many years and I believe that the practice of grinding down these welds is quite general. At least one large manufacturer of stationary boilers has made grinding of welded seams standard practice and claims that this procedure is necessary in order to obtain a smooth surface and to eliminate surface defects.

I believe that grinding of welded seams is necessary particularly from the standpoint of fatigue cracking. It will give us added assurance and I believe that in the long run we will gain by adopting this procedure.

Secretary Stiglmeier: I would like to ask Dr. Johnson one question. If the weld is not ground, would the X-ray picture show a true picture?

Dr. Johnson: The X-ray is largely used for the determination of internal defects. External imperfections can be removed by grinding.

Secretary Stiglmeier: You will agree, though, that a smooth weld properly ground will show a defect far better than if it is not ground.

Dr. Johnson: Yes.

Secretary Stiglmeier: Then it is necessary to grind them to get a true picture of your X-ray readings.

Dr. Johnson: Yes.

Mr. F. S. Hartle (Board of Transport Commissioners for Canada): Mr. Chairman, as I understand it one of the limiting factors in the increased application of welded boilers is the lack of stress--relieving facilities throughout the country. It has come to my knowledge that in Germany, particularly in the latter part of World War II, they adopted, shall I call it, an Autofrettage method for stress-relieving without the necessity of furnaces. I wonder if anyone has had any experience with this method, what the results were, and generally what they may think of it.

President Heidel: Is there anybody present here who could answer that question?

We will have a report on Topic No. 3 next, Mr. Ray McBrian, Chairman: "Problems and Uses of Modern Boiler and Firebox Steel."

Secretary Stiglmeier: Gentlemen, we had a telegram from Mr. Ray McBrian that due to court proceedings he could not be with us today, however, he forwarded a wire to Mr. W. F. Collins, Engineer of Tests, New York Central System, and Vice-Chairman of his committee, asking him to preside with the presenting of his committee paper, and it is our understanding that Mr. Collins is in the room to present said report, and will Mr. Collins come forward and present the committee report.

Mr. W. F. Collins: Mr. President, Mr. Secretary, Members and Guests: Mr. Ray McBrian's paper on "Problems and Uses of Modern Boiler and Firebox Steel" is to be presented by one of the technicians from his laboratory at Denver, Colorado. It appears in your Official Program, and is a very complete paper. I think it is one of the most modern and up-to-date papers that I have read. I had the opportunity of looking it over coming to Chicago on the train, and it is certainly new to me. I think you will probably find many interesting and new ideas. I am going to ask Mr. W. J. Holtman, Metallurgist of the D. & R. G., to present this paper at this time. Mr. Holtman.

Topic No. 3

PROBLEMS AND USES OF MODERN BOILER AND FIREBOX STEEL

MR. RAY MCBRIAN, *Chairman*, Engineer of Standards and Research
Denver, Rio Grande & Western Railroad
MR. W. F. COLLINS, *Vice-Chairman*, Engineer of Tests
New York Central System

MR. L. E. GRANT, Engineer of Tests
Chi, Mill, St. Paul & Pacific R.R.
MR. W. C. THEISINGER, Manager,
Tech plate Sales
Lukens Steel Company

MR. R. E. SENIFF, Engineer of Tests
Baltimore & Ohio Railroad
MR. R. C. ALTMAN,
Service Metallurgist
Carnegie-Illinois Steel Co.

MR. A. J. TOWNSEND, Vice-President, Engineering
Lima-Hamilton Corporation

During the past several years much has been reported to you as to the examples and causes for failures of steam locomotive fire boxes and boilers. Since it is not necessary to remind us that the problems arising from the use of steel in modern steel locomotive boilers and fireboxes may aptly be those found in such new types of power as the "Turbine," etc., it is well to briefly review the important factors as presented you and then discuss what improvements have been made and what is possible. To this end the question and importance of stresses will be discussed by Mr. W. B. Leaf, of the D&RGW Laboratory. Mr. Walter Collins will discuss an important phase; that is, a flanging test for new steels.

"In 1921 it was stated in this country that there has been little or no work done on which the rational mechanical treatment at elevated temperatures can be based. The effect of raising the temperatures on the properties of metal cannot as yet be stated in terms of any definite law; at present it is necessary to treat each class of materials separately. It is necessary then that technological tests of materials to be used in boilers be continued since the plates are not only used at elevated temperatures, but they are weakened by being perforated with rivet holes."

The realization for the need of such studies improving boiler construction was well expressed by R. Baumann, a German research worker, as far back as 1922. The work reported on was completed in 1914. One of Baumann's points of summary bears repeating at this time. "On driving a rivet the plates are stressed over an extensive area, as far as the adjacent holes. Consequently, when multiple riveted joints are used the metal at each rivet hole is subjected to repeated stress reversals which as is known very materially lowers the toughness of the plate. A further injury may result when the plates become warped as a result of high riveting pressures. On driving adjacent rivets, the plates are again forced together. This is also the case in caulking the seam, all of which results in stress reversals. It is evident that abusive handling of the plates is not permissible; such abusive handling may occur in fitting the plates, etc. In general it may be stated that careful workmanship, such as the removal of chips and burrs between plates, the production of properly shaped and properly seated rivet heads, proper care to make rivet holes register, etc., is essential to preserve the plates in good condition and to prevent, in so far as possible, overstrain of the material. Careful workmanship in this respect is of great importance in highly stressed joints, and especially those which, in service, are to be subjected to high temperatures and considerable temperature fluctuations."

Baumann listed other conclusions with respect to physical changes in the steel with temperature and stress. All this work has been covered in other recent years, metallurgical and stress concepts have been developed and much of this work has been discussed before this association. It has been recognized that deoxidation practice in steel making, structure, chemical composition and numerous other factors all enter into the discussion when attempting to determine failure causes.

It has been stated from this platform in years past that workmanship in boiler construction and repair is of major import. In our examinations of failed specimens of firebox and boiler steels during the past year, steels which represent failures on A.A.R. member roads throughout the country, we find that improper workmanship seems to more and more reflect itself in boiler and firebox failures. It is a fortitutious circumstance that this factor, more than any other, is readily controllable when so recognized and properly evaluated.

The following slides are a few interesting failure samples received bearing on these important factors.

Special studies have been made of test ingots of various analysis to determine resistance to aging and blue brittleness.

The test ingots of varied analysis were made in a 100 lb. induction type furnace. From the top position of each ingot sufficient bar stock was forged for Jominy hardenability tests. The balance of each ingot was then forged into 2" x 5" sheet bar stock and then rolled into ⅜ and ½" plate stock.

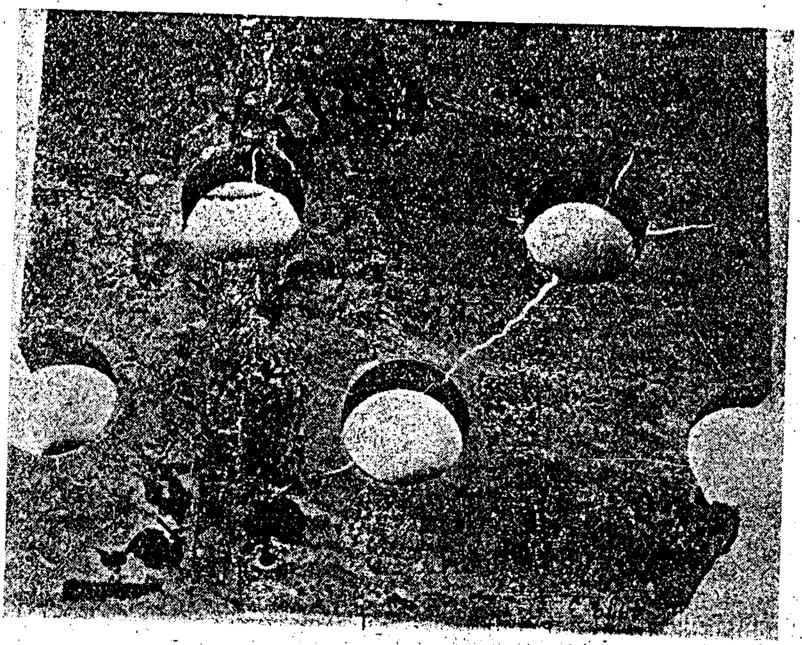
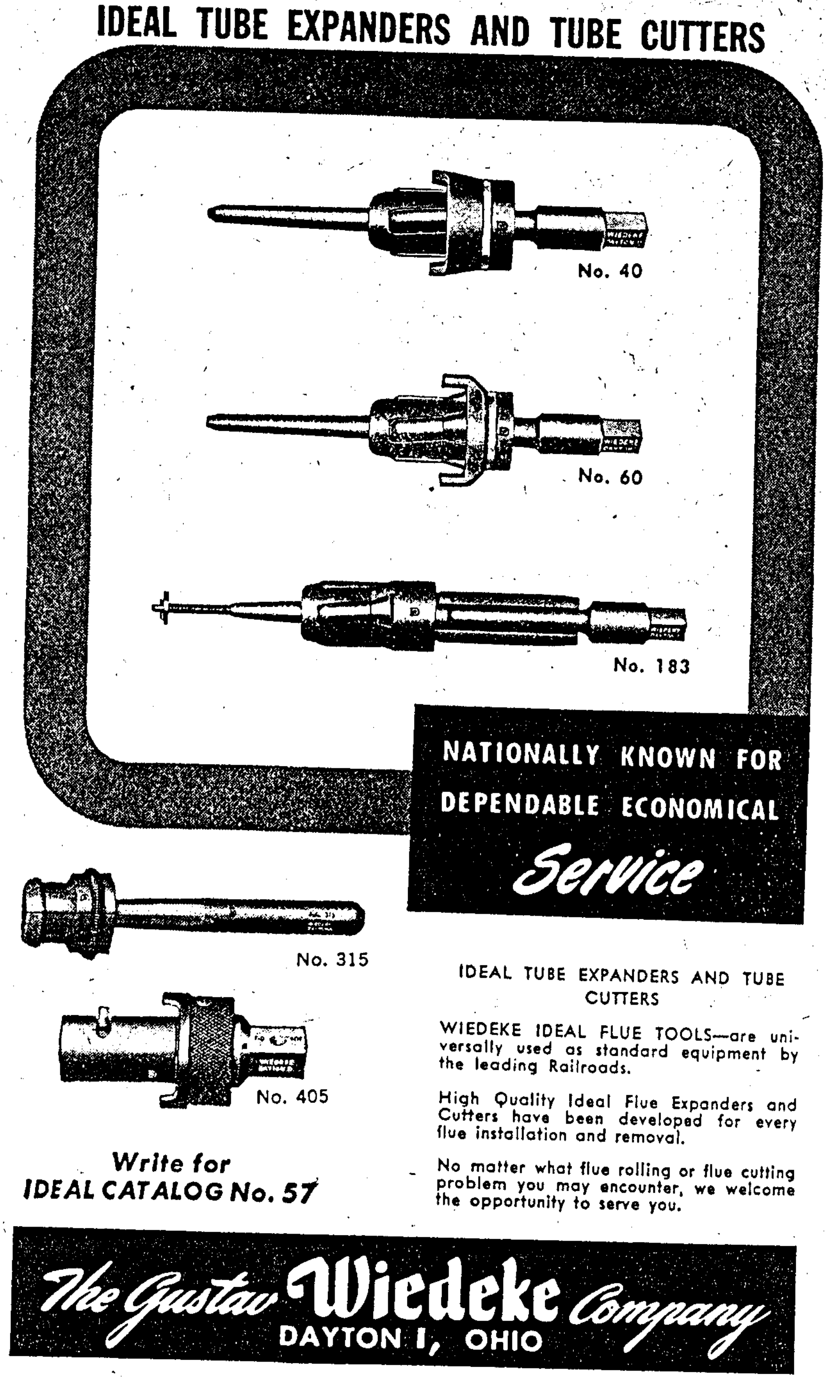


Figure 1. Boiler shell in service five years. Note poor weld and out of round holes.



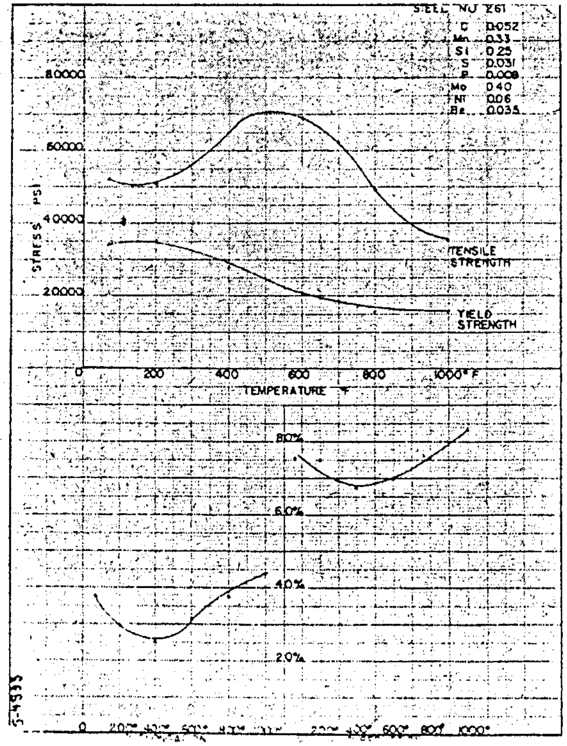


Plate 9. Low carbon, molybdenum steel with beryllium addition.

DISCUSSION

These special steels were made to selected analysis for the purpose of determining the effects of additions of alloying special deoxidizers, other elements and of reduction in carbon and manganese content.

Copper was added to three steels in amounts over .50% because copper as a residual had been questioned and to determine what beneficial effects might arise from the use of copper as an alloying element.

Phosphorus was added to five of the steels in amounts above .09% to determine if there were any deleterious effects.

Silicon was added to six of the steels in amounts varying from .25% to .45%.

Beryllium was added in small amounts to two of the steels.

The special deoxidizing agents in addition to aluminum were titanium, zirconium and columbium.

To Review Blue Brittleness

In our investigations we have found this phenomenon to be associated with all the typical specification steels (A.A.R. and A.S.T.M.) Firebox and Boiler steels, carbon and alloy grade.

In testing at elevated temperatures, plotting the curves, tensile, yield strength, elongation and reduction of area versus temperature blue brittle tendencies are manifest by an increase in tensile and yield strength, a decrease of ductility (elongation, reduction of area) at critical temperatures 400° to 600°F.

Briefed examples are as follows, (a study of charts furnished in first report will further show these tendencies).

EXAMPLES OF PRE-SERVICE STEELS

Type	*Tensile strength p.s.i.*			*Elongation %*		
	Rm. Temp.	*400°F*	*600°F*	*Rm. Temp.*	*400°F*	*600°F*
A.A.R. Rimmed	48,000	81,000	55,000	38	21	34
A.A.R. Carbon	52,000	69,000	55,000	33	20	31
A.S.T.M. Carbon-molv	85,000	99,000	95,000	23	18	21
A.S.T.M. Nickel	64,000	77,000	73,000	25	21	30
A.S.T.M. Silicon-Manganese						

Again the Theory Regarding Cause

Precipitation of carbides, nitrides or possible oxides at slip planes during straining. Rate of precipitation increases with increase of testing or operating temperature.

Aging

The phenomenon of aging of firebox and boiler steels appears to be closely associated with that of temper brittleness. A tensile test through the blue brittle range is the quickest way we have found to date of distinguishing between a non-aging and an aging steel. The table given under blue brittleness, (pre-service tests), is indicative that in addition to these steels to being predicted as aging steels they are also susceptible to blue brittleness.

On steels removed from service at room temperature tests, aging is manifested by an increase in ultimate and yield strength and loss of ductility when compared with the original physical tests or tests of unused new materials.

Residuals

Analysis of failed materials during the past few years has been made for the purpose of determining the effect of "residual" elements in the steel. The residual elements may be defined as those elements occurring in the finished products which are not deliberately added, but are picked up from scrap or other sources. These elements have been present in firebox and boiler steels for many years as the analysis of some failed materials shows.

ANALYSIS OF FAILED MATERIALS

Type—Firebox. Service Life—36 Mos. Specification—A.A.R.Carbon.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.21	.02	.03	.39	.02	.10	.13	.10	.10	.02	—	—

Type—Firebox Rimmed. Service Life—12 Mos. Specification—A.A.R.Carbon.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.15	.02	.04	.45	.15	.06	.06	.13	.09	.03	—	—

Type—Firebox. Specification—A.A.R.Carbon.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.15	.02	.04	.46	.015	.02	.15	.13	.10	.036	—	trace

Type—Boiler. Specification—A.S.T.M.C-Mo.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.21	.02	.02	.75	.19	.05	.40	.08	.10	trace	—	.01

Type—Boiler. Specification—A.A.R.Carbon.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.21	.02	.02	.39	.03	.10	.03	.13	.14	trace	—	.002

Type—Boiler. Specification—A.S.T.M.C-Ni.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.17	.03	.02	.71	.21	.22	.06	2.45	.11	—	—	.002

Type—Boiler. Service Life—8 years. Specification—A.A.R.Carbon.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.22	.02	.02	.35	.02	.06	.05	.06	.14	trace	—	trace

Type—Boiler. Service Life—18 years. Specification—A.S.T.M.Si-Mn.

C	P	S	Mn	Si	Cr	Mo	Ni	Cu	Sn	V	Al
.22	.01	.02	.69	.20	—	.002	.02	.07	—	—	—

A discussion of all this work on composition analysis of new types and failed steel is:

"Steel No. 254. Carbon-manganese, molybdenum with .96 columbium added is most interesting and suggest further studies for both carbon steel with residual elements present and for all alloy steels. This steel, because of columbium addition, has high carbide stability showing an almost straight line curve in the physical property versus temperature chart for all properties. This type of curve offers the ultimate in predictability by tests as to non-aging and non-blue brittle tendencies.

"Steel 253 contained .18% molybdenum, .80% Chrome and .156% phosphorus, from the curve, physical property versus elevated temperature it appears the blue brittle range, if present, has been shifted to a higher temperature range. This steel was made for consideration of its possible high temperature properties.

"Steel No. 258 contained .42% molybdenum, .83% chrome, .15% phosphorus, with .07% addition of titanium and .10% zirconium. It is unusual in that thru the usual blue brittle range, especially at 200° F. instead of increasing in strength, the curves show a loss.

"Steels numbers 259 and 261, low carbon .40% and .42% molybdenum with addition of .065% and .035% of beryllium, were made for study for their elevated temperature properties and as to the effects of small beryllium additions. While showing good elevated temperature properties, they appear susceptible to aging.

"Steel No. 255 is a high nickel content, low carbon steel with .60% copper with no special deoxidizers.

"Steel No. 256, with only .028% carbon, .42% manganese, .17% molybdenum and .23% nickel, no special deoxidizers was made to determine the possibilities of utilization of residuals or small amounts of alloying elements, with reduction in carbon content. Fairly good physical properties were obtained, further work is desirable in that additions of special deoxidizers are desired to flatten out curves thru blue brittle range.

It will be noted that four of the special steels contain appreciable percentages of phosphorus, (No's. 256, 253, 257 and 258)

These steels all show a rise in tensile strength without an accompanying rise in yield strength thru the 450 - 600° F zone. The permissible amounts of phosphorus is limited by the carbon present and in these low carbon steels the carbon content can be above that present in the specification steels. It is indicated that apparently the sum of carbon plus phosphorous has probably a maximum value of about 0.25% without accompanying brittleness.

In our studies of steels to date it appears that aluminum additions alone, will not result in complete removal of blue brittle and aging tendencies of carbon and alloy steels for boiler and firebox service.

Evidently the tendency for carbon and alloy steels to develop blue brittle tendencies and aging are the result of carbide precipitation, and of the presence of nitrogen, oxygen, etc.

Steels now being made to the various specifications are being found to contain residual elements which from accumulative amounts may change the steel from a plain carbon to that of an intermediate alloy stage or vary properties of the alloy material. By comparison of the analysis of the special steels, and the chart showing residuals present in failed materials, it will be noted that in the special steels utilization of alloys accompanying carbon reduction to secure physical properties may be possible.

As a summary of all these studies to date it appears that metallurgical improvements in steels for use in firebox and boiler service can be made, thru addition agents to reduce aging and blue brittle tendencies. Residuals can be utilized to improve physical properties. The harmful residuals have yet to be identified and determined.

The question of costs of making such steels is important. The recognition of fabricating and operating stresses is necessary, workmanship must be improved by the utilization of such processes as the all welded boiler.
This report is submitted as information.

EFFECT OF RESIDUAL STRESS IN BOILER FAILURES

By Walter Leaf, Research Technician
Denver & Rio Grande Western R.R. Co.

There are several simple considerations of the physical properties of boiler steel, understanding of which will lead to realization of what must be done to prevent failure.

1. Failure in this discussion is to be defined as the development of a crack or cracks in the steel of such a nature that disastrous consequences would result if the boiler remained in service.

2. Such cracks are formed and develop only in areas stressed in tension, and the crack is always at right angles to the direction of maximum tensile stress. This concept is of the utmost importance.

3. Stress to produce such cracks can be either residual, induced by service, or both. The effects of each class are additive.

4. Steel is not a homogeneous material, and its physical properties, over both large and small areas, vary with varying directions.

5. Steel is not a stable material, and strain or distortion in localized areas in conjunction with high temperature may produce added straining influences.

6. Intergranular corrosion will not start nor progress in areas subjected to compressive stress.

7. Measurement of strain or deformation in one direction only is not sufficient to define the stress condition, because when steel is stretched in one direction, transverse dimensions shrink. The ratio between these perpendicular dimension changes is known as Poissons Ratio, which for steel is about 0.28.

8. Stresses in two or three directions at right angles to each other produce more disasterous consequences than simple one directioned stress. In boiler construction and operation, we always find appreciable stress in at least two directions, and in some areas three.

Residual stress may be thought of as a condition in solids such that, if a portion of the solid is carefully removed, the remaining portion changes shape or dimension. This fact offers a very convenient means of determination of residual stress. Since the work piece must be of such a size that it contains innumerable grains or crystals of the material, each having directional properties and random orientation, the net directional components of all the stresses present are measured. The assumption that residual stresses are uniform through-out the piece, both as to direction and magnitude, is not necessarily true, and will deviate more with increasing complexity of the geometry and working of the piece.

There are several ways in which residual stresses are induced into a piece, but all of them include plastic deformation of portions only of the piece. Obviously, if the entire piece has been plastically deformed, uniformly in amount and direction, there can be no residual stress; but since steel is not homogeneous, micro residual stresses will be present in such amounts that the sum of all components equals zero in any direction.

We are now concerned with methods of boiler fabrication which induce damaging residual stress, and means of offsetting their effects. In general there are two fabricating steps which induce residual stress, cold rolling of the sheet, and machining it. If a strip of steel is bent slightly and released, it assumes its original shape. If bent more, it retains a partly bent shape, and residual stress of a value slightly below the yield point of the material is present, in the outer layers. Since the convex side of a boiler sheet is in tension, cracking will proceed in the laps if other conditions are suitable. The cure for this evil would be to shotblast the convex surface in the lap area to put it in compression.

The other method of fabrication which induces residual stress is machining, including drilling, reaming and grinding. It is standard practice to ream rivet holes, but the reamers are never as sharp as they should be. Consequently, metal is pushed around instead of being cut off, leaving tensile stress, which again allows intergranular corrosion.

Again the cure is compressive stressing, which can be done by shot blasting, or simpler, merely driving an oversized pin through the finished hole. Recently a rotating heater has been developed for this purpose, where a hammer slightly smaller in diameter than the hole is driven at high rotation speed by an air gun with eccentric balance in the rotor. The machine is merely run through the hole, and the job finished in seconds.

Grinding is probably the method of fabrication to which the least amount of thought has been given. Three damaging actions can take place. The cutting edges in a grinding wheel are merely tool points which are improperly shaped, for clean cutting. A coarse wheel digs furrows in the metal, pushing it at right angles to the direction of wheel travel. Here the residual stress is compression in the peaks and tension in the valleys. Since the valley is an effective stress raiser, any operating tresss is multiplied by an appreciable factor. A dull, loaded wheel will push metal ahead of it, leaving residual tension and possibly torn metal. The third action is burning, which leaves a damaged metal. The answer here is to be found in consultation with an expert on grinding, to find the proper wheel for the job, and in a high degree of training of the operators. Similarly, ground areas should be shot blasted, to put the surface in residual compression.

Since these various damaging actions take place in almost any direction, and since the operating stresses are in variable direction, especially of riveted joints, the resulting stress pattern is truly complicated. Naturally, if induced residual stress, direction of stress raisers, an operating stress all line up in somewhat the same direction, the result is disasterous.

The idea of shot blasting to produce residual compression was presented last year at this meeting in the report given by Mr. McBrian, so no new

PROBLEMS AND USES OF MODERN BOILER AND FIREBOX STEEL

By C. N. Loeffler, *Sales Engineer*
Alco Products Division, American Locomotive Company

In selecting a material for use in a locomotive boiler, certain basic factors must be considered. These factors are as follows:

1. Suitability of the material for service conditions.
2. Adaptability of the material to the design and manufacturing processes.
3. Best value for cost of the final product.

The suitability of a material for locomotive boiler service includes such considerations as oxidation and corrosion resistance, tensile strength and fatigue strength.

Oxidation resistance is unique to any particular material; a wide range existing between the carbon and low alloy steels on the one hand and the high alloys on the other hand. It is generally true, however, that strength considerations govern except in the case of non-pressure parts.

Corrosion resistance while also dependent on the material is not too important a factor in making a selection between carbon steel and low alloy steels. It is in itself however a serious problem and this is where we have to rely upon water treatment to minimize failures. Great advances have of course been made along these lines in recent years. The use of welded boiler shells also offers protection against embrittlement at joints.

High tensile strength, fatigue strength, and toughness are the principal advantages in the choice of alloys over carbon steel for boiler plate. Higher strength is desirable in that weight may be reduced when required. Some notched bar impact tests have been conducted on various steels as an indication of what may be expected under fatigue loads and cyclic temperature changes, and while the results are not conclusive it is evident that the additions of alloys improve endurance limit and toughness of the steel particularly due to refinements in the grain structure. It must be remembered, however, that the material will not compensate for deficiencies in design and "stress-raisers" should be avoided. The welded boiler appears to be the logical answer to this.

The adaptability of the material to design and manufacturing processes is extremely important. I am thinking particularly of welded boilers in the sense that the use of materials such as the low chrome-moly group steels should be avoided in that their air-hardening characteristics promote cracking and that preheat and post heat treatment is required, thereby increasing not only the cost but chance of failure. On the other hand, reports of tests on the welding of nickel steels and manganese vanadium steels reported before this association last year, indicate that no particular difficulties need be expected and no special cost increasing techniques are required.

It would be expected that such operations as cold rolling or cold forming would be no more difficult than with ordinary carbon steel due to the high ductility and lesser plate thicknesses for equal strength.

Mr. Collins' paper presented at this meeting also indicates that manganese-vanadium steel is quite satisfactory for hot forming operations such as the dome flanging described. The fine grain size of manganese-vanadium steel even under hot working is an indication of the advantages of this type of steel.

The third factor stated above, "best value for cost of final product," does not imply the lowest cost. In general, the cost of alloy steel plates, shapes, etc. will exceed those of carbon steel. If sufficient consideration is not given to the adaptability of the material to manufacturing methods as stated above, shop fabrication costs will also increase and the final boiler cost will be high compared to carbon steel. However, if the design proportions the material properly to its characteristics, and manufacturing methods involved, the value will be greater than the initial cost indicated at first sight. It can be concluded that a properly designed all-welded alloy steel boiler will satisfactorily fulfill these conditions.

The Alco Products Division of the American Locomotive Company expresses its thanks to the M.B.M.A. for allowing it to participate in the discussion of this subject and also to the N.Y.C.RR. and the Vanadium Corporation of America for their cooperation in some of the test work performed at our Dunkirk, N. Y. plant on alloy steel material for boiler construction.

Mr. Collins: Thank you, Mr. Loeffler.

Mr. Collins: I believe that Mr. Altman, the Metallurgist for Carnegie, Illinois, is present. I was wondering if he would care to offer a few comments on this paper. He is interested in the alloy development.

Mr. R. C. Altman (Carnegie Steel Co): We have followed the Manganese-Vanadium development with considerable interest. About all we have to say is that we seem to have come to the end of the road as far as laboratory work is concerned and we are waiting for Mr. Collins' Railroad to make some kind of a decision as to the use of this material; or if not, we would like to know the further steps we should take from a laboratory angle on this material. As you all know, the thing we are going to finally have to do is to build a material that is going to be the only answer to this problem. (Applause)

Mr. Collins: Somebody mentioned the Molybdenum steel. I wonder if a representative is here from the Molybdenum Company. (No response)

We were talking about Vanadium steel. Has Mr. Merrill any further comments on flanging or welding steel?

Mr. Merrill: Nothing further.

Mr. Collins: Mr. Grant, who was not present before, may have something to say.

Mr. L. E. Grant (Engineer of Tests, Milwaukee Road): Gentlemen, these remarks about the effect of temperature changes on the steel in which the gentlemen pointed out that a temperature change of approximately 100° Centigrade would produce the same effect as 30,000 lbs. tension would, reminded me of some tests that we made on one of our locomotives a number of years ago where we were having a great deal of trouble with cracking in the sidesheets. That cracking was occurring between the staybolts and an examination of sections, cut from the sheet after failure, indicated that the temperatures on the fire side of the sheet must be very high and we wanted to find out if we could what that temperature might be. So we made some test plates in which we inserted fine thermo couple wires at three locations. These thermo couples were placed, one near the fire side surface, one near the water side and one in between. These plates were installed in the firebox with three on each side, one near the front end, one near the back end of the firebox and one in the middle.

We ran a test with that engine in which we checked the temperature indications of these thermo couples in the various parts of the firebox and we found that the surface of the sheet was approaching temperatures of around 800° F., when the engine was working hard. But the point that seemed of most importance to us was not that the temperature got so high but as soon as the engine was shut off that the temperature dropped from around 800° to about the temperature of the water, which was a little over 400° on those engines. It dropped in a very few seconds from around 800° to a little over 400° F.

You don't have to be a metallurgist or a technician to know that this extremely rapid change in temperature is going to set up a very high stress in the sidesheets. The cracking was practically in a vertical direction, starting on the surface at the staybolt holes and working down from one staybolt to the next. We believed that the cause of the cracking was fundamentally the extremely high rate of temperature change in the different layers of the sheet.

Thank you. (Applause)

Mr. Christopherson: I still believe that the metallurgist has not given us the right answer. Mr. Leaf mentioned to you in his address, that we as Boilermakers do not use good taps or we have some incorrect workmanship when we apply staybolts.

I would like Mr. Leaf to answer this question? As a rule when staybolt holes are to be tapped out we have about 4 taps, these taps are used in line so that 4 holes will be tapped out, and soon through the entire job. When the leakage occurs it may be the first bolt that was tapped, but why should the fifth one be tight, the same tap that did the first hole is also the one that tapped the fifth one. It does not show sense, on the one hand you develop this stress cracks in your laboratory. On the other hand when you receive a part of a cracked side sheet you call it fatigue corrosive cracking and the Boilermaker is the cause?

Mr. Collins: Does Mr. Leaf have a comment on that?

Mr. E. P. Fairchild (Gen. Boiler Inspector, Atlantic Coast Line): When the temperature was taken from the fire side of the sheet as stated by the gentleman, I would like to know if the sheet on the water side was clean or if there was a coating of silicate scale on the water side of the sheet.

Mr. Grant: In answer to that question I would say that I don't think we have any firebox sheets that don't have some scale on the water side. We have had some very shortlived sheets in those same locomotives where the sidesheet lasted approximately six months, and in cases like that where the life has been unusually short we have found a silicate type of scale, a transparent, very thin and very hard scale on the water side of the sheet. The opposite to that, the same kind of steel, same kind of locomotive but operating in different territory with different water conditions, the same kind of steel has lasted about eleven years. That is probably a reflection of both water conditions and the service to which the locomotive is put.

Mr. Collins: I wonder if a representative from the Dearborn Chemical Company is here. I saw one of the representatives in the room earlier.

Are there any other questions before we close? We have still got a minute here. If not, I would like to thank Mr Holtman for presenting Mr. Ray McBrian's paper, and also thank Mr. Leaf for his paper.

President Heidel: I want to thank Mr. Collins and the help that he had in presenting this topic.

It is getting near closing time. If there is no further business to be brought before the Association we will adjourn at this time to reconvene promptly at two o'clock this afternoon.

. . . The meeting recessed at eleven-fifty o'clock . . .

WEDNESDAY AFTERNOON SESSION

SEPTEMBER 21, 1949

The session was called to order at two-thirty o'clock by President Heidel.

President Heidel: The meeting will come to order. First on the afternoon program will be a Report of the Committee on Law; Mr. C. L. Combes, Chairman. Mr. Combes not being present, Mr. Christopherson will take over.

REPORT OF THE COMMITTEE ON LAW

C. L. Combes, *Chairman*
S. E. Christopherson, *Vice Chairman*
E. H. Gilley

Mr. S. E. Christopherson (Vice-Chairman): In the absence of our Chairman Mr. Combes which we regret very much not being here, I am taking his place. You have all heard Mr. Stiglmeier's report to you on the money situation of the treasury. I do not believe that there is any one here that would like to see him go to Atlanta. So we will have to change the Law to read a little different with your approval.

In article VII, page 267 of our 1948 proceedings the changes are as follows.

Sec. 2 to read:
"The Secretary-Treasurer shall be a member of this association and shall receive twenty-five per cent of all dues collected, and SHALL RECEIVE A PERCENTAGE OF THE ADVERTISING NOT TO EXCEED FIFTY PER CENT."

This is the only change we have in the By-Law President Heidel. What is your pleasure?

Secretary Stiglmeier: Mr. Chairman, let me say a few words on that. At the meeting this morning I spoke to you in regard to the total amount of receipts and disbursements that were listed in my Annual Report. You will note that there was a total of $2,620.00 turned over to the Treasury from advertising in 1948.

It is for these reasons that I would like to see that said paragraph be changed to read that it shall not *exceed* fifty per cent. I don't believe it will ever reach the amount of fifty per cent or near it, and I would appreciate very much if you would vote that this change be made.

Mr. Desmond: I move that the change as suggested be incorporated in our By-Laws.

. . . . The motion was seconded by Mr. R. A. Culbertson, General Master Boiler Maker, Chesapeake & Ohio R.R., and upon vote was declared carried . . .

President Heidel: If there is nothing further from the Committee on Law, we will pass on to the Report of the Committee on Memorials, Mr. Stanley F. Wentz, Chairman.