *A* and



DETAILS OF CONSTANT RESISTANCE ROCKER OF DELTA TRUCK

B of the rocker rest in their seats in the pockets. The bearing surface *C* is an arc of a circle whose center coincides with the center of *B* and the corresponding surface *D* is a similar arc with its center at the center of *A*. The radius of each is 10 15/16 in. The seat *F* in the cradle has two inclined surfaces *G* and *H*. When the truck is in its normal central position, the inclined surface *G* stands at right angles to a radius drawn from the center of *A* to the point of intersection of the two curves *D* and *C*, and the surface *H* is at right angles to a similar radius drawn from the center of *B*.

Then if, for example, the cradle moves to the right the rocker turns on *B* and *A* lifts from its seat. As the distance from *A* to *B* is 3¼ in. the rocker rests in the angle between the surfaces *G* and *H* and lifts the cradle through the first 1¾ in. of its movement, and then the cradle rolls up on it so that it is lifted continually from the moment it moves out of center. The total distance that the cradle can move is 10½ in. on each side of the center.

In order to prevent the slipping of the rocker and cradle surfaces over each other there are two prongs *EE* projecting downward from the inclined seat on the cradle through openings in the rocker.

The dotted lines show the cradle seat and the rocker in their extreme positions.

The Commonwealth, that is used, has been applied to a very large number of locomotives and combines in one piece the miscellaneous castings used at the rear end of locomotives with the built up construction.

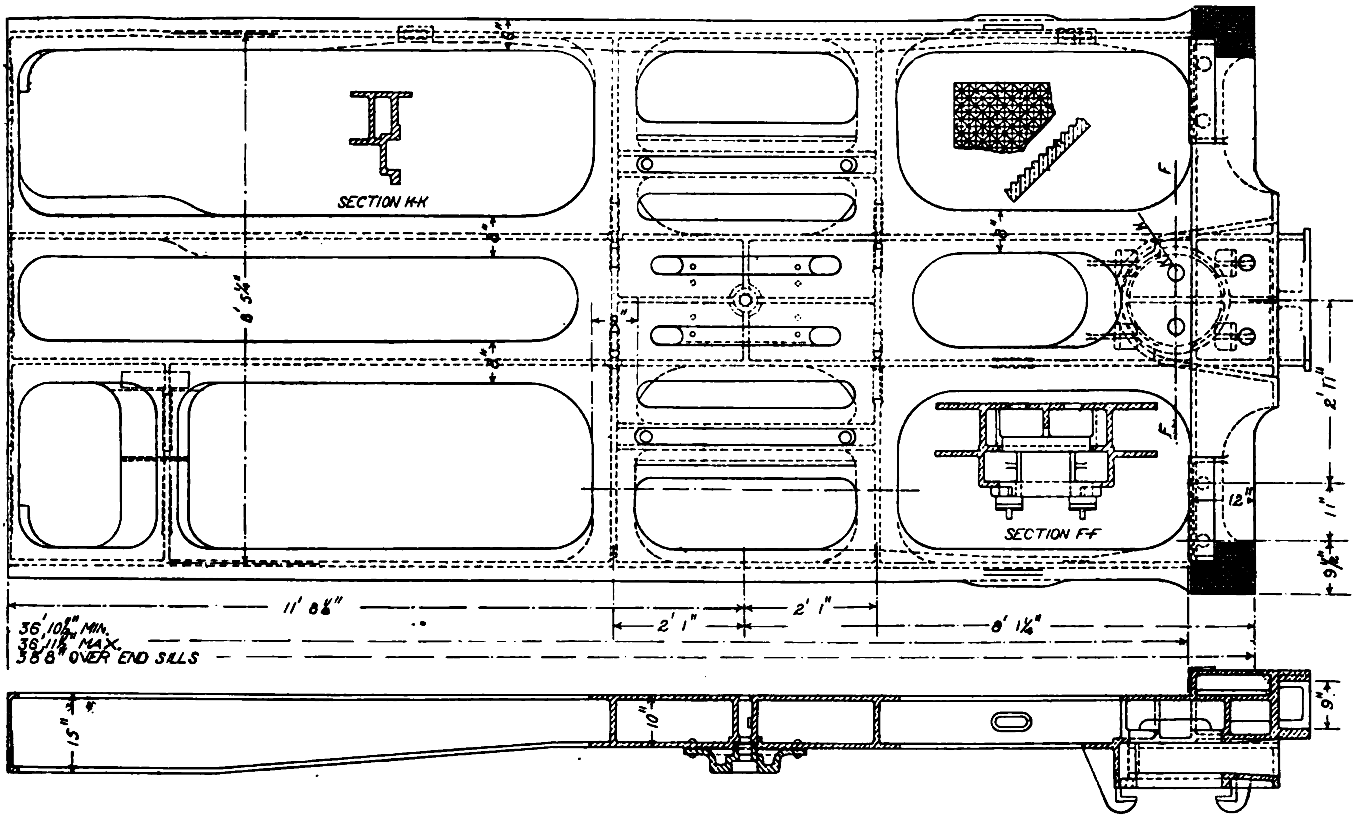
Attention has already been directed to the large capacity of the tender in coal and water. This necessitated a correspondingly heavy frame and truck. The accompanying engraving illustrates a plan and side elevation of about one-half the length of the frame. The remarkable thing about this frame is that it was cast in one piece. This frame is 38 ft. 8 in. long over the end sills and 8 ft. 11¼ in. wide over the side sills. The sills are fish-bellied 15 in. deep at the center and 10 in. at the ends. The material is kept at a uniform thickness of 1 in. throughout the whole structure.

The great weight of the tender and its load necessitated the use of the 6-wheel truck, which is shown both in the line and half-tone engravings. As in the case of the tender frame the truck frames were cast in one piece by the Commonwealth Steel Company. This frame has a total length of 11 ft. 9 in. and a width of 7 ft. 2½ in. It is cast with two transoms and an opening between them for the center plate and truck bolster. The side frames are cast in the form of an inverted U at the center and wheels, as shown in the half section at the center, while on the line *A B* it is of box shape with one side partially cut away to give access to the equalizer *C*. The transoms are box-shaped with horses for the bolster hangers. The bolster on which the side bearings are cast is H-shaped in plan and is suspended from the transoms of the frame by the hangers *D*.

An interesting feature of this truck is the spring suspension, which reminds one of that of the Norfolk & Western six-wheeled truck described in RAILWAY AND LOCOMOTIVE ENGINEERING for August, 1922, although it is quite different from it.

The truck bolster with its center plate and side bearings is suspended by hangers from the two transoms, thus transmitting the whole weight of the car body directly to the truck frame. As these transoms lie midway between the wheels an unequal load would be imposed on the wheels if the truck rested directly on oilbox springs.

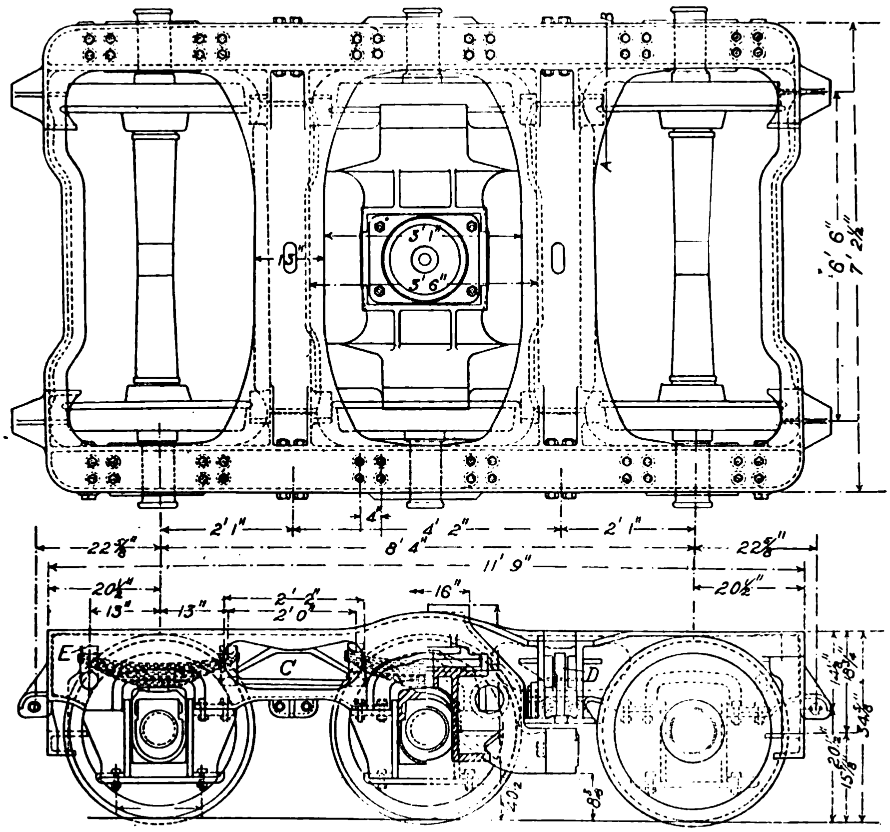
Semi-elliptic springs are used on the oilboxes, and these are 26 in. long from center to center of their hangers. The hangers at *F* at the outer ends of the outer



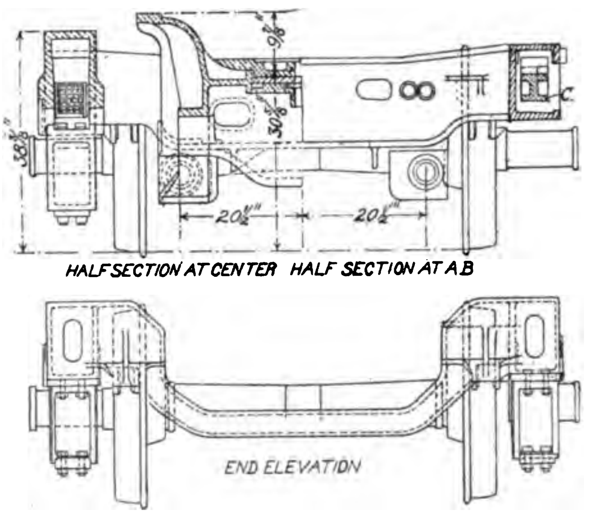
PLAN AND SIDE ELEVATION OF TENDER FRAME OF DENVER & RIO GRANDE LOCOMOTIVE. (BUILT BY COMMONWEALTH STEEL CO.)

wheel springs take hold of the truck frame directly. In a line with the center of the transom, 1-shaped equalizers *C* are placed. These are 20 in. long from center to center of their hangers, and bear against the truck frame at their centers while their ends rest in stirrup hangers carried by the ends of the semi-elliptic springs.

The action can be most easily understood by reference to the illustration of the diagrammatic arrangement of the suspension. The semi-elliptics rest on the axle boxes 1, 1, 1. The end elliptic takes hold of the truck frame at 2, 2. The truck frame also rests on the equalizers at 3, 3, so that it is supported at the four points



SIX WHEEL COMMONWEALTH STEEL TENDER TRUCK FOR DENVER & RIO GRANDE MOUNTAIN LOCOMOTIVE



SIX WHEEL TENDER TRUCK

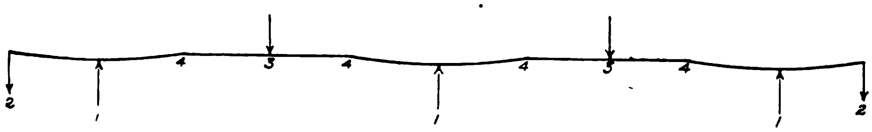


DIAGRAM OF SPRING SUSPENSION OF SIX WHEEL COMMONWEALTH TRUCK FOR DENVER & RIO GRANDE WESTERN MOUNTAIN LOCOMOTIVE

2, 3, 3 and 2. As the points 3, 3, are in line with the center of the bolster they would naturally take the whole weight of the car and would put only half as much weight on the outer wheels as on the center one. But as the weight, put upon the equalizers at 3, is distributed equally to the springs at 4, 4 the end springs act as equal-armed levers and exert the same lifting force on the truck at 2 as there is a downward pull on them at 4. In order to meet this upward thrust an amount of weight equal to this lifting force is carried by the frame from the bolster to 2, so that only two-thirds of the load put upon the transom by the bolster is transmitted to the equalizer at 3. And, as half of this is put upon the center spring by the equalizer at 4, it follows that one-third of the total weight of the tender is carried by the center wheels and the same amount by each of the two others.

The axle journals are 6 in. in diameter and 11 in. long. The pedestals are finished on their upper surfaces and bolted to the frames.

Air Brake Association Proceedings

The printed proceedings of the 29th Annual Convention of the Air Brake Association will be issued later this year than usual, we are advised by Secretary F. M. Nellis, for two reasons: First, because of postponement of the convention from its usual time early in May to the latter part of June. Second, because of the shopmen's strike, during which air brake men were pressed into extra duties, making it impossible to find time to correct and return their remarks to the Secretary for printing. However, the book is now on the press and should be ready for distribution about December 15.

New Haven Orders Twelve Electric Locomotives

The contract for five electric locomotives recently placed with the Westinghouse Electric Manufacturing Company has since been increased intermittently until a total of twelve locomotives are now covered by the contract. The entire number will be practically a duplication of those now in operation in high speed passenger and freight service into the Grand Central Terminal, New York City.

Each locomotive will weigh approximately 181 tons and will be of the 2-6-2-2-6-2 type. The equipment will be such that the locomotives can haul a 900-ton train in express passenger service on either 11,000 volts alternating current or 600 volts direct current. The locomotives will be driven through gears and quills by six twin motors. When the twelve new locomotives are put into service there will be a total of 117 Baldwin Westinghouse freight, passenger and switcher type locomotives in operation on the New York, New Haven and Hartford Railroad.

Can Our Railroads Come Back?

A Review of Certain Phases of This Most Important Question

By W. E. SYMONS, Consulting Engineer

One of the most important questions before the people of this country, since the return of our railways to their owners, has been, "Can they come back?" and although our ablest railway executives, statesmen, bankers and writers have devoted much time to the subject, yet there still seems to be a wide range of opinion or diversity of thought, both as to responsibility for their condition, proper remedial measures, and what progress has resulted from their application.

To come direct to the point at issue, I would say, yes, they *can* come back, and considering the stupendous task involved have made *wonderful* progress in that direction.

Just what the final outcome will be is of course at present somewhat problematic, although it can be safely said without fear of successful contradiction, that if the railways are accorded fair treatment by the Government and all others at interest *they will come back*, and by this same token the writer has no hesitancy in saying, that if the *railways had been accorded fair treatment* by the Government both prior to and during the war, they would *not* today, as a whole, be in a condition to warrant the general criticism now directed against them.

Having thus defined my position and taken issue with certain railway critics, it seems quite proper my reasons should be clearly set forth.

First, while I hold no brief to defend either the Railways or the Public, and do not hesitate to admit instances of mismanagement or wrongdoing on the part of the railways in the past, yet with equal frankness I hold the railways *were not* treated fairly in the past and are not today receiving the aid and cordial support essential to their success.

For more than thirty years many of those seeking political preference or other worldly gain seemed to specialize in corporate abuse with particular reference to railways. True, there has been and are now some brilliant exceptions to whom credit is due, but so large a majority of those who influence or mould public opinion have either openly denounced our railway owners and managers, or charged them with inefficiency in various degrees, with the result that the public mind has been systematically poisoned against the railways in general, and one of the most effective methods of aiding in their early and complete recovering would be for every person and all agencies to lend a helping hand—being particularly careful lest any act of commission or omission should progress in this direction be impeded.

Doubtless many well intentioned public speakers or writers, who are not really unfriendly to the railways at heart, use information not wholly reliable or correct, thus reflecting adversely on efficiency of management, when if they had made proper inquiry, an injustice to the railways might have been avoided.

Among numerous instances of the foregoing character there recently appeared in a popular publication, with a circulation of close to one million, and that is probably read by several million people who are more or less influenced by its contents, an article on this subject which, while not wholly excusing the Government for certain shortcomings, placed the burden of responsibility on the railway managements—in other words, a verdict of guilt was rendered, while much of the evidence should be *thrown out*.

This article is selected for criticism as it deals with railway service and the equipment provided, in which the public generally is most interested, as compared with that abroad. It is an example of the class of material that is accepted by the editors of newspapers and popular magazines, that has had such pernicious effect on the attitude of our people to the railways.

Our critic maintains, "It has been said that the traditional efficiency of the American railway, its traditional superiority to any other railways in the world, is a thing of the past." He continues, "we have always thought of our trains as the fastest in the world, *they are not*." Then to prove this, English and French schedules are compared with ours, adding that the greater comfort of sleeping car travel abroad is another feature in which we are lacking. Let us see. In any comparison the elements must be reduced to similar or comparable terms and on this, the only equitable basis of comparison, I hold that neither the English, French or any other nation runs trains of such tonnage and speed as we do in this country. The English and French trains maintained are fast trains, but their equipment is very light as compared to ours, and if one of their fast passenger engines was coupled to one of our heavy all steel, through passenger trains, it would not be able to even approach our speed schedules, and to think of using the light cars and trains commonly used over there would be entirely out of the question.

Aside from the issue of the weight of the trains, we have here schedules better than those abroad, and as a matter of fact, some years ago there were schedules in France and England where with light trains they approximated our high speed passenger runs, but there have been extensions in their schedules generally, and on the whole there is no longer any basis for comparison in respect to fast passenger schedules. Some high speed records may be of interest;

Of twenty-four fast runs ranging from 63 to 120 miles per hour I find 21 were made in the U. S. and 2 or about 10 per cent in England. Of the 24 runs 3 exceeded 100 miles per hour all in U. S. One it was reported having reached a speed of 120 miles per hour for a short distance. (See *World Encyclopedia*, 1922, page 337.) The writer has ridden on both English and French high speed passenger engines that made splendid records, but the weight of trains were as a rule about one-half the weight of our trains and their permanent way or track favorable to higher speeds than ours. Incidentally the writer may be pardoned for mentioning that the engine credited with making 120 miles per hour was of his design and he was riding in the cab when this run was made.

Quite recently an engine on the Union Pacific R. R. took a train of 816 tons at a speed of 50 miles per hour on an ascending grade of 0.82 per cent. The engine developed an indicated housepower of 3,500. No engine in England or France ever made such a record and the writer very much doubts if any two of their passenger engines could equal this performance.

On comparable terms we are providing the fastest passenger train service, and by any fair measure of value the Pullman service is the equivalent of best in sleeping car equipment anywhere in the world today.

LOCOMOTIVE EQUIPMENT

Second, all this foreign "superiority" is due to the use of "ultra-modern equipment." Our railways are out of date or old-fashioned in not using modern up-to-date appliances on locomotives, such as (a) Superheaters; (b) Brick archers; (c) Feed water heaters; (d) Boosters; (e) Mechanical stokers. "All much used abroad; are making slow progress here." Let us see as to who is, and who is not making progress along these lines.

Superheaters:

Our critic maintains that the Baltimore and Ohio uses a superheater with good results, thus implying other roads do not but should use it and thus be up to date.

aged property. They use superheaters with good results, and so does almost every other railroad of consequence in the United States. Superheaters have been put into nearly every locomotive that is being built, and have been for fifteen years. There are about 38,000 locomotives in England and France combined, 65 percent of which, have superheaters. In the United States there are about 68,000 locomotives, and of these 42,000 are fitted with superheaters, and they are being applied to old locomotives at the rate of a thousand a year. So we can justly claim leadership in the use of this device.

Brick Arches:

Brick arches have been practically standard practice of American locomotive engineering for years. Seventy per cent of all our locomotives are equipped with them.

Feed Water Heaters:

This is a device that shares great economy in stationary plants but is not so easily applicable to locomotives. The designers of American locomotives have *not* been and are not now asleep on this question. There are so many complications in the way of immediate introduction; the quality of the water, the rate of consumption, and above all the necessity that there shall never be any failure of the supply; that they have been obliged to go more slowly.

Manufacturers here have been experimenting with the device for years and it is only recently that they have had one that they could offer as dependable. Yet with all the necessity for extreme caution they are being steadily introduced and there are now a substantial number in service. Here again, our enthusiastic detractor should have his attention called to the vastly greater quantities of water used on American locomotive as compared with the European.

The American Railways certainly stand in the front ranks of those who use ultra-modern equipment.

Electrification of Steam Lines:

The next feature to which attention is invited is that of electrification, which of course is good in its place, but our detractors go beyond the most enthusiastic of the electricians in prescribing it for universal use. The places where its introduction means economical operation are continually increasing, and its extension will follow, but there is absolutely no ground for the general implication that wonderful savings at once result, and as our critic sets up many items such as 45 engines doing the work of 120, saving coal and oil fuel of 259,000 tons and 31,700,000 gallons with many other factors which effect operating expense. Electrification is in substance offered as a solution of financial problems.

The writer is heartily in favor of electrification of railways wherever it is *physically feasible* and *financially possible*, and by this token the proposition must stand or fall. Measured by this standard of financial success, let us see just what are the results on the St. Paul and New Haven.

The Santa Fe, Union Pacific, Northern Pacific and Great Northern railways cross the mountains, and could impound water for hydro-electric motive power purposes the same as the St. Paul. The same is true as to certain lines in New England territory. Yet if one were to judge the financial results from operation in the light of our critic's claims for electrification, the only conclusion would be that the first four roads were electrified, and the last two were still clinging to what our critic would imply is the antiquated extravagant steam locomotive, which conclusion is entirely unfounded.

Name of road	Electrified: Yes or no	Electrified: Date	Price of stock and dividend rate: Then		Now		Amount paid to Share holders since 1917
Santa Fe	No	....	100	6%	100	6%	Millions
Union Pacific	No	....	125	8%	140	10%	Millions
Northern Pacific	No	....	108	7%	75	5%	Millions
Great Northern	No	....	120	7%	83	7%	Millions
St. Paul	Yes	1915 Com.	100C.	4%	24	0	Millions
			125P.	7%	36	0	Nothing
New Haven	Yes	1915-1907	200	8%	21	0	Nothing

The writer does not hold the unfavorable financial condition of these two properties mentioned was brought about through financing electrification—in fact, it is fair to assume that other causes were largely responsible, and it is also safe to say that if both properties had not been in the hands of exceedingly capable executives for some years past, they would in *spite* of the *electric feature* have been in the hands of receivers, while the future of each is not at present any too rosy.

RAILWAY BREAKDOWN AND GOVERNMENT CONTROL

Our critic now refers to the so-called railway breakdown in 1917 government control which followed and the wonderful things accomplished by Mr. McAdoo.

The failure in 1917 was largely due to a parsimonious policy of the various authoritative bodies which have to do with rates and other factors which had over a long period operated to prevent the managements of our railways from being kept in shape to handle the business, and as proof of this about the first thing Mr. McAdoo did was to boost the rates horizontally away above what the carriers had been vainly trying for years to get. Then followed wage increases and national agreements that practically destroyed the efficiency of lines as transportation units and in this wretched impoverished condition they were thrown back to their owners over night, and the next afternoon papers in many cities were at once demanding to know why they were not getting better service and threatening government ownership as a penalty.

A majority of writers and speakers still lean in that direction, although it is clear to most all railroad men that the carriers have not even yet recovered from the adverse effects or blight of government control, and until they have again been free agents long enough to put this house in order, criticism, except of the constructive order that would tend to strengthen their hands, would seem to be quite out of place.

Capital, no matter whether it be the savings of the worker, a person of wealth, or the funds of an institution, will automatically flow in the direction of *safe, sound* investment and *fair* return thereon.

Hundreds of millions of dollars during the past five or six years have been directed, much of it at great loss, from railroad securities to (a) farm loans, (b) municipal paper, (c) industrial securities, and (d) government bonds of a low interest-bearing rate, for the plain simple business reason that the public have been afraid of, and are yet, owing to this insidious propaganda, quite shy of railroad securities, which of course impairs their credit.

The Interstate Commerce Commission and other authoritative bodies agree that their present earnings are inadequate for proper maintenance and return to the shareholder.

If all people who do not from personal knowledge thoroughly understand the railway situation, will keep their mouths shut on this subject for a reasonable time, and all those who do understand it will be given proper consideration and aid from the public and all regulatory and legislative bodies, the flow of capital will turn to railroad securities, business will boom, and then if the carriers do not make good, call them to account in terms void of ambiguity.

Cost of Locomotive Operation

It is well known that the cost of locomotive operation is one of the principal items in railroad expenditures. What this is is set forth by the recent estimate of a road in the Middle West. According to the figures given the total cost of locomotive operation for this road, for 1920, was $74,454,628 and the cost per locomotive owned per annum was $34,029. The survey showed that of the total sum, $28,789,-756 went for fuel; $26,462,086 for repairs; $81,442,173 for wages of the enginemen, firemen and enginehouse employes; $424,-917 for lubricants, and other supplies, $335,696. Of the cost of running a single engine, $13,158 went for fuel; $12,094 for repairs; $8,429 for wages; $194 for lubricants and $153 for other supplies.

Snap Shots—By the Wanderer

The most celebrated sermon that was ever preached, contained an exhortation to "judge not that ye be not judged," to refrain from beholding "the mote that is in thy brother's eye, but considerest not the beam that is in thine own eye," and added the advice to "first cast out the beam out of thine own eye; and then shalt thou see clearly to cast out the mote out of thy brother's eye." And all in protest against the epigram of Savonarola's that "every man thinks his way is the way of God." All this and more was suggested by the examination of a number of railroad reports. The Interstate Commerce Commission, among other things, asked the railroads, anent the hearing on power brakes, for any suggestions that they might have to make. There was about an equal division between those who had no suggestions and those who emphasized the fact that if other roads would maintain their air brake equipment as well as we are doing there would be no trouble. Of course they did not put it in quite that way, but that was the natural inference to be drawn.

Why! Bless your soul if all those righteous Pharisees who stood there in the temple and thanked the Lord that they were not as other roads were, even as that X Y Z, would live up to their professions, the trouble from leaky brake cylinders and variation in piston travel would "vanish like the breath into the wind." Such is the difference between practice and profession, and "ever will be, world without end. Amen."

A few months ago I culled a recommendation from a mechanical officer and now I am driven to that old query in Ecclesiastes: "Is there anything whereof it may be said, see this is new? it hath been already of old time, which was before us." I had never seen it done, never heard of its having been done, and thought surely "this is new." When, lo, I find that a number of roads have incorporated in their rules for the making up and inspection of trains, one requiring that they be stretched. How well the rule or order is followed I am far from being prepared to say. But, from a gleaning of reports as to break-in-twos, it would seem that couplers slipping by are contributing more than their proper share and due proportion.

The rules as to coupler heights are very definite but this is a standing test or measurement. Under stress they rise and fall and so slip by, by the hundreds and thousands. They are the cause of damages piled on damages, until the imagination is staggered by the amount. So why would it not be well to look more carefully for a defect that causes so much trouble on the road? One road has a rule that freight trains on arrival at terminals shall have the slack stretched and be left with the brakes fully applied.

It is possible that if this rule were followed everywhere and an immediate inspection made, many couplers that had a tendency to slip by would be caught before they were moved on again.

Now that we are talking of brakes suppose we keep it up, and look a little at piston travel. There seems to be a tendency to shorten travel, when making adjustments and for what is probably very good reasons. The 8-in. travel on which calculations are based must be less when standing if it is not to be exceeded when running, and running is when the brakes are used. But there are a number of local rules prescribing the setting at 5 in. which means a higher brake cylinder pressure than the calculations call for. A sort of compromise between an empty and loaded car in order to secure a greater effectiveness on the latter. Abroad there is a practice of cutting the travel down to 4 in., but, with all due respect to American institutions it is probable that their standard of maintenance is higher than ours, and there is not as much difference between running and standing travel. The short travel certainly has the advantage of more pressure for less air, and air conservation is an item worthy of the most careful consideration when it comes to the handling of a big train down a long grade.

I was standing beside a cinder pit the other day, watching the cleaning of the ash pans of a big engine. A hose was playing on the hot ashes as they were raked out: but, in spite of the liberal supply of water, the air was filled with the fine dust that we all know so well. The boiler and cab were covered so that they resembled the dusty miller and the exposed working parts such as the grinders were receiving a contribution that would do its share towards facilitating cutting, heating and wear. Perhaps all this could not have been avoided, but there was one thing that ought not to have been. About once every fifteen or twenty seconds the air pump would take a deep breath of this reeking air, and then stop as though choked by what had been drawn into its cylinder. It was laying up a store of heating and bad action that would be more than apt to put in an appearance at the very time when a liberal supply of air would be most needed. The neighborhood of the cinder pit and the coal wharf is no place for the air pump to be working. Shut it off. Some roads have rules to the effect that air pumps are not to be run when the fires are being cleaned, but it is not always observed.

I do not know whether they do it or not. If they do I can hardly see the justice of it. If not, then, like any other unenforced law it had best be repealed and removed from the statute books. By what rule of right or reason a train crew should be held responsible for slid flat wheels, goes beyond my comprehension; yet one great road, at least, states in its book of rules that "crews are held responsible for slid flat wheels." A little dirt may so easily get into a triple valve and cause it to fail to release; the brakes may stick and the wheels may slide until the spot is away beyond condemning size, and the crew in the caboose and on the engine be completely ignorant of it all. A trainman's eyes are well trained to catch defects at long distance, but a half or even a quarter of a mile is a long distance at which to catch and fix the few sparks that fly from sliding wheels at night and a side wind may sweep away all trace of a hot and smoking wheel by day. It is well to urge crews to alertness and vigilance, but why load them with responsibilities for the acts of God and the cussedness of inanimate things? Such a rule and its enforcement looks like a deliberate fostering of the activities of the grievance committee and I am interested to learn as to how the thing works out in practice.

I. C. C. Expenditures

The total expenditures of the Interstate Commerce Commission for the fiscal year ending June 30, 1921, were $6,193,714.54. In 1887—the year in which the Commission came into existence—the total expenditures were only $15,140.05.

The principal items which go to make up the Commission's expenses are salaries, appropriations, examinations of accounts, safety appliances, locomotive inspection, and the study of valuations.

In 1887 the total salaries paid to Commissioners amounted to $10,181, and in 1921 to $124,900. General expenditures from general appropriations in 1887 amounted to $4,959, and in 1921 to $1,876,293.43.

The examination of accounts by the Commission commenced in 1909, in which year $105,223.92 was spent, while in 1921 the total costs were $480,006.21.

In 1901, the year in which the Commission commenced the study of safety appliances, etc., $11,908.86 was spent, and in 1921 $331,442.24.

Locomotive inspection in 1912 cost $149,791.55, and in 1921 $294,973.10.

The study of valuations of the railroads, which commenced in 1912, cost in that year $10,366.33, and in 1921 $2,728,656.45.

The total expenditures of the Commission from 1887 to 1921, by decades, have been as follows:

1887	$15,140.05
1890	180,440.07
1900	243,624.10
1910	1,163,336.97
1920	5,542,373.70
1921	6,193,714.54

Pacific Type Locomotives for the Atlantic Coast Line

The main line of the Atlantic Coast Line R. R. is characterized, throughout the greater part of its length, by comparatively light grades and curves. A heavy passenger traffic is handled, especially during the winter tourist season; and the freight consists largely of perishable goods, which are moved on fast schedules. Up to 1911, a large part of this traffic was handled with locomotives of the ten-wheeled (4-6-0) type; but the increased weight of passenger trains required locomotives of greater power than could be obtained with this wheel arrangement, and in the year mentioned, the Pacific (4-6-2) type was adopted for the heaviest passenger traffic. These Pacifics, built by The Baldwin Locomotive Works, were subsequently followed by others built on various orders. The latest development of the series is shown in the accompanying illustration of engine 1606, which is one of 45 ordered from The Baldwin Locomotive Works in 1922. A comparison of the leading dimensions of these various Pacific type designs is given in the following table:

Date	Cylinders	Drivers	Steam Pressure	Grate Area	Water Heating Surface	Superheating Surface	Weight on Drivers	Weight total Engine	Tractive Force
1911	22" x 28"	72"	185	54.2	3539	...	138,950	220,850	29,600
1912	22" x 28"	72"	200	54.2	2917	590	139,800	225,900	32,000
1914	22" x 28"	68"	200	54.2	2635	524	140,400	226,500	33,900
1918	23" x 28"	68"	200	56.5	3345	792	151,050	243,850	37,000
1922	25" x 28"	69"	200	66.7	3349	830	166,770	275,950	43,000

A combustion chamber was used in the design of 1914, reducing the tube length from 20' — 6" to 18' — 6". This accounts for the reduction in heating surface.

PACIFIC OR 4-6-2 TYPE LOCOMOTIVE FOR THE ATLANTIC COAST LINE. (BUILT BY THE BALDWIN LOCOMOTIVE WORKS.)

The new locomotives, which are designated as Class P-5-B, are closely similar, in weight and general dimensions, to the standard light Pacifics built for the U. S. Railroad Administration. The most important change is a reduction in the driving wheel diameter from 73 to 69 inches. This raises the tractive force, and gives a ratio of adhesion, in the new locomotives, of 3.88. The weight on drivers is thus utilized fully, and the hauling and steaming capacities are large in proportion to the wheel-loads carried in this design.

The boiler has a maximum diameter at the dome ring of 86", and is built with a conical connection in the middle of the barrel. This provides an ample water-space under the combustion chamber, which is 23½" long. The firebox seams are welded throughout, and the tubes are welded into the back tube-sheet. Flexible bolts stay the combustion chamber and throat, and there is a partial installation of such bolts in the sides and back-heads. The firebox contains an arch, and the labor saving equipment includes a power operated firedoor and grate shaker, and a coal pusher on the tender.

The valve gear is of the Baker type, controlled by the Ragonnet power reverse mechanism. The valves have a steam lap of 1⅛" and an exhaust clearance of ¼", and are set with a travel of 6½" and a lead of ¼". The guides and crossheads are of the Alligator type, and the piston-rods, in accordance with Atlantic Coast Line practice, are bolted to the crossheads instead of keyed.

These locomotives have ample speed capacity for the passenger train schedules on the Coast Line, and they are also well adapted to fast freight service on lines having moderate grades. They are, therefore, an excellent "all-around" engine for work on this road.

The following are the principal dimensions of these locomotives.

Gauge, 4 ft. 8½ ins.; cylinders 25 ins. x 28 ins.; valves, piston, 14 ins. diam.

Boiler.—Type, conical; diameter 74⅝ ins.; working pressure, 200 lbs.; fuel, soft coal.

Firebox.—Material, steel; staying, radial; length, 114⅛ ins.; width, 84¼ ins.; depth, front, 81⅝ ins.; depth, back, 62½ ins.

Tubes.—5½ ins. and 2¼ ins.; number, 36 and 188; length 19 ft.

Heating Surface.—Firebox, 202 sq. ft.; combustion chamber, 44 sq. ft.; tubes, 3,076 sq. ft.; firebox tubes, 27 sq. ft.; total, 3,349 sq. ft.; superheater, 830 sq. ft. Grate area, 66.7 sq. ft.

Driving Wheels.—Diameter, outside 69 ins.; diameter, center, 62 ins.; journals, main, 11 ins. x 13 ins.; journals, others, 10 ins. x 13 ins.

Engine Truck Wheels.—Diameter, front, 31⅜ ins.; journals, 6½ ins. x 12 ins.; diameter, back, 43 ins.; journals, 9 ins. x 14 ins.

Wheel Base.—Driving, 13 ft.; rigid 13 ft.; total 34 ft. 11 ins.; total engine and tender 70 ft. 9½ ins.

Weight in Working Order.—On driving wheels, 166,770 lbs.; on truck, front, 54,330 lbs.; on truck, back, 54,850 lbs.; total engine, 275,950 lbs.; total engine and tender, 470,000 lbs.

Tender.—Wheels, number, 8; wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel capacity, 16 tons.

Tractive Force, 43,000 lbs. Service, passenger.

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American Railways

RAILWAY AND LOCOMOTIVE ENGINEERING would be false to the principles of its founders if it at any time by act of omission or commission, either lend aid to any form of propaganda calculated to influence the public mind against railway interest, or failed to step in the front ranks of the firing line in their defense whenever the opportunity presented itself.

The success of any business of consequence is dependent on (a) sound financial basis and efficient organization, (b) adequate volume of business with net profits sufficient to properly maintain the physical plant and make a fair return to the shareholder. To accomplish either or all these things a public utility must also have the good will and confidence of its patrons, The Public. The American Railways have under adverse conditions, which at times and from certain sources were openly hostile, made wonderful progress not only in the high wages paid employes, and unequaled service rendered, but also in ultra modern equipment employed, yet in the face of all these accomplishments, and the fact that our railways are still staggering under the tremendous load thrown on their shoulders through the termination of government control, there are yet those who through a desire or willingness to join in a propaganda against the railways, either by implications or statement charge our railways with being out of date and old fashioned, which spells inefficiency.

Such propaganda can have only one effect. It contributes to the ends sought by the enemies of our transportation system in that it poisons the public mind and impairs railway credit, without which no substantial degree of prosperity can be looked forward to.

On another page in this issue will be found a reply to an article in a recent publication with a circulation of close to one million and that is probably read by several million American thinkers, in which American railways are arraigned before the bar of public opinion in a manner calculated to weaken or destroy public confidence rather than strengthen it.

With a full knowledge on our part of the wonderful progress made by American Railways in the development of the complete transportation unit, particularly their leadership in the design and use of the most modern proven devices that effect economy and safety, we are glad to present the communication by W. E. Symons to our readers.

The article which Mr. Symons has selected for criticism through the pages of this paper is one of many of similar character that have been appearing in some of the popular magazines and newspapers.

The irresponsible and insidious propaganda for the repeal of the Transportation Act, and against our railways as a whole, has been so far-reaching in its influence that it appears that even some of our more able editors and writers have felt the blight. A new school of theorists have developed that have been directing their attention to some of our more complex railway problems, and it is to be regretted that they are able to present their unfounded ideas and theories to the public through the press. This is largely responsible for the present attitude of our people to the railways.

We developed under private ownership and operation the greatest railway system of the world, and what we now need is a constructive policy to sustain and build up this transportation system. To do so we must have public confidence and support.

Division V—Mechanical

It is now thirty years or more since the first proposition was made to consolidate the Master Mechanics' and Master Car Builders' Associations. It was the red rag to the bull, so far as the car builders were concerned, and they fought the proposition year after year, and successfully for many years. Why? Simply because, at first, they thought the Master Mechanics, being the stronger association and having to deal with a more technical and higher type of structure, would so absorb them that they would lose their identity and finally fade out of sight. It was the struggle of the little man to maintain his position in the sun. It was an old and honored organization; its records were the best of their kind in the world, and its founders and early members were men whose names were as familiar as household words in railroad circles. They were men of marked individuality and were determined to maintain that individuality unbroken and untouched for themselves and the association of which they were so proud.

Then suddenly. almost without warning, there came a great war and these two great associations whose proceedings and deliberations constitute the most valuable contributions in the world in the railroad field, "vanished as the breath into the air," and became overnight, almost, Division V—Mechanical.

They gave up their sovereignty like an Indian prince and rule only by permission. They drive the horse as a child holds the reins behind his father's hands.

For more than forty years these two associations held their annual conventions without a break and gave to the world a technical library beyond compare. And, for the individuals, there was such a gathering and interchange of ideas that many a man laid aside his problems until he could discuss them with his peers at the piazza conventions that have slowly faded since the days of Saratoga and Old Point Comfort. But the conventions were held in fair weather and foul, in days of prosperity and of gloom.

But when they were lost in Division V the continuity of the meetings was broken and it seems as though the interest of the members has fallen away. There is little to stir the pride of a man to be able to say that he belongs to Division V. There is no distinguishing mark. It needs too much explaining, and when the explanation has been made, it merely shows the man to be a member of some subordinate division of an organization which stands for something that most people know nothing about.

So the announcement that there will be no convention of Division V—Mechanical in the June of 1923, hardly elicits the raising of an eyebrow.

It seems a pity that such a course should be taken.

The roster of committees shows an interesting list of subjects for the current year, and as one looks down the list of committee members, he sees names that stand in the forefront of American railroad mechanics, the results of their work are sure to be of value.

But it will be hidden under a bushel. Men, busy men, do not read the proceedings of technical societies. They lay them aside for "some more convenient time," and then forget them. The committees lose the impetus given by the knowledge that the results of their labors will be buried in archives and will miss the incisive criticism of interested and competent speakers.

And the individual, who would have attended, who would have read and heard the papers, and listened to and taken part in the discussion; he is missing an important link in his training, and the railroads are losing far more in money and time than the holding of the conventions could possibly cost. With such a situation as that before us, it is not the act of prudence or forethought to throw away such advantages as are sure to accrue. It is always well to make a temporary sacrifice for the sake of gaining advantages that are sure to come; and it is a short-sighted mistake to omit one of these conventions for any reason whatsoever. And if the practice is continued there is danger that Division V may lose even the interest that it still holds as a subordinate section of a society, over which its members have no control and in which they have little interest.

Condition of Equipment Improves

Cars

The railroads of the United States on November 1 last had 249,960 freight cars in need of repairs, or 11 per cent of the cars on line, according to reports received today from the carriers by the Car Service Division of the American Railway Association. This was a reduction of 20,085 cars since October 15 last. This also was the smallest number of freight cars in need of repairs since March 1, 1921.

Since July 1 last, the date on which the shopmen's strike began, there has been a reduction of 74,623 cars in the number in need of repairs, the total on that date having been 324,583, or 14.3 per cent of the cars on line.

On November 1 last year, the number in need of repairs totaled 345,201 cars.

Of the total number in need of repairs on November 1, 198,669 were in need of heavy repairs, which was a reduction of 16,253 cars since October 15. Reports also showed 51,291 cars in need of light repairs on November 1, which was a decrease of 3,832 since October 15.

Motive Power

The railroads of the country repaired and turned out of their shops during the period from October 15 to November 1, last, the largest number of locomotives for any half-month period in approximately the last two years, according to reports received today from the carriers by the Car Service Division of the American Railway Association.

During that half-month period, 13,490 locomotives were repaired. This also exceeded by 2,086 the number turned out of the shops from October 1 to October 15, last.

Locomotives in need of repair on November 1 totaled 18,366, or 28.5 per cent of the number on line. This was a decrease of 865 since October 15, at which time 19,231, or 29.8 per cent, were in need of repairs.

Of the total number on November 1, last, 15,101 were in need of repairs requiring more than 24 hours. This was a decrease since October 15 of 834 locomotives in the number needing heavy repairs. The remaining 3,265 represented locomotives in need of light repairs, which was a decrease of 31 within the same period.

Reports filed by the carriers show that on November 1 the railroads had 46,096 serviceable locomotives, an increase of 909 over the number on October 15.

Vital Problems of Our Railways

Herbert Hoover, Secretary of the Department of Commerce, under the above title in the forthcoming annual report of the Department, discusses the railway situation from various angles. Some of his ideas in regard to railway regulation are selected as follows:

"Railway cars are the red blood corpuscles of commerce, and we suffer from commercial anæmia every year because of a subnormal supply of these health-supplying agents. The losses through short transportation are a tax upon the community greater than the cost of our government, because such a shortage not only stifles the progress of production and introduces speculation into distribution but it also seriously affects price levels.

"The management of our principal railways today by all the tests of administration, of load factors, of mechanical efficiency, etc., is the most efficient transportation machine in the world in so far as it is not limited by causes beyond the managers' control.

"We have tried uncontrolled operation; we have tried negative regulation in the prevention of discrimination; we have tried nationalization; we are now trying positive regulation. Nationalization would be a social and economic disaster; free operation would reconstruct the vicious practices of thirty years ago. Regulation in some form is necessary, but constructive development of this regulation—to preserve the initiative and responsibility of our railway executives, to secure the fine values of private operation, and at the same time to secure public protection and assure adequate service—are absolutely vital.

"We must have increased transportation, if we are to maintain our growing productivity. We must therefore find a way out of the cycle of systematic starvation, and the denudation of our railway managers of their responsibilities and initiative."

First All-Steel Sleeping Cars in Europe

The first all-steel sleeping cars to be used on the Continent of Europe have been sent on a train ferry from the Immingham Dock at Hull to Calais. The two cars thus carried composed the first installment of an order for forty new type all-steel cars for the International Sleeping Car Company. They are larger than any cars previously built in England and their successful carriage proves the value of train ferries in England.

Automatic Control of Fire in Car Shops

To the Editor:

Of particular interest, not only to engineers having to do with the construction and maintenance of railway shops properties, but also to those who are interested in similar industrial properties, will be the recent instance of the automatic control of fire by automatic sprinklers in the freight car erecting shop at the Turcot Works of the Canadian Car and Foundry Co., Ltd., near Montreal, Que., Canada.

This erecting shop is a large one-story building, 80 x 800 ft., all one area. The walls are of brick and glass in metal sash; the roof, light planks supported by unprotected steel beams and trusses. The distance from floor to roof is 39 feet. Five tracks run the length of the building. At the time of the fire they were filled with box cars, 75 in all. The shop is equipped throughout with a dry-pipe automatic sprinkler system controlled by six automatic air valves. Five metal fire curtains under the roof divide the system into six sections.

The fire broke out early in the morning of October 17, 1922, in a box car spotted in the center of the building. It was discovered by the watchman who gave the alarm. A line of hose was stretched by the night shift at the plant, and before this was brought into play the sprinklers overhead began to open. The fire burst through one end and the doors of the car and ignited the corners of nearby cars. The water from the sprinklers blanketed the blazing car and extinguished the fire in the nearby cars, thus confining the fire to the locality of origin.

The performance of the sprinklers was remarkable considering the height of the roof, 39 ft. above grade, and the nature of the obstructions to water distribution offered by the box cars. As the fire was directly beneath one of the divisional fire curtains the sprinklers in two sections opened, 10 in one and 11 in the other, 21 in all.

The principal fire damages was to the burned box car, but no practical loss resulted as the car was to be rebuilt. The damage to the building amounted to $50.00.

This is a most comprehensive instance of effective automatic control of fire under most adverse conditions and in a class of property, in which, because of size and height of buildings and nature of occupancy, some engineers are doubtful about the successful application of the principle of automatic control of fire by automatic sprinklers.

Ira G. Hoagland.

Railway Shop Kinks

Some Special Tools in Use on the Pennsylvania and Chesapeake & Ohio Railroads

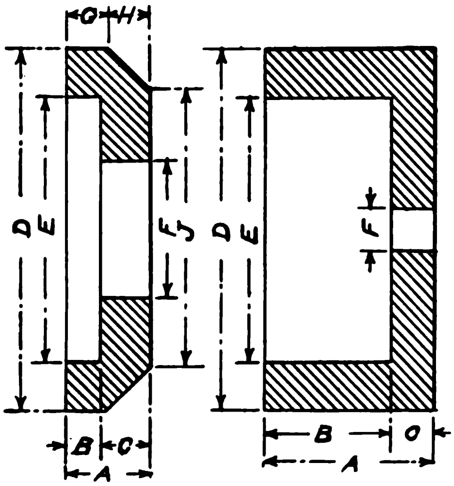
Emery Wheels for Grinding Air Brake Bushings

An elaborate set of tools and appliances has been developed in the shops of the Pennsylvania R. R. for repairing the various parts of the air brake apparatus. Among them is a set of emery wheels for grinding bushings. These are of the two general shapes shown in the engravings, and the dimensions for the several sizes are given in the accompanying table.

No.	Fig.	A	B	C	D	E	F	G	H	J
1	1	3/4	5/16	7/16	3 1/4	2 3/8	1 1/4	3/8	3/8	2 1/2
2	1	1/2	1/4	1/4	1 1/2	3/4	3/8	1/4	1/4	1
3	1	1/2	1/4	1/4	2	3/4	3/8	1/4	1/4	1 1/2
4	2	1 1/2	1 1/8	3/8	2 1/2	1 3/4	3/8			
5	2	1 1/2	1 1/8	3/8	2	1 1/4	3/8			
6	1	1/2	1/4	1/4	2 3/4	1 1/8	7/8	1/4	1/4	2 1/4
7	1	1/2	1/4	1/4	1 7/8	3/4	3/8	1/4	1/4	1 3/8

SIZES OF EMERY WHEELS FOR GRINDING AIR BRAKE BUSHINGS

There are seven sizes of these wheels, adapted to as many different purposes, and in making them two grades of material is used. Wheels Nos. 1 to 5, inclusive, are known as crystolon wheels, with No. 30 grain of the I and J grades. Wheels Nos. 6 and 7 are alundum wheels of 36 to 46 grain of grade A. These grades and specifications refer to those made by the Norton Company, Worcester, Mass.



EMERY WHEELS USED FOR AIR BRAKE REPAIRS

The following are the uses to which the several wheels are adapted and for which they should be used.

No. 1. Triple valve distributing valve; H6 and C6 brake valve, bottom case K.

No. 2. Feed valve; large and small charging valves; high pressure valve; 2 in. Gold & Leslie steam heat regulator valves.

No. 3. Release piston; large, small and emergency piston bushings for UC valves. High speed reducing valve.

No. 4. S-5 air pump governor bushing.

No. 5. S-4 air pump governor bushing.

No. 6. Large main valve piston bushing for 8½ in. and 9½ in. air compressor, top head.

No. 7. Small main valve piston bushing and exhaust piston bushing for air compressor.

Chuck for Machining Back End of Main Rod Brasses and Boring Driving Boxes on a Vertical Boring Mill

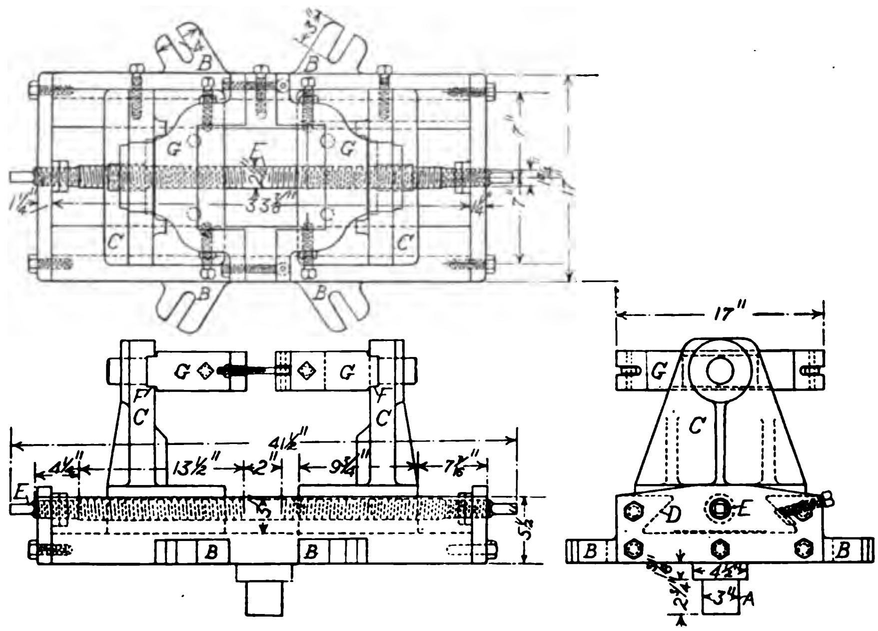
This chuck serves to hold main rod brasses and driving boxes for boring and facing and insures that the two faces shall be exactly parallel to each other.

It has a cast iron base with a teat *A* which fits in the hole in the center of the table of the machine to which it is to be attached. This insures accurate centering. The base is then bolted to the table by the lugs *B*. Sliding on this base are two heads *CC*, which are dovetailed into it, as shown at *D*, with an adjusting strip on one side held by set screws. These heads are moved to and from each other by the right and left hand screw *E* so that they act as a centering chuck.

The upper part of the heads are grooved at *F*. Holders *G* for the work are let into and are held in line by these grooves. For driving boxes or similar work these holders are of the shape shown in the engraving and are drawn together by the small eyebolts ¾ in. in diameter that serve to clamp the work firmly. These holders are also carried on trunnions that extend through and have a bearing in the holes drilled in the heads *C*.

The method of using the chuck is to place the holders in position and then after blocking the work up on the base the heads are run together, firmly clamping and centering the work. The nuts on the eyebolts are then tightened and the blocking removed.

If it is a driving box it can then be faced off on one side and bored. When this is done the heads are drawn back, by means of the right and left hand screw, until the holders *G* have been drawn clear of the grooves *F*. When this occurs the holders and the work are carried by the trunnions alone and may be rotated through a half revolution. This done, and the heads run back so that the holders are engaged in the grooves, the work is clamped in position for facing the other side exactly parallel to the first.



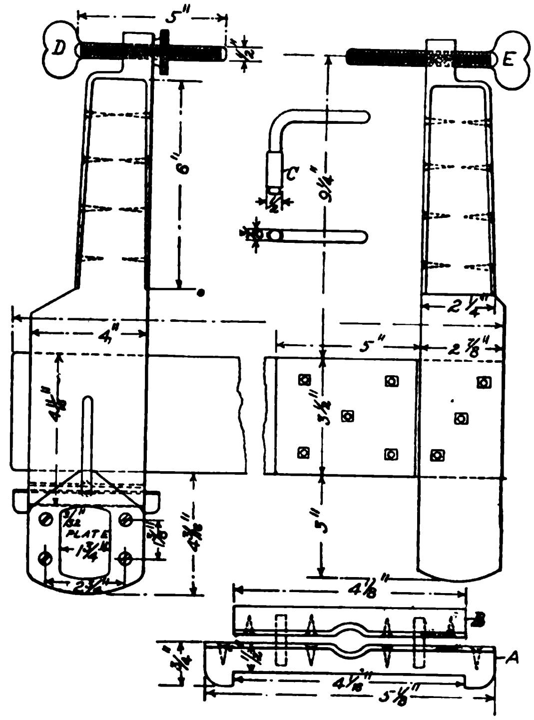
CHUCK FOR MACHINING BACK END OF MAIN ROD BRASSES AND BORING DRIVING BOXES ON BORING MILL

Driving Wheel Calipers

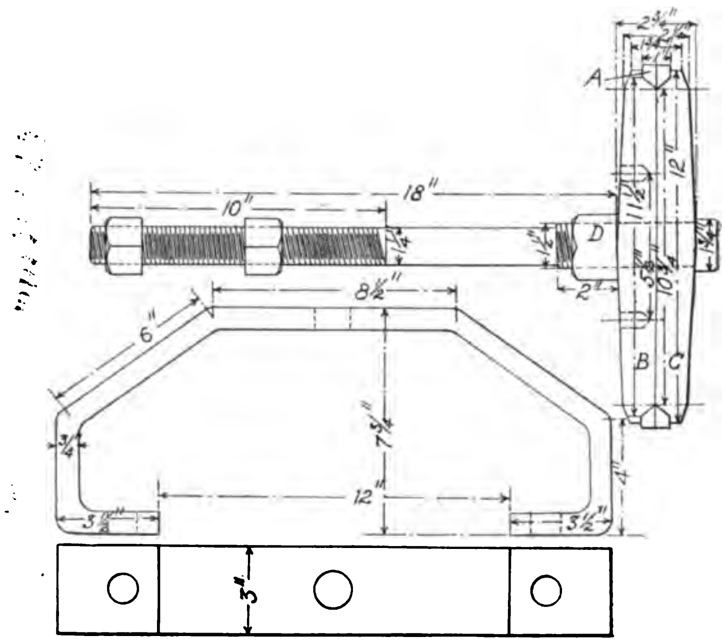
This and the following items in this article were obtained from the mechanical department of the Chesapeake & Ohio R. R.

This driving wheel caliper is a tram with one head fitted for rough adjustments and also with a screw caliper point for the fine and accurate adjustments. There is also a screw adjustment in the fixed head.

The bar is of cherry 7 ft. 9 in. long and of 3½-in. by ½-in. material. This has sufficient stiffness for the work and yet is light enough to be easily handled. The bodies of the heads are also of hard wood. Both are 1¼ in. thick, and have a mortise for the insertion of the bar. The fixed head is 2⅞ in. wide and is fastened to the bar by three ¼-in. bolts.



DRIVING WHEEL CALIPERS



APPARATUS FOR TESTING VALVE BUSHINGS

The moveable head is 4 in. wide and its mortise is 4 11/16 in. wide to accommodate the locking gib and key. These latter are shown in detail at the bottom of the engraving.

There is a gib *A*, whose lips catch hold of the two edges of the moveable head with a key *B* which rides above it and has a bearing against the bottom of the bar. They are both cut away at the center and faced with a strip of steel 3/32 in. thick which conforms to the curved contour of their adjoining faces.

The prying apart of the gib and the key against the head and the bar respectively serves to lock the former in place. This is done by means of the locking cam *C*, which is shown in detail in the upper portion of the engraving. This cam, the diameters of which are ⅜ in. and ½ in., respectively, is inserted through a hole in the movable head and between the gib and key through their cut-away portion at the center. The mortise in the head is of such size that when the ½ in. diameter lies at right angles to the line of the gib, the head will be loose and as it is turned it spreads the two pieces apart and tightens the head.

The upper part of the two heads is capped by a light brass casting which is threaded to take the setting screws *D* and *E*. These screws are simple thumb screws 5 in. long. The capping casting is held in place by wood screws with countersunk treads.

Apparatus for Testing Valve Bushings

It is sometimes necessary to test valve bushings for tightness and when this is done it is necessary to have the ends open and accessible. At the same time the bushing must be closed in order to hold the pressure that may be applied to it.

The apparatus here shown is for that purpose.

There is a steel yoke made of 3-in. by ¾-in. steel which is bolted to the head of the chest. It springs out instead of in, in order to give room for the turning of the nuts on the tightening head.

This head resembles a piston in general appearance, and is made in two pieces. Their outside diameter is 12 in. and they are cut away on their periphery to form a groove in which two rings of Tuffs packing *A* is inserted. This groove and the packing that fits into it is cut on an angle of 45 degs., so that when the two parts of the head *B* and *C* are drawn together by the nut *D* on the rod, the packing will be forced out against the wall of the bushing so as to make a tight joint.

The method of using it is to put the head into the bushing, locating it where it is desired that it shall be and then drawing the two parts together by tightening the nut *D*.

When this is done the outer nut on the stem is run off, the yoke slipped over the stem and bolted to the flange of the chest. The stem itself is then held in place by the two nuts on its threaded portion, being run up against the yoke. This to prevent the head being blown out of place by the pressure.

Engineer's Spring Seat Box

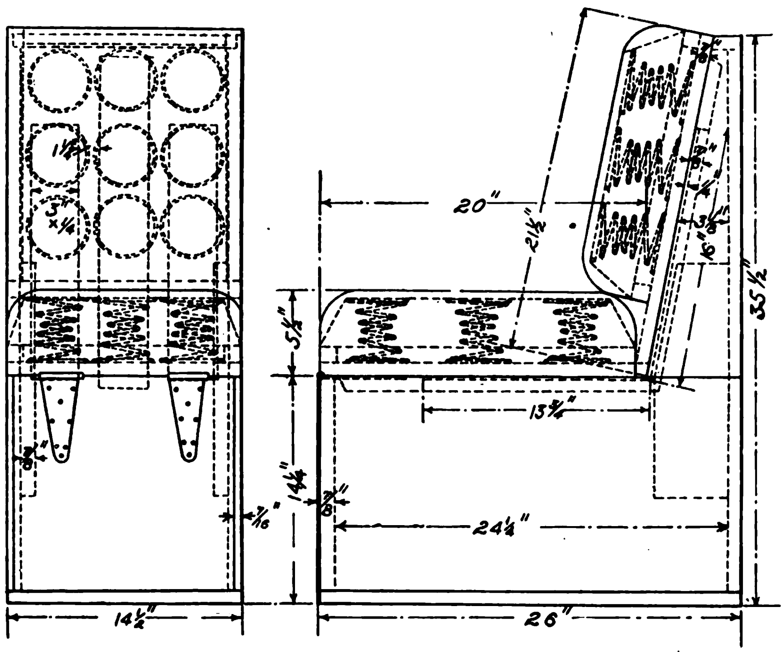
An engineer's spring seat may not be exactly a shop kink but it is such a decided kink that may add to or detract from the comfort of the men in the cab that it may well be incorporated as among useful railroad kinks.

The seat illustrated is one that has been designed to give the maximum of comfort and convenience to the engine crew. The springs are 4 in. in diameter, made of ⅛-in. diameter wire and nine in number each, for the seat and the back. They are held in a stout frame of oak 1 in. square, and stayed by heavy canvas webbing, as shown by the dotted lines of the engraving.

The seat is hinged at the front so that the interior of the box, which measures 24¼ in. by 12¾ in. by 12½ in., is readily accessible. The uncompressed height of the seat, as will be seen from the dimensions given, is 19¾ in. above the foot plate. The only thing to add is that the seat fulfills the purpose for which it was designed, and is endorsed by the crews.

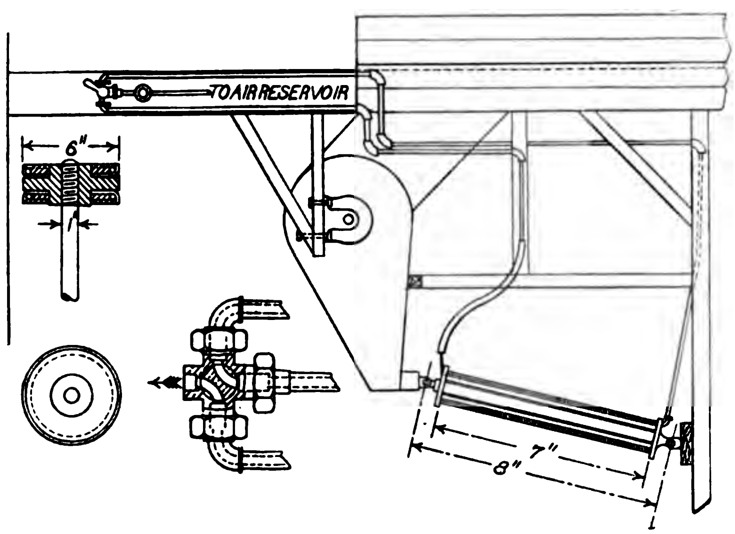
Air Hoist for Operating Coal Chute

The moving of coal chutes at coaling stations for the delivery of coal to the tenders is ordinarily difficult and disagreeable work, because of the usual inconvenience of the location and the dirt that is its unavoidable accompaniment.



ENGINEERS' SPRING SEAT BOX

A very simple arrangement of an air hoist has been installed at the coaling stations of the Chesapeake & Ohio at Clifton Forge and Fulton (Richmond), Va., by which the chutes are raised and lowered mechanically, thus avoiding much that it is desirable to avoid.



AIR HOIST FOR OPERATING COAL CHUTES

The hoist itself is made of a piece of 6-in. tubing 7 ft. long. The heads are faced, packed and held to each other by through bolts running from one to the other, the length of the tube.

The upper head is cast with a lug through which a pin passes by which it and with it the tube is suspended from an overhead bracket on which it is free to swing. The outer end of the piston rod is pivoted in a similar manner to the outer end of the chute spout.

The piston is a simple casting consisting of a hub with a disk projecting from its center against which the packings are backed. The packing is a plain cup packing held out by an expanding ring made of 5/16-in. diameter steel. The whole is screwed on to the piston rod, the end of which is riveted over. As will be seen, from the engraving, there are two packings so that the piston will work under pressure in both directions.

The air is admitted to and exhausted from the two ends of the cylinder by a four-way cock, the construction of which will be readily understood by a reference to the engraving. This not only admits the air from and to the ½-in. piping but can be turned so as to cover all four passages leading from the valve.

Record Shipment of Electric Locomotives

The third shipment of electrical equipment for the Chilean State Railway, consisting of six complete electric locomotives, the largest shipment of electric locomotives ever made, recently left the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company. The shipment was valued at $700,000 and represented a partial fulfillment of the $7,000,000 contract awarded the Westinghouse International Company by the Chilean State Railways.

Thirty-nine electric locomotives, 15 for road freight service, six for express passenger service, 11 for local passenger service and seven for switching service, are to be built by the Westinghouse Company for the Chilean Railways. The six locomotives in the recent shipment are of the road freight type and weigh approximately 103 metric tons each. They are capable of maintaining an average speed of 35 miles per hour when hauling a 770-ton train on any part of the line between Valparaiso and Santiago, except the heavy Tabon grade.

Two railroad flat cars were required to ship each locomotive. The cab, not mounted on the trucks, occupied one car, and six motors, the number required to drive each locomotive, occupied another. Each cab was completely equipped for operation when assembled at its destination.

The trucks for the locomotives will be loaded on board ship at the Eddystone Docks of the Baldwin Locomotive Works at Philadelphia with the equipment shipped from East Pittsburgh. From Philadelphia the locomotives will go directly to Valparaiso, Chile, where they will be assembled. The remaining locomotives will be shipped at the rate of about one a week, according to recent announcement.

Employe Casualties Greatly Reduced

A recent report of the Interstate Commerce Commission covering fatal and other injuries to railway employes in the past five years shows the following:

In 1917, 401 switchmen or their helpers were killed and 12,004 injured. In 1921, only 169 were killed and 6,711 injured.

In 1917, 478 freight brakemen and flagmen were killed, and 13,094 injured. In 1921 only 186 were killed and 7,012 injured.

In 1917, 78 engine foremen were killed and 1,815 injured. In 1921, only 39 were killed and 1,094 injured.

In 1917, 88 freight conductors were killed and 3,099 injured. In 1921, only 48 were killed and 1,921 injured.

These figures are convincing evidence of the success of the efforts of employes and managements to reduce casualties among railroad workers.

Suggestions as to the Standardization of Machine Tools

By Fred H. Colvin and K. H. Condit

There are two outstanding phases to the problem of standardization of machine tools, one as it affects the builder and the other its effect on the user of the machines. The former can be left to the builders themselves as it affects the cost of manufacture and the amount of capital invested. The latter, the effect of standardization on the user, is of direct interest to all.

One of the first considerations in making or advocating any change from existing practice is whether the benefits to be derived are worth the cost. This holds good with the proposals for standardization of machine tools and this question of cost very frequently makes what we are pleased to call standardization, really a matter of elimination. We usually eliminate unnecessary sizes and make those which we retain the standard, rather than adopt an entirely new standard which is the result of careful investigation, calculation and experiment. And while this may not be the ideal procedure, it is the practical solution in most cases. Devising a new standard too often means simply adding another variety rather than eliminating many which are now in use.

The Advantage of Uniformity

Those who deprecate this unscientific method of standardization should remember that one of the greatest advantages of standardization, perhaps the greatest, lies in uniformity rather than in perfection as to the standard adopted. Taking the gear shift of an automobile as an example, the question of superiority in any particular shift sinks into insignificance in comparison with the advantages of having any one of the gear shifts adopted as standard on all cars. The typewriter keyboard is another excellent example of this.

Standardization of machine tools from the standpoint of the user can be confined to two specific points, work-holding and tool-holding devices. The former affects principally the spindle noses of lathes and the T slots of planers, milling machines, boring machines, drilling machines and the like. Tool holding devices affect the spindle noses of milling machines and drilling machines, turret holes, tool posts, grinding wheel spindles, etc. And while these look innocent enough on the surface it does not take long to find that it involves the old controversy as to tapers, which is enough to start a heated argument in any shop.

Interchangeability and Accuracy

Every mechanic who has handled precision work knows that it is not practicable to interchange lathe chucks on very accurate work with the idea that the chuck will run dead true on more than one machine. On the great majority of work, however, the ability to change chucks from one lathe to another, without the bother of making adapters (which usually add considerably to the overhang) would be of great service in many shops. In the same way fixtures should be interchangeable from one machine to another by the use of standard T slots in the tables and probably standard distance of the first slot from the edge of the table.

The inability to use given turret tools in more than one machine imposes an unnecessary expense on the shop overhead and also directly affects future sales of the machines in question. The builder whose machine has odd sizes of turret holes, for example, will have a hard time securing an order from a shop equipped with machines having a different size, even though one be as logical as the other. And while an order once secured might tend to force a continued use of this machine, it is apt to prevent an order at least as often as to secure one.

T Slots

The standardization of T slots is probably the easiest place to make a beginning and here again it will undoubtedly result in the elimination of perhaps half the sizes, retaining only those which are necessary. A canvass of the total number of each size of T slot cutters sold should make it easy to select the sizes most in use.

But even T slots have several points to consider. The width of slot opening, the width and depth of the T for the bolt head, and the depth of metal over the slot to resist pulling out a piece of the table. Uniformity as to this latter feature is, however, less important than the width—as that is what affects the use of tongs for locating milling fixtures and the like. The distance of the outside T slots from the edge of table is also important.

It may be well to emphasize right here, that no matter what is being standardized, it must be remembered that a definite tolerance must be given in each case. And in considering tolerances, let us bear in mind that the modern tendency is toward a unilateral tolerance—a plus tolerance on the slot or hole and a minus tolerance on the part which fits into it. Let us get away from the "plus *or* minus" tolerance on the same piece.

Standardizing T slots also involves the standardizing of the T slots which are to be used in them. Carl Barth has given this careful attention and his recommendations have been taken up by H. Cadwallader, Jr., of Philadelphia, who now manufactures T bolts to the Barth standards.

Another point to be considered in standardizing work- and tool-holding devices is to have the same size on as many machines as may be practicable. It may often be convenient to use the same chuck on a 14-in. and a 24-in. lathe. This is probably too big a range to be adequately covered by the same spindle nose, but it is quite possible that the same size of nose might be used on two or three sizes of machines. Some builders already use the same feed box on different sizes of machines, which is a very sane and sensible practice.

There is considerable talk of standardizing machine capacities, such as the swing of a lathe. But while it would be more convenient all around to know just what was meant by a 14-in. lathe, this is really a problem of the salesman and the buyer. If the seller prefers to cut prices by selling a 17-in. lathe under the name of a 14-in. lathe, it hardly affects the user so long as the work-holding or tool-holding devices on the lathe are standardized.

The milling machine builders have perhaps done more in this line than builders of any other machine tools. A No. 1 machine now has approximately the same capacity in nearly all makes. The use of numbers, however, has little to commend it, whether it be milling machines or wire gauges, and it is believed that main dimensions as to capacity would be more satisfactory to users.

Standardization Does Not Hamper Progress

One of the stock objections to standardization is that it prevents progress and the development of new ideas and designs. If, however, we consider that the Society of Automotive Engineers has done more in the way of standardization than anyone else and then note the development in the automobile industry, this objection is easily answered. Is it likely that automobiles or other machinery would be more highly developed if each builder used a special sized nut with a special thread? Standardization of such parts as nuts, piston pins and other parts simply means that the designer calculates his requirements, such as to the kind of loads and stresses and selects the standard part which meets his needs, instead of designing an entirely new nut or pin of a slightly different size. It must also be remembered that standards are not as fixed as the pyramids, but can be changed whenever occasion really demands.

While all our efforts at standardization at this time should be devoted to such details of machine tools as affect the

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A paper read before the American Society of Mechanical Engineers.

user, such as the work- and tool-holding devices as has been pointed out, it is quite probable that the machine tool builders themselves may find further standardization desirable. Research may show that bearings of certain dimensions are best for given spindle loads and speeds. Designers would then determine the load to which the spindle of a new machine would be subjected, and after considering all the conditions, would select the proper bearing from a list of standards. This would simplify manufacture and greatly reduce the number of tools and gauges to be carried in stock as well as the stock of bearings themselves. This phase of the matter, however, does not concern the user of the machine and he will do well to confine his efforts at securing standardization to such features as concern him directly.

The Problem of Securing the Adoption of Standards

In addition to the engineering and economic aspects of machine tool standardization, there is the adoption phase—for all practical purposes this is a selling problem. The best engineers of the United States, or of the world for that matter, may gather in solemn conference and decide that certain standards shall be established but they have no power to do anything more. If the manufacturer concludes that his present practice is sufficiently satisfactory and is not convinced of the need for innovation there is little that the standardizers can do.

Very often the problem is essentially a "selling" problem and one for which the average engineer is temperamentally unsuited. Diplomacy, tact, persuasiveness, the stock-in-trade of the salesman are needed at this stage of the game. Even they would be futile if no means were at hand for gathering together the men who must make sacrifices if a standard is to be adopted, for lacking such means the task of reaching each man individually and reconciling his views with those of all the others, would be Herculean.

The machinery for handling the engineering and industrial problems connected with this phase of standardization already exists in the American Engineering Standards Committee, and the Rules of Procedure of this Committee are designed to bring about the early adoption of approved American Standards. To this end all Sectional Committees are required to include in their personnel representatives of *all* organizations which are in any way interested in the manufacture or use of the standard under consideration. Since these organizations are officially represented on the Committee which prepares the standard, it is obvious that the members of these organizations are committed to the adoption of the standard to the extent that any individual or firm is committed by the actions of an organization to which he or it belongs. Just how well this arrangement is going to work out when it comes to universal adoption of a standard it is too soon to say, but at least the plan shows promise.

It may be that the Division of Simplified Practice of the Department of Commerce recently organized by Secretary Hoover will have a part to play in securing the general adoption of the standards for small tools and machine tool elements which are to be developed by the Sectional Committee sponsored jointly by the National Machine Tool Builders' Association and The American Society of Mechanical Engineers. This, of course, will be determined as the work of the Committee progresses.

So far the Division has done its best work in fields of industry not closely connected with engineering. It is cooperating, however, to the fullest extent with the American Engineering Standards Committee in furthering the establishment and introduction of standards.

Standardization is a tremendous job and it may prove to be one beyond the capacity of any standards body yet organized. But it is a job that must be done and some means will have to be found. For the present, existing agencies should be given the fullest possible support by every one interested, manufacturer or user. Whatever is accomplished will benefit everyone and is well worth any sacrifices that may have to be made.

Design of Risers and Vents Suitable for Vertical Locomotive Frame Welds

In Thermit-Welding a fracture in a vertical locomotive frame member, it has not been found advisable to place any risers directly up against the frame at the upper edge of the collar because this reservoir of heat so close to the frame is likely to melt the section away above the weld, and yet when the risers are placed ¼ in. or more down from the top edge of the collar it is evident that there will be a pocket above the level of the base of the riser in which air will be trapped when the mold is filling rapidly with steel.

It is therefore very important that this extreme top edge of the collar all away around the section should be completely vented to the top of the mold so as to allow the air to escape freely as the mold is filling. It is advisable to lay in, alongside of the frame, thin wooden shims, 1/16 in. to ⅛ in. thick, which are withdrawn after the mold is rammed and, therefore, completely vent the top edge of this collar all the way around. It is true that this space will be filled with steel but the fin will be so small that it will chill against the frame and not weld to it and therefore can be readily chipped off upon completion of the weld.

Railway Mileage of the Continents

In a recent issue of the *Archiv für* Eisenbahnwesen presented its annual compilation of the railway mileage of the world. An analysis of this compilation, which relates to the year 1920, discloses some interesting information as to the relative mileage in the United States and in other countries.

The world's mileage in 1920 was 748,005 miles. This is distributed among the continents as follows:

	Mileage	Per Cent of Total
The Americas (North and South)	380,194	50.8
Europe	237,888	31.8
Asia	74,115	9.9
Africa	32,239	4.3
Australia	23,569	3.2
Totals	748,005	100.0

North and South America combined contain over one-half of the railway mileage of the world, America and Europe combined contain over four-fifths, while the great areas of Asia, Africa and Australia combined represent the remainder of less than one-fifth.

The railway mileage of the United States of America is reported as 264,373 miles. This is approximately 70 per cent of the total mileage of the Americas and 35 per cent of the mileage of the world. It exceeds the total mileage of Europe by 11 per cent and that of Asia, Africa and Australia combined by more than 100 per cent.

How the railway mileage of the United States compares with that of some of the other countries of the world can best be indicated by means of multiples, showing how many times the mileage of the United States is more than that of the other countries. These countries are the ten which stand next to the United States in point of mileage:

	Railway mileage	Ratio of U. S. mileage to mileage of country named
United States	264,373	...
Russia (including Asiatic)	51,646	5.1 times
Canada	38,888	6.8 "
British East Indies	36,325	7.3 "
Germany	36,131	7.3 "
France	35,145	7.5 "
United Kingdom	24,396	10.8 "
Argentina	23,156	11.4 "
Brazil	17,478	15.1 "
Mexico	15,841	16.7 "
Italy	12,501	21.1 "

In other words, the railway mileage of the United States is five times as great as the mileage of Russia, which contains the next largest system of railways. Our mileage is nearly seven times that of Germany or France, nearly eleven times that of the United Kingdom and twenty-one times that of Italy.

European Railway Notes

Giving Some Details in Regard to Russia, Latvia, Hungary, Etc.

The Department of Commerce sent out a questionnaire some time ago, asking for information regarding the condition of the railroads of Europe. The consular replies to these questions are, to a great extent, of such a purely statistical nature that cannot well be published as they stand. Among the roads regarding which this information has been received are those of Finland, Latavia, and Rumania.

As to the equipment of the Finnish railroads all of the locomotives with the exception of a few old yard locomotives are equipped with the Westinghouse air brakes and an oil-gas or acetylene lighting system. There are 14,470 freight cars on the lines and of these 6,352 are fitted with the Westinghouse air brakes and all of the rest have brakepipes for conveying the air through the train. The car capacity for the four-axled cars is 30 tons and for the ordinary two-axled cars it runs from 8.5 to 16.5 tons. The length of the four-axled cars is a little over 42 ft. and that of the others ranges from 21 ft. to 28 ft.

Automatic signalling is used at only about 60 of the more important stations and block towers are installed at only two of them. Kerosene is used for the signal lights with a few exceptions where acetylene is used. The introduction of modern electrical apparatus has been undertaken during the past few years, and it is proposed to adopt it as rapidly as possible. The Finnish railway shops have done some experimenting in the construction of electrical apparatus, but in general, foreign equipment must be relied upon.

The Finnish railways are at present maintained in a fairly satisfactory and effective operating condition. More rolling stock both cars and locomotives are needed to replace the losses sustained during the war when 58 locomotives and 440 passenger cars and 5,000 freight cars belonging to the roads were sent into Russia and were retained there as war booty under the terms of the Finnish-Russian peace treaty. On the other hand Finland acquired 1,200 freight cars in the same manner. This latter equipment is still in need of much repairing, including the installation of the air brake, as will be noted from the figures given above.

In spite, however, of the small amount of rolling stock available since the war, the freight carried in 1921 exceeded that carried during 1913, just preceding the war.

In view of the general satisfactory business conditions that have prevailed in Finland since the war and the period of general depression, coupled with the fact that the Finnish railways are being operated on a basis that is profitable to the state, the reports state that it appears to be probable that a favorable prospect exists for American firms to do business with them in supplying rolling stock, rails, shop machinery, signal apparatus and general supplies.

While these reports of the Finnish railways are not those of that paint the situation as one of glowing prospects, the reports that come from Latvia are decidedly gloomy.

It was reported on the first of April of this year that there were 512 passenger cars in the country of which 6.3 per cent were listed as out of service on account of needed repairs. Yet even this statement is believed to indicate a more favorable condition than that actually existing, as a great many of the cars that are listed as sound and actually in operation are in need of new tires, bearings and other repairs of greater or lesser importance. A lack of equipment in the railroad shops as well as financial reasons have prevented the carrying out of these much-needed repairs.

The Latvian railroads possess about thirty-five freight cars which have a length of about 40 ft. and a carrying capacity of 40 tons, the balance are of the four-wheeled type and are from 20 ft. to 26 ft. long and have a capacity of 16 tons.

The roads are handicapped to a certain extent by the difference that exists between their gauge and that of the Russian roads with which they connect. The Latvian gauge is 4 ft. 8½ in. and that of the Russian roads is 5 ft. In order to overcome this and permit of an interchange or at least a reception of the Russian rolling stock it is proposed to lay a third rail to the Russian gauge during the coming year.

A very antiquated Russian signalling system is still in use, in which oil lamps are used, but plans have been adopted for the introduction of a modern electric signalling system. No contracts have yet been given out for this equipment, and lack of funds may cause an indefinite postponement of it, so that there is no prospect of its execution in the immediate future.

As for the shops the state has two main shops, one at Libau and the other at Riga, to which must be added five district shops. Owing to the fact that most of the machinery in these shops was taken into Russia during the war, great difficulty has been encountered by the Latvian authorities in repairing the rolling stock. As there are no private shops all of the repairing has had to be done in the railway shops.

It is proposed by the railway administration to spend 15,000,000 Latvian rubles during the coming year in the purchase of new machinery and equipment, for which purpose a purchasing commission has already been sent into Germany. About a year ago a 50-year lease was concluded with a German firm for the restoration of the important shops at Dvinsk, which are to be re-equipped and placed in condition, within one year for making major repairs to locomotives at the rate of fifty per year.

A project for the electrification of the Latvian railways coincident with the construction of hydro-electric stations on the Dvina River has been worked out by the railroad administration, for which it would be glad to negotiate with foreign capital, but the general economic conditions of the country do not yet appear to justify the expenditure of such large sums as this project would require.

The old Russian Imperial naval work shops at Libau which are now in the posession of the Latvian Government, could be made available as a railway shop and the government would be willing to negotiate with foreign interests for their lease.

It is also possible that the state railways could, themselves, be leased or concessioned to foreign interests for complete operation. The Latvian Government is, itself, in no condition to make any large expenditures for the railways for some years to come, unless it succeeds in obtaining capital from abroad. The consul states that he has been repeatedly informed by the government officials that they would be particularly interested in negotiating with American firms along these lines.

Bad as this is the reports from Rumania are not much better, if any. For example a year ago there were 4,113 locomotives owned by the railroads of which 2,759 were out of service, and the same can be said of two-thirds of the passenger cars and about a half of the freight cars.

Almost all of the Rumanian railroad officials maintain that the present poor condition of transportation is caused by the lack of sufficiently large and efficient locomotive repair shops. Because of the rise in the value of the Czecho-Slovak crown and the fall of the leu, the Rumanian Government finds that it is now too costly to have locomotives repaired in Czecho-Slovak shops and efforts are being made to cancel contracts for locomotive repairs in Czecho-Slovakia.

The large steel plant at Reshitza in Rumania, is increasing its capital by some 25,000,000 lei with the idea of undertaking the manufacture of new locomotives and repairing the old ones. It was maintained, last spring, by prominent railway officials that by this last autumn, in addition to being able to repair locomotives, they would have a production of 100 locomotives per year.

As to other matters cars of 10 and 15 tons' capacity make up the bulk of the freight rolling stock with a small percentage of 6, 8, 20 and 25 ton cars.

In addition to the new locomotives that were received last winter as the result of purchase in Germany, there were also received a number of passenger and freight cars from Bulgaria as prescribed by the reparations terms of the treaty of peace between Rumania and Bulgaria.

The program that was mapped out as necessary a year ago is that there should be a reconstruction of the trackage with heavier rails to carry the larger locomotives that are now in service; the double tracking of some of the main sections; the conversion of all of the tracks in Bessarabia to a standard gauge; the reconstruction of all bridges to a standard type and the supplying of ballast, the renewing of switches and the improving of the stations.

Hungarian State Railways

Railroads of Hungary, with the exception of a few sidings owned by private industrial and agricultural organizations, are operated by the government through the Chief Supervising Department of the Bureau of Railway and Steamship Navigation, Royal Hungarian Ministry of Commerce. In order to gain a comprehensive knowledge of the present state railroads, it is necessary to begin with the study of conditions existing prior to the war, and continue through to 1921. The information given in this report was obtained from the chief supervising department of the Bureau of Railway & Steamship Navigation, and other reliable sources.

Prior to the war the exchange of merchandise between western and eastern Europe was carried on chiefly by rail over the network of the Hungarian State Railways—considered an important link in the chain of international lines of communication—with uniform gauge, a standard tariff and efficient customs regulations tending to insure the transportation of merchandise with the least amount of delay and inconvenience. However, conditions caused by the revolution in 1918, subsequent military occupation and the treaty of Trianon, has destroyed pre-war efficiency and has caused considerable reductions in carrying capacity and revenue to the state, while international traffic has suffered for lack of transportation facilities.

During the commumist revolution in 1919, a considerable amount of damage was done to the rolling stock by neglect and wanton destruction, and it is reported that the military authorities in occupation after the downfall of the Soviet Government, further increased the inefficiency of management and decreased the former efficial guarantees for security in traffic. However, the extent to which international trade suffered is noticeable also through the detachment of important sections of the railroads in consequence of the division of territory stipulated by the treaty of Trianon. According to governmental authorities, there were only six customs stations in Hungary during the union of the dual monarchy, four at the Rumanian frontier, one at the Serbian frontier, and one at Fiume, on the Adriatic, which was established to handle overseas traffic, whereas, present Hungary is credited with 19 such stations and should a customs station be established on every line crossing the new frontiers, the number would be increased to over fifty, thus illustrating the difficulties at present encountered in interstate transportation.

The chief railway stations formerly accredited to Hungary but now detached, are: Csap, to Czechoslovakia—Szatmar, Nagykaroly, Nagyvarad and Arad to Rumania —and Szabacka to Jugoslavia. These centers are reported by transportation men of Budapest, to be equipped with freight yards, customs facilities, warehouses, water supply, coal bunkers, lodging for railroad employees changing duty, machine shops, etc. The establishment of the new frontier stations cutting off these important centers from uninterrupted traffic brings the Hungarian line to open country at the frontier without any facilities to handle international or local traffic. Practically all the new frontier stations are poorly equipped such as would be expected at small unimportant interior towns, and they cannot meet the necessary requirements for efficient despatch, and owing to the low purchasing value of the crown and the general economic condition of the country, nothing of importance in the matter of equipment can be done at present, causing further delays and insecurity to traffic.

According to the statement of the government, there are 621 officials and 5,405 men, or a total of 6,026 employees of the 1921 personnel in excess of the number actually required by the railroads. These employees are separately listed and receive their salaries, amounting to 79,215,000 crowns annually, from the Ministry of Finance.

The State railways are under the supervision of the Ministry of Commerce through four appropriate bureaux, namely, general railways, suburban lines, technical and tariff questions. The Royal Hungarian Chief Supervising Department of the Ministry of Commerce exercises direct control over the railways, and as such supervises the regulation and safety of traffic over the State and privately owned railways, and controls the repairs and developments that are considered necessary for the general efficiency of the roads; also, acting under the authority granted it by the Ministry of Commerce, the department judges on all matters pertaining to the discipline of all railway officials and employees.

The management of the Royal Hungarian State Railways is governed by seven directors, whose spheres of control and activities are segregated into as many divisions:

The present condition of the railways is not at all satisfactory, but the Hungarian officials continually place the blame for the actual deplorable state on the military forces in occupation from August to November, 1919, and the substitution of material reported to have been either carried away or destroyed by the foreign military forces appears to be a most difficult proposition, because of the present economic condition of the country, and the lack of hard coal and iron ore mines, forests, oil, and other essential natural resources, at one time within the territory of Hungary. Now all such material must be purchased on foreign markets while the purchasing value of the crown continues to remain very low. The need for repair, lack of cars and locomotives, and poor road-beds has brought about a considerable reduction in the traffic of the railways, and the management has been compelled to reduce the speed of the locomotives, in order to guarantee the safety to travel. Although indications of improvement are reported nothing of importance is noticeable in this regard, but regardless of the poor conditions of the roads, the Hungarians claim that they were the first country in Central Europe and the Balkans, to establish regular and reliable railway traffic after the armistice.

According to concrete data obtained from various government sources, the situation as regards the present condition of rolling-stock, etc., is as follows:

On November 3, 1918, an inventory of the Royal Hungarian State Railways showed the rolling-stock to be:

Freight cars	104,757
Passenger and mail cars	11,923
Locomotives	4,816

In September, 1920, including newer cars and locomotives, and after the Soviet régime, foreign military occupation and detachment of territory, the inventory was reported to have been as follows:

Freight cars	26,327
(Of the above 3,521 were under repairs)	
Cars including foreign property	42,445
Locomotives	1,857
Under repair	845
Serviceable locomotives	1,012

According to the figures supplied to the consulate by the government, 1,350 locomotives, 2,700 passenger coaches and 36,000 freight cars were taken by the Rumanians after the armistice, including the best locomotives, too heavy for use on the Rumanian railways, and it is further reported that these locomotives are now lying idle in Rumania, although badly needed in Hungary. In connection with the number of freight cars, it should be observed that there are 3,000 box cars now being used as dwellings by those employes of the State Railways who were ejected from the territories detached from Hungary, in consequence of the peace treaty. These men refused to take the oath of allegiance to the new government and, so, were forced to leave the territory.

All material used by the State Railways is purchased by the purchasing department. However, should an order exceed a certain sum, as regulated by the executive directors, from time to time special permission must be obtained from the Ministry of Commerce, before an order can be placed.

The tariff of the Hungarian State Railways is arranged so as to follow a progressive scale, and is based on a 100 kilogram unit, and a 10 kilometer unit by distance with a minimum increase of 100 per cent. Passenger rates are based on the myriametric system (6.2137 miles) by distance; there are I., II. and III. class compartments for passengers on practically all trains. Owing to the great advance in the price of material and labor during the latter part of 1921, the Hungarian State Railways were forced to increase their passenger fares by 100 per cent, and freight rates from 100 per cent to 1,100 per cent beginning March 20, last.

There are no special agreements with foreign countries in the strict sense of the term, as all interstate traffic is carried on in conformity with the international agreement concluded at Berne, Switzerland. Inasmuch as direct goods shipment is arranged by the interchange of cars between lines an agreement has been reached between the members of the German Railway Association, for the mutual cooperation on all lines. However, owing to the attitude assumed by neighboring countries, traffic between these States and Hungary is carried on with difficulty, but it is hoped that more friendly relations between them will be brought about in the near future.

As the low purchasing value of the crown and the general economic condition of the country will not permit of large purchases of material, the construction of any new lines in Hungary cannot be considered for sometime to come. However, inasmuch as the Hungarian coal mines are unable to supply the necessary amount of coal, even of inferior quality, it is planned by the State Railways to endeavor to make use of all the energy resources of the country for the electrification of the railways. A trial electrification of 15 kilometers (9 miles) has been under consideration, and it is reported that work will begin soon.

In order further to reduce expenses, the authorities are considering plans for reorganization in an endeavor to reduce the number of employes without a reduction in the general efficiency of the roads.

Czechoslovakia

The Republic of Czechoslovakia in 1920 was served by 13,690 kilometers of railway lines. In 1921 there were 14,030 kilometers in use, including State and privately owned lines.

In the years immediately preceding the war 96,000,000 passengers and 57,000,000 tons of freight were carried annually on the main lines of railways in what is now the Czechoslovak Republic, the receipts from this traffic amounting to 588,000,000

and 46,000,000 tons of freight were hauled, the receipts therefrom amounting to almost 3,000,000,000 crowns.

The year 1921 witnessed a consistent growth in passenger traffic, over 159,000,000 having been carried; but freight tonnage fell off to slightly over 43,000,000 tons, the gross receipts for that year having been 3,873,499,000 crowns. It will be noted that while there has been a substantial increase in passenger traffic, as compared with pre-war years, the freight tonnage is considerable lower. It is expected that this condition will continue in 1922, since the passengers carried in the first six months of this year numbered over 80,000,000, while the freight traffic will probably amount to only about 70 per cent of the pre-war tonnage.

Freight and passenger rates on the railways of Czechoslovakia are among the highest in Europe, it being computed that they are thirteen times greater than those in Germany. There has been considerable agitation for a reduction, although the officials point out that the present basis of rates is the reason for their administration showing a surplus, as against the deficit constantly piling up in Germany.

Report of French Commission on Air and Vacuum Brakes

Early this year the French Minister of Public Works appointed a commission to examine and recommend for adoption the type of brake considered most suitable for use on French freight cars. The Westinghouse, Clayton-Hardy, and Lipkowski were examined. An extract from the report of this commission follows:

Considering that the Clayton-Hardy vacuum brake has been shown to be the most apt of the three for descending long and steep grades; that the Westinghouse brake—supplemented, for the purpose by a number of retaining valves—insures the descent under conditions of security which are sufficient; that the Lipkowski brake equipped with the control and retaining valve assures the descent also under conditions of safety which are considered sufficient;

Considering that for tests on the level the three systems have given results that are satisfactory and comparable, one with the other, with regard to stopping distances, with a slight superiority in favor of the vacuum brake;

Considering that in the course of these same tests the Westinghouse brake, which has back of it long practical experience in America, is the one which has given the least abrupt reactions and that it permits the braking of the train in a satisfactory manner; that, on the contrary, the other two systems, and especially the Lipkowski brake, have given a certain number of very abrupt reactions which might present a serious inconvenience on freight trains;

Clayton-Hardy brake for braking freight trains would involve the adoption of the same system for the braking of passenger trains; and further considering that the abolition of the air-brake apparatus, which is now used on a very large number of slow small cars, would result in a very great increase in expenditures, without counting the serious operating disturbance which this transformation would cause during the transitory period; that, furthermore, the Clayton-Hardy apparatus, which is heavier and more cumbersome than the other two systems, would present the inconvenience of sensibly increasing the dead weight of all vehicles; that under these conditions the adoption of that system would not be justified unless, contrary to what was brought out by the tests, it was shown to be markedly superior to the other two systems;

Considering that the Lipkowski brake has up to the present time been subject only to a limited number of tests and has not been tried out in actual practice; that even in the course of the tests various modifications and improvements were made on the system, and that it is still in the course of evolution and can not be considered as having reached its final form:

It is the unanimous opinion of the 11 members of the commission that—

It seems advisable to give the preference to the Westinghouse brake, with only one main pipe characterized by the use of the special triple valve and by the addition of a coupling permitting the temporary adaptation, for the descent of very heavy trains on steep grades, of the ordinary retaining valve:

That it seems advisable to the French Government to propose to allied nations and to countries adhering to the protocol of Berne of May, 1907, the adoption of this brake.

It is understood that the choice of the Westinghouse brake does not necessarily involve its exclusive adoption and that it will be possible to adopt in the future any other equivalent air-braking system which may be used in conjunction with it in any proportion.

Commercial Attaché Chester Lloyd Jones at Paris reports that the recommendation of the commission rests in the hands of the Conseil Supérieur des Chemins de Fer, which is supposed to meet in the near future.

Few Wood Mail Cars in Service

According to a statement of the Post Office Department, there are 1,087 railway post office cars in service, only four of which are of all wood construction. Of the balance, 862 are all steel, 154 have steel underframes and 67 are steel reenforced.

Of the 4,074 "combination" cars in use only 382 are all wood, while of the balance 1,104 are all steel, 641 have steel un-

Mechanical Couplers on the Railways of India

Railway Department of the Government Has Under Consideration the Possibility of Their Introduction on the Broad Gauge Roads There.

By Our India Correspondent

Referring to the item that appeared on page 210 of the August, 1922, issue of RAILWAY AND LOCOMOTIVE ENGINEERING relative to the introduction of M. C. B. type couplers on certain cars sent to India, it is interesting to note that although the reference is correct inasmuch as such cars are used on the Bombay Back Bay Reclamation and are equipped with mechanical couplers, it is premature to say that these are fore-runners of a change on the main line railways. The cars under notice are used for the special work of dumping earth into that part of the Back Bay which is to be reclaimed, and as they had to be built with very low underframes to enable the side tips to clear the 5 ft. 6 in. gauge, central automatic mechanical couplers were used to meet difficulties in design and also provide for rapid coupling and uncoupling. One of these construction trains is shown in Fig. 1.

FIG. 1. CONSTRUCTION TRAIN ON BOMBAY DEVELOPMENT FITTED WITH M. C. B. COUPLERS

The note, however, gives an opportunity to call attention to the question which is now before the Railway Department of the Government of India, viz., the adoption of central mechanical couplers of the M. C. B. type in replacement of the present buffers and screw couplings. Whereas, 20 years ago with loads of some 500 or 600 tons behind the tender and with the easy manipulation required by the traffic department, it was quite possible to handle the trains equipped with screw couplings and buffers, now with loads approximating 2,000 tons and with schedules quickened up to meet increasing demands of traffic, and further the equipment of freight trains with continuous brakes, the question has arisen as to whether some better appliance should not be used for coupling the vehicles.

The railway which has taken the lead in this matter is the Great Indian Peninsula. Figure 2 shows a train of their cars which have been fitted experimentally with M. C. B. couplers, to demonstrate the advantages that would accrue if such a device is generally adopted.

The Indian broad gauge railways extend over 16,000 miles of track. There are 6 large Administrations including the State, and these own among them some 6,000 locomotives, 14,000 passenger and 150,000 goods vehicles. All this stock has so far been fitted with spring buffers and wrought iron drawgear with screw couplings. In recent years high tensile steel has replaced iron in many cases, but manifestly the strength of the couplings must be considered that of the weakest until such time as all vehicles are equipped with something stronger. It is estimated that to strengthen up the drawgear, replace with high tensile steel details and generally improve the present coupling and buffing arrangements to meet the wants of trains of 3,000 tons behind the tender will cost $45,000,000.00, whereas, to equip the whole stock with couplers of M. C. B. type in replacement of the present buffers and screw couplings, the total capital expenditure necessary would be only about $20,000,000.00. The advocates therefore claim that this latter is by far the better procedure to adopt, for it would not only secure a stronger coupling but one which has many mechanical advantages in safety -

FIG. 2. 2,000 TON TRAIN, VIEW FROM REAR TO SHOW 10-TON CABOOSE. TRAIN THROUGHOUT FITTED WITH CONTINUOUS BRAKES

of operation, manipulation, etc. Further, closer coupled trains would be automatically secured suitable for operation with continuous brakes by the mere fact of pushing the vehicles together. Figure 3 shows the present method of coupling in India. It has been ascertained that to couple, with arrangements in the best of condition, the average time taken by a coupling-man is

FIG. 3. SHOWING NATIVE SWITCHMAN ATTACHING SCREW COUPLING ONTO HOOK, TIGHTENING COUPLING, AND LEAVING VEHICLES

30 seconds per coupling—with a train of 60 vehicles 30 minutes must be allowed as the minimum for coupling or uncoupling the vehicles. With mechanical or M. C. B. type couplers, the connection would be made practically instantaneous and the only work necessary would be to couple up the brake pipes, which experiments have shown can be performed in about 10 minutes.

We understand that the Committee of Locomotive and Carriage Superintendents, who are the mechanical advisers to the Indian Railway Conference Association, have already expressed their opinion in favor of the adoption of mechanical automatic couplers and the method of applying them they suggest might be similar to that which has been adopted in Australia, the couplers being placed below the present drawgear, as shown in the illustrations, figures 4 and 5. During the transition period they can be used when two fitted vehicles become adjacent, but when a fitted wagon is brought up against a vehicle equipped with the ordinary European attachments, the couplers remain out of action and below the drawhooks and couplings.

FIG. 4. SHOWING STANDARD WAGONS FITTED WITH M. C. B. COUPLERS

FIG. 5. STANDARD OPEN WAGONS FITTED WITH M. C. B. COUPLERS

The Railway Board have now deputed an officer to thoroughly examine the question, prepare estimates and also to secure experience in the U. S. A. It appears therefore probable that it cannot be long before the Indian broad gauge railways have mechanical couplers in general operation.

New Publications on Railway Subjects Issued by the Westinghouse Electric & Manufacturing Company.

Suggestive ideas on the solution of two important problems confronting the electric railway operator, maintenance of equipment and proper application of transportation methods, are offered in two attractive publications issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The first book—Electric Railway Equipment—Helpful Hints on its maintenance—S. P. 1656, contains 112 pages and is the first edition of what will evidently be an encyclopedia of operation and maintenance of equipment. It gives the electric railway operator or the man directly in charge of maintenance a ready reference on maintenance practice. Combined with this information are illustrated pages showing a clear, concise manner the superior constructive features of modern railway equipment. In the book are combined a catalog, instructive book and maintenance stories from the technical press.

The second book, S. P. 1655, is a 20 page publication entitled "Electric Railway Transportation." The Light Weight Double Truck Car, the Safety Car and the Trolley Bus are the three leading topics discussed with pictures portraying the actual operation and installation of each type in the United States and Canada accompanying each discussion. It is the purpose of this book to show the merits of each mode of transportation and the special field of service for which each is best adapted.

Because of the unusual interest and activity of railroads in heavy traction electrification, this company has also had reprinted an article on the "Advantages of Railroad Electrification," by Mr. R. J. O'Brien, that appeared recently in the technical press. The publication is known as reprint No. 128. In answer to the questions, "Why electrify?" and "What are the advantages of electrification?" statistics and data acquired from actual operating records on both steam and electric roads serve as a means of comparing the two methods of operation. These statistics touch on fuel consumption, maintenance costs, schedule possible under existing modes of transportation, and other subjects of importance. The feasibility of electric operation in tunnels, on heavy mountain grades, in congested freight yards, or in heavy interurban traffic are also clearly set forth.

In order to acquaint the industrial gear user with the advantages of Micarta gears, the company issued a 20 page booklet, Folder 4506, entitled "Salient Facts on Silent Gears." The booklet describes the advantages of the use of Micarta gears and pinions and gives photographs and data describing some of their applications.

Railroad Equipment Notes

Locomotives

The Oliver Iron Mining Company may purchase 10 switching locomotives.

The Grand Trunk is inquiring for 10 Mountain type and 10 Sante Fe type locomotives.

The Montour Railroad has ordered 4 Mikado type locomotives from the American Locomotive Company.

The Pere Marquette has ordered 20 switching locomotives from the American Locomotive Company.

The Western Pacific has ordered 6 Mikado type locomotives from the American Locomotive Company.

The American Woolen Company, Boston, Mass., has ordered one 4-wheel switching locomotive from the American Locomotive Company.

The Pennsylvania-Ohio Electric Company, Youngstown, Ohio, has ordered one-4-wheel switching locomotives from the American Locomotive Company.

The New York, New Haven & Hartford has ordered 12 electric locomotives from the Westinghouse Electric & Manufacturing Company.

The Mexican Railway Company, Ltd., has ordered 10 electric locomotives. These locomotives will be constructed and equipped jointly by the General Electric Company and the American Locomotive Company.

The Erie Railroad has placed an order with the Standard Tank Car Company for 92 locomotive boilers.

The Philadelphia & Reading will construct five Pacific type locomotives at its Reading shops.

The Southern Pacific Company has ordered nine Pacific type locomotives for its Texas Lines from the Baldwin Locomotive Works.

The Chesapeake & Ohio has placed an order with the American Locomotive Company for 6 Pacific type and 2 Mountain type locomotives.

The Toledo Terminal is reported to have placed an order with the American Locomotive Company for 2 locomotives of the Consolidation type and and 1 6-wheel switching locomotive.

The Fruit Growers' Express Company has placed an order with the American Locomotive Company for one four-wheel switching locomotive.

The Chicago Milwaukee & St. Paul has purchased 50 Mikado type locomotives from the Baldwin Locomotive Works.

The Richmond Fredericksburg & Potomac has ordered 1, 8-wheel switching locomotive and 1, 6-wheel switching locomotive from the American Locomotive Company.

The Aluminum Company of America is inquiring for 2, 8-wheel switching locomotives.

The Seaboard Air Line has ordered 1 locomotive from the American Locomotive Company. It has also ordered 1 locomotive from the Baldwin Locomotive Works and 1 from the Lima Locomotive Works.

The Central of New Jersey has ordered 10 Mikado type locomotives from the American Locomotive Company. This company is now inquiring for 4 Pacific type locomotives.

The Illinois Central has ordered 85 Mikado type locomotives from the Lima Locomotive Works. It is expected that this road will place an order soon for some additional locomotives.

The Georgia Railroad is inquiring for 5 locomotives.

The Delaware & Hudson is inquiring for 1 locomotive.

The Lehigh Valley is inquiring for 30 locomotive tenders.

The Colorado Midland is inquiring for 1 Mikado type locomotive.

The Chicago, Burlington & Quincy is inquiring for 50 Mikado type locomotives and 10 Santa Fe type engines.

The Central of New Jersey, has ordered 5 Pacific type locomotives from the Baldwin Locomotive Works. This company is now inquiring for 10, 8-wheel switching engines.

The Boston & Albany R. R. is reported to inquiring for additional motive power.

The Central Railroad of New Jersey, previously reported as having purchased two Mikado type locomotives from the American Locomotive Co., is reported to have increased this order to ten.

The Fonda, Johnstown & Gloversville is inquiring for 1, 8-wheel switching locomotive.

The Duluth & Iron Range has ordered 3 Mikado type locomotives from the Baldwin Locomotive Works.

The Calumet & Arizona Mining Company is inquiring for 3, 6-wheel switching locomotives.

The Chicago, Milwaukee & St. Paul has ordered 50 Mikado type locomotive from the Baldwin Locomotive Works.

The Wisconsin & Michigan has ordered 2 4-6-0 type locomotives from the Baldwin Locomotive Works.

The Delaware, Lackawanna & Western has ordered 5 Pacific type locomotives from the American Locomotive Company.

The Pittsburgh Steel Company has ordered 1 switching locomotive from the Baldwin Locomotive Works.

The Toledo, St. Louis & Western has ordered 2 switching locomotives from the Baldwin Locomotive Works.

The Detroit & Toledo Shore Line has ordered 2 switching locomotives from the Baldwin Locomotive Works.

Freight Cars

The Mississippi Central is inquiring for from 100 to 200 flat cars.

The Cornwall Railroad is inquiring for 40 ore cars of 50-tons' capacity.

The General Electric Company is inquiring for 2 tank cars of 10,000 gal. capacity.

The Charlestown & Western Carolina has ordered 100 single sheathed box cars of 40 tons' capacity from the Standard Tank Car Company.

The Beacon Oil Company, Boston, Mass., has ordered 50 tank cars of 8,000 gal. capacity from the American Car & Foundry Company.

The Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., has placed an order with the General American Car Company for 3 flat cars of 30-tons' capacity.

The Minneapolis, St. Paul & Salt Ste. Marie has ordered 500 box cars and 250 gondola cars from the Pullman Company and 500 box cars from the American Car & Foundry Co.

The St. Louis South Western is inquiring for 500 double sheathed box cars of 40 tons' capacity, 500 automobile cars of 40-tons' capacity. The company is also inquiring for 200 ballast cars of 50-tons' capacity.

The Chicago & North Western is inquiring for 800 steel ore cars of 50-tons' capacity. from the Pullman Company.

The Western Pacific is inquiring for 800 general service gondola cars and 1,000 to 1,500 stock cars. This equipment, it is reported, is to be used by the Denver & Rio Grande Western.

The Union Tank Line is reported to be in the market for 500 to 2,000 tank cars.

The Union Pacific is reported to be contemplating the purchase of 5,000 refrigerator cars for the Pacific Fruit Express Company.

The United States Fuel Company is in the market for 211 coal cars for its Clinton, Ind., mine, and 100 for its Vermillion mine at Westfield, Ill.

The Cornwall Railroad is in the market for 50 ore cars.

The Charleston & Western Carolina Railway is reported to have placed an order with the Standard Tank Car Company for 100 single sheathed box cars.

The Live Poultry Transportation Company will build in its own shops about 100 chicken cars.

The General American Tank Car Corporation will build 1,000 tank cars for rental purposes.

The Tennessee Coal & Iron is reported to have placed an order with the Chickasaw Shipbuilding & Car Co. for 195 miscellaneous cars.

Baltimore & Ohio is inquiring for 2,000 hopper cars of 50- to 70-tons' capacity, and 1,000 low side gondola cars.

The Ulen Contracting Corporation 120 Broadway, New York City, N. Y., is inquiring for 35 flat cars.

The Union Pacific has placed an order

with the American Car & Foundry Company for 100 tank cars.

The Central Railroad of Brazil is inquiring through the car builders of this country for prices on 200 box cars and 200 gondola cars.

The Great Southern Refining Company, Lexington, Ky., is inquiring for about 80 tank cars of from 6,000 to 10,000 gal. capacity.

The East Jersey Railroad & Terminal Company has placed an order with the American Car & Foundry Company for 36 50-ton tank cars of 10,000 gal. capacity.

Watson Robb & Company has purchased 13 service box cars from the Canadian Car & Foundry Company which they have converted into two office cars five bunk cars, two cook cars and four service dining cars.

The Chicago & Rock Island & Pacific has ordered 500 box cars from the Western Steel Car & Foundry Company and 500 Gondolas cars from American Car & Foundry Company. This company is now inquiring for additional 1,500 cars. They are now preparing specifications.

The Pittsburgh Steel Company is inquiring for 25 gondola cars.

The Southern Pacific contemplates buying from 500 to 2,000 50-ton tank cars of 10,000 gal. capacity.

The Detroit, Toledo & Ironton Railroad is inquiring for 500 box cars of 50-tons' capacity and 500 hopper cars of 55-tons' capacity.

The Chicago, Milwaukee & St. Paul, is inquiring for 3,000 gondola cars, 1,500 box cars and 500 automobile cars, and is also considering the purchase of 7,000 gondola cars of 50-tons' capacity and 3,000 box cars of 40-tons' capacity.

The Louisville & Nashville is reported as inquiring for 2,000 steel hopper cars of 55-tons' capacity and 1,000 box cars of 50-tons' capacity, has ordered 2,100 hopper cars from the American Car & Foundry Company and has ordered box cars each from the Chickasaw Shipbuilding Company and the Mt. Vernon Car Manufacturing Company.

The Louisville & Nashville is inquiring for bids for the repairing of 250 hopper cars.

The Pennsylvania Equipment Co., dealers in second-hand machinery are inquiring for 100 second-hand, 50-ton, all steel, self-clearing hopper cars and 100 flat bottom gondola cars.

The Canadian National Railways are reported to be contemplating the purchase of about 6,000 freight cars.

The Pacific Fruit Express contemplates asking for bids soon for about 5,000 refrigerator cars.

The Atlanta & West Point and Western Railway of Alabama are inquiring for 150 hopper cars of 50-tons' capacity.

The Gulf Refining Company, Pittsburgh, Pa., has ordered 150 tank cars from the Standard Steel Car Company.

Passenger Cars

The Central R. R. of New Jersey has placed orders for 25 coaches with the American Car & Foundry Company and also 25 coaches with the Standard Steel Car Company.

The Pennsylvania has ordered 3 gasoline motor cars from the J. G. Brill Company. These cars are to be used on the Smyrna branch, and the Bustleton branch.

The Central of Brazil contemplates buying in the near future from 50 to 100 cars of various types for passenger service.

The National Railways of Mexico are in the market for 10 steel mail cars, 40 ft. long.

The Chicago & Northwestern has placed an order with the American Car & Foundry Co. for 40 coaches and 10 baggage cars.

The Atchison, Topeka & Santa Fe., is said to be considering the purchase of two dining cars.

The Pennsylvania Equipment Co., of Norwood, Pa., dealers in second-hand machinery are in the market for two cafe-observation cars.

The New York Central is said to have asked bids on 35 steel passenger coaches, two steel dining cars, five steel combination passenger and baggage cars, ten steel baggage cars, and ten steel passenger cars.

The Atlanta & West Point is inquiring for two 70-ft. steel baggage cars.

The Chicago, Rock Island & Pacific has ordered 50, 70-ft. steel suburban cars from the Standard Steel Car Company.

The Alabama, Tennessee & Northern R. R. is reported to be inquiring for several gasoline motor rail cars.

The Long Island is inquiring for 40 motor passenger cars and 10 trailers, and is also inquiring for ten steam passenger cars and 20 trailers.

The Maine Central R. R. is reported to have placed an order with the Standard Steel Car Co. for seven baggage cars.

The Pennsylvania R. R. is reported to be inquiring for additional passenger equipment.

Buildings, Structures, Etc.

The Gulf Coast Line will construct a six-stall concrete roundhouse at Brownsville, Tex., at a cost of about $50,000.

The Baltimore & Ohio has plans under way for the construction of additions to the car and locomotive repair shops at Garrett, Ind. Including the equipment, it is estimated that the cost of these improvements will be about $500,000.

The Texas & Pacific has plans underway for extension of its roundhouse at El Paso, Texas.

The Michigan Central has called for bids for the construction of a new car repair shop, 30 x 200 to be erected at Niles, Mich.

The Louisville & Nashville will expend about $250,000 for new locomotive and car repair shops with equipment at Leewood, Tenn.

The Missouri Pacific is reported to have plans under way for new machine repair shops at Wichita, Kans.

The Kansas City Southern has plans for the construction of new locomotive and car shops at Pittsburg, Kans.

The Tennessee Central has plans under way for rebuilding the locomotive and car repair shops at Nashville, Tenn., that were recently destroyed by fire.

The Pennsylvania Railroad is reported to have awarded contract to John T. Pettyjohn of Lynchburg, Va., for the construction of the superstructure of its five-stall engine house, crew restroom and oil house at Hagerstown, Md. This carrier is also preparing plans for the construction of a one-story engine and roundhouse, including turntable, water tower, coaling station and handling equipment at Detroit, Mich.

The Galveston Harrisburg & San Antonio Ry., operated by the Southern Pacific Co., has prepared plans for the construction of a new repair plant at El Paso, Tex., including a one-story locomotive erecting shop, an addition to its present engine house and shop, a storehouse and other buildings.

The Chicago, Indianapolis & Louisville will erect a one-story frame shop at Lafayette, Ind., which will cost approximately $8,000.

The Union Pacific's new terminal facilities at Los Angeles, Calif., will include an engine house, locomotive shops, car and coach shops, and a coach yard.

The Bangor and Aroostook is planning for the rebuilding of the repair shops at Houlton, Me., that were recently destroyed by fire.

New Freight Cars for the Southern Pacific

The immediate construction of 7,000 freight cars, to cost more than $8,000,000, has just been authorized by the executive committee of the Southern Pacific Company. This new equipment, which will be delivered during 1923, does not include refrigerator cars for handling perishables, as the company's supply of refrigerators is provided by the Pacific Fruit Express Company, in which the Southern Pacific owns a one-half interest. The new equipment program of the Pacific Fruit Express, soon to be announced, will add a substantial number of refrigerators to the 21,598 it now owns. Plans for the construction of the new cars for the Southern Pacific are nearing completion and it is expected that a large proportion of the cars will be built on the Pacific Coast with Pacific Coast materials and labor. The new cars will be of the most modern design. The total number of cars owned by the Southern Pacific Company at present is more than 58,000.

Items of Personal Interest

Alonzo G. Trumbull has been appointed chief mechanical engineer of the Erie.

J. E. O'Brien has been appointed manager of the mechanical department of the Seaboard Air Line.

Ralph Wilson has been appointed machine shop foreman of the Atchison, Topeka & Santa Fe at Richmond, Calif.

W. B. Whitsitt has been appointed assistant mechanical engineer of the Baltimore & Ohio with headquarters at Baltimore, Md.

Marcus A. Dow, formerly general safety agent of the New York Central, has been chosen president of the National Safety Council.

J. W. Riley has been appointed district manager of the Car Service Division of the American Railway Association with headquarters at St. Louis, Mo.

Philip H. Minshull, master mechanic of New York, Ontario & Western at Middletown, N. Y., retired on November 1, after service of nearly fifty years with the company.

Walter Freyman, Daniel O'Connell, Fred G. Ripkey and Thomas Sheehan have been appointed traveling firemen on the Lehigh & Susquehanna Division, and George Weller and Andrew Dow on the Central Division of the Central Railroad of New Jersey.

E. H. McFadden has been appointed master mechanic of the St. Louis Southwestern at Pine Bluff, Ark. He was formerly assistant superintendent of shops at the same point. A. Townsend, formerly traveling enigneer, has been promoted to the position of assistant superintendent of shops.

James H. Calkins, an engineer on the New York Central, has been retired under the 70-year age limit. Mr. Calkins has the distinction of having piloted the Twentieth Century Limited from Elkhart to Toledo on its initial run in 1902. When he piloted the New York Central's crack train into Elkhart on his last run he completed 53 years of railroad service.

George Geer of Bozeman, Mont., 83 years of age, believed to be the oldest locomotive engineer in the United States, has decided to turn over his engine to the newer generation.

Although Mr. Geer declares his eye to be as bright and his brain as clear as they were in 1854, when he began railroading, he thinks 54 years on an engine and 67 years as an active railroader entitled him to one of the comfortable pensions of the Northern Pacific Railway. Despite his advanced years, Mr. Geer has always—even up to his last service days—passed with high rank the most exacting examinations and tests of his profession and held his seniority until just a few days ago, when he resigned to go on the retired list.

New Northwestern Agents Flannery Bolt Co.

The Minnesota Supply Company with offices in the Pioneer Building, St. Paul, Minn., has been appointed northwestern representative of the Flannery Bolt Company, Pittsburgh, Pa. Blake C. Hopper, formerly with the American Steel Foundries, has been appointed secretary-treasurer of the Minnesota Supply Company.

Norwalk Iron Works Opens General Western Offices

The Norwalk Iron Work Company, pioneer builders of compressors, manufacturing air and gas compressors for all purposes and also refrigerating machinery, with general offices and works, South Norwalk, Conn., has just opened a Chicago office. It is located at 627 W. Washington Boulevard and is in charge of Mr. L. R. Bremser who, for thirteen years, was associated with The Gardner Governor Company. He is thoroughly familiar with all angles of the compressor business.

Standard Stoker Company

The stockholders of the above company at their annual meeting re-elected W. A. Larner as president. Mr. Larner is also vice-president of the Peyton-duPont Securities Co. Other officers of the company are: Vice president, Eugene duPont, also director E. I. duPont deNemours Co.; secretary and treasurer, T. W. Keithley.

Frank P. Roesch, formerly western manager of the company at Chicago has been advanced to the position of sales manager of the company at Chicago, has Mr. Roesch has had wide experience in the railway mechanical department. He is considered an authority on all subjects pertaining to locomotive operation.

MEMBERS PITTSBURG AIR BRAKE CLUB MET OCTOBER 26, 1922.

Front Row Sitting: R. I. Cunningham, W. A. B. Co.; R. W. Williams, W. A. B. Co.; F. W. Pennington, W. A. B. Co.; W. A. Jex, T. & O. C. Ry.; R. W. Long, P. & L. E. Ry.; L. G. Plank, Penn. System; J. W. Walker, Penn. System; F. H. Parke, W. A. B. Co.; W. W. Shriver, B. & O. Ry.; J. M. Denser, Penn. System; Bert Hyanes, N. Y. A. B. Co.; Harry Sneck, B. R. & P. Ry. *Back Row Standing:* F. C. Young, W. A. B. Co.;

Books, Catalogues, Etc.

The Story of the Rome, Watertown & Ogdensburgh Railroad, by Edward Hungerford, 269 pages. Robert M. McBride & Co., New York.

It has been said that every event contains the elements of romance. But one would hardly expect it to be possible to weave a romance out of the construction and operation of a railroad built through a country nearly as flat as a pancake and without even the element of a frontier to assist. Yet this is what Mr. Hungerford has succeeded in doing, and one is led to suspect that the secret of the matter lies in the fact that he, himself, is a product of the country through which the road runs. He carries the name of an old Jefferson County family and many of the things that he relates, belong to the traditions of that north country.

That Watertown should have made an early attempt to secure a rail communication with the New York Central was most natural because of its location on the Black River which flows over a series of falls, from above the town to its mouth at Sacketts Harbor. But money was difficult to obtain, and the struggle of the men who fathered the road and finally brought it into being is told in a manner that runs a close second to a real thriller.

Then there were the heroic efforts to keep it open in the winter, in the days when there were no rotary plows, when twenty-five foot drifts abounded in the Richland plains and the snow was shoveled from platform to platform, up and up, until the line was cleared.

He tells of the personnel of officers and men, and lingers with delight over the memories of the fleet brass-bedecked and bedizened locomotives that were the pride of their runners and the admiration of the community.

Then comes the dark days of the Sam Sloan administration when the road was wrecked and stripped, to fall at last into the hands of a great system and become merely one of its divisions.

But it had its past, a brilliant past, during which it was loved, admired and abused, and it is about this that Mr. Hungerford has woven a most interesting story.

Tentative Standards, 1922, of the American Society for Testing Materials, 774 pages. Published by the Society, Philadelphia, Pa.

Tentative standards, in this case, closely resemble in status and effect, the recommended practice of the old Master Car Builders' and Master Mechanics' Associations. They are on trial, on probation for a time before being advanced to the position and dignity of a real standard.

For many years this society has been de- [...] ner of things. Its committees have done an immense amount of patient research work, some of which has been of great economic value. The mass of the whole is more than is generally understood. Even in the volume under consideration there are 163 of the "tentative" grade, covering the wide range from shipping containers, through a mass of methods of chemical analysis to the determination of the physical characteristics of various metals.

Among the specifications there are eighteen relating to steel, wrought and cast iron, most of which are of special interest to the railroads. One of these is that for chilled cast iron wheels. This calls for a chemical specification, which will probably have to fight its way through a deal of strenuous opposition before it ceases to be tentative.

One of the features in the presentation of some of the standards is the use of English measurements followed by their metric equivalents; another point that is still far from adoption.

It is impossible and undesirable to so much as list the standards that are here presented for criticism preceding a final acceptance and advancement, but in looking over the list published at the end of the volume, it seems as though there were very few subjects within the range of human knowledge that had not been touched upon.

The Mechanism of Lubrication, by William Stone; 36 pages; 7¼ in. by 9½ in. Industrial Australian and Mining Standard, Melbourne.

The author of this pamplet was formerly the chief electrical engineer of the Victorian Government Railways, and in it he has set forth the principles of lubrication as they have become established, principles that are, for the most part based upon the well-known investigations of Beauchamp Tower in 1883 and the mathematical analyses that were made of his results by Prof. Osborne Reynolds and A. G. M. Michell.

Mr. Tower was engaged in making a series of investigations on lubrication for the Institution of Mechanical Engineers for the determination of the factors of resistance under various conditions when, to use his own words:

"A very interesting discovery was made when the oil bath experiments were on the point of completion; the experiments being carried on were those on mineral oil; and the bearing having seized with 625 lbs. per sq. in. the brass was taken out and examined, and the experiment repeated. While the brass was out, the opportunity was taken to drill a ½-in. hole for an ordinary lubricator through the cast-iron cap. [...] together again and started with the oil in the bath, oil was observed to rise in the hole which had been drilled for the lubricator. The oil flowing over the top of the cap made a mess, and an attempt was made to plug up the hole, first with a cork and then with a wooden plug. When the machine was started the plug was slowly forced out by the oil in a way which showed that it was acted on by a considerable pressure. A pressure gauge was screwed into the hole, and on the machine being started the pressure, as indicated by the gauge, gradually rose to above 200 lbs. per. sq. in. The gauge was only graduated to 200 lbs., and the pointer went beyond the highest graduation. The mean load on the horizontal section of the journal was only 100 lbs. per sq. in. This experiment showed conclusively that the brass was actually floating on a film of oil, subjected to a pressure due to the load. The pressure in the middle of the brass was thus more than double the mean pressure. No doubt if there had been a number of pressure gauges connected to various parts of the brass they would have shown that the pressure was highest in the middle and diminished to nothing towards the edges of the brass."

This was the starting point, on which the mathematicians based their work, the result of which showed that the position of the journal under the bearing varied on either side of the center line according to the work that it has to perform, so that the thickness of the film of oil, on which it is carried, varies, and that this film must be subjected to a pressure such as Mr. Tower found. The analysis also showed that a positive pressure in the oil film can only be produced where the film is diminishing in thickness, and that where the film has an increasing thickness in the direction of motion, the pressure, if above atmospheric, will diminish to that value, and if the divergence between the journal and brass continues further, the pressure will become negative and the film will rupture and cease to fill the place between them. The film will, however, remain continuous where it exists, and will completely separate the brass from the journal unless an excessive load be applied.

It was also shown that when the operating conditions are such that the minimum thickness of the oil film is one-half of the difference of the radii of the brass and journal, that the angular position of the thinnest part of the film is about 40 degrees to the off side of the perpendicular through the center of the brass, and this is the condition under which the bearing will carry the maximum safe load.

It was also shown that the same principles which control the lubrication of circular bearings apply with equal force to plane surfaces, namely, that if they are to be efficiently lubricated they must not be parallel to each other.

Stone has brought out in his pamphlet, which, taken as a whole, is an exceedingly clear and complete exposition of the principles of lubrication..

A Study of Air Steam Mixtures

The investigation of air-stream mixtures is the outgrowth of an investigation of the reheating of compressed air by C. R. Richards, former Director of the Engineering Experiment Station and Dean of the College of Engineering, and J. N. Vedder, Research Assistant in Mechanical Engineering of the University of Illinois, the results of which have been presented in Engineering Experiment Station Bulletin No. 130. In this earlier investigation the employment of steam as a reheating agent was found to result in an increased thermal efficiency for the mixture of air and steam, as compared with the use of either air or steam separately, in an engine operating expansively. These results were such as to justify a further study of air-steam mixtures.

It is the purpose of this bulletin to treat the subject of air-steam mixtures in considerable detail both by means of a theoretical discussion and by reporting actual tests made with different proportions of air and steam at different initial air temperatures and under various load conditions. To facilitate the practical application of the results secured, the thermal properties of various mixtures are presented in the form of Mollier charts. These charts will greatly simplify the solution of problems connected with the subject. Copies of Bulletin No. 131 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Conveying Machinery Catalogue

The Link-Belt Company, of Chicago, Philadelphia and Indianapolis, announces the completion of a new General Catalog No. 400 which embraces their entire line. It is the most complete book they have ever issued on this subject. It contains 832 pages, is cloth bound and can be obtained from any Link-Belt branch office.

This catalog not only includes the complete Link-Belt line, but also the products of the H. W. Caldwell & Son Company plant of that company.

Railway Business Association

The annual meeting of the Railway Business Association was held November 9, at the Hotel Commodore, New York. In presenting its annual report, the general executive committee said that: "Continuance of railway buying depends upon the confidence of railway equipment financiers and investors in the adequate income policy of the government. We are facing a period of active attempts to repeal or weaken the adequate income clauses of the Transportation Act. The Railway Business Association is the only organization concentrating on watching and resisting that movement. Railway executives of many other associations rely on the Business Association for co-operation before taking voluntary action; therefore, the association carries important responsibilities."

The business meeting was followed in the evening by the fourteenth annual of the association, which was largely attended by the members, the railway supply manufacturers of the country and their guests. President Alba B. Johnson of Philadelphia presided, and reviewed the work of the association during the year. The other speakers of the evening were Charles B. Markham, president of the Illinois Central; James A. Emery, Counsel of the National Association of Manufacturers, and the Hon. George Wharton Pepper, United States Senator from Pennsylvania.

President Markham dealt with the shortage of transportation in his address, which we publish elsewhere in this issue.

Public Opinion and Railway Labor Disputes was the subject of Mr. Emery's address, in which he dealt with the unsatisfactory provisions of the Transportation Act.

The subject of Senator Pepper's address was, The Safety Point in Railway Regulation.

Results of Government Ownership in Canada

The Canadian Government for several years has owned and operated a railway system of about 17,000 miles in direct competition with the Canadian Pacific, which is privately owned and managed. The result has been that the Canadian Pacific, while charging the same rates as the government railway, has been continually able to pay dividends of 10 per cent on its stock.

On the other hand, the government-owned and managed railways have, through yearly deficits, added to the public debt of the Dominion since 1914 more than $600,000,000, all of which money has been supplied from the public treasury. The deficit which the treasury has had to make up for its nationally owned and managed railways amounts to taxation of about $14 for every man, woman and child in the Dominion, or in a family of five about $70 a year.

Annual Index of Railway and Locomotive Engineering

The index to the contents of volume 35 of Railway and Locomotive Engineering which includes the twelve issues of the year of 1922 will be ready for distribution about December 30, and will be furnished to subscribers on request.

Use of the Locomotive Whistle

Superintendent T. Ahern of the Coast Division of the Southern Pacific, in a communication to the locomotive engineers says that extensive tests show that a whistle call for a station should never be less than five seconds, the long blasts of the crossing signal two and a half seconds, and the short ones one second. Particular care should be exercised to cut off the blasts sharply and not to slur them. It is of the utmost importance in causing sound to travel that these instructions be carried out. After sounding a whistle cut off the steam completely and allow a perceptible time to elapse between the blasts. They then are carried to a distance very much more clearly than if jumbled into one continuous blast. The whistle is an important safety device.