THE BOILER MAKER

VOLUME XXI

JANUARY TO DECEMBER, 1921

PUBLISHED BY

ALDRICH PUBLISHING COMPANY

IN CONJUNCTION WITH

SIMMONS-BOARDMAN PUBLISHING COMPANY

WOOLWORTH BUILDING, NEW YORK, N. Y., U. S. A.

34 VICTORIA STREET, WESTMINSTER, S. W. I., LONDON, ENGLAND

INDEX

JANUARY TO DECEMBER, 1921

Note—Illustrated articles are marked with an (*) asterisk.

ARTICLES

Accidents: Bureau of Locomotive Inspection Report. A. G. Pack *5
Acetylene and oxygen hose markings 44
Acetylene Association report on gas welding. 345
Acetylene torch, misfiring when cutting..... 287
Acetylene, why pick on.................. 20
Air locomotive tanks, fabricating from heavy plate. C. E. Lester *313
Alwyn-Schmidt, L. W.: Foreign trade developments in boiler industry 139
American Boiler Manufacturers' Association, meetings 82, 198
American Engineering Council meets 34
American locomotives, superheater practice in *301
American Society of Mechanical Engineers' boiler code. Dr. D. S. Jacobus 45
American Society of Mechanical Engineers' code. E. R. Fish 200
American Society of Mechanical Engineers, meeting of 107
American Society of Mechanical Engineers, shop inspection trips for 146
American Uniform Boiler Law Society. Chas. E. Gorton 76, 198
American Welding Society, specifications for welding material 140
Angles between sides of hopper 239
Apprentices, information for boiler shop. George L. Price 20
Arch tubes, new method of applying. "Maple Leaf" *136
Armstrong, George W.: Shop practice at DuBois *102
A. S. M. E. Boiler Code Committee, work of. 19, 75, *142, *171, *230, 279, *338
A. S. M. E. boiler code for unfired pressure vessels 341
A. S. M. E. boiler code, how it works in Ohio 11
A. S. M. E. locomotive boiler construction code 111, 318, *346
Association, Master Boiler Makers', executive committee meeting of 252
Autogenous welding, investigation of 288
Autogenous welding process, speeding up boiler repairs. C. E. Lester *194

Baldwin Locomotive Works, new Santa Fe locomotive boilers at *95
Bearings, why they heat 50
Bending with aid of the torch 172
Best type crown stays 290
Best type of side sheet applied to narrow and wide fireboxes of locomotives 292
Beveling firebox sheets to provide for contraction 143
Bissel, G. W.: Necessity of uniformity in regulation of boiler construction and operation 60
Blast pipe, gusset layout for *353
Blower connection, layout of *208
Board of Boiler Inspectors, National. C. O. Myers 335
Boiler accessories, steam, safety features of. Warren Hilleary 173
Boiler and staybolt taps, standardization of.. *39
Boiler code, American Society of Mechanical Engineers'. Dr. D. S. Jacobus 45
Boiler code, A. S. M. E., how it works in Ohio 11
Boiler code committee, work of A. S. M. E. 19, 75, *142, *171, *230, 279, *338
Boiler code, locomotive, adopted 111
Boiler code, progress in adoption of. Charles E. Gorton 229
Boiler code rulings of Pennsylvania Board 196
Boiler, construction and operation, necessity of uniformity in regulation of. (paper) G. W. Bissel 60
Boiler construction, marine, welded. Francis Butt-Gow *1
Boiler departments, cooperation between. S. F. Jeter 46
Boiler design, strength of tubes a factor in. John S. Watts 315
Boiler, dryback type 179
Boiler efficiency and furnace design. Dr. D. S. Jacobus 169
Boiler explosion, a fatal 73
Boiler explosions, inspector necessary to prevent disastrous 342
Boiler failure, An unusual *15
Boiler flanging, methods of, George A. Richardson *281
Boiler heads, flanging and dishing. Geo. A. Richardson *245
Boiler industry, ethics in the. George W. Bach 201
Boiler industry, foreign developments. L. W. Alwyn-Schmidt 139
Boiler inspection, department, Ohio, organization and work of. C. O. Myers...... 33
Boiler inspection regulations in California.. 292
Boiler inspection service, reorganization of New York 232
Boiler inspection, uniformity in. C. O. Myers 199
Boiler inspection work in Pennsylvania. William P. Eales 334
Boiler inspections, value of................ *225
Boiler inspector, qualification and duties of. J. C. McCabe 47
Boiler inspector, work of present day. J. L. Raleigh 233
Boiler inspectors, National Board, constitution and by-laws of.................... 107
Boiler inspectors' convention, proceedings.. 76
Boiler inspectors, state board of Pennsylvania 283
Boiler law society, American uniform 198
Boiler, locomotive, construction code of A. S. M. E. 318, *346
Boiler, long seam, explosion of *256
Boiler maker, duties of aboard a naval transport. R. B. Harrison *253
Boiler maker, fifty years as a *260
Boiler makers, elementary mechanics for. William C. Strott *12
Boiler makers, items of interest to 182
Boiler manufacturers', meeting............ 82
Boiler patents, selected..*32, *62, *94, *126, *156, *184, *214, *244, *272, *300, *328, *358
Boiler plates, manufacture of. George A. Richardson *329
Boiler regulation in Pennsylvania 334
Boiler regulations, marine, Hoover favorable to 252
Boiler repairs, autogenous welding process. C. E. Lester *194
Boiler ruptures with man in firebox 234
Boiler settings, constructing horizontal. H. E. Dart *127
Boiler shell, cause of cracking through girth seam rivet holes 291
Boiler shells, tapping radial holes in *141
Boiler shop apprentices, information for. George L. Price 20
Boiler staybolts, locomotive, standardization of. C. E. Lester *144
Boiler, stool for supporting front end. E. A. Miller *111
Boiler tests, locomotive, notes on. Lawford H. Fry *249
Boiler trade in the Orient, expanding American. Charles W. Geiger............... *157
Boiler tubes, manufacture of charcoal iron *187
Boiler tubes, properties and composition of. Albert E. White *104
Boiler tubes, speeding up the safe ending of *215
Boiler welding repairs in England *339
Boilers and economizers. Dr. D. S. Jacobus 40
Boilers, changing old lap seam to butt seam construction *109
Boilers, locomotive, details of new Sante Fe *95
Boilers, locomotive, repairing by electric welding *306
Boilers, necessity for standard stamping of. E. R. Fish 77
Boilers, oil fired, increased use of in Europe. T. Sington 146
Boilers, railway stationary, inspection rules in Canada 137
Boilers, Scotch marine, quantity production of *63
Boilers, Scotch, standard single ended...... *49
Boilers, uniform rules for low pressure. F. W. Herendeen 77
Brazing and forming copper pipes. C. E. Lester *222
Breeching layout *56
Bureau of locomotive inspection report. A. G. Pack *5
Butt-Gow, Francis: A revolution in marine boiler construction *1

Calculating stresses in pressure vessels. William C. Strott *132, *163
Calculations for large tank 24
Calculations for plates and camber layout... *88
Camber for slight taper and plate calculations *88
Cause of boiler shell cracking through girth seam rivet holes 291
Changing old lap seam boilers to butt seam construction *109
Charcoal iron boiler tubes, manufacture of.. *187
Chute development, spiral *266
Cleaning boiler tubes 208
Code, American Society of Mechanical Engineers'. E. R. Fish.................... 200
Code, locomotive boiler construction....318, *346
Composition and properties of boiler tubes. Albert E. White *104
Compressed air machinery, safety code for. 280
Cone intersection and development *120
Conical tank development *268
Constitution and by-laws of National Board of Boiler Inspectors..................... 107
Constructing horizontal boiler settings. H. E. Dart *127
Construction, a revolution in marine boiler. Francis Butt-Gow *1
Contracts: When a contract isn't a contract. Edwin L. Seabrook 11
Convention, American Boiler Manufacturers' 198
Convention, Master Boiler Makers Association 292
Convention, National Board of Boiler Inspectors 45
Convention, proceedings at boiler inspectors' 76
Cooperation between state boiler departments and insurance companies. S. F. Jeter.. 46

Copper pipes, forming and brazing. C. E. Lester ... *222
Copper versus steel for boiler tubes ... 292
Cowl ventilators, layout of ... *296
Crown sheet failure without explosion ... *145
Crown stays for various classes of locomotives ... 290
Cylinder and cone intersection, layout of ... *120
Cylinder and elbow intersection ... *54
Cylinder, layout of transition piece intersecting a ... *150

Dart, H. E.: Constructing horizontal boiler settings ... *127
Data sheets, simplification of, and standard stamping of boilers. Jos. F. Scott ... 198
Design, boiler, strength of tubes a factor in. John S. Watts ... 315
Design, furnace and boiler efficiency. Dr. D. S. Jacobus ... 169
Design, locomotive, special factors influencing. M. H. Haig ... *168
Design and operation of present day locomotives. H. W. Snyder ... *224
Design, riveted joint, principles of. William C. Strott ... *191, *226, *257, *284, *311, *336
Details of new Santa Fe locomotive boilers ... *95
Dies and punches, power ... *73
Dishing and flanging boiler heads. George A. Richardson ... *245
Draft pressure and stacks ... *27
Draftsmen, plate shop, points to remember. D. M. McLean ... *344
Drawings, methods of filing and numbering. L. H. Park ... 231
Duties and possibilities of National Board of Boiler Inspectors. Fred R. Low ... 77
Duties of a boiler maker aboard a naval transport. R. B. Harrison ... *253
Duties of National Board of Boiler Inspectors. F. R. Low ... 203

Eales, William P.: Inspection work in Pennsylvania ... 334
Economizers and boilers. Dr. D. S. Jacobus ... 40
Efficiency of boiler and furnace design. Dr. D. S. Jacobus ... 167
Elbow and cylinder intersection ... *54
Elbow head connection, layout of ... *238
Elbow, rectangular, layout of ... *151
Electric arc process, welding storage tanks with. William Schenstrom ... *219
Electric welding: A revolution in marine boiler construction. Francis Butt-Gow ... *1
Electric welding, repairing locomotive boilers by ... *306
Electrical equipment, standardizing the installation of. D. R. Weedon ... 18
Electro-percussive welding ... 262
Electrode process welds, testing covered ... *161
Elementary mechanics for boiler makers. William C. Strott ... *12
Eliminating the smoke nuisance and conserving fuel ... 80
Elimination of firebox deterioration behind grate bars ... 291
Engineering Council, American ... 34
England, boiler welding repairs in ... *339
Ethics in the boiler industry. George W. Bach ... 201
Expanding American boiler trade in the Orient. Charles W. Geiger ... *157
Explosion, boiler, a fatal ... 73
Explosion of long seam boiler ... *256
Explosions, boiler, inspector necessary to prevent ... *342

Fabricating tanks from heavy plate. C. E. Lester ... *313
Failure of boiler, an unusual one ... *15
Failure of crown sheet without explosion ... *145
Federal Shipbuilding Company, quantity production of Scotch marine boilers ... *63
Fell, E. W.: Fitting liners to smoke tubes in superheater boilers ... *209
Fell, E. W.: Renewable stay heads for fireboxes ... *35
Fifty years as a boiler maker ... *260
Filing and numbering drawings, methods of. L. H. Park ... 231
Financing our foreign trade. George Ed. Smith ... 101
Firebox deterioration behind grate bars ... 291
Firebox sheets, beveling, to provide for contraction ... 143
Fireboxes and flues, welding ... 171
Fireboxes of locomotives, best type of side sheet to be applied to ... 292
Fish, E. R.: Necessity for standard stamping of boilers ... 77
Fitting liners to smoke tubes in superheater boilers. E. W. Fell ... *185
Flanging and dishing boiler heads. George A. Richardson ... *245
Flanging, boiler, special methods of. George A. Richardson ... *281
Flue safe ending, standardization of. C. E. Lester ... *109
Flues and fireboxes, welding ... 171
Foreign trade council, national ... *38
Foreign trade developments in boiler industry. L. W. Alwyn-Schmidt ... 139
Foreign trade, financing our. George Ed. Smith ... 101
Forming and brazing copper pipes. C. E. Lester ... *222
Formulating rules for inspection. S. F. Jeter ... 200
Fry, Lawford H.: Notes on locomotive boiler tests ... *249
Fuel, conserving, and eliminating the smoke nuisance ... 80
Fuel, saving, with exhaust steam injectors. Clarence Roberts ... *159
Fundamental principles of trigonometry. William C. Strott ... *41
Furnace design and boiler efficiency. Dr. D. S. Jacobus ... 169
Furnace door, water cooled. C. E. Lester ... *280
Furnaces, circular, rules for staying ... 57
Furnaces, working pressures on. John S. Watts ... *112

Gas welding, Acetylene Association report on ... 345
Gases, metal cutting properties of. Pierre E. Haynes ... 9
Geiger, Charles W.: Expanding American boiler trade in the Orient ... *157
Girth seam rivet holes, cause of boiler shell cracking through ... 291
Gorton, Charles E.: American Uniform Boiler Law Society ... 76, 229
Grate area, ratio of heating surface to. John S. Watts ... 18
Grate bars, elimination of firebox deterioration behind ... 291
Gusset layout for blast pipe ... *353

Haig, M. H.: Factors influencing locomotive design ... *168
Harrison, R. B.: Duties of a boiler maker aboard a naval transport ... *253
Haynes, Pierre E.: Metal cutting properties of gases ... 9
Hearing on A. S. M. E. code for unfired pressure vessels ... 341
Heating surface ratio to grate area. John S. Watts ... 18
Hemispherical head, development of ... *56
Herendeen, F. W.: Uniform rules for low pressure boilers ... 77
High efficiency riveted joints. John S. Watts ... *278
Hilleary, Warren: Safety features of steam boiler accessories ... 173
Hobart, James F.: The "Yazoo" railroad shops at Vicksburg ... *166
Hood development ... *54
Hoover favorable to revision of marine boiler regulations ... 252
Horizontal boiler settings, constructing. H. E. Dart ... *127
Hose markings, acetylene and oxygen ... 44
Hopper angles and oblique transition piece development ... *297
Hopper sides, angles between ... *239
Inclining the torch when cutting ... 287
Increasing the capacity of old locomotives. C. B. Smith ... 16
Information for boiler shop apprentices. George L. Price ... 20
Injectors, fuel saving with exhaust steam. Clarence Roberts ... *159
Inspection, boiler, regulations in California ... 292
Inspection, boiler, uniformity in. C. O. Myers ... 199
Inspection department, organization and work of Ohio boiler. C. O. Myers ... 33
Inspection, formulating rules for. S. F. Jeter ... 200
Inspection of rendering tanks necessary ... *317
Inspection rules for railway stationary boilers in Canada ... 137
Inspection service, boiler, reorganization of New York ... 232
Inspection work in Pennsylvania. William P. Eales ... 334
Inspections, boiler, value of ... *225
Inspector, boiler, necessary to prevent boiler explosions ... *342
Inspector, boiler, work of present-day. J. L. Raleigh ... 233
Inspectors, boiler, National Board of. C. O. Myers ... 335
Inspectors, boiler, state board of Pennsylvania ... 283
Inspectors, convention, National Board of Boiler ... 45
Inspectors convention, proceedings at ... 76
Installation and operation of thermic syphons ... *273
Installation of electrical equipment, standardizing. D. R. Weedon ... 18
Investigation of autogenous welding ... 288

Jacobus, Dr. D. S.: American Society of Mechanical Engineers' Boiler Code ... 45
Jacobus, Dr. D. S.: Boilers and economizers ... 40
Jacobus, Dr. D. S.: Furnace design and boiler efficiency ... 169
Jeter, S. F.: Cooperation between state boiler departments and insuring companies ... 46
Joint design, riveted, principles of. William C. Strott ... *191, 266, *257, *284, *311, *336
Joints, high efficiency riveted. John S. Watts ... *278

Lap seam boilers, changing to butt seam construction ... *109
Laying out plate work, triangulation method. H. Bull ... 181
Layout for blast pipe, gusset ... *353
Layout of blower connection ... *208
Layout of breeching ... *56
Layout of camber for slight taper and plate calculations ... *88
Layout of cone intersection ... *120
Layout, conical tank ... *268
Layout of cowl ventilators ... *296
Layout of double-angle pipe ... *118
Layout of elbow head connection ... *238
Layout of elbow intersected by a cylinder ... *54
Layout of helical pipe ... *24
Layout of hemispherical head ... *56
Layout of hood development ... *54
Layout of oblique pipe joint ... *118
Layout of oblique transition piece and hopper angles ... *297
Layout of oval pipe ... *87
Layout of rectangular elbow ... *151
Layout of scalene cone ... *87
Layout of single sweep tee. John S. Watts ... *181
Layout of spiral chute ... *266
Layout of spout for settling tank ... *352
Layout of stack collar ... *267
Layout of tapering elbow sections forming compound curve ... *179
Layout of tapering Y ... *240
Layout of transition piece ... *325
Layout of transition piece intersecting a cylinder ... *150
Layout of Y connection ... *89
Lester, C. E.: Fabricating tanks from heavy plate ... *313
Lester, C. E.: Forming and brazing copper pipes ... *222

Lester, C. E.: Standardization of flue safe ending ... *109
Lester, C. E.: Standardization of locomotive boiler staybolts ... *144
Lester, C. E.: Welding process, autogenous, speeding up boiler repairs ... *194
Locomotive boiler tests, notes on. Lawford H. Fry ... *249
Locomotive boilers, repairing by electric welding ... *306
Locomotive boilers, Santa Fe, details of. ... *95
Locomotive code adopted by American Society of Mechanical Engineers ... 111
Locomotive design, special factors influencing. M. H. Haig ... *168
Locomotive fireboxes and flues, welding.... 171
Locomotive fireboxes, narrow and wide 292
Locomotive inspection report, Bureau of. A. G. Pack ... *5
Locomotive repair shop, the key to transportation problem ... 82
Locomotive tanks, air, fabricating from heavy plate. C. E. Lester ... *313
Locomotive tubes, methods of welding safe ends on ... 289
Locomotives, American, superheater practice in ... *301
Locomotives, crown stays for... 290
Locomotives, increasing the capacity of old. C. B. Smith ... 16
Locomotives, present day, necessity for improvement in design. H. W. Snyder ... *224
Long seam boiler, explosion of... *256
Low, Fred R.: Duties and possibilities of the National Board of Boiler Inspectors... 77
Low pressure boilers, uniform rules for. F. W. Herendeen ... 77

McCabe, J. C.: Qualifications and duties of a boiler inspector ... 47
McLean, D. M.: Points for plate shop draftsmen to remember ... *344
Machinery, compressed air, safety code for 280
Manufacture of boiler plates. George A. Richardson ... *329
Manufacture of charcoal iron boiler tubes... *187
Marine boiler construction, revolution in. Francis Butt-Gow ... *1
Marine boiler regulations, Hoover favorable. 252
Marine boilers, Scotch, quantity production of *63
Marine equipment exposition to be held in New York ... 262
Massachusetts boiler rules, changes in...... 204
Master Boiler Makers' Association, annual convention ...252, 292, 288
Mechanics, elementary, for boiler makers. William C. Strott ... *12
Meeting of the American Society of Mechanical Engineers ... 107
Metal cutting properties of gases. Pierre Haynes ... 9
Method of applying arch tubes. "Maple Leaf" ... *136
Methods of filing and numbering drawings. L. H. Park ... 231
Methods of welding safe ends on locomotive tubes ... 289
Miller, E. A.: Stool for supporting front end of boiler ... *111
Miller, S. W.: Testing welds in steel plates 69
Myers, C. O.: National Board of Boiler Inspectors ... 335
Myers, C. O.: Organization and work of Ohio Boiler Inspection department 33

National Board of Boiler Inspectors. C. O. Myers ... 335
National Board of Boiler Inspectors, constitution and by-laws of ... 107
National Board of Boiler Inspectors' convention ... 45
National Board of Boiler Inspectors, Duties and possibilities of. Fred R. Low.....77, 203
National Board of Boiler Inspectors, purpose of the formation of. Jos. F. Scott 76
National foreign trade council ... *38
Necessity for standard stamping of boilers. E. R. Fish ... 77
Necessity of uniformity in regulation of steam boiler construction and operation (paper). G. W. Bissel ... 60
New York State boiler inspection service.. 232
Notes on shop practice at DuBois. George W. Armstrong ... *102
Notes on locomotive boiler tests. Lawford H. Fry ... *249

Oblique transition piece development and hopper angles ... *297
Ohio boiler inspection department. C. O. Myers ... 33
Oil fired boilers in Europe, increased use of. T. Sington ... 146
Operation and installation of thermic syphons *273
Organization of Ohio boiler inspection department. C. O. Myers ... 33
Osbourne, F.: Staybolt and stud driver and remover ... *80
Oval pipe, layout of ... *87
Oxy-acetylene torch, bending with aid of.... 172
Oxy-acetylene welding ... 292
Oxy-acetylene welding, shear reclaimed by.. *160
Oxygen and acetylene hose markings...... 44

Pack, A. G.: Bureau of Locomotive Inspection report ... *5
Park, L. H.: Methods of filing and numbering drawings ... 231
Pennsylvania boiler code ... 196
Pipe construction, helical ... *24
Pipe, double angle, layout of ... *118
Pipe joint, oblique, layout of ... *118
Pipes, copper, forming and brazing. C. E. Lester ... *222
Plant inspection trips for American Society of Mechanical Engineers ... 146
Plate shop draftsmen, points to remember. D. M. McLean ... *344
Plate work, triangulation method of laying out. H. Bull ... 181
Plates, boiler, manufacture of. George A. Richardson ... *329
Plates, testing welds in. S. W. Miller..... 69
Points for plate shop draftsmen to remember. D. M. McLean ... *344
Power punches and dies ... *73
Practical method of welding locomotive fireboxes and flues ... 171
Pressure vessels, calculating stresses in. William C. Strott ...*132, *163
Pressure vessels, unfired, bearing on A. S. M. E. code for ... 341
Price, George L.: Information for boiler shop ... 20
Principles of handling men, fundamental... 57
Principles of riveted joint design. William C. Strott ...*191, *226, *257, *284, *311, *336
Proceedings at boiler inspectors' convention 76
Production of Scotch marine boilers in quantities ... *63
Progress in adoption of Boiler Code. Charles E. Gorton ... 229
Progress of boiler regulation in Pennsylvania ... 334
Properties and composition of boiler tubes. Albert E. White ... *104
Punches and dies, power ... *73

Qualifications and duties of a boiler inspector J. C. McCabe ... 47
Quantity production of Scotch marine boilers *63

Railroad shops, at Vicksburg. James F. Hobart ... *166
Raleigh, J. L.: Work of present day boiler inspector ... 233
Ratings, boiler and engine ... 119
Ratio of heating surface to grate area. John S. Watts ... 18
Rectangular elbow, layout of ... *151
Regulation of boilers, progress of, in Pennsylvania ... 334
Rendering tanks, inspection of necessary.... *317
Renewable stay heads for fireboxes. E. W. Fell ... *35
Reorganization of New York boiler inspection service ... 232
Repair shop, locomotive, key to transportation problem ... 82
Repairing locomotive boilers by electric welding ... *306
Repairing superheater units ... *80
Repairs, boiler, autogenous welding process. C. E. Lester ... *194
Repairs, boiler welding, in England ... *339
Report of Bureau of Locomotive Inspection. A. G. Pack ... *5
Report on gas welding, Acetylene Association 345
Reports of Master Boiler Makers' Association 288
Revolution in marine boiler construction. Francis Butt-Gow ... *1
Richardson, George A.: Flanging and dishing boiler heads ... *245
Richardson, George A.: Manufacture of boiler plates ... *329
Richardson, George A.: Special methods of boiler flanging ... *281
Rivet holes, girth seam, cause of boiler shell cracking through ... 291
Riveted joint design, principles of. William C. Strott ...*191, *226, *257, *284, *311, *336
Riveted joints, high efficiency. John S. Watts ... *278
Rivets, rivet heads and laps ... 209
Rivets, why do they leak? ... 204
Roberts, Clarence: Saving fuel with exhaust steam injectors ... *159
Rogers, E. W.: Fifty years a boiler maker *260
Rules for low pressure boilers. F. W. Herendeen ... 77
Rules for staying plain circular furnaces.... 57

Safe ending of boiler tubes ... *215
Safety code for compressed air machinery. 280
Safety features of steam boiler accessories. Warren Hilleary ... 173
Santa Fe locomotive boilers, details of new *95
Saving fuel with exhaust steam injectors. Clarence Roberts ... *159
Scalene cone, development of ... *87
Scotch boilers, standard single ended ... *49
Scott, Jos. F.: Purpose of the formation of the National Board of Boiler Inspectors 76
Seabrook, Edwin L.: When a contract isn't a contract ... 11
Service of inspector necessary to prevent disastrous boiler explosions ... *342
Setting circular furnaces ... 57
Setting for horizontal boilers. H. E. Dart 127
Settling tank, layout of spout for... *352
Shear, reclaimed by oxy-acetylene welding.. *160
Shop draftsmen, plate, points to remember. D. M. McLean ... *344
Shop practice at DuBois. George W. Armstrong ... *102
Shops, railroad, at Vicksburg. James F. Hobart ... *166
Simplification of data sheets and stamping of boilers. Joseph F. Scott ... 198
Sington, T.: Increased use of oil fired boilers in Europe ... 146
Smith, C. B.: Increasing the capacity of old locomotives ... 16
Smith, George Ed.: Financing our foreign trade ... 101
Smoke tubes, fitting liners to superheater. E. W. Fell ... *185
Snyder, H. W.: Necessity for improvement in design and operation of locomotives.... *224
Special factors influencing locomotive design. M. H. Haig ... *168
Special methods of boiler flanging. George A. Richardson ... *281
Specifications for welding material adopted by American Welding Society ... 140
Speeding up boiler repairs by welding process. C. E. Lester ... *194
Speeding up the safe ending of boiler tubes *215
Spiral chute development ... *266
Spout for settling tank, layout of ... *352
Stack collar layout ... *267
Stacks and draft pressure ... *27
Stamping of boilers, standard. E. R. Fish 77
Standard requirements for staying flat surfaces. John S. Watts ... *254

Standard single ended Scotch boilers *49
Standardizing the installation of electrical equipment. D. R. Weedon 18
Standardization of boiler and staybolt taps. *39
Standardization of flue safe ending. C. E. Lester *109
Standardization of locomotive boiler staybolts. C. E. Lester *144
State Board of Boiler Inspectors proposed for Pennsylvania 283
Staybolt and stud driver and remover. F. Osbourne *80
Staybolt taps, standardization of......... *39
Staybolts, locomotive boiler, standardization of. C. E. Lester *144
Staybolts, welded, installed in Santa Fe boilers 162
Stay heads for fireboxes, renewable. E. W. Fell *35
Staying flat surfaces. John S. Watts...... *254
Stays and stayed surfaces............ 179
Steel plates, testing welds in. S. W. Miller 69
Steel versus copper for boiler tubes....... 292
Stool for supporting front end of boiler. E. A. Miller *111
Storage tanks, welding, with electric arc process. William Schenstrom *219
Strength of tubes a factor in boiler design. John S. Watts 315
Stresses in boiler shells............ 150
Stresses in pressure vessels, calculating. William C. Strott *132, *163
Strott, William C.: Calculating stresses in pressure vessels *132, *163
Strott, William C.: Elementary mechanics for boiler makers............ *12
Strott, William C.: Fundamental principles of trigonometry............*41, *71
Strott, William C.: Principles of riveted joint design *191, *226, *257, *284, *311, *336
Superheater boilers, fitting liners to smoke tubes in. E. W. Fell............ *185
Superheater practice in American locomotives *301
Superheater units, repairing............ *80
Syphons, thermic, operation and installation of *273

Tank plates, calculations for............ 24
Tank, settling, layout of spout for......... *352
Tanks, fabricating from heavy plate. C. E. Lester *313
Tanks, rendering, inspection of necessary.... *317
Tanks, storage, welding. William Schenstrom *219
Tapering elbow, layout of............ *179
Tapering Y—heavy plate development...... *240
Tapping radial holes in boiler shells....... *141
Tee, single sweep, layout of. John S. Watts *181
Tempering and hardening tool steel........ 180
Testing covered electrode process welds.... *161
Testing welds in steel plates. S. W. Miller 69
Tests, locomotive boiler, notes on. Lawford H. Fry *249
Thermic syphons, operation and installation of *273
Torch, acetylene, inclining when cutting.... 287
Trade, foreign, developments in boiler industry. L. W. Alwyn-Schmidt 139
Training of welding operators............ 50
Transition piece intersecting a cylinder, layout of *150
Transition piece, layout of............ *325
Transportation problem, locomotive repair shop, key to 82
Trigonometry, fundamental principles of. William C. Strott *41, *71
Tubes, arch, new method of applying. "Maple Leaf" *136
Tubes, boiler, cleaning............ 208
Tubes, boiler, copper versus steel........... 292
Tubes, boiler, manufacture of charcoal iron *187
Tubes, boiler, properties and composition of. Albert E. White *104
Tubes, boiler, speeding up the safe ending of *215
Tubes, fitting liners to superheater. E. W. Fell *185
Tubes, locomotive, methods of welding safe ends on 289
Tubes, strength of, a factor in boiler design. John S. Watts 315

Uniformity in boiler inspection. C. O. Myers 199

Value of boiler inspections *225
Ventilators, cowl, layout of *296

Water cooled furnace door............ *280
Watts, John S.: A criticism of high efficiency riveted joints *278
Watts, John S.: Ratio of heating surface to grate area 18
Watts, John S.: Standard requirements for staying flat surfaces............ *254
Watts, John S.: Strength of tubes a factor in boiler design 315
Watts, John S.: Working pressures on furnaces *112
Weedon, D. R.: Standardizing the installation of electrical equipment............ 18
Welded staybolts installed in Santa Fe boilers 162
Welding, autogenous, investigation of...... 288
Welding, electric: A revolution in marine boiler construction. Francis Butt-Gow.. *1
Welding, electric, repairing locomotive boilers by *306
Welding, electro-percussive 262
Welding, gas, Acetylene Association report on 345
Welding locomotive fireboxes and flues.... 171
Welding material, specifications adopted by American Welding Society 140
Welding operators, training of 50
Welding, oxy-acetylene 292
Welding repairs, in England *339
Welding safe ends on locomotive tubes, methods of 289
Welding storage tanks with electric arc process. William Schenstrom *219
Welds, testing covered electrode process.... 161
Welds, testing steel plate. S. W. Miller.... 69
When a contract isn't a contract. Edwin L. Seabrook 11
White, Albert E.: Properties and composition of boiler tubes *104
Why pick on acetylene?............ 20
William Schenstrom: Welding storage tanks with electric arc process............ *219
Work of A. S. M. E. Boiler Code Committee 19, 75, *230, 279, *338
Work of present day boiler inspector. J. L. Raleigh 233
Working pressures on furnaces. John S. Watts *112

Y connection layout *89
"Yazoo" railroad shops at Vicksburg. James F. Hobart *166

COMMUNICATIONS

Acetylene and oxygen hose markings........ 91
Acid drum explodes 152
Advantages of triangulation method of laying out plate work. H. Bull............ 181
Another record of boiler shop service. Richard Mapleston 298
Apprentice problem, finding solution to the. 123
Apprentices, every day questions answered for. George L. Price 326
Apprentices, information for. George L. Price 355
Apprenticeship problem. Charles W. Carter, Jr. 30
Areas of cylindrical pipes or ducts. William F. Schaphorst *29

Boiler, effect of cold air on heated locomotive. J. A. Grainge............ 91
Boiler failure in planing mill, lap seam crack causes. J. P. Morrison............*122
Boiler inspectors, requirements for. Chas. J. Vedder 90
Boiler inspectors, typical examination questions for 29
Boiler, low pressure, severe test on welded. J. H. Petherick, Jr. 211
Boiler makers, items of interest to. George L. Price 152
Boiler, repairing a bagged............ 242
Boiler scale, cost of. W. F. Schaphorst.... 270
Boiler, Scotch, is doomed. W. F. Schaphorst 59
Boiler shop service, another record of. Richard Mapleston 298
Boiler shop service record, an unusual. John Cook 270
Boiler shops, men with broad training needed in 28
Boiler tubes, watertube, causes of bowing in. William Svatos 153

Cause of cracks in tube sheet flange. Chas. A. Norton 59
Chart for computing capacities of rectangular tanks *326
Cost of boiler scale. W. F. Schaphorst..... 270
Checking up shop orders 90
Cracks, cause of, in tube sheet flange. Chas. A. Norton 59
Crown sheet failure on oil fired locomotive. W. T. Fraser............ *298
Cylindrical pipes or ducts, areas of. William F. Schaphorst *29

Dividers, setting accurately for spacing off. H. W. Sibert 212
Does hydrostatic pressure count? Charles W. Carter, Jr. *58
Doubling plates, notes on the fitting of. John S. Watts *58
Drum, acid, explodes............ 152

Effect of cold air on heated locomotive boiler. Walter J. A. Grainge............ 91
Efficiency, formula for. W. F. Schaphorst.. 123
Every day questions answered for apprentices. George L. Price............ 326

Failure caused by lap seam crack. J. P. Morrison *122
Flange work, top heating for. Joe B. Holloway 355
Formula for inefficiency. W. F. Schaphorst. 123

Hose markings, acetylene and oxygen....... 91
Hose markings, oxygen and acetylene. John S. Watts 44
Hydrostatic pressure, does it count? Charles W. Carter, Jr. *58

Ideas under a bushel. W. F. Schaphorst.. 153
Inefficiency, formula for. W. F. Schaphorst. 123
Information for apprentices. George L. Price 355
Inspection incidents in railroad shops. "Flex Ible" 28
Inspectors, boiler, typical examination questions for 29
Inspectors, requirements for. Charles J. Vedder 90

Lack of standardization in welding hose markings. Davis-Bournonville Co. 91
Lap seam crack causes boiler failure in planing mill. J. P. Morrison *122
Layout of single sweep tee. John S. Watts *181
Layout problem, simple. Charles W. Carter, Jr. *152
Locomotive shop practice, notes on. G. L. Price 211
Locomotive, stoker fired, makes continuous run over three divisions 124
Locomotive stokers, mechanical 241
Locomotive tender tank, welded. J. W. Murphy *269
Locomotives, oil fired, crown sheet failure on. W. T. Fraser *298
Low pressure welded boiler, severe test on. J. H. Petherick, Jr. 211

Mechanical locomotive stokers 241
Men with broad training needed in boiler shops 28

Notes on locomotive shop practice. G. L. Price 211
Notes on the fitting of doubling plates. John S. Watts *58

Oil fired locomotive, crown sheet failure on. W. T. Fraser *298

Plate work, advantages of triangulation method of laying out. H. Bull 181

Railroad shops, Inspection incidents in. "Flex Ible" 28
Reader's comment on the magazine. Joseph Smith 91
Rectangular tanks, chart for computing capacities of *326
Repairing a bagged boiler 242
Requirements for boiler inspectors. Charles J. Vedder 90
Right angle triangles, scale to aid in solving. W. F. Schaphorst 212
Rivet spacing, table for use in laying out. Donald M. McLean 241

Scale to aid in solving right angle triangles. W. F. Schaphorst 212
Scotch boiler is doomed. W. F. Schaphorst 59
Setting dividers accurately for spacing off. H. W. Sibert 212
Severe test on low pressure welded boiler. J. H. Petherick, Jr. 211
Shop, boiler, an unusual service record. John Cook 270
Shop orders, checking up 90
Shop practice, locomotive, notes on. G. L. Price 211
Shops, railroad, inspection incidents in. "Flex Ible" 28
Standardization in oxygen and acetylene hose markings, lack of. Davis-Bournonville Co. 91
Stoker fired locomotive makes continuous run over three divisions 124
Stokers, mechanical locomotive 241
Straightening a tank frame. C. J. Casbourne 270

Table for use in laying out rivet spacing. Donald M. McLean *241
Tank frame, straightening. C. J. Casbourne 270
Tank, locomotive tender, welded. J. W. Murphy *269
Tanks, rectangular, chart for computing capacities of *326
Tee, single sweep, layout of. John S. Watts *181
Top heating for flange work. Joe B. Holloway 355
Triangles, right angle, scale to aid in solving. W. F. Schaphorst 212
Tube sheet flange, cracks in. Charles A. Norton 59
Tubes, watertube boiler, causes of bowing in. William Svatos 153
Typical examination questions for boiler inspectors 29

Watertube boiler tubes, causes of foaming in. William Svatos 153
Welded boiler, low pressure, severe test on. J. H. Petherick, Jr. 211
Welded locomotive tender tank. J. W. Murphy *269
What is the formula for inefficiency? W. F. Schaphorst 123
Wrenches, don't lengthen. W. F. Schaphorst 91

EDITORIALS

Air tanks and pressure vessels, code for 321
American Boiler Manufacturers' Association, annual convention 175
American Boiler Manufacturers' Association, fall meeting omitted 321
Application of autogenous welding to boiler repairs 205
Apprentice classes, importance of establishing 205
A. S. M. E. Boiler Code Committee, work of the 83
Arc welding, electric, report on 321
Autogenous welding, application to boiler repairs 205
Autogenous welding, report on 321

Boiler and furnace economy 349
Boiler capacity, measure of 147
Boiler code committee work 83
Boiler code for construction of unfired pressure vessels 349
Boiler code, locomotive, adoption of 115, 321
Boiler construction in United States, need for uniform 51
Boiler failure during inspection 234
Boiler heads, flanging and dishing of 263
Boiler making industry, prospects of 21
Boiler settings, standardization of 147
Boiler tubes, investigation on composition and properties of 115
Boilers, efficiency of 175
Boilers, portable, explosions of 263
Boilers, welding of, by covered electrode process 21
Bureau of Locomotive Inspection report 21

Code, boiler, for construction of unfired pressure vessels 349
Code for air tanks and pressure vessels 321
Code, locomotive boiler construction 321
Convention, American Boiler Manufacturers' Association 175
Convention of Master Boiler Makers' Association 83
Covered electrode welding process applied to boiler construction 21

Dangers met in compressed air machinery 83
Design of riveted joints 175
Dishing and flanging boiler heads 263

Economizers used to increase boiler efficiency 175
Economy, boiler and furnace 349
Efficiency of boilers 175
Electric arc welding, report on 321
Employment bureau for technical men 235
Explosions of portable boilers 263
Explosive mixtures in compressed air systems 83

Flanging and dishing of boiler heads 263
Flue shop operation, increasing efficiency of 239
Foreign trade, financing 115
Furnace and boiler economy 349

Increasing efficiency of flue shop operation 239
Index, annual, The Boiler Maker 293
Investigation on composition and properties of boiler tubes 115

Joints, riveted, design of 175

Locomotive boiler code, adoption of 115
Locomotive boiler construction code, A. S. M. E. 321
Locomotives, accidents to 21

Master Boiler Makers' Association, convention of 83, 115
Master Boiler Makers' Association, reports 293
Measure of boiler capacity 147

National Board of Boiler and Pressure Vessel Inspectors, first meeting of 51
National Board of Inspectors recognized in many states 293

Pressure vessels, unfired, boiler code for construction of 349

Rating of boilers in terms of heating surface 147
Report on autogenous welding 321
Report on electric arc welding 321
Reports of Master Boiler Makers' Association 293
Riveted joints, design of 175

Shop efficiency, increasing 239
Shop "time savers" 51
Standard stamping of boilers 293
Standardization of boiler settings 147

Tubes, boiler, investigation on composition and properties of 115

Unemployment conference held in Washington 293
Unfired pressure vessels, boiler code for 349
Uniform boiler construction in United States 51

Welding, autogenous, practical application of 205
Welding, autogenous, report on 321
Welding, electric, report on 321
Welding of boilers 21

ENGINEERING SPECIALTIES

Air compressor, belt-driven, Ingersoll-Rand Company *295
Air valve, pressure seated. Cleveland Pneumatic Tool Co. *177
American Boiler Appliances Co.: Protection ferrule for boiler tubes *323
Amplex, Inc.: Bending angles and other structural shapes *350
Angles, bending, and other structural shapes. Amplex, Inc. *350
Arc welding lead, semi-automatic. General Electric Co. *350
Automatic boiler cleaner. Automatic Boiler Cleaner Co. *207
Automatic collapsing tap. National Acme Company *52
Automatic fire alarm. Pyrene Mfg. Co. 116
Automatic starter for squirrel cage motors. Cutler-Hammer Mfg. Co. *264

Baird Pneumatic Tool Company: Staybolt cutter adapted for riveting *23
Barnes Drill Co.: Self-oiling gang drill *207
Bath, John and Co.: Development in roughing and finishing taps *176
Belt-driven air compressor. Ingersoll-Rand Company *295
Bench drill stand. Black & Decker Mfg. Co. *22
Bending angles and other structural shapes: Amplex, Inc. *350
Black & Decker Mfg. Co.: Bench drill stand. *22
Black & Decker Mfg. Co.: Drill adapted for bench use 323
Blower for forced draft or ventilating service. Coppus Engineering & Equipment Co. *322
Boiler, for locomotive cranes. Industrial Works *176
Boiler tubes, ferrule protection for. American Boiler Appliances Co. *323
Boiler tubes, lap welded, testing. National Tube Company 52
Boring and drilling machines, tilting and rotary table for. Pawling & Harnischfeger Co. *264
Boring, drilling and milling machines. Pawling & Harnischfeger Co. *322
Brush for electric grinder. Independent Pneumatic Tool Company *85

Chicago Pneumatic Tool Co.: Rivet set 116
Chuck for holding broken drills. Wayne Tool Mfg. Co. *237
Cleaner, boiler, automatic. Automatic Boiler Cleaner Co. *207
Cleveland Crane and Engineering Co.: Overhead handling system *351
Cleveland Pneumatic Tool Co.: Pressure seated air valve *177
Cleveland Punch & Shear Works Company: Semi-automatic spacing table *84
Combustion recorder maintains double analysis of flue gases: Mono Corporation of America *265
Coppus Engineering & Equipment Co.: Blower for forced draft or ventilating service *322
Crane cage, safety. Pawling & Harnischfeger 85
Cutler-Hammer Mfg. Co.: Automatic starter for squirrel cage motors *264
Cutting torch, machine for operating. Linde Air Products Co. *22

Double spindle threading machine. Geometric Tool Co. *149
Drill adapted for bench use. Black & Decker Mfg. Co. 323
Drill, gang, self oiling: Barnes Drill Co. .. *207
Drill stand, bench. Black & Decker Mfg. Co. *22
Drill standard, equipped with wire brush cleaner. Ingersoll-Rand Co. *177
Drilling machine. E. L. Fogleman *206
Drilling machine, gantry type. William K. Stamets *237
Drills and grinders, electric. Wodack Electric Tool Corporation *53
Electric Arc Cutting and Welding Company.: Portable electric welding outfit *23
Electric drills and grinders. Wodack Electric Tool Corporation *53
Electric rivet heater. General Electric Co.. *116

Feed control and variable speed drive. Oilgear Co. *323
Ferrule protection for boiler tubes. American Boiler Appliances Co. *323
Fire alarm, automatic. Pyrene Mfg. Co. 116
Flannery Bolt Co.: New Type grease cup ... 323
Flue welder, universal. Southwark Foundry & Machine Co. *148
Fogleman, E. L.: Portable plate drilling machine *206
Forge, portable oil burning. Norton Manufacturing Company *52

Gage, slitting, for rotary shear. Niagara Machine & Tool Works *351
Gang drill, self-oiling. Barnes Drill Co. *207
Gantry type drilling machine. William K. Stamets *237
Gas engine driven arc welding units. General Electric Co. *236
General Electric Co.: Electric rivet heater.. *116
General Electric Co.: Gas engine driven arc welding units *236
General Electric Co.: Semi-automatic arc welding lead *350
Geometric Tool Co.: Double spindle threading machine *149
Grease cup, new type. Flannery Bolt Co. ... 323

Hanna Engineering Works: Pneumatic boiler head riveter *116
Horizontal boring, drilling and milling machines. Pawling & Harnischfeger Co. *322
Houston, Stanwood & Gamble Co.: Plate press with sectional dies *148

Independent Pneumatic Tool Company.: Brush for electric grinder *85
Industrial Works. Scale-proof boiler for locomotive cranes *176
Ingersoll-Rand Co.: Belt-driven air compressor *295
Ingersoll-Rand Co.: Drill equipped with wire brush cleaner *177

Keller Pneumatic Tool Company: Pneumatic rivet buster 23

Lap welded boiler tubes, testing. National Tube Company 52
Lathe, simplicity features, new. Oliver Machinery Co. *149
Linde Air Products Co.: Machine for operating cutting torch *22

Machine for operating cutting torch. Linde Air Products Co. *22
Mono Corporation of America: Combustion recorder *265

National Acme Company: Automatic collapsing tap *52
National Tube Company: Testing lap welded boiler tubes 52
New York Blue Print Paper Company: Parallel ruling attachment for drawing boards. *85
Niagara Machine & Tool Works: Power squaring shears *236
Niagara Machine & Tool Works: Ring and circle shear *294
Niagara Machine & Tool Works. Slitting gage for rotary shear *351
Norton Manufacturing Company: Portable oil burning forge *52
Novo Engine Company: Portable welding set operated by Novo engine *295

Oil burning forge, portable. Norton Manufacturing Company *52
Oil Gear Co.: Feed control and variable speed drive *323
Oliver Machine Co.: 16-inch rapid production lathe *149
Operation time watch. Mortimer J. Silverberg Co. *265
Overhead handling system. Cleveland Crane & Engineering Co. *351

Pawling & Harnischfeger Co.: Horizontal boring, drilling and milling machines *322
Pawling & Harnischfeger Co.: Safety crane cage 85
Pawling & Harnischfeger Co.: Tilting and rotary table for boring and drilling machines *264
Plate drilling machine, portable. E. L. Fogleman *206
Pneumatic boiler head riveter. Hanna Engineering Works *116
Pneumatic rivet buster. Keller Pneumatic Tool Company 23
Portable electric welding outfit. Electric Arc Cutting & Welding Co. *23
Power squaring shears. Niagara Machine & Tool Co. *236
Press, double screw, for plate work. Toledo Machine & Tool Co. *177
Press with sectional dies. Houston, Stanwood & Gamble Co. *148
Pressure seated air valve. Cleveland Pneumatic Tool Co. *177
Pyrene Mfg. Co.: Automatic fire alarm 116

Ring and circle shear. Niagara Machine & Tool Works *294
Rivet buster, pneumatic. Keller Pneumatic Tool Co. 23
Rivet heater, electric. General Electric Co.. *116
Rivet set. Chicago Pneumatic Tool Co. 116
Riveter, pneumatic, boiler head. Hanna Engineering Works *116
Ruling attachment, parallel, for drawing boards. New York Blue Print Paper Company *85
Ryerson steel service, telephone equipment. 149

Safety crane cage. Pawling & Harnishfeger Co. 85
Scale-proof boiler for locomotive cranes. Industrial Works *176
Self-oiling gang drill. Barnes Drill Co. *207
Semi-automatic arc welding lead. General Electric Co. *350
Shear, ring and circle. Niagara Machine & Tool Works *294
Shear, turret rotary, for cutting metal. Southwark Foundry & Machine Company *294
Shears, power squaring. Niagara Machine & Tool Co. *236
Silberberg, Mortimer J.: Operation time watch for studying efficiency *265
Slitting gage for rotary shear. Niagara Machine & Tool Works *351
Southwark Foundry & Machine Company: Turret rotary shear for cutting metal *294
Southwark Foundry & Machine Co.: Universal flue welder *148
Spacing table, semi-automatic. Cleveland Punch and Shear Works Company *84
Speed drive, variable, and feed control. Oilgear Co. *323
Spot welding machine. Taylor Welder Co.. *206
Stamets, William K.: Gantry type drilling machine *237
Staybolt cutter adapted for riveting. Baird Pneumatic Tool Company *23

Tap, automatic collapsing. National Acme Company *52
Taps, development in roughing and finishing. John Bath and Co. *176
Taylor Welding Co.: Spot welding machine. *206
Threading machine; double spindle. Geometric Tool Co. *149
Tilting and rotary tables for boring and drilling machines. Pawling & Harnischfeger Co. *264
Toledo Machine & Tool Co.: Double screw press for plate work *177
Tramrail, overhead handling system. Cleveland Crane and Engineering Co. *351
Turret rotary shear for cutting metal. Southwark Foundry & Machine Company. *294

Universal flue welder. Southwark Foundry & Machine Co. *148

Watch for studying efficiency. Mortimer J. Silberberg *265
Wayne Tool Mfg. Co.: Chuck for broken drill shanks *237
Welder, arc, semi-automatic. General Electric Co. *350
Welding machine, spot. Taylor Welder Co. *206
Welding outfit, portable electric. Electric Arc Cutting and Welding Company *23
Welding set operated by Novo engine. Novo Engine Company *295
Welding units, gas engine driven. General Electric Co. *236
Wodack Electric Tool Corporation: Electric drills and grinders *53

LAYING-OUT PROBLEMS

Blast pipe, gusset layout for *353
Blower connection, layout of *208
Breeching layout *56

Camber layout for slight taper and plate calculations *88
Chute development, spiral *266
Collar layout, stack *26
Cone and cylinder intersection *120
Cone development, scalene *87
Cone intersection and development *120
Cowl ventilators, layout of *296
Cylinder and cone intersection *120
Cylinder intersecting an elbow *54
Cylinder, transition piece intersecting *150

Development of hemispherical head *56
Development of spout for settling tank *352
Double angle pipe layout *118

Elbow head connection *238
Elbow intersected by a cylinder *54
Elbow layout, rectangular *151
Elbow sections forming a compound curve, tapering *179

Gusset layout for blast pipe *353

Head development *54
Head, development of hemispherical *56
Helical pipe construction *24
Hopper angles and oblique transition piece.. *297

Oblique pipe joint *118
Oblique transition piece and hopper angles.. *297
Oval pipe layout *87

Pipe construction, helical *24
Pipe joint, oblique *118
Pipe layout, double angle *118
Pipe layout, oval *87
Plate calculations and camber layout for slight taper *88
Plate development, heavy-tapering Y *240
Plate work, advantages of the triangulation method of laying out. H. Bull 181

Rectangular elbow layout *151

Scalene cone development *87
Settling tank, development of spout for *352
Simple layout problem *152
Spiral chute development *266
Spout for settling tank, development of *352
Stack collar layout *267

Tank, settling, development of spout for *352
Tapering Y—heavy plate development *240
Tee, single sweep, layout of. John S. Watts. *181

Transition piece intersecting a cylinder...... *150
Transition piece, layout of *325
Tapering elbow sections forming a compound curve *179
Triangulation method of laying out plate work, advantages of. H. Bull 181

Ventilators, cowl, layout of *296

Y connection, layout of *89

PARAGRAPHS

A. S. M. E. code for "miniature" boilers, hearing on 335
Allen, Francis B., Obituary 268
Associations .. 31, 61, 93, 125, 155, 183, 213, 243, 270, 299, 327, 357

Beaman, Charles F., Obituary 242
Boiler inspectors, examinations for......... 158
Boilers, "miniature," code for............ 335
Business notes.. 27, 30, 53, 85, 180, 210, 237, 270, 297, 325, 354

Dugger, Jarrot P., Obituary 356

Examinations for boiler inspectors.......... 158

Heating steel plate with oxy-acetylene torch. 111

Kimman, Henry J., Obituary 297

Locomotive, new type 15
Locomotive, steam, in United States 343

"Miniature" boilers, code for 335

Obituary notices.. 210, 242, 268, 297, 325, 356
Oxy-acetylene torch, heating steel plate with. 111

Personals.. 8, 30, 57, 75, *92, *117, 153, 154, 162, 177, 182, 242, 252, 351

Sneddon, James P., Obituary.............. 219
Stafford, B. E. D., Obituary............... *356
Steam locomotive in United States 343
Steel plate, heating, with oxy-acetylene torch. 111
Stewart, James C., Obituary 297, 325

Trade publications.. 30, 61, 93, 125, 155, 183, 213, 243, 270, 299, 327, 357

Under Feed Stoker Company of America.. 114

QUESTIONS AND ANSWERS

Air lift pump 26
Angles between sides of a hopper, determining *239
Arc length, rule for finding 119
Arches, firebrick, in locomotive boilers..... 151
Autogenous welding, boiler repairs by..... *26

Beveling plate for welding repairs.......... 209
Blast pipe, gusset layout for *353
Blower connection *208
Boiler and engine ratings 119
Boiler, dry back 179
Boiler head segments—rivets, rivet heads and laps 209
Boiler, locomotive, placing cement in water leg of 325
Boiler repairs and welding *88
Boiler repairs by autogenous welding....... *26
Boiler, re-staying wet bottom.............. 267
Boiler shells, transverse and longitudinal stresses in *150
Boiler, vertical type, staying submerged combustion chamber of 180
Boiler work, general questions on 239
Boilers and engines *55
Boilers, horizontal, welding tubes in 27
Boilers, leaky 57
Boilers, locomotive, uses of firebrick arches in 151
Boilers, painting 210
Boilers, retubing 210
Breeching layout *56

Buckled plates and frames, straightening... *352

Camber layout for slight taper and plate calculations *88
Cement in water leg of locomotive boiler, placing 325
Chute development, spiral *266
Cleaning boiler tubes 208
Cleaning brass tubes 208
Combustion chamber of vertical type boiler, staying 180
Cone development, scalene *87
Connection, elbow head *238
Cone intersection and development *120
Conical tank development *268
Cowl ventilators, layout of *296
Cutting and welding hose connections, leaky 324
Cylinder and cone intersection *120
Cylinder, elbow intersected by *54
Cylinder, transition piece intersecting *150
Cylindrical furnace, repair to plain......... *324

Determining angles between sides of a hopper *239
Development of hemispherical head *56
Development of spout for settling tank..... *352
Development of Y-breeching 118
Double-angle pipe layout *118
Draft pressure in stacks *27
Dry back boiler 179

Elbow head connection *238
Elbow intersected by a cylinder............ *54
Elbow layout, rectangular *151
Engine and boiler ratings 119
Engines and boilers *55

Feed water discharge and questions on watertube boilers 238
Firebrick arches in locomotive boilers, uses of 151
Frames and plates, straightening buckled.... *352
Furnace, cylindrical, repair to *324

General questions on boiler work 239
Gusset layout for blast pipe *353

Hardening and tempering tool steel 180
Head development *54
Head, hemispherical, development of *56
Helical pipe construction *24
Hopper angles and development of oblique transition piece *297
Horizontal boilers, welding tubes in 27
Hose connections, leaky cutting and welding. 324

Layout, camber, for slight taper and plate calculations *88
Layout, double-angle pipe *118
Layout, gusset, for blast pipe *353
Layout of an oblique pipe joint *118
Layout of cone intersection *120
Layout of cowl ventilators *296
Layout of cylinder and cone intersection... *120
Layout of oblique transition piece and hopper angle *297
Layout of oval pipe *87
Layout of tapering elbow sections 179
Layout of transition piece *325
Layout of Y connection *89
Layout problem, simple *152
Layout, scalene cone *87
Leaky boilers 57
Leaky cutting and welding hose connections. 324
Locomotive boiler, placing cement in water leg of 325

Oblique pipe joint, layout of *118
Oblique transition piece development and hopper angles *297
Oil burning, pressure for 352
Oval pipe layout *87
Oxy-acetylene equipment, leaky cutting and welding hose connections 324

Painting boilers 210
Pipe construction, helical *24
Pipe joint, oblique, layout of *118

Pipe layout, double angle *118
Pipe layout, oval *87
Plate calculations and camber layout *88
Plates and frames, straightening buckled... *352
Plate calculations for large tank *24
Pressure for oil burning 352
Pump, air lift 26

Ratings, boiler and engine 119
Rectangular elbow layout *151
Removing damaged tubes *209
Repair to plain cylindrical furnace *324
Repairs and welding, boiler *88
Repairs, boiler, by autogenous welding...... *26
Repairs, welding, beveling plate for......... 209
Re-staying wet bottom boiler 267
Retubing boilers 210
Rule for finding length of arc 119

Scalene cone development *87
Settling tank, development of spout for.... *352
Spiral chute development *266
Spout for settling tank, development of ... *352
Stack collar layout *267
Stacks and draft pressure *27
Staying, vertical type boiler 180
Stays and stayed surfaces 179
Steel, tool, hardening and tempering 180
Stirling tubes and mud drums 209
Straightening buckled plates and frames.... *352
Stresses in boiler shells *150

Tank, large, calculations for *24
Tank, settling, development of spout for.... *352
Tapering elbow sections forming a compound curve *179
Tapering Y—heavy plate development *240
Tool steel, hardening and tempering 180
Transition piece intersecting cylinder *150
Transition piece, layout of *325
Transverse and longitudinal stresses in boiler shells *150
Tube, welding, electric *121
Tubes, boiler, cleaning 208
Tubes, brass, cleaning 208
Tubes, removing damaged *209
Tubes, Stirling and mud drums 209
Tubes, welding, in horizontal boilers........ 27

Ventilators, cowl, layout of *296

Water leg of locomotive boiler, placing cement in 325
Watertube boilers, questions on 238
Welding and cutting hose connections, leaky. 324
Welding, autogenous, boiler repairs by...... *26
Welding repairs, beveling plate for......... 209
Welding tube, electric *121
Welding tubes in horizontal boilers........ 27
Wet bottom boiler, re-staying 267

Y-breeching, development of 118
Y connection, layout of *89

TECHNICAL PUBLICATIONS

American Society for Testing Materials, proceedings for 1920 61

Boiler Book. H. E. Dart 89

Elementary Machine Shop Practice. James A. Pratt 89
Encyclopedia, Welding. L. B. Mackenzie and H. S. Card 121

Machine Shop Practice, Elementary. James A. Pratt 89
Modern Welding Methods. Victor W. Page. 121

Proceedings of the American Society for Testing Materials for 1920 61

Welding Encyclopedia. L. B. McKenzie and H. S. Card 121
Welding Methods, Modern. Victor W. Page. 121

THE BOILER MAKER

JANUARY, 1921

A Revolution in Marine Boiler Construction

Electric Welding on New British Boiler Effects Saving in Time and Materials Used in Construction

BY FRANCIS BUTT-GOW

At the St. Peter's works of Messrs. R. & W. Hawthorn Leslie & Company, Limited, Newcastle-on-Tyne, a boiler has been built on entirely new principles. This boiler, which is known as the Hawthorn-Wyber has been under steam for over seven months with most satisfactory results. It has been tested to 360 pounds hydrostatic pressure and 180 pounds steam pressure to the satisfaction of Lloyd's, British Corporation and Bureau Veritas.

The construction of this boiler, which will be called the grooved-shell type for convenience, as distinguished from the ordinary marine boiler, which is constructed of flanged and riveted end plates, is as follows:

The back and front ends are in two plates. The cross seams are lapped, requiring two separate grooves in the boiler shell plate. The length required for the outside groove, Fig. 2, of the boiler shell plate is the circumferential length of the top end plate; the length required for the inside groove of the boiler shell plate is the circumferential length of the bottom end plate. The front end top plate and the back end top plate fit in the outside groove on the boiler shell.

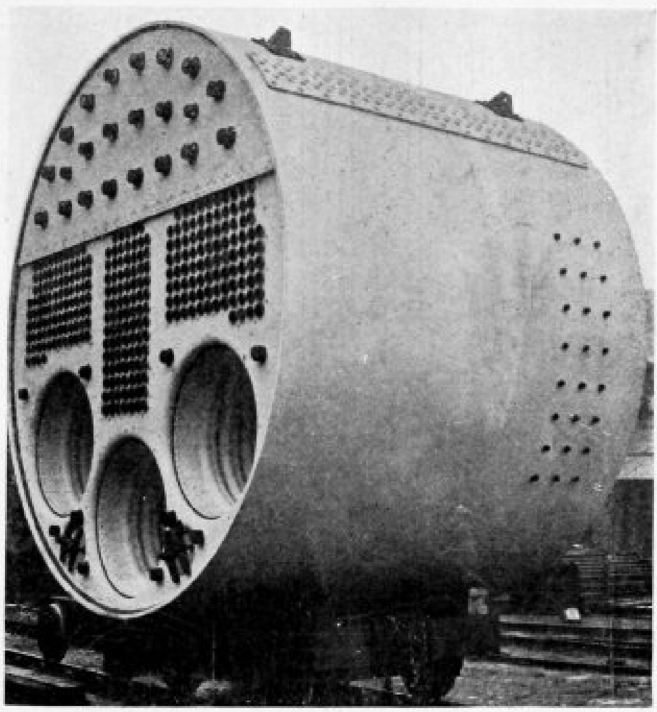


Fig. 1.—Scotch Marine Boiler With Welded Heads

The depth of the groove in the boiler shell is such that the strength of the plate is not less than that of the circumferential seams of the riveted flange boiler. The width of the bottom of the groove in the shell plate is 1/8 inch wider than the thickness of the end plate, with 1/2-inch bevel at the top of the groove. This enables the welder to get a solid body of metal between the front wall of the groove and the end plate, thus avoiding any outward movement from internal pressure. The welding inside the boiler is only intended to prevent water getting between the end plates and the shell plates and causing corrosion. These grooves are machined on a plate edge planer, while the shell plate is in the flat. The shell plate is afterwards rolled ready for the end plates.

The end plates are turned to the circumferential length at the bottom of the groove in the boiler shell, less 1/16-inch clearance all around. The cross seam of the back end plate is hydraulically riveted before turning to size. The front end plate is only bolted with tight fitting back bolts while turning to size, as later on this end has to fit the boiler shell in two separate plates.

Preparing the End Plates

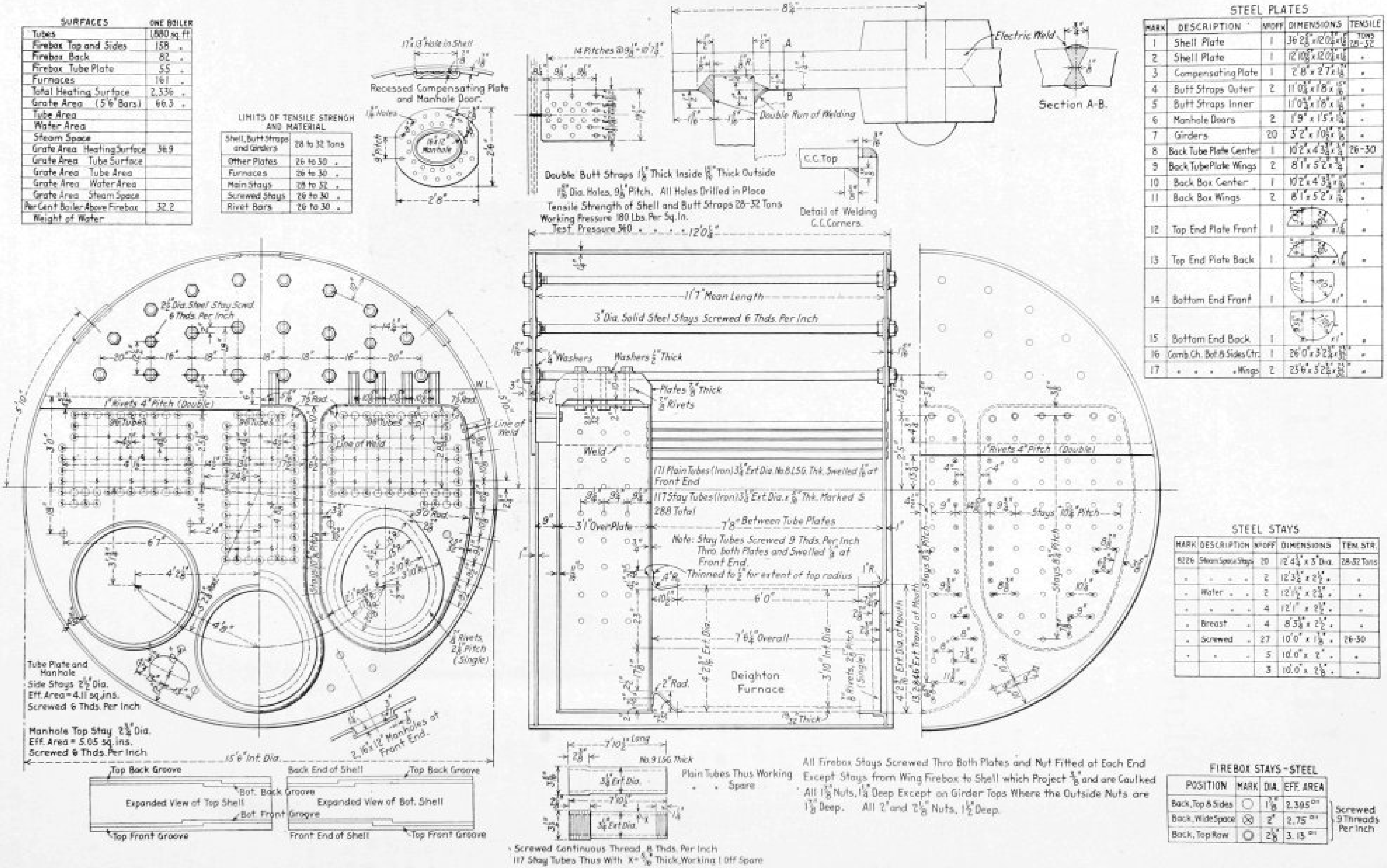
If it were possible to get a plate large enough, the back end could be fitted in one plate. The front end, however, as will be seen later on, must be in two plates. The end plates are turned to the required diameter on a machine with a revolving table, which has a capacity up to 20 feet diameter. The back end plate is now laid on two blocks about 12 inches above the floor level; the shell plates are lifted into position and the inner wall of the groove in the shell allowed to seat on the boiler end plate as shown, Fig. 6. The two shell plates are then secured by service plates, making use of the butt strap holes in the shell for this purpose, and the butts of the shell plates drawn close together.

The butts of the shell plates are next welded both inside and out for about 8 inches on both ends of the boiler, so that the weld will be at least 2 inches under the butt straps proper at the butt of the plates. The service plates are then removed, and the butt straps bolted up inside and outside of the boiler shell.

Back End Plate Spot Welded to Shell

The back end plate is now ready to be spot welded to the boiler shell. To guard against expansion circumferentially, this is done in 8 places equally divided over the circumference of the inside of the shell, Fig. 7. The boiler is now turned back end up, and the butt straps riveted on the shell with the hydraulic riveter. After the butt straps are finished the back end plate is welded to the shell inside and outside simultaneously, the shell being horizontal during this operation.

While this is being done, the combustion chambers are also under way. The wrapper plate is then bent to template and the horizontal seam electrically welded. The edges of the back tube plate and the combustion chamber back are machined to the inside size of the rebate on the wrapper plate,



SURFACES

SURFACES	ONE BOILER
Tubes	1,880 sq ft
Firebox Top and Sides	158 "
Firebox Back	82 "
Firebox Tube Plate	55 "
Furnaces	161 "
Total Heating Surface	2,336 "
Grate Area (5'6" Bars)	66.3 "
Tube Area	
Water Area	
Steam Space	
Grate Area Heating Surface	36.9
Grate Area Tube Surface	
Grate Area Tube Area	
Grate Area Water Area	
Grate Area Steam Space	
Per Cent Boiler Above Firebox	32.2
Weight of Water	

LIMITS OF TENSILE STRENGH AND MATERIAL

Shell, Butt Straps and Girders	28 to 32 Tons
Other Plates	26 to 30 "
Furnaces	26 to 30 "
Main Stays	28 to 32 "
Screwed Stays	26 to 30 "
Rivet Bars	26 to 30 "

STEEL PLATES

MARK	DESCRIPTION	Nº OFF	DIMENSIONS	TENSILE
1	Shell Plate	1	36'2[illegible]" x 12'0[illegible]" x 1[illegible]"	TONS 28-32
2	Shell Plate	1	12'10[illegible]" x 12'0[illegible]" x 1[illegible]"	"
3	Compensating Plate	1	2'8" x 2'7" x 1[illegible]"	"
4	Butt Straps Outer	2	11'0[illegible]" x 18" x $\frac{15}{16}$"	"
5	Butt Straps Inner		11'0[illegible]" x 18" x 1[illegible]"	"
6	Manhole Doors	2	1'9" x 1'5" x 1$\frac{1}{4}$"	"
7	Girders	20	3'2" x 10[illegible]" x [illegible]"	"
8	Back Tube Plate Center	1	10'2" x 4'3[illegible]" x [illegible]"	26-30
9	Back Tube Plate Wings	2	8'1" x 5'2" x $\frac{3}{4}$"	"
10	Back Box Center	1	10'2" x 4'3[illegible]" x [illegible]"	"
11	Back Box Wings	2	8'1" x 5'2" x [illegible]"	"
12	Top End Plate Front	1	[illegible]	"
13	Top End Plate Back	1	[illegible]	"
14	Bottom End Front	1	[illegible]	"
15	Bottom End Back	1	[illegible]	"
16	Comb. Ch. Bot. & Sides Ctr.	1	26'0" x 3'2[illegible]" x [illegible]"	"
17	" " " " Wings	2	25'6" x 3'2[illegible]" x [illegible]"	"

STEEL STAYS

MARK	DESCRIPTION	Nº OFF	DIMENSIONS	TEN. STR.
8226	Steam Space Stays	20	12'4$\frac{1}{4}$" x 3" Dia.	28-32 Tons
"	" " "	2	12'3$\frac{1}{2}$" x 2$\frac{1}{2}$" "	"
"	Water " "	2	12'0$\frac{1}{2}$" x 2$\frac{3}{4}$" "	"
"	" " "	4	12'1" x 2$\frac{1}{2}$" "	"
"	Breast "	4	8'3$\frac{5}{8}$" x 2$\frac{1}{2}$" "	"
"	Screwed "	27	10'0" x 1$\frac{7}{8}$" "	26-30
"	" "	5	10'0" x 2" "	"
		3	10'0" x 2$\frac{1}{8}$" "	"

FIREBOX STAYS-STEEL

POSITION	MARK	DIA.	EFF. AREA
Back, Top & Sides	○	1$\frac{7}{8}$"	2.395 □"
Back, Wide Space	⊗	2"	2.75 □"
Back, Top Row	◎	2$\frac{1}{8}$"	3.13 □"

Screwed 9 Threads Per Inch

Fig. 2.—Details of Construction of New Type Welded Boiler Approved by Lloyd's Survey

less 1/16 inch all around. The combustion chamber back plate is then fitted in place in the wrapper plate rebate, and the plates tacked together at intervals by spot welding, the

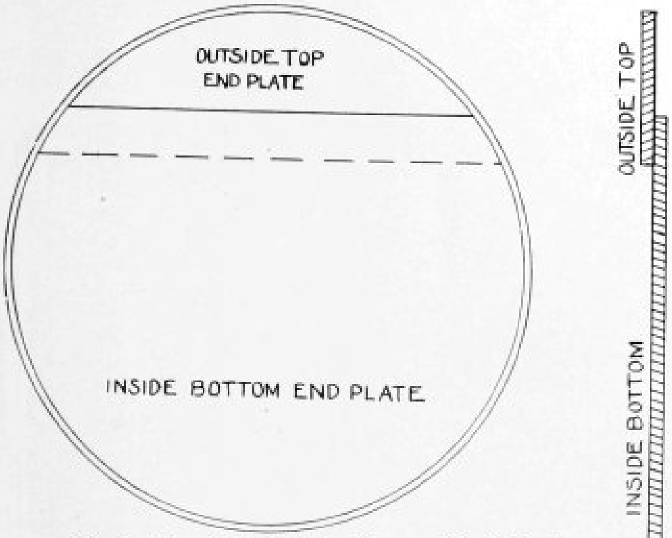


Fig. 3.—Two Plates Used in Front and Back Head

back being afterwards welded all around the inside and outside of the combustion chamber.

In this boiler we have three furnaces with Gourlay ends. The back end flanges of the furnace are now riveted to the back tube plates, the edges of the back tube plates having

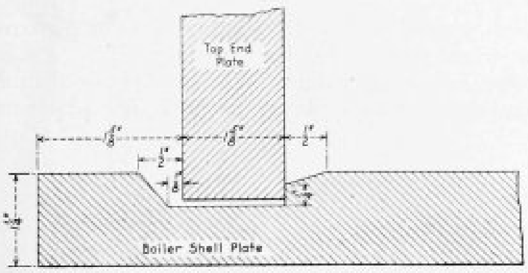


Fig. 4.—Detail of Groove in Shell

been previously machined to fit the rebates in the front end of the wrapper plates. In welding the back tube plates to the wrapper plates, the process is the same as in the case of the combustion chamber back plates, already outlined. The welding of the three combustion chambers being now completed, they are secured together with the intermediate partition water space screw stays.

Having completed the welding on the inside of the boiler back plate to the shell, the full set of combustion chambers with furnaces attached, is now lifted into the boiler shell and secured temporarily against the inside of the back end plate, thus giving the welder room to work inside the boiler front plate.

The front end being ready, the tack bolts are taken out of the cross seam, and the top and bottom plates separated. The bottom front plate is then placed in the inner groove of the boiler shell, there being sufficient spring in the boiler shell, when lying horizontal to allow the plate to enter the groove in the shell plate quite freely. The top plate of the boiler front is then slid into place in the outer groove, care being taken to fair the rivet holes.

The front now being in place, the cross seam is riveted by hand. After spot welding as was done with the back end plate, the front plate is welded all around inside and out. When the front is completed, the furnaces are passed through the furnace mouths, drilled and riveted, the boiler stayed and tubed and hydraulically tested.

The dimensions of the boiler are as follows:

Internal diameter, 15 feet 6 inches.

Mean length, 11 feet 6 inches.

Three Gourlay-Deignton corrugated furnaces; furnace mouth outside diameter 4 feet 2 9/16 inches.

Working pressure, 180 pounds per square inch.

There are 480 feet of welding required in a boiler of this size. One good welder should do all that is required in about 6 weeks; by employing 6 or 7, a boiler can be welded in a week. The cost of the electrodes used on the grooved boiler should about equal the cost of the rivets used in a flanged boiler. The difference in weight of the boiler plate required is very little in similar sized boilers, although larger diameter end plates and larger back tube plates and combustion chamber back plates are required on a flanged shell boiler, for the required depth of flange.

Improved Radial Combustion Chamber Top

The radial crown of the combustion chamber top gives full access to the gases radiating on the top of the combustion chamber by not being blanketed in the upper corners. The water inside the boiler circulates more freely over the radial crown, thereby securing a greater evaporation which compensates for any loss of heating surface caused by dispensing with the tubes in the top corners of the flat combustion chamber top, and this without increasing the height of the chamber or increasing the diameter of the boiler.

The tops of the radial crowns are more easily cleaned because of the absence of girder stays, so that greater heating efficiency is obtained. Saving of time and material together with labor are possible by dispensing with the square or small radial corners on the top of the back tube plates and combustion chamber back plates. This type of construction also effects a saving in materials for girder stays and girder bolts, as well as in the time and labor of shaping, drilling, tapping and fitting girder stays in position.

The drilling, tapping and fitting of the two top wing rows of water space stays in combustion chamber sides are also eliminated.

A longer boiler shell plate is required in a grooved boiler to allow the end plates to fit into the groove, and to allow for a

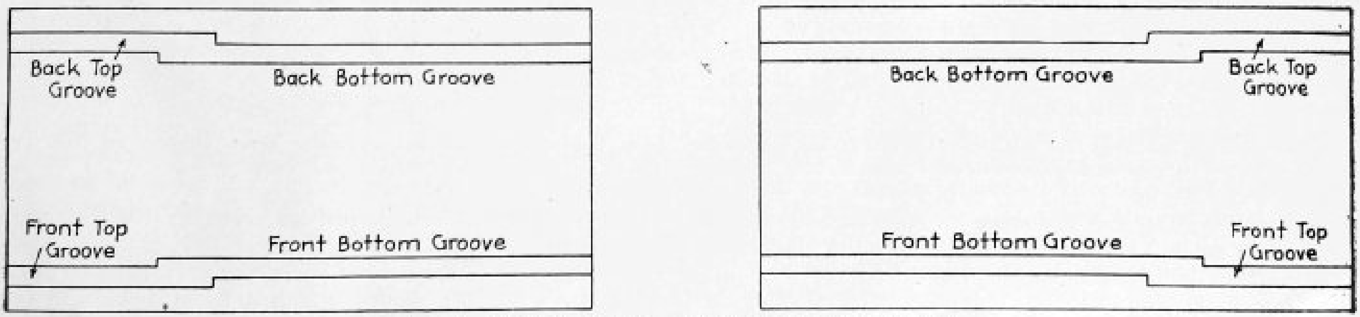


Fig. 5.—Expanded Views of Bottom and Top of Shell

landing edge. The same applies to the combustion chamber wrapper plates.

Comparison of Structural Work on Grooved and Flanged Boilers

For comparison as regards the work required on the two classes of boilers, an outline of the construction of a flanged boiler is given below:

For example in a boiler shop turning out one boiler per week, all the working plant is required to meet this output. The hydraulic flanging machine, the plate-heating furnace, and flanging fires work one week on flanging, leveling and annealing the boiler end plates, combustion chamber and back end tube plates, as well as jointing the corners of the flanged back and front end plates for this one boiler.

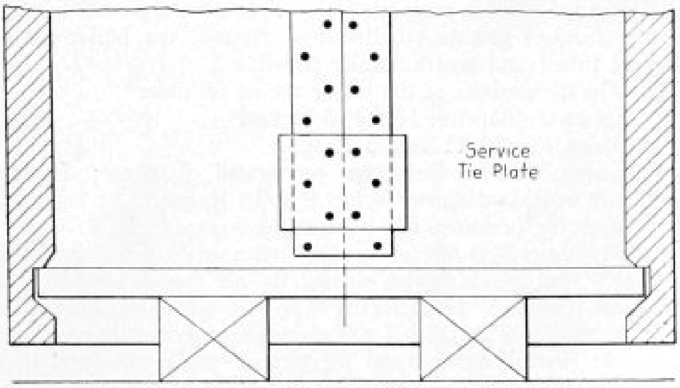


Fig. 6.—Method of Seating Shell on End Plate

On the Hawthorn-Wyber boiler one week's labor per boiler is saved on flanging, leveling, annealing, and jointing. The saving in coal consumption would be at least 20 tons per week, in addition to about 7 tons of coke.

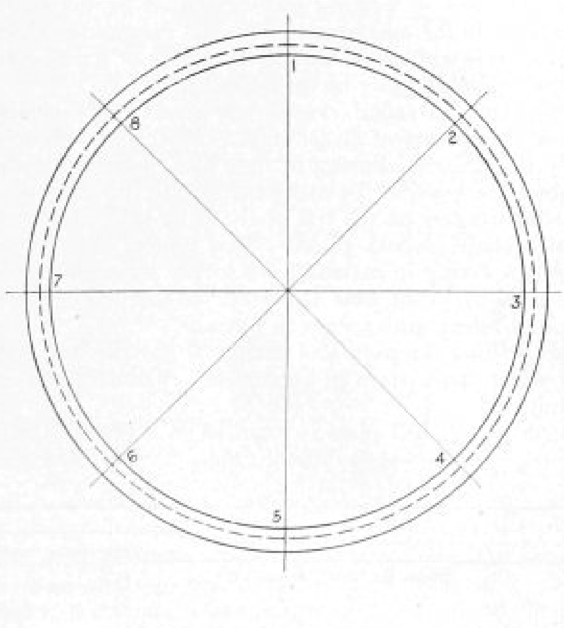


Fig. 7.—Dividing the Shell Into Small Sections to Provide Against Expansion During Welding Process

In a flanged boiler of this size (15 feet 6 inches), there are 290 rivet holes, 15/16 inch diameter to be drilled through the double ply of plate at each end of the boiler.

After drilling and countersinking around the boiler shell, the flanged end plates are taken out of the boiler and separated, the rivet holes cleaned in the shell and end plates, and the flanged landing edges planed on the end plates. They are then reassembled and the back end plate cross seams hydraulically riveted. The back end plate is now bolted up with the shell ready for hydraulic riveting.

None of the work described above is required on a grooved shell boiler. The flanged end boiler is taken to the hydraulic riveter, and the back end plate riveted in the boiler shell. The front end is usually riveted by hand with 3 or 4 squads of riveters. Both ends of the boiler are then calked inside and out.

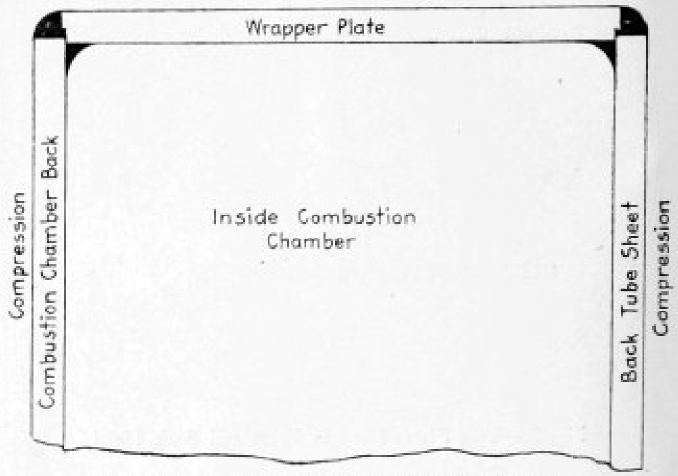


Fig. 8.—Welding the Wrapper Sheet in Place

These operations are all eliminated in the grooved type boiler, where welding has been used.

A similar saving of time and labor is obtained in the combustion chamber back plates and back tube plates on flanging, leveling, annealing, drilling, riveting (340 rivets in each combustion chamber) and assembling.

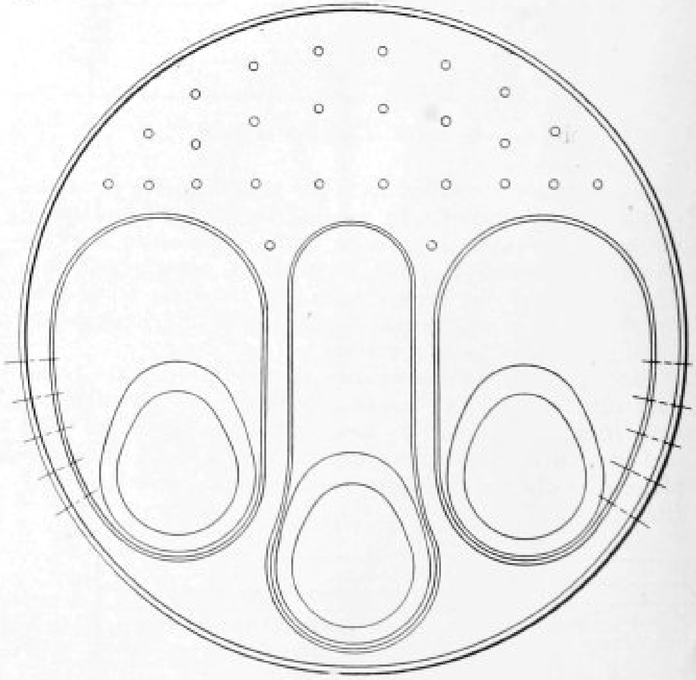


Fig. 9.—Improved Combustion Chamber Top as Designed for New Type Welded Boiler Construction

In all cases of the flanged boiler, the work must be assembled twice; that is bolted up, then taken down and later reassembled.

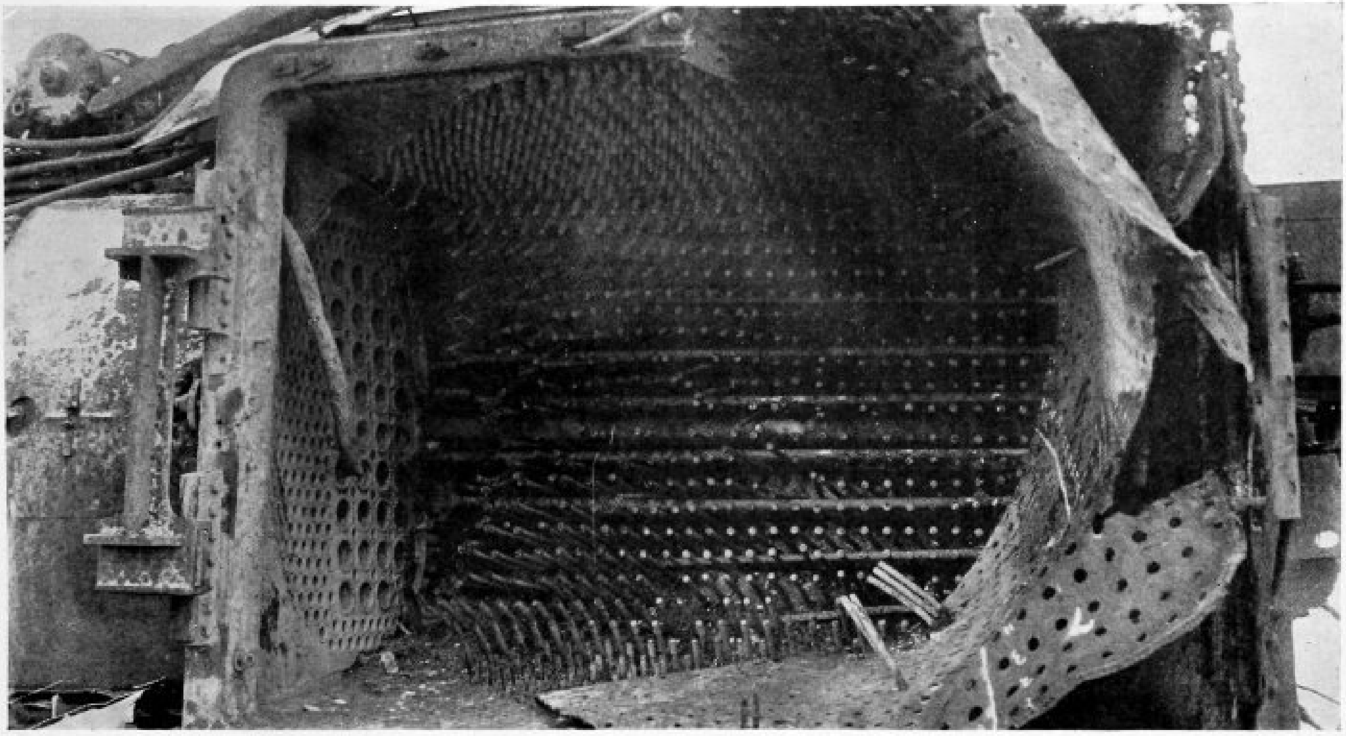


Fig. 1.—Typical Crown Sheet Failure Caused by Low Water

Bureau of Locomotive Inspection Report

Number of Locomotive Accidents Due to Failure of Boilers and Appurtenances Shows Decrease

BY A. G. PACK*

The outstanding feature of the report of the chief inspector of locomotives to the Interstate Commerce Commission for the fiscal year ending June 30, 1920, is the increase in the number of accidents and casualties resulting from failures of parts of locomotives and tenders. Although the percentage of locomotives inspected which were found defective decreased from 58 percent in 1919 to 52 percent in 1920, the number of accidents increased 49 percent, the number killed 15 percent and the number injured 41 percent. A summary of the chief inspector's report is given below.

A summary of all accidents and casualties occuring during the fiscal year ended June 30, 1920, as compared with the year ended June 30, 1919, covering the entire locomotive and tender and all of their parts and appurtenances, shows an increase of 49 percent in the number of accidents, an increase of 16 percent in the number killed, and an increase of 42 percent in the number injured. This increase is due almost wholly to disregard for the requirements of the law and rules, as well as to safety of construction and operation. This is especially true with what are sometimes considered unimportant parts; for instance, 26 percent of the increase in accidents and injuries was due to failure of grate shakers; 10 percent was due to failure of reversing gear, and 10 percent to failure of squirt hose.

A summary of all accidents and casualties caused by failure of the boiler and its appurtenances only, for the fiscal year ended June 30, 1912 (the first year of the existence of the law), as compared with the year ended June 30, 1920, shows a decrease of 47 percent in the number of accidents, a decrease of 48 percent in the number killed, and a decrease of 49 percent in the number injured. These decreases are especially gratifying when considering the increased number of locomotives in service and the increased traffic being handled, together with the increased duties imposed on the inspectors by the amendment to the boiler inspection law, which extended their duties to the entire locomotive and tender and the parts and appurtenances thereof, which has added greatly to their work. These decreases demonstrate the wisdom of complying with the requirements of the law and rules, and the wisdom and foresight of its advocates when requesting its enactment.

As shown by Table 4, derailments due to defects in or failure of parts of the locomotive or tender have been the direct cause of a number of most serious accidents, and the loss of life and limb, as well as damaged property and have forcibly demonstrated the necessity for proper inspection and repair of the running gear, driving gear, and brake rigging.

During the year the inspectors of this bureau were called upon by the commission to perform various duties not in connection with their regular work, which materially reduced the number of locomotives shown inspected by them, as well as the number ordered out of service, and it appears that certain railroad officials and employees have taken advantage of their temporary absence and permitted locomotives to remain in service with serious defects, which would have been known to them had proper inspections been made and reports rendered as required.

It was found necessary to ask the courts to inflict the penalty provided in section 9 of the law, because of the defective condition in which locomotives were being operated by one

*Chief inspector, Bureau of Locomotive Inspection.

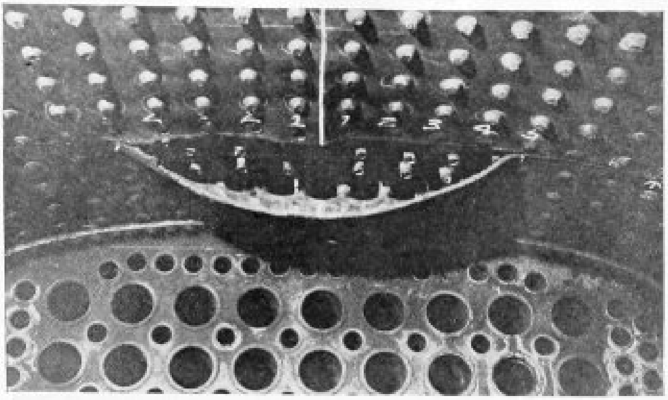


Fig. 2.—Combustion Chamber Crown Sheet Failure

carrier and its willful violation of the requirements of the law and rules. This case is now pending and is set for the October term of the court. It is evident that unless an immediate improvement is made by certain other carriers it will be necessary to file similar suits in the near future. That the law places the burden of proper inspection and repair and compliance with the rules of inspection on the carriers owning or operating the locomotives seems to have been lost sight of, and this is reflected in the increased number of accidents and casualties during the year.

In the last annual report attention was directed to certain violent explosions where the failure of seams united by the autogenous process was a strong contributing factor to the seriousness of the accident. During the year a number of accidents have been investigated where the autogenous welding failed with evident increasing fatal results, in view of which, and considering that the percentage of failures of such welds involved has not decreased, I am still of the opinion that such methods should not be applied on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which fully conforms to the requirements of the law and rules, nor in the so-called low water zone of a firebox, where overheating and failure are liable to occur. This should apply with equal force to all parts of the locomotive and tender subject to severe strains and shocks, where, through failure, accidents to employees and the traveling public might occur.

During the year 258 applications were filed for extension of time for the removal of flues, as provided in rule 10. Investigation showed that in 31 of these cases the condition of the locomotives was such that no extension could properly be granted. Twenty-five 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. Ten extensions were granted after defects disclosed by our investigation had been repaired. Thirty-seven applications were withdrawn for various reasons and the remaining 155 were granted for the full period requested.

As provided in rule 54, there were filed 1,680 specification cards and 5,584 alteration reports. These were carefully checked in order to determine whether the boilers represented were so constructed as to be in safe and proper condition for service, and that the stresses given had been correctly calculated.

The effective date of the requirements relative to the factor of safety for locomotive boilers, as fixed by the commission's order, has made necessary the strengthening of various parts of numerous boilers and a reduction in the working pressure on many of the older and weaker ones.

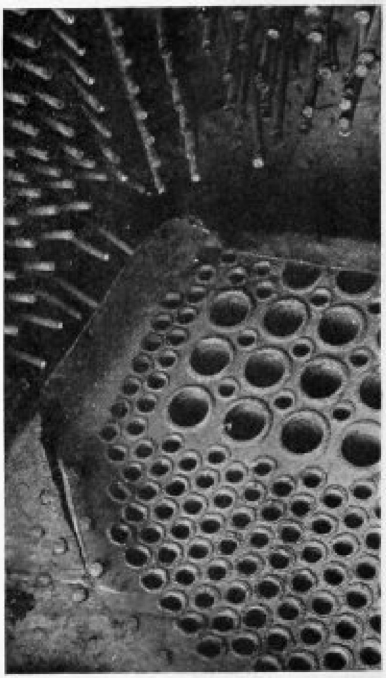


Fig. 3.—Seam Failure Probable Cause of Disastrous Explosion

During the year close attention was given to the equipping of locomotives with headlights that would meet the requirements of the commission's orders of December 26, 1916, and December 17, 1917, and reports indicate that on July 1 (the date fixed for full compliance with the requirements) practically all locomotives in service were equipped in accordance therewith. These lights are meeting with the hearty approval of employees and so far as we are able to learn of the officials in charge where the locomotives are in operation.

No formal appeal has been taken from the decision of any inspector, during the fiscal year, as provided in section 6 of the law, which again demonstrates the thoroughness and good judgment which characterizes their work.

The greater part of the annual report is given over to a review of investigations on water level indicating devices installed in locomotives. This report was published in detail in the September and October, 1920, issues of THE BOILER MAKER.

During the period of Federal control, the assistant director investigations were made at the request of the railroad administration, and reports furnished covering conditions found and action taken. In this and in other ways this bureau cooperated with the railroad administration during Federal control to the fullest extent consistent with the purpose of the law.

In accordance with the provisions of Section 7 of the act of February 17, 1911, amended March 4, 1915, which required, in addition to the annual report of the chief inspector, that he should make such recommendations for the betterment of the service as he might wish, the following recommendations are given for the improvement of the service:

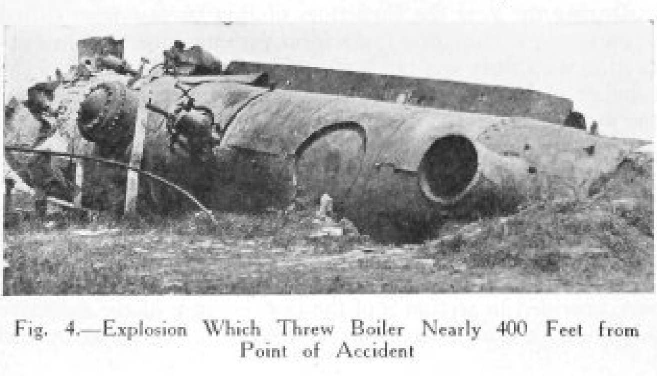


Fig. 4.—Explosion Which Threw Boiler Nearly 400 Feet from Point of Accident

Fig. 5.—Superheater Header and Units 600 Feet from Point of Explosion

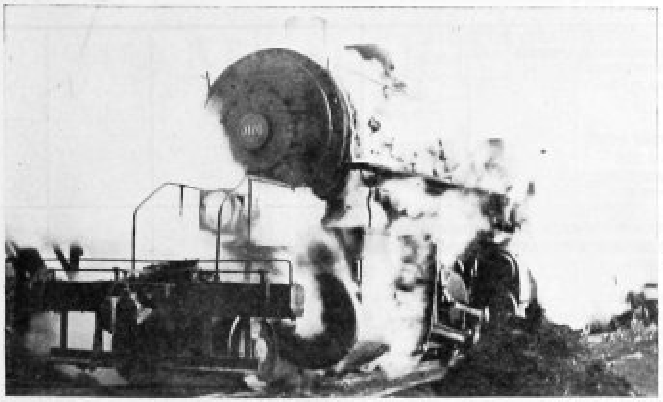


Fig. 6.—Locomotive With Excessive Steam Leaks Dangerous to Operate as Well as Uneconomical

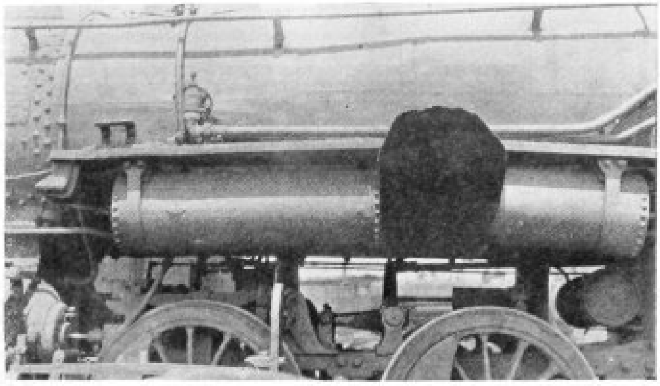


Fig. 7.—Main Air Reservoir Ruptured Where Metal Had Corroded to Nearly 1/32 Inch in Thickness

That the act of February 17, 1911, be amended so as to provide for additional inspectors, to be appointed by the commission, upon the recommendation of the chief inspector, 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 that the locomotives might be employed in moving traffic without unnecessary peril to life or limb, at which time there were approximately 63,000 locomotives in service coming under the jurisdiction of the law.

Since this act was established it has been amended, extending the authority of the chief inspector and his two assistants, together with all of the district inspectors, to cover the entire locomotive and tender and all of their appurtenances, and the number of locomotives in service has increased approximately 11 percent. With the extended duties of the inspectors and the increase in the number of locomotives in service it is impossible for the number 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 no doubt in the future, as in the immediate past, this bureau will be called on from time to time to assist in making many investigations necessary to fully carry out the requirements.

To be in position to do this it will be 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 in the service such inspectors it will be necessary to increase their salaries so as to be commensurate with the duties performed and the responsibilities carried. The absence of inspectors from their accustomed duties or the lack of sufficient number to fully cover the situation is soon reflected by the increased number of accidents and casualties and the deficiencies in the condition 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, upon the recommendation of the chief inspector, as the needs of the service develop, and so that adequate salaries may be paid to the inspectional force 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 in accordance with this.

That all locomotives not using oil for fuel have a mechanically operated firedoor, 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 firedoor, so that it may be conveniently operated by the person firing the locomotive.

This recommendation is based on the results of many investigations of boiler 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 firebox, many times being directed toward the firedoor.

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 steam and boiling water, with the contents of the firebox, 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 firebox, and with the firedoor necessarily open, under such circumstances it is impossible for it to be closed.

The automatic firedoor 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 firedoor 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 firedoor is also of great value in prevention of serious cracks and leaks in firebox sheets, by limiting the time firedoors are open when placing coal on the fire, thus reducing the amount of cold air admitted, which causes loss of temperature, 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.

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

Fig. 8.—Bottom Water Glass Cock Stopped Up Causing Incorrect Water Level Indication

Fig. 9.—Washout Plug Which Blew Out While Being Tightened Under Pressure

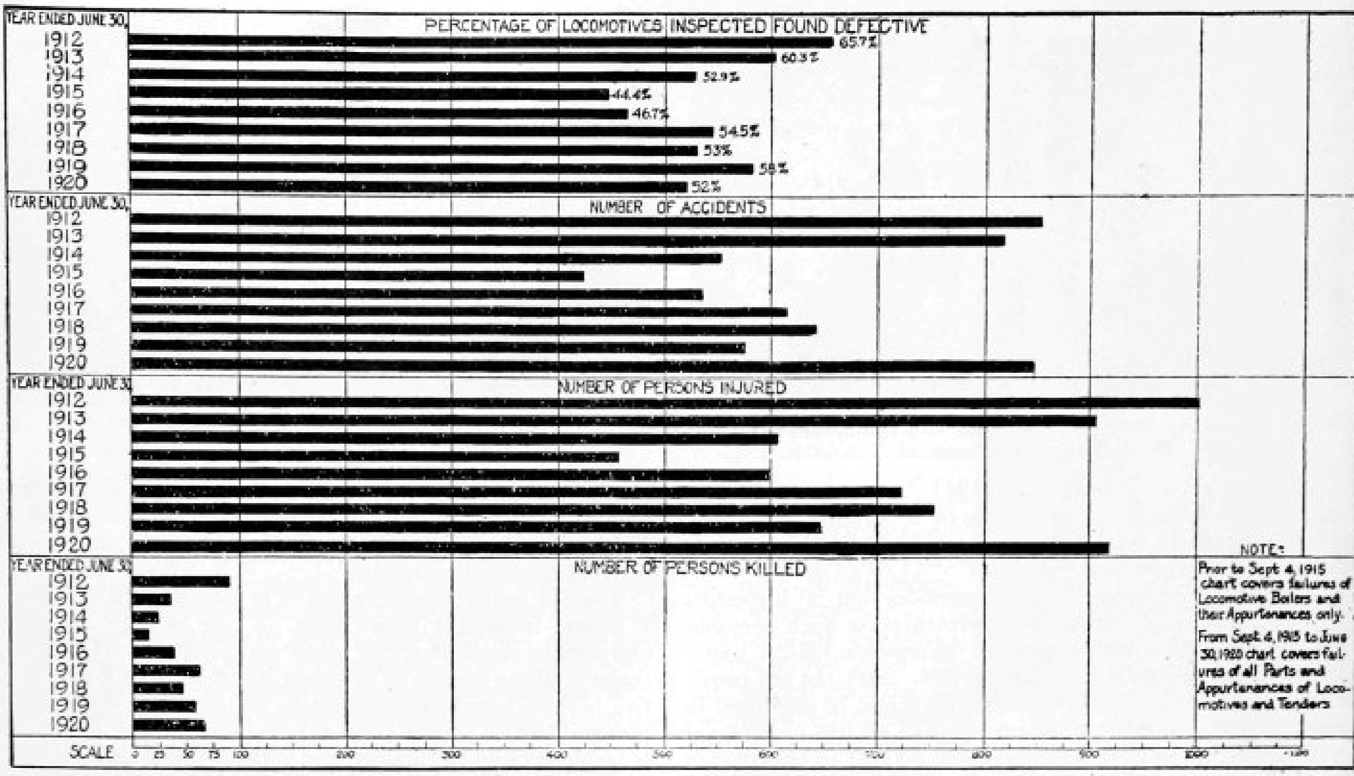


Fig. 10.—Graphic Summary of Results of Inspection and Accidents Due to Locomotive Failures, 1912-1920

apparent that it hardly requires further comment. We believe, however, that this is an appliance which is vital to the safety of the employees and general public at highways and other public places where the railroads traverse. 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.

That cabs of all locomotives not equipped with front doors 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.

That all locomotives where there is a different indication between the gage cock and water glass of two or more inches of the water level under any conditions of service be equipped with a suitable water column to which shall be attached three gage cocks and one water glass with not less than 6 inches, preferably 8 inches, clear reading, and one additional water glass with not less than 6 inches, preferably 8 inches, clear reading, located on the left side or back head of the boiler. The water glasses to 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 a corresponding level within 1 inch and be so located, constructed and maintained that the engineer and fireman may under all conditions of service have an easy and clear view of the water in the glass from their respective and proper positions in the cab. The gage cocks to be so located that they will be in easy reach of the engineer from his proper position in the cab while running the locomotive, extension handles to be applied if necessary to accomplish this.

All gage cocks to be supplied with suitable nipples that will direct their discharge into a properly located and constructed drain or dripper that will convey the discharging water to near the cab deck; nipples to be not less than ½ inch nor more than 1 inch above the top of the dripper or drain and kept in correct alinement.

Gage cocks and water glasses are now practically the universal method of gaging the water level in the boiler, and since the two devices located on the same boiler do not show a corresponding level under operating conditions, it is clear that one or the other must be incorrect, therefore misleading.

Investigations made by this bureau and a line of reasoning clearly establish the fact that gage cocks when applied directly in the boiler register incorrectly. It is very important that at least two devices, attached separately to the boiler, be employed for this purpose so as to form a double check and so as to have one appliance in case of failure of the other while on the road and away from points where repairs can be made.

Should other appliances than the column and glasses as recommended be invented which will safely and properly indicate the water level in the boiler, due consideration can be given them in lieu thereof.

J. P. Maloy, for about twenty-five years connected with the Lagonda Manufacturing Company, Springfield, Ohio, has recently formed the Chicago Engineering Company, of which he is the head.

Harry H. Bates has returned to the employ of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., in the stoker engineering department.

D. G. McMillan, formerly with the Williams Printing Company, New York City, as maintenance engineer, has been appointed power superintendent with the Willys Corporation at Elizabeth, N. J.

Metal Cutting Properties of Gases

BY PIERRE E. HAYNES*

The elements effecting the gases used both for welding and cutting metals are discussed in the accompanying article. Producers of commercial oxygen have carried out extensive investigations on the manner in which impurities interfere with the oxidation process of severing metals. A statement of the results of this experimental work should prove helpful in bringing about a clearer understanding of the operation of cutting and welding apparatus.

Only a year ago the published word of erstwhile authorities contained statements that cast iron could not be severed by the oxidation process. Three and one-half percent of carbon, the self-same material that furnishes the artificial heat of the world, prevented oxidation of iron. Why couldn't iron be oxidized in the presence of carbon, when carbon is more easily combustible than the iron itself? It seemed so simple that a simple answer was required. Cast iron, they said, melted below its temperature of ignition and freezing slag prevented the raising of the iron above its melting point. This explanation was so generally accepted that with a few exceptions no attempts were made to develop the art of cast-iron cutting.

Because it constitutes one of the major elements of the cost of steel cutting, and because it is one of the materials not prepared by the consumer himself, commercial cutters are prone to assign all variations in cutting cost or quality to the oxygen and in support of this contention, present cost determination and other data, which indicate the undesirability of nitrogen as an impurity. A recent writer points dramatically to the overwhelming cataclysm, which would result if nitrogen were combustible. "A lightning stroke," so he says, "would explode the beneficent atmosphere surrounding the earth." While not recommending nitrogen as a commercial fuel, one must remark that every lightning stroke does form nitric acid, and deposits of nitrates at favored spots on the earth's surface, indicate that in the aggregate, large amounts of nitrogen are being burned. Not to be outdone by nature, our Norwegian friends draw lightning strokes from waterfalls, for the purpose of burning nitrogen to form the world's most valuable acid.

> The art of severing metal by oxidation is not yet twenty years old, and it has been stated that our knowledge of the subject is quite complete and comprehensible. Its companion, the art of welding, is several thousand years old, and its first practice has marked the birth of every civilization on the face of this planet. Who will venture that with all this ancient development and modern research, the world's knowledge of welding is complete and comprehensible, not to say simple!
>
> The art of severing metal by oxidation is in its infancy. We know we can cut some metals because it is being done, but the exact mechanism of cutting is not yet well understood. PIERRE E. HAYNES.

With respect to burning or combustibility, nitrogen differs from iron in measure only, and as a matter of fact, the difference is the same for practically all substances. Some substances burst into flame immediately upon exposure to air or oxygen while others like wood usually require a flame for kindling. Iron kindles in oxygen at red heat, while a mixture of acetylene and oxygen may be ignited by allowing it to impinge on iron below its temperature of incandescence. The kindling temperature of nitrogen is high, but what careful observer has failed to detect the odor of nitric acid, where steel cutting is being performed?

Oxygen is not satisfied with its ability to successfully attack its neighbors and form new substances. This aristocratic gas combines with itself and forms ozone, king of oxidizers. That it combines with itself is proven by the fact that three volumes of oxygen form only two volumes of ozone. The unmistakable odor is usually present, wherever oxy-acetylene cutting is being performed. Whether it enters into the actual process of cutting has never been determined. The fact remains that oxygen combines with itself with a negative heat of combustion.

Essentials of Flame-Cutting Process

Stripped to known facts, the process of flame cutting of steel consists of the elevation of some spot to the kindling temperature, the application of oxygen and the progressive direction of the oxidizing jet along the desired path. The requirements are:

1. A preheating flame hot enough to bring the iron to its ignition point without delay.
2. The intelligent adjustment and direction of the cutting appliances to maintain highest efficiency and results of desirable quality.
3. Oxygen of a suitable quality and at the correct pressure and jet velocity.

A wide range of fuels may be found to meet the first requirement, although the use of poorer fuels usually results in a greater expense for oxygen and labor.

The personal element is by far the most important in the determination of the cost of cutting. A 12 percent variation in cutting cost, with all other conditions constant, would be considered excellent from the standpoint of reproducibility; and a 20 percent variation is not at all uncommon for workers under ordinary observation.

Regulation of Pressure and Jet Velocity of Oxygen

The pressure and jet velocity of the oxygen are important because they determine the amount of iron oxidized, and the cleanliness and dispatch with which the molten oxides are removed. They are matters of torch design and adjustment. Authorities seem to agree fairly well regarding these points, but disagree with regard to the effect of the various impurities found in the commercial oxygen. Proponents of the use of electrolytic oxygen insist that regardless of the nature of the impurities, the small difference in the quality of commercial oxygen is an effective element in the cost of cutting steel, and that at even purity, electrolytic oxygen is superior to liquid air oxygen because of the combustibility of hydrogen and certain alleged villainous qualities of nitrogen.

It has been stated that the impurities in liquid air oxygen suffer a much greater quantitative variation than those in electrolytic gas. While not able to speak for the whole oxygen industry, I believe that I am safe in saying that there is nothing inherent in any of the so-called liquefaction pro-

* Chief chemist, Linde Air Products Company; consulting chemist, Union Carbide and Carbon Corporation.

cesses that would prevent the limit of variations to much smaller values than those referred to. The purity of all commercial oxygen has been improved greatly in the last few years, electrolytic oxygen manufacturers being forced to increase their purity because of the inherent risk in the compression of oxygen containing hydrogen. This risk is still present and, although in much lesser degree, will always be a potential one until machines and men are rendered perfect. The cost of producing a reliably safe product is reflected in the greater cost of production of electrolytic oxygen to which attention has been frequently called.

In one of the recent articles considerable stress is laid on the advantage of electrolytic oxygen over liquid air oxygen because of the absence of nitrogen. The total absence of any impurity other than hydrogen is accounted for by the fact that electrolytic oxygen is made from distilled water. It would be impossible to state the total amount of electrolytic oxygen made by the use of distilled water, but inasmuch as good filtered water has been found satisfactory it is doubtful if the use of distilled water is general. The statement that electrolytic oxygen is made from distilled water is, however, in error since it is necessary to add some substance to make the water conduct the electric current. Commercial caustic soda is usually used for this purpose, and unless the soda is fairly pure there is some danger of pollution of the products. Impurities originating from the water or electrolyte are of relatively no importance, however, except for gases dissolved in the water, which are sure to appear in the oxygen.

Careful analyses of electrolytic oxygen always disclose from 0.1 percent to 0.3 percent of nitrogen, which may come from the gases dissolved in the electrolyte or may diffuse into the cylinder, which stands empty with the valve open. Regardless of the source, this small amount of nitrogen seems always to be present. On the other hand the impurity of liquid air oxygen consists of nitrogen and argon—not nitrogen alone.

If oxygen impurities are to be considered in the light of cooling agents, we must consider them from the standpoint of their percentage by weight and not volume. On this basis nitrogen is approximately 50 percent by weight of the impurity of electrolytic oxygen and 60 percent by weight of the impurity of liquid air oxygen. Argon, because of its low specific heat, is much more desirable than either hydrogen or nitrogen. As a cooling agent hydrogen stands out as a notorious offender, its specific capacity for the conduction of heat being approximately six times that of any other gases in the flame.

As proof of these statements, theoretical calculations of the temperatures of the inner cones of oxyacetylene flames have been made using electrolytic and liquid air oxygen at various concentrations.

Flame Temperature	*Degrees Centigrade Absolute*		
	98 Percent	99 Percent	99.5 Percent
Liquid Air Oxygen.......	5040	5050	5060
Electrolytic Oxygen......	5035	5048	5060

In the calculation of the above, the nitrogen impurity of electrolytic oxygen was maintained constant at 0.2 percent (an average experimental value) in order to indicate that as hydrogen was eliminated, the flame temperature of liquid air oxygen was approached. The percentages of the argon and nitrogen in liquid air oxygen were the amounts found in actual practice. The above values do not include the effect of the higher heat conductivity of hydrogen.

In practice, the above differences in flame temperatures would never be detected. They are given for the purpose of showing that small as the effect may be they are unfavorable to the electrolytic oxygen.

If we argue that the heat yielded by the combustion of hydrogen is of value we again find ourselves up against a similar condition. If we try to find the effect in the preheating flame we learn that acetylene has at least 4 times the net or low heating value of an equal volume of hydrogen so that the heat added to the flame by 1 percent of hydrogen impurity is:

$$.01 \times .25 = .0025 = \tfrac{1}{4} \text{ of 1 percent}$$

In addition to this it has been determined that the preheating flame supplies less than 30 percent of the total heat available in cutting, the balance coming from the combustion of the iron. The effect of the hydrogen impurity is therefore further reduced to at least

$$.30 \times .0025 = .00075 \text{ or } \frac{75}{1000} \text{ of 1 percent}$$

What reputable engineer will risk his good name by assigning commercial advantage in a technical process to the addition of less than 1/10 of 1 percent of the available heat?

Effect of Heating Oxygen

Let us then turn to the contention that the nitrogen expands and dilutes the oxygen. In the first place all gases have the same coefficient of expansion with heat and it is absolutely impossible to change the oxygen percentage in a mixture by heating it. The oxygen expands at the same rate as the impurities and no change in the constituency is possible. On the other hand, expansion (or dilution) of the oxygen would take place if the gas were perfectly pure because any gas expands to larger volume when heated at constant pressure.

And what becomes of the much to be desired hydrogen impurity as it passes through the flame to be burned in the outer envelope? Has it not also expanded with heat; does it not also occupy space; has it not absorbed heat? In fact is there any undesirable attribute that nitrogen has which is not also possessed by hydrogen in the same or greater degree. Only one real advantage is claimed and that is the fuel value of the hydrogen, but this quantity is ridiculously small and negligible for all purposes.

Certain peculiar properties claimed for nitrogen by a recent writer include that of being expanded by heat in such a way that cooling of the nitrogen results. A student observing experiments with liquid air for the first time and being much impressed by the evolution of vapor at such low temperatures, exclaimed,—

"It's so hot it's cold."

So with our friend's nitrogen impurity,—it is hot because it is cold and vice versa.

Causes of Hardness in Steel

It seems almost impossible that claims for surface hardening on account of a nitrogen impurity in the oxygen will be accepted generally. In the first place the hardening of steel is controlled almost entirely by its carbon content and rate of cooling. If, as is claimed, nitrogen containing oxygen cuts slower than that containing hydrogen, it appears reasonable to expect that the slower operation will give the slower cooling and result in softer surfaces. In addition we must not forget that the oxygen jet aspirates large amounts of air into the kerf, and that the hot surface of the metal almost invariably cools in a bath of air so that the nitrogen in the flame from the liquid air oxygen is a small percent of the total nitrogen. This same set of conditions will also be found with the use of electrolytic oxygen. The preponderance of atmospheric nitrogen renders the fractional effect of the oxygen impurity negligible.

The question of surface hardness has not been raised previously except in connection with the use of hydrogen as a fuel instead of a hydrocarbon gas. It was claimed that hydrogen used as fuel produced a steel surface free from carbonization. At first glance the statement appeared logical, but a casual analysis showed that the steel burned in the process of separation yielded sufficient carbon to account for the maximum carbonization found. A microscopic examination of surfaces cut with acetylene and hydrogen used separately as fuels failed to discover any appreciable difference in the amount of carbonization.

The carbon contents of the samples before cutting were less than 0.2 percent, and after cutting it was found that a thin layer of metal on the cut surfaces had had their carbon contents increased to 0.9 percent or greater. Carbon had been added in the case of the oxy-hydrogen cut as well as that of oxy-acetylene. In the case of the oxy-hydrogen cut, the only source of carbon was the steel and the amount of carbon added was fully as great as in the case of the oxy-acetylene cut. It would be grossly unfair to insist that acetylene is a source of carbonization when the use of a no-carbon fuel results in carbonization. The carbonization was a result of the avidity of molten steel for the carbon in adjacent burning steel; the origin was the same in both cases.

Efficiency of Cutting Flame

The cutting of steel is approximately 70 percent efficient or in other words the oxygen required to burn all the iron removed to oxide is about 70 percent of that usually used. It is physically impossible to obtain complete mixing of iron and oxygen in the small time allowed in the kerf so that there will always be some oxygen and some iron uncombined. It is quite improbable that the conditions of theoretically perfect cutting will be approached closely and the possible increase in cutting efficiency is less than the advantages extravagantly claimed for some apparatus and materials. As competition grows keener and materials and apparatus approach perfection, differences will be smaller and more difficult to detect. The inability to disprove extravagant claims must not be confused with absolute proof that they are correct. Not only must experimental data be carefully studied but it must be considered in a rational, reasonable manner, free from bias and devoid of that amateurish enthusiasm, which is generally present where new and interesting lines of investigation are being opened up.

Upon the shoulders of the engineering profession is a great responsibility. The great complication of our industrial life demands interpreters who, not only comprehend the facts, but sense the value of a true and accurate translation of them into terms generally understood. This is one of the functions of the engineer—the rational interpretation of technical information in the light of fundamental scientific principles.

How the A. S. M. E. Boiler Code Works in Ohio

Out of about 20,000 boilers in use in the state of Ohio there were but three explosions in the fiscal year ended June 30, 1920. The cause of failure in one of these cases was the punching and drifting of rivet holes in the construction of the boiler. This practice was permitted at the time this boiler was built, but has since been prohibited in Ohio. Another explosion was due also to careless construction, made possible by incorrect design. The Ohio Board of Boiler Rules is taking steps toward the elimination of this particular type of boiler by the reduction of its safe working pressure. A third explosion resulted from the use of a boiler that had not been inspected and was used in violation of the Ohio boiler inspection law. If this boiler had been properly inspected, safety devices would have been insisted upon that would have prevented the explosion.

These facts are set forth in the annual report of the division of boiler inspection of the Industrial Commission of Ohio. It may be mentioned in this connection that the state of Ohio has adopted the A. S. M. E. Boiler Code and has made it a part of its boiler inspection laws.—*Power.*

When a Contract Isn't a Contract

BY EDWIN L. SEABROOK

There are frequently cases where business men fall into the error of thinking they have a contract when they have not, and the other party cannot be held responsible, however reliable he may be. Merchandise is offered someone on certain terms and he agrees to take it, provided the terms are changed a little or something else is done. Many business men have the idea that under such circumstances the seller is under obligation to refuse the new condition if he does not wish to agree to it. If the seller is silent they think he is bound to accept it. There is nothing at all to such a view. If a new condition is added or imposed by the buyer, the seller need pay no attention whatever to it.

A case of this was recently decided which shows that the buyer cannot hold the seller to a contract unless it is a contract. It is one of the cases where a man thought or believed he had a contract when he actually had none. It so happened that the seller offered in writing to furnish a certain article at so much per ton. The one to whom the proposition was made was asked to sign his acceptance and return it so that both parties would have a complete copy of the transaction.

The party who wished to buy received the offer, signed it, but added these words: "Buyer's weights to govern settlement." This form of acceptance was communicated by a letter calling attention to the change and expressing the hope that it would be acceptable. The seller received the communication, made no reply and did not deliver the goods. The buyer demanded delivery, and after waiting a reasonable time went out into the open market, bought at a higher price because the prices had materially advanced in the meantime and sued for the difference. A lower court decided against the seller, but the court of appeal reversed this decision.

This case was decided on the theory that when the buyer returned the seller's offer with the stipulation "Buyer's weights to govern settlement" he did not accept the offer at all. He did what was equivalent to making a counter offer which the seller did not accept. There was, therefore, no contract and no obligation on the part of the seller to make delivery. The court in deciding said:

"The contention of the buyer, as we understand it, is that under the circumstances the seller was bound to make some answer to his communication, and the failure to do so amounted to his consent. We are clearly of the opinion that the seller was not under any duty to make an answer to the communication and he was not bound by his silence."

Business men should pay particular attention to this because there are buyers (also sellers) who give offers in writing leaving the way open to a complete repudiation of the contract by the seller (or buyer) by adding some new condition which is not in accordance with the offer. If the seller (or buyer) does not explicitly accept these in the offer or condition, which should always be in writing if the other part of the contract is in writing, there is no contract and the seller (or buyer), as the case may be, is not under obligation to do anything if he does not wish to.

If any change is suggested in any offer made for buying or selling merchandise, get the acceptance of the other party to it in writing.

Elementary Mechanics for Boiler Makers*

Method of Determining the Composition and Resolution of Forces—Applying Force Diagram to Boiler Design

BY WILLIAM C. STROTT†

Having thus evolved a simple explanation of the meaning of the terms "force" and "reaction" in a previous chapter, we shall now delve deeper into the subject of composition and resolution of forces.

In Fig. 7 (a) we encounter a condition somewhat similar to that which was shown in Fig. 1.

Here we have two forces of 500 pounds each acting in *different* directions on a given point, and it should be readily seen that if the point be considered as free it would move vertically downwards on a line bisecting angle *a* which the directions of motion of the two forces make with each other. This is true because the forces are symmetrically applied and of equal magnitude, hence what one force tends to deflect from the horizontal direction is equally and oppositely compensated for by the other force. Therefore to hold two such forces in equilibrium a force would have to be applied to the body equal in magnitude to the resultant, but acting in the opposite direction.

When a diagram similar to Fig. 7 (a) is presented nearly every student is inclined to get the impression that the resultant is equal to the *sum* of the two diagonal forces. That this assumption is erroneous can be proven by referring again to our model of the spring balance. In Fig. 7 (a) the two forces A and B act towards a given point, whereas in Fig. 1 the force in the springs acts *away* from the point. (In the spring balance model the lower point O of the system where the diagonals and weight intersect is considered the point on which the forces act.) Therefore the "pull" of the spring balances may be likened to a pair of component forces. The *resultant* of these two diagonal forces would be equal in magnitude to the weight, but acting in the opposite direction, which is, of course, graphically represented by the vertical line oA on Fig. 2.

If either of the component forces A or B in Fig. 7 (a) be considered removed, the body will move in the direction of application of the remaining force, but with both forces acting on the body in unison, as shown, the component forces cannot possibly cause the body to move in a separate path, for the reason that they create horizontal component forces which react equally against each other and nullify any tendency of the body to move in either an oblique or horizontal direction. Nevertheless the horizontal component R_h represents dissipated energy, and, since it performs no useful work, the body will not, in consequence, receive the full value of both forces, as would be the case if both forces acted one behind the other. These horizontal components are identical with the horizontal thrust created between the supports of our spring balance model, which also represents dissipated or wasted energy, for it should be recalled that the actual stresses in the diagonals were greater than the actual vertical load they were supporting. The foregoing work now leads us to a consideration of the following statement from applied mechanics:

"Any single inclined force may be resolved into a vertical and a horizontal component."

A simple demonstration of this principle may be had by reference to the accompanying illustration, Fig. 8.

* Continuation of article commenced in December issue of THE BOILER MAKER

† Engineering department of the Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

HORIZONTAL AND VERTICAL COMPONENTS OF FORCES

Everyone knows that when pulling a load the more nearly horizontal the tongue of the wagon is with the line of pull, the less will be the effort required to move it. When the angularity a which the tongue makes with the line of pull is considerable a decided tendency to lift the load can be felt. The reason for this is that the actual direct pull applied to the wagon tongue is divided into two forces—one being the horizontal component which does the useful work (as BD of Fig. 8), and the other the vertical component force as DC, which represents dissipated energy. In the illustration the actual effort which the man makes in moving the truck is indicated by the letter W, the wasted effort is indicated R_v, and the effective force by R_h.

A diagram of these forces may be constructed identically as in the case of the spring balance model. Let a diagonal line AD be drawn representing the actual direction of the force applied to the truck. The length of this line should be drawn to some scale to represent the magnitude of the force W. The vertical and horizontal lines drawn from the extremities of the diagonal will then represent to the same scale the magnitude of the vertical and horizontal component forces respectively.

The student has now been made familiar with the principles of that branch of applied mechanics known as "the composition and resolution of forces," but no instructions have as yet been given for performing such calculations mathematically. In practice, however, we cannot work with models, hence stresses in structures must be determined through the medium of stress diagrams which may be solved either graphically or by trigonometry. The graphical solution will first be explained.

GRAPHIC SOLUTION OF STRESS DIAGRAMS

In Fig. 7 (a) let the diagonal lines oA and oB represent the direction of two forces acting on the point O. From any point on the drawing board, as A, see Fig. 7 (b), lay off line oA to some convenient scale, say 1 inch equals 100 pounds, or 5 inches long. It should make the same angularity with the horizontal as indicated on the force diagram at (a), or 30 degrees. Next mark with an arrowhead the direction in which this force acts, also in accordance with the force diagram. Line oA which has thus been layed out represents to a specified scale the magnitude and direction of a given force. Now from the upper extremity of line oA, and to the same scale, lay off line oB, whose direction must be the same as that specified for line oB in the diagram. This completes the representation of the known forces, and what we now wish to find is the magnitude and direction of their resultant.

To do this we simply connect the lower extremities of lines oA and oB with the dotted line R. This completes the figure, which becomes a triangle and is known as a force triangle. By scaling line R on his drawing the student should find that it measures 8⅝ inches long, or (8.625×100 pounds) equals 862.5 pounds, which is the magnitude of the desired resultant. The direction of the resultant force is determined from the force triangle; it should be noticed that the resultant travels in a direction beginning at the end of the last force and ending where the first force began. In other words, for any force triangle or parallelogram to be in equilibrium the diagram must automatically close; that is, the resultant should end where the first force began. The magnitude of each of the horizontal components R_h is evidently represented by the length of line R_h drawn perpendicular to AB from point O.

The foregoing graphic method of stress determination is simple and convenient when absolute accuracy is not required. It is obvious that when large forces are being dealt with it would be necessary to use a comparatively small scale in order to include the diagram within the limits of the drawing board, in which case it would be difficult to scale the forces accurately; an error of a small fraction of an inch in some cases might cause an error of thousands of pounds. Nevertheless these problems are just as readily solved by means of

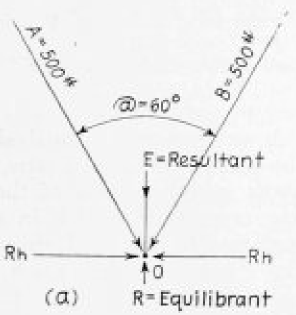


Fig. 7(a).—Finding Resultant of Forces Acting at a Point

Fig. 7(b).—Graphical Method of Determining the Resultant

trigonometry. For those who do not have a working knowledge of this branch of mathematics the graphic method will have to suffice. It is essential, however, to the best interests of the student that he take up the study of this branch of mathematics.

Solution of Diagram by Trigonometry

To solve Fig. 7 (a) by trigonometry, a force diagram is made identically as at (b), except that the lines representing the forces need not be drawn to scale. We have then repre-

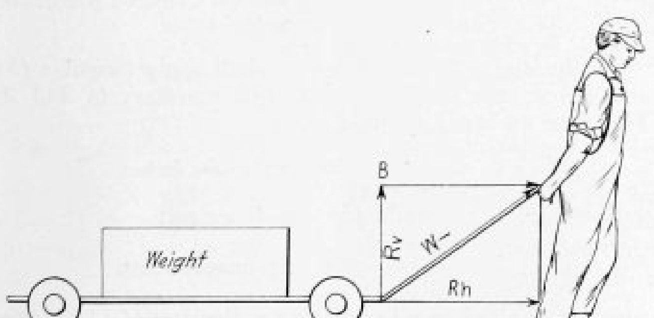


Fig. 8.—Resolution of Forces Into Vertical and Horizontal Components

sented an *oblique angle* triangle, which, by means of the line R_h projected from point O and perpendicular to line AB, may be divided into two distinct right angle triangles of equal magnitude. In these right triangles the length of one side and the magnitude of one of its angles are known to find the other two sides. The solution to this problem follows:

From trigonometry we learn that the cosine of any angle equals $\frac{\text{side adjacent to the angle}}{\text{hypotenuse}}$.

From a table of the trigonometric functions of angles we find that the cosine of 30 degrees equals 0.86603; therefore $AB/500$ equals 0.86603, whence AB equals 0.86603×500, or 430.15 pounds. This figure of course represents only one-half the magnitude of line AB, whence the actual value for the resultant equals 2×430.15, or 860.30 pounds. This very closely approximates the result which was graphically determined, but the trigonometric solution is the more accurate.

There is considerably more to this subject than is necessary to present here, but the foregoing discussion is deemed sufficient to give the student a working knowledge of the theory of force and motion. If he masters this short treatment of the subject he will be able to apply his knowledge to ordinary design problems.

Computing Size of Diagonal Boiler Braces

Having now learned how any inclined force may be resolved into a vertical and horizontal component, we are prepared to return to that part of our design where we left off, viz., the determination of the size of the diagonal boiler head braces.

Referring to Fig. 1 we find that the horizontal load R_h on each brace is 10,018 pounds. This load is due to the steam pressure on the head, as was previously explained. Due now to this horizontal thrust of the heads a stress indicated as F_d in the illustration is transmitted diagonally through the body of the brace. This diagonal force creates a certain vertical pull R_v in the shell plate resisted by an equal and opposite reaction R_v in the boiler head. Therefore the forces indicated in the illustration by the letters R_h and R_v represent the horizontal and vertical components respectively of the diagonal (or resultant) force F_d.

In this case the magnitude of the horizontal component is known to determine the magnitude of the resultant F_d, which latter will of course be the actual load on the brace and ultimately determine its size.

We learned previously that the greater the angularity of the diagonal, the greater will be the load on the diagonal. It should therefore, be the aim of the designer to decrease, as far as possible, the angularity a which the brace makes with the shell (see Fig. 1). This is accomplished by using braces as long as practical, thereby increasing dimensions L, and consequently angle a. Of course, decreasing dimension H, will have a similar effect, but the latter is usually fixed by the time the designer comes to determining the angularity, because as was previously explained, the initial requirement is to locate a sufficient number of braces over the segment so as to obtain uniform load distribution, and

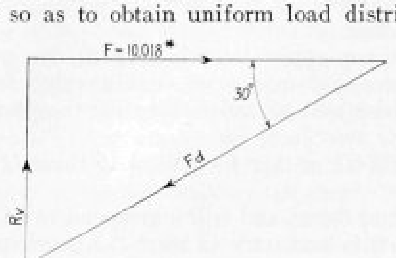


Fig. 9.—Force Diagram of Stresses in Boiler Bracket Problem

not to exceed certain minimum pitches from center to center of the braces.

Let us now suppose that the greatest angle which any brace makes with the shell is 30 degrees. A force diagram may now be made, representing the existing condition, as in Fig. 9.

We now have a right angle triangle with one angle and its side adjacent known, to find the other two sides. From trigonometry we learned that, cosine of any angle equals

$$\frac{\text{side adjacent to angle}}{\text{hypotenuse}}.$$

From a table of trigonometric functions of angles, we find that cosine of 30 degrees equals 0.8660. Then in Fig. 9, $\frac{F}{F_d}$ equals the sine of a, or $\frac{10{,}018}{F_d}$ equals 0.8660; whence F_d equals $\frac{10{,}018}{0.8660}$ or 11, 564.

By now following a common sense method of reasoning, through the medium of the foregoing trigonometric solution, the above problem may be resolved into a simple fractional equation as follows:

Figs. 1 and 9 are evidently similar triangles, that is, their angles are of the same magnitude; therefore, the trigonometric functions of corresponding angles of Fig. 1 and 9 have similar values, whence they are termed *similar* triangles. We may say then, that the cosine of angle a in Fig. 1, equals the cosine of the similar angle in Fig. 9. As the cosine of angle a in Fig. 9 is equal to $\frac{F}{F_d}$ then in Fig 1, the cosine of angle a must evidently be $\frac{l}{L}$

"Two things that are equal to the same thing, are equal to each other," therefore,

$\frac{F}{F_d} = \frac{l}{L}$ or $F \times L = F_d \times l$, whence, by transposition of terms, we have the final equation;

$$F_d = \frac{F \times L}{l} \qquad (1)$$

Formula (1) simply means that if we multiply the horizontal (direct) thrust on the brace by the diagonal dimension L, of Fig. 1, and then divide this product by the horizontal dimension l, the quotient obtained will be the resultant load F_d on the brace. By applying formula (1) the student will not need to work with the angles in his calculations. A study of the formula should convince the student of the correctness of the principle upon which its development was based, for although the actual magnitude of the angle does not enter the formula, its cosine ratio $\frac{L}{l}$ nevertheless is present.

We shall now apply formula (1) to our problem, but it will be necessary to assume certain value for l and L. Any dimensions will be satisfactory for the purpose just so that $\frac{l}{L} = 0.8660$, or that L equals 1.15 times l, which is, of course, the same thing, and will correspond to an angle of 30 degrees, which is necessary to meet the previously assumed condition. Therefore, assuming l, = 31.18 inches, and L, = 36 inches, we may substitute in formula (1) as follows:

$$F_d = \frac{10{,}018 \times 36}{31.18} = 11{,}564 \text{ pounds.}$$

The required net cross sectional area of each brace is found by dividing the actual load F_d on the brace by the allowable unit working strength of the stay material, thus;

$$A = \frac{F_d}{C}, \text{ in which:} \qquad (2)$$

A = required net cross sectional of stay in square inches.
F_d = actual diagonal load on stay in pounds.
C = allowable unit stress in stay (9,500 pounds per square inch for weldless diagonal stays). (6,000 pounds per square inch for welded diagonal stays.)

Substituting values for letters in formula (2) we have:

$$A = \frac{11{,}564}{9{,}500}, \text{ or } 1.217 \text{ square inches.}$$

If round braces of the Scully type are going to be used, this area will be met in a rod having a diameter of 1¼ inches.

We now finally present the American Society of Mechanical Engineers' Boiler Code formula for the size of diagonal braces for boilers and pressure vessels:

$$A = \frac{a \times L}{l}, \text{ in which:} \qquad (3)$$

A = sectional area of diagonal stay in square inches.
a = sectional area of direct stay in square inches.
L = length of diagonal stay, as indicated in Fig. 1, in inches.
l = length of line, drawn as indicated in Fig. 1, in inches.

The student is requested to compare the above formula with our formula (1), which we developed by analysis. The only difference between the code formula and ours, is that the code considered the cross sectional areas of the braces instead of the forces acting upon them, which in the end, amounts to the same thing, that is, the total stress in the stay is resisted by a section of metal A, while the horizontal thrust could be resisted by a smaller section a. Therefore, A, L, a, l, or $\frac{A}{L}$ equals $\frac{a}{l}$, whence.

$A = \frac{a \times L}{l}$, which is the same as the code formula given above.

In order to apply formula (3), it would be necessary to know the value of A, which is simply the cross sectional area of stay that would be required if there were no angularity, or in other words, simply a *direct* stay. Its value may be determined direct by the following formula, an analysis of which should not be necessary at this advanced stage of the treatise.

$$a = \frac{W}{C \times N}, \text{ in which:} \qquad (4)$$

W = total load on segment to be stayed.
C = allowable unit stress per stay (9,500 pounds per square inch for weldless). (6,000 pounds per square inch for welded.)
N = number of stays used.

For the student's convenience we shall apply formulas (3) and (4) to our problem. It is first necessary to find A. Therefore we apply formula four:

$$a = \frac{140{,}250}{9{,}500 \times 14}, \text{ or } 1.05 \text{ square inches.}$$

Now applying formula (3) for A, we get;

$$A = \frac{1.05 \times 36}{31.25}, \text{ or } 1.217 \text{ square inches,}$$

which is obtained in a bar, having a diameter of 1¼ inches, being the same result as previously obtained by applying our own formula (1).

The purpose of the code was to place within easy reach of all who might be interested in the subject simple rules and formulas for the safe design of steam boilers and pressure vessels. There is not a formula in the entire code that has not been derived from correct engineering principles, and wherever these did not at first seem to give the very best practical results, the formulas were revised in accordance with the very best practice known.

An Unusual Boiler Failure*

Several months ago a boiler failure occurred in the power plant of a large automobile factory, and as it was of an unusual character, a brief description of it will be of interest. The boiler referred to is of the watertube type, and has 252 tubes, each 4 inches in diameter and 18 feet long, and two drums, each 48 inches in diameter and 20 feet long. The heads of the drums are 19/32 of an inch in thickness, and the shell plates are 15/32 of an inch thick. The longitudinal seams of the drums are quadruple riveted, with double butt straps, and have a calculated efficiency of 93.1 percent. The boiler is operated at a pressure of 200 pounds per square inch.

Previous to the failure the boiler had been cut out of service in order to make some maintenance repairs, and after these had been completed the boiler was filled with water for the purpose of applying a hydrostatic-pressure test. It was impossible to raise the desired pressure within the boiler, however, and the discovery was made that water was running down on the brick work and between the tubes. Some of the brick work at the rear of the boiler was removed and it was found that a bulge 42 inches long, 36 inches wide, and 6½ inches deep had developed in the *upper* shell plate of one of the drums, directly beneath the smoke breeching, and that there was an opening about 3 inches long in the plate at the center of the bulge.

The apparent explanation of this failure is that the shell

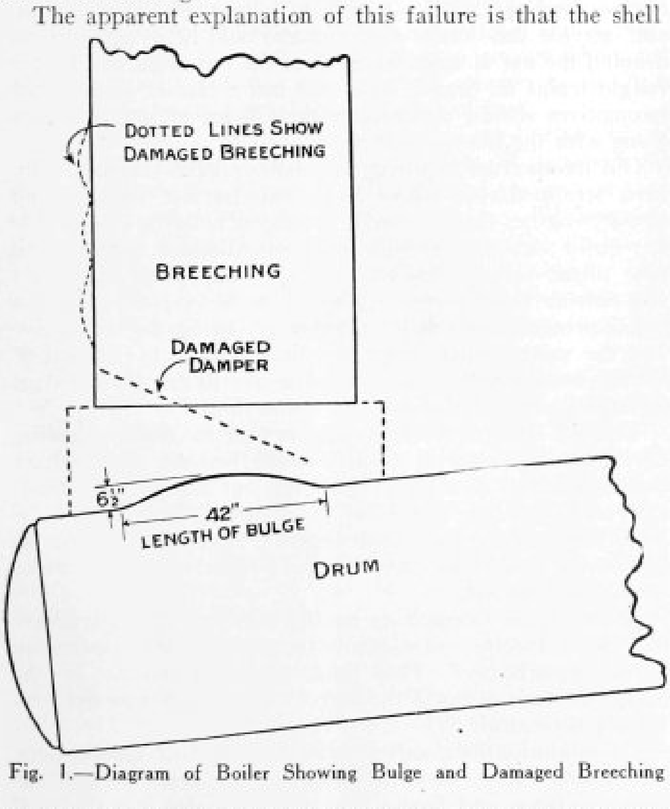


Fig. 1.—Diagram of Boiler Showing Bulge and Damaged Breeching

of the drum became locally overheated; that the bulge was formed by the action of the internal steam pressure on the overheated part; and that finally a small opening developed at the center of the bulge, due to the reduction in the thickness of the metal at that point.

If we assume that the drum shell failed because of overheating of the metal we must assign a cause for such action. Bags and bulges in boilers are usually caused by accumulations of oil, grease, or scale, which have been deposited on the interior parts of boilers directly exposed to the flame and the products of combustion, and which form a non-conducting coating between the heat on one side of the metal plate and the water on the other side. For obvious reasons it is

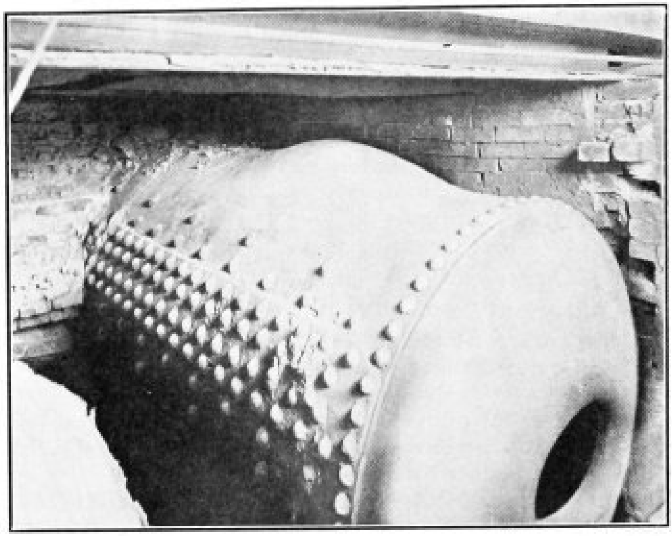


Fig. 2.—Result of Overheating in an Improperly Cleaned Boiler

unlikely that deposits of this nature could have caused the trouble in the present case.

It seems probable that combustible material of some kind accumulated on the outside of the upper part of the drum where the bulge developed and, becoming ignited, caused the metal to soften and stretch under the action of the internal steam pressure. The kinds of combustible material that might have caused the damage in this particular location are practically limited to two—soot (with which may be included flue dust and cinders) and shavings. It seems rather unlikely that a dangerous temperature could have been brought about by the combustion of soot alone, under the prevailing conditions, although it is well known that this material, when deposited in combustion chambers and elsewhere about boiler settings, will remain at a high temperature for several days after the fires in the furnaces have been extinguished; and in many cases inspectors have been seriously burned by putting their feet or hands into these hot deposits.

There is the further possibility, however, that shavings, which were used in part as fuel for the boiler furnace, were carried along by the draft through the gas passages to the stack at which point the velocity of the current of hot air and gases became reduced so as to be no longer strong enough to sustain the shavings, which then dropped on to the top of the drum. These shavings may have become ignited, and if a considerable quantity had accumulated, previous to the ignition, the resulting heat may have caused the damage.

Fortunately, no personal injuries resulted from the accident, and the property loss was limited to the expense involved in repairing the damaged shell plate of the drum. On account of the large size of the bulge and the high pressure carried on the boiler, it was recommended that a new course be substituted for the damaged one, rather than to attempt to force the bulge back into position and apply a patch. It was also recommended that doors be placed in the brick work between the breeching and the drums on the boiler, to give access for cleaning out accumulations of soot, as often as might be found necessary.

A new type of locomotive has just been successfully tested on the railway from Ipswich to Toowoomba, Queensland, Australia. Known locally as the C17, it is fitted with a Robinson superheater, and has a lower boiler pressure than the C16 locomotive hitherto used, but it is much more economical in the consumption of water and coal. On the trial run the new locomotive consumed, with a full load, 800 pounds less coal, 1,300 gallons less water than its forerunner with a similar load.

* Reprinted from *The Travelers Standard*. Published by the Travelers Insurance Company, Hartford, Conn.

Increasing the Capacity of Old Locomotives*

BY C. B. SMITH†

The usual policy of the railroads with reference to the purchase of new locomotives and the conversion of old ones is not, in the opinion of the writer, as well provided for as the demands of the service require. The difficulty lies in the fact that shop facilities are inadequate, a large amount of both time and money being unnecessarily consumed in order to keep locomotives in service. The author cites examples of satisfactory reconstruction which justify the improvement programme advocated, and states that the application of all the desirable auxiliaries to old engines is prohibitive without a radical provision for carrying out such a programme.

In these days of the high cost of railroading, responsible officers of the mechanical departments realize that the necessity for reducing the cost of all locomotive operation and maintenance is more urgent than ever. Such saving can be accomplished in two ways, one by using new and modern locomotives, the other by rebuilding old types.

The purchase of new locomotives is usually confined to the largest units permissible for each type required, and they are equipped with superheaters and other modern devices as selected by the purchaser. Older engines of modern type, but not originally supplied with superheaters, are also being so equipped at general shoppings of these engines on the greater number of the roads of the country, and as rapidly as local conditions will permit. This improvement brings the older locomotives up to the capacity of those more recently purchased, and such reconstruction will, undoubtedly, be continued until all such locomotives have been modernized. The wisdom and economy of this work are known to all.

The replacement or betterment of the older locomotives is becoming more of a problem where suburban and local passenger service and branch line traffic still require the maintenance of the lighter types of locomotives that can handle such traffic. Such engines are periodically returned to the shops for repairs, and the frequency of these shoppings could be reduced and mileage between them increased if the time were taken at one shopping to modernize them. Extensive reconstruction, however, requires a longer shopping period and reduces the number of engines available for road service.

Factors which will increase the capacity of a locomotive may do so directly or indirectly, singly or in connection with others. When setting out to rebuild a locomotive the experienced supervisor appreciates the opportunity to apply many devices and facilities which will standardize the engine in accordance with the railroad company's practice, and in so doing reduce repairs and stores department expense in maintenance.

The aggregate of such improvements results in a locomotive which in proportion to its capacity will produce service results comparable with those of entirely modern construction, and at a cost approximately one-half that for a new locomotive of similar capacity. The difficulty in carrying forward an extensive reconstruction programme, however, is in finding the shop facilities either on the railroad or among the locomotive builders in order to advance the work at a satisfactory rate of progress. Nevertheless, despite this difficulty the results which could be obtained from the operation of reconstructed locomotives, if they could all be rebuilt within the next few years, would justify a special effort on the part of railroad managements to bring it about.

On roads where the number of old locomotives which warrant rebuilding is sufficient to require a period of more than three years to complete the work, it would seem necessary to arrange for enlargement of shop facilities in order to hasten the reconstruction. If, however, adequate shopping facilities are not forthcoming, the improvement programme for locomotives must be confined chiefly to the application of superheaters and the substitution of piston for slide valves; together with the minor but relatively important betterments that may usually be applied at the shopping period. On some roads this work alone will require six years at the present rate to equip what can rightly be called the "early-modern" locomotives.

Some of the engines built within the past ten years have developed weaknesses in frames and in parts of running gear. It has proved justifiable to reconstruct them by substituting new parts of stronger design and thus avoid recurring breakages which interrupt both the road service of these engines and the repairs to others. On roads whose traffic and service conditions now demand and will continue to demand the use of light locomotives for passenger trains and freight trains on branch lines, the better classes of the light locomotives should also receive their share of improvements along with the heavier power.

Old locomotives requiring new boilers have very generally been scrapped, but where light train service demands no heavier engines than formerly, the writer believes it advisable to rebuild such engines with radial-stay boilers, superheaters, new piston-valve cylinders, main frames when necessary, and outside valve gears. If there is to be no increase in the boiler pressure over that formerly carried by the locomotive and the valve motion has given little trouble by breakages, the Stephenson motion may be connected to the piston valves through the usual rocker-shaft connections.

The old eight-wheeled, American type locomotives having crown bar boilers with deep fireboxes between frames have become obsolete on many large roads, but on the small roads and on branchline and local train service in much of the New England territory these engines, modernized as far as consistent, should be carefully considered where the traffic conditions warrant.

Atlantic-type locomotives having outside valve gears have had their capacity and economy increased by the application of the superheater. This work permitted the use of the engine in long-distance through service which was not previously successful.

Consolidation locomotives reconstructed with superheaters, new piston-valve cylinders, outside valve gears, new front-frame sections, and frame cross-ties have also had their capacity increased, and have been successfully used in regular freight service on a mountain division greatly needing such power. The cost of the above-mentioned improvements, including heavy general repairs and entirely new fireboxes, would not exceed one-half the cost of new locomotives of the same capacity.

Discussion

The first to speak in regard to increasing the capacity of old locomotives was Frank McManamy, now assistant director-general of railroads.

The application of the superheater, the stoker and the feed water heater were commented upon as among the best measures toward modernization, but with the application of these, as with other devices, intelligent handling and adequate main-

* Abstract of paper presented at the railroad section of the American Society of Mechanical Engineers, December 8, 1920.

† Mechanical engineer, Boston and Maine Railroad.

tenance are essential before they can be of any real value. The simple application of these devices is not sufficient; they must be properly used and adequately maintained.

In a written discussion of the subject submitted by W. O. Moody, mechanical engineer of the Illinois Central, the necessity for adequate shop, as well as locomotive terminal facilities, was emphasized. Mr. Moody pointed to the fact that in the absence of shop facilities adequate for current maintenance of locomotives, little could be hoped for toward the modernization of locomotives upon any considerable scale. In this connection it should be remarked that the locomotive companies who, until recently, have been busily engaged on new locomotive construction, are now in a position to undertake considerable modernization work for the railroads, and in view of the possibilities in this direction it would appear to be an opportune time for the railroads to assign some of this work to the locomotive builders, where they are unable to undertake it in their own shops and are not justified in the purchase of new locomotives.

Arguments for Feed Water Heating

Some strong arguments in favor of locomotive feed water heating were presented by E. A. Averill, vice-president of the Locomotive Feed Water Heater Company, who contributed to the discussion as follows:

"Increasing the capacity of all old and semi-modern locomotives, whenever increased capacity can be used and increasing the efficiency of those which are in a service where increased capacity will not show a return, should be the first feature to be investigated and carefully analyzed.

"It may interest you to know that feed water heaters, which will raise the temperature of the water from 40 degrees or 50 degrees to from 230 degrees to 250 degrees, have been in successful railroad service for over three years. Furthermore, these heaters filter all the water formed from the condensed exhaust steam and return it, free from oil, to the tender. This adds about 14 percent to the capacity of the tender and greatly extends the distance that can be made between stops for water.

"On most locomotives an increased boiler capacity can be fully used in regular service and, furthermore, since any boiler is most economical and most efficient at its lower rates of working, an appliance which makes the boiler larger always shows returns. It gives increased capacity when it is needed and it gives greater efficiency when the larger capacity cannot be used. A feed water heater lies entirely in this class of equipment. It permits the boiler to deliver 9 pounds of steam for each pound of coal burned where, without the heater, it would deliver but 7.8 pounds of steam for each pound of coal. If, however, service conditions were such that only the smaller quantity of steam could be employed, a boiler equipped with a feed water heater would be operating at 65 percent efficiency, as compared with 61 percent for the same quantity of steam, without the heater, and thus this appliance is giving a return of one sort or another at all times."

Superheat as a Means to Increased Capacity

In commenting on the subject of increasing the capacity of old locomotives, H. B. Oatley, chief engineer of the Locomotive Superheater Company, took this opportunity of bringing out, somewhat in detail, the features which have prompted the very extensive superheating programmes which have been in vogue on many of the railroads for a considerable period.

"By the addition of a high degree superheater," Mr. Oatley said, "it has been demonstrated that the steam consumption per horsepower hour is reduced about 28 percent. The figures commonly accepted as representing good practice are 27 pounds for saturated steam and 19.5 pounds for superheated steam. In the case of the 0-6-0 type boiler, the horsepower has been increased 15 percent; for the 4-4-0 type 14 percent; for the 2-6-0 type 13 percent; for the 2-8-0 type 10 percent, and for the 4-4-2 type 10.2 percent. The maximum cylinder horsepower, using the American Locomotive Company's figures, has, by the addition of a superheater, been increased about 8 percent.

Must Modernize Eventually

"In his remarks on the subject of increasing the capacity of old locomotives, J. T. Anthony, vice-president of the American Arch Company, stated that with 65,000 locomotives in service on American railroads, only 35,000 are equipped with superheaters; 43,000 with arches; 37,000 with automatic fire doors; 15,000 with power reverse gears; 2,000 with automatic driving box wedges, and only 30 with feed water heaters. The reasons commonly given for this condition, he said, "are lack of shop facilities and inability to get appropriations with which to carry on the work. But it is difficult to understand why the responsible officials who willingly make appropriations of millions of dollars for grade reductions, curve eliminations, etc., with the sole idea of increasing train loading and reducing operating expenses, should turn a deaf ear to the requests of the mechanical departments when they have the same object in view.

"There are only three methods of increasing the heating surface of an existing firebox, i. e., by the installation of a combustion chamber, or arch tubes, or thermic syphons. At the present time there are only 6,000 locomotives equipped with combustion chambers, and something over 100 equipped with thermic syphons, this device being of rather recent origin. Many of the existing boilers can be improved by adding combustion chambers when new fireboxes are put in, thereby increasing the firebox volume and reducing the ofttime excessive flue lengths, and in other cases new back-ends should be put on when it is necessary to renew fireboxes of narrow and antiquated designs, thereby increasing the grate area and firebox volume. Too little attention has been paid to the possibility of improvements in old boilers by these means. While it is true that the addition of superheaters and brick arches often reduces the demands made upon it, there is still a lot of room for improvements in the firebox, particularly in regard to the firebox as a furnace wherein fuel may be burned efficiently. In this connection we might call attention to the poor designs of ashpans on thousands of our present locomotives, on many of which it is impossible to secure an adequate air supply. Such conditions can be remedied at comparatively little expense and effect a large saving in fuel.

"The many improvements that have been made in locomotive design in the past 10 or 15 years have not come about in answer to any loud and sustained cry from the railroads for more efficient locomotives. The railroads asked for larger and more powerful locomotives, but the devices that have made the locomotives of increased capacity and efficiency possible have been largely left to the ingenuity of the railway supply companies and, in a smaller degree, to the locomotive builders. The development of the several well-known fuel economy and capacity increasing devices has been due to the labor and efforts of men who have left the railway service, in many cases on account of the lack of interest of the railroad in the device which the individual was trying to get perfected and used.

"If we can judge the future by the past, there will be no radical provisions made for the carrying out of a locomotive reconstruction programme until the officials of the mechanical and operating departments awake to a full realization of the possibilities of reducing present operating expenses by the maintenance of a high standard of efficiency of *all* their locomotives, and by their urgent demands and intelligent presentation of facts convince the higher authorities—those who have to dig up the money—of the feasibility and desirability of such a programme."

Standardizing the Installation of Electrical Equipment*

BY D. R. WEEDON†

Standardization of electrical equipment cannot mean duplicate motors, control, generating apparatus, etc., but can mean standardization of design for installation or application, type of drive, style of control and ratings. A great deal of benefit can be derived by putting the same general types of electrical apparatus on the same general types of machine tools.

Motor drive means to different people different things. For example, on the same line of tools some manufacturers will apply a high torque motor, others a low torque motor, some constant speed, others adjustable speed; some equip their machines completely, including a line switch, other manufacturers have even omitted starters where starters are necessary. A motor driven tool might mean to one manufacturer a motor belted to the tool from the floor or ceiling, while to others it means a motor actually built into the machine.

With this great diversity of ideas as to motor driven tools confusion and dissatisfaction occur. If the machine tool manufacturer would only take the electrical manufacturer's engineer into his confidence at the time of design, money will often be saved and worry eliminated. If the electrical drive would be looked upon more as a mechanical item—that is, a necessary part of the tool instead of an after thought—the results would be surprising.

Supporting Brackets for Motors

After a tool has been completed it is usually necessary to make a special bracket to support the motor, and sometimes a request is made that a special motor be built. Both of these plans are unsatisfactory and an earlier attention to this point would usually provide a suitable mounting without difficulty.

Some manufacturers purchase only the stationary and rotating parts of motors and build the mechanical parts in their own shops. This tends to reduce bearings as well as expensive speed boxes, levers and other machine parts, making a simple and compact drive, and increasing the efficiency of the tool without decreasing the efficiency of the motor.

Another important precaution is to apply a motor of proper horsepower and speed to the tool. Only by actual tests can this be done and the electrical engineer can easily and quickly determine the exact horsepower to be applied. Very often a large size tool is purchased to machine bulky parts with light cuts.

Of course in connection with the proper power there should be taken into consideration the range of speeds of motors. It should also be borne in mind that a variable speed motor might be either alternating or direct current, while an adjustable speed motor is direct current only. By adjustable is meant a motor whose speed settings can be definitely determined and maintained regardless of the load being carried.

Millwright Work Eliminated with Direct Drive

In the installation of motor driven tools there is a decided saving because of the omission of counter shafts with bearings, and the necessary millwright work. In reversing service, such as planer or other shock service, the direct connected motor absorbs this stress with its inherent cushioning effect, instead of throwing the strain on hangers, shafts and belts.

Of course there are tools where it is practically imperative that belt drive be used. Many times this can be arranged by placing the motor on an extension of the machine bedplate or even mounting it on the floor. This does not interfere with crane operation, nor with the lighting arrangements of the shop. In a certain shop the lighting bill was cut 40 percent where overhead shafting and belts were eliminated.

When designing a tool for using a standard motor, the mounting should be of a type that will accommodate more than one make of motor. If at all possible, the design should take either alternating or direct current motors of at least two makes.

Methods of Control

With either type of motor two types of control can be used—automatic and manual. With automatic the control can be placed at a remote location with the pilot switch close by the operator's hand. With manual control or starter it should be placed as near the operator's position as possible without interfering with the proper manipulation of the tool. Especially on lathes, a master drum control can be operated from the apron by means of a spline shaft.

By equipping the control with a proper overload relay, expensive friction clutches which would otherwise often be necessary to protect the machine tool from extraordinary strains are eliminated.

Of course the importance of having the starter for the motor equipped with what is termed "low voltage protection" is well understood. This means that if for any cause the line circuit fails, the motor will not automatically restart when the current returns. Without this the operator, forgetting to open the line, might be changing a tool or gaging his work, and serious results would follow the unexpected starting of the motor.

In selecting the starting equipment the advisability of using automatic control should be carefully considered, with the push buttons conveniently placed. It has been thought by many that automatic control is very expensive, but such is not the case. In those cases where cost is greater the difference is usually justifiable.

Plant engineers know that for certain groups of machinery it will ofttimes work well to have one motor drive several tools. The machine tool manufacturer, however, wants the best possible result from his own machine, and this usually with more or less disregard, within reason, to the first cost of the tool.

In order to make a real application of correct principles, and this means that all tool builders should apply the same types of electrical equipment to the same general line of tools, requires a careful study of the nature of the service, such as continuous or intermittent rating, variable, light or heavy load factor, and the like. All these items bring into consideration the temperature rating allowable and the proper application regarding high and low torques and speeds. For these various combinations there are motors and control available.

* Abstract of a paper read before the National Machine Tool Manufacturers' Association, New York City, November 11, 1920.

† Boston office of the Westinghouse Electric and Manufacturing Company.

The Ratio of Heating Surface to Grate Area

BY JOHN S. WATTS

Having come across many cases of boilers built in such a way as to bring the ratio between the heating surface and grate surface to a figure that could not possibly give efficient results, I have concluded that the fact that this ratio (within certain limits) has considerable bearing on the efficiency of the boiler is not as thoroughly understood among boiler designers and operators as it should be.

The worst case I remember was a vertical boiler, 6 feet 6 inches diameter by 10 feet high, in which the ratio of heating surface to grate surface was only about 25 to 1, instead of 45 to 1, which was the figure giving the best results with the class of coal and other conditions applying. The owner complained that no matter how hard he fired he could not keep up steam. Investigation showed that the grate area was about right for the power he required, but that there was not nearly enough heating surface to absorb the heat from the coal burned. Whatever coal was burned over and above the amount transmitted by the heating surface was wasted, as it simply went to raise the temperature of the gases in the smoke stack.

The area of grate surface required to evaporate a given quantity of water per hour is dependent upon the following factors:

The calorific value of the coal upon which depends the amount of coal to be burned per hour to evaporate the required amount of water.

The amount of coal which can be efficiently burned per square foot of grate per hour.

Considering the first factor, experience shows that one pound of coal will evaporate between 5 and 12.5 pounds of water, depending upon the quality of the coal and upon the efficiency of the fireman.

Referring to the second, the amount of coal that can be efficiently burned per square foot of grate per hour varies between 10 and 24 pounds, depending upon the amount of ash in the coal, which tends to choke up the grate, and upon the kind of coal used, the efficiency of the fireman, the draft and the design of the grates. The figures given are for natural draft, and may be increased to almost 100 pounds with forced or induced draft.

From the foregoing it will be obvious that the boiler manufacturer building a standard line of boilers can only be expected to furnish a boiler with the area of grate surface required under average conditions, as the factors given above vary too considerably to expect him to know exactly the proper area without knowing all the exact conditions, some of which cannot be known until the boiler is put into commission.

The problem is rendered more complicated still by the fact that to evaporate a given quantity of water with a poor grade of coal will require the combustion of a larger quantity of fuel, and that a smaller quantity of the poor coal can be burned per square foot of grate per hour than of a better coal.

Fortunately it is possible for a good fireman to vary the amount of coal burned per square foot of grate per hour, within reasonable limits, losing much in efficiency. If the grate surface is too small the boiler may fail to deliver the desired evaporation, but the economy will likely be higher than if the grate is too large.

If the grate area is too large the heat will be wasted in the chimney gases, or the fireman will carry too thin a fire, and so allow an excessive amount of air to pass through the fuel bed, lowering the temperature of combustion and losing efficiency. This can be readily determined by taking the temperature of the gases at the point where they leave the heating surfaces; the temperature should not be more than 100 degrees F. higher than the temperature of the steam. If the temperature is higher than this, an excessive amount of heat will escape up the chimney, and as a decrease of 100 degrees in this temperature will increase the efficiency by 6 to 7 percent it is well worth following up.

A high temperature of the escaping gases may possibly be due to the heating surfaces becoming covered with soot or scale, and the temperature should be taken when these surfaces are clean before deciding that the grate is too large.

Having by experimental work fixed the area of the grate in its correct proportion to the heating surface, the temperature of the escaping gases will, in the future, furnish an excellent test to indicate the cleanliness of the heating surfaces.

To determine whether or not an excessive amount of air is passing through the fuel bed, it is necessary to analyze the gases for carbon dioxide, for which purpose there are sold various kinds of apparatus easily handled by the average power house attendant. The analysis should show the presence of 15 percent of carbon dioxide in the gases at the point where they leave the heating surfaces. If there is less than this percentage present, too much air is being admitted. Some or all of this excess air may be leaking in through cracks in the setting or around the doors, and all such openings should be carefully inspected and made airtight. Obviously the presence of air leakage will cut down the efficiency whether it gets through the fuel bed or through openings in the setting.

To determine the amount of heating surface required to evaporate a given quantity of water is a much simpler matter, as an excess of heating surface will tend rather to increase the efficiency. For this reason it is usual to assume that one square foot of heating surface will evaporate 3 pounds of water per hour, although much larger evaporation has been obtained. The actual amount will depend upon what is counted as heating surface and the general type and design of the boiler.

Having carried out the tests outlined above, if the percentage of carbon dioxide and the temperature of the escaping gases seem to be about right the heating surface must be insufficient for the quality of coal used if the boiler fails to deliver sufficient steam.

To sum up, if the boiler does not supply the steam required, take the temperature of the escaping gases; if this is more than 100 degrees above that of the steam and the heating surfaces are clean the grate is too small. If this temperature is not excessive, try an analysis for carbon dioxide, and if this is much less than 15 percent, assuming that the setting has been made airtight, the coal is not being fired efficiently and should be improved until the analysis shows somewhere near 15 percent carbon dioxide. If both the temperature of the waste gases and the percentage of carbon dioxide are about right the grate area is too small.

If the boiler does supply sufficient steam but is burning too much coal, try the temperature of the escaping gases; if this is higher than it should be, the grate is too large. If this temperature is correct, try for carbon dioxide, and if this is much below 15 percent the grate is too large.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the boiler code. Anyone desiring information as to the application of the code is requested to communicate with the secretary of the committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of the society for approval, after which it is issued to the inquirer.

Case No. 319.—Is it allowable, under the requirements of paragraph 308 of the boiler code, to connect to a boiler to be operated at a pressure exceeding 15 pounds and not to exceed 100 pounds for the return of condensation to a heating system a 4-inch return connection, this same return connection being used as a blow-off, but the blow-off connection therefrom being reduced, however, to 2½-inch pipe size or less?

It is the opinion of the committee that such a connection for return of condensation will not be in accordance with the requirements of paragraph 308 of the code. It will be necessary to use an independent connection for the return.

Case No. 320.—Will it meet the requirements of paragraph 303 of the boiler code where a non-return angle valve is mounted directly on the steam outlet nozzle of a boiler, and to the outlet of this valve there is bolted a gate valve, forming the two stop valves required, to provide the ample free blow drain between the two valves by a 1½-inch pipe tap in the side of the non-return angle valve just above the seat, in order to avoid the necessity of placing a fitting between the two valves?

It is the opinion of the committee that such a construction will fully meet the requirements of paragraph 303.

Case No. 321.—Is a boiler of the porcupine type where stub tubes are screwed in the furnace sheet subject to the requirements of paragraph 250 of the boiler code, or is the screwed connection of such stub tubes permissible?

Paragraph 250 refers specifically to firetube boilers and is therefore not applicable to a boiler of the porcupine type in which the tubes are operated under conditions similar to those of the watertube type of boiler. Paragraph 251 refers to tubes which are expanded into the tube sheets and does not apply to the tubes with screwed ends. It is the opinion of the committee that the pipes or tubes should meet the requirements recommended by the committee in the reply for Case No. 296—that special redrawn pipe, not to exceed 1½-inch standard pipe size made from lap-welded iron of puddled stock and tested to 1,000 pounds hydraulic pressure, may be used for a working pressure not to exceed 200 pounds per square inch, provided the wall thickness is at least 50 percent greater than the wall thickness required by the code for tubes of watertube boilers. The minimum number of threads should conform with the values given in Table 8 of the code. The closed ends of the stub tubes may be welded by the forging process.

Useful Information for Boiler Shop Apprentices

BY GEORGE L. PRICE

At what temperature does boiler water change into steam?

In a vessel open to the atmosphere and at sea level, steam will be generated at 212 degrees F.; in a closed vessel the temperature at which the steam will be generated depends upon the pressure.

Why are the edges of flues and door sheets beveled from the centerline of the rivet holes out to the edge of the sheet?

There is little or no strain on this position of the flange of the door and flue sheets from the center of the rivet holes to the edge of the sheet, so that it can be beveled without unduly weakening the lap, and in this way fire cracks from the rivet hole to the calking edge can be prevented.

Are such cracks usually dangerous?

When they extend from the rivet hole to the calking edge they are not particularly so, but if continued into the solid plate they become quite dangerous. It is often practicable to calk fire cracks, especially firebox seams.

Hammer Testing Boilers

When staybolts are being subjected to the hammer test, why is a pressure of 40 or 50 pounds usually maintained in the boiler?

This pressure is carried so that the two parts of a broken staybolt will be separated a little, thus permitting the cracks to be more readily found.

What is the object of drilling a telltale hole in a staybolt?

The telltale hole facilitates the finding of broken or fractured bolts.

Why are telltale holes attached to the outer sheets of the firebox?

This is done because staybolts usually break at or near the outer sheets of the firebox.

Which is the most dangerous, a boiler with four broken staybolts adjacent to one another—that is, in a nest—or a boiler with ten broken staybolts, no two of which are within two or three feet of each other?

The boiler with four broken staybolts in a nest would be positively dangerous, while the boiler with the ten broken staybolts distributed would be much safer to operate for the tensile strains would be distributed over a greater number of adjacent bolts.

Find the efficiency of the end section of plate of a single riveted chain where the pitch of rivets is 2 inches and the diameter of rivet holes ¾ inch.

This problem is readily solved by using the simple formula:

$$\frac{\text{Rivet pitch} - \text{the diameter of rivet hole}}{\text{Pitch}} = \text{efficiency},$$

which in this case gives:

$$\frac{2 - 0.75}{2} \times 100 = 62.5 \text{ percent.}$$

This formula is usually written:

$$\frac{P - D}{P} = E,$$

where:

P = pitch of rivets, in inches.
D = diameter of rivet holes, in inches.
E = efficiency of rivet joint.

Why Pick on Acetylene ?

Every little while one reads of acetylene explosions or the explosion of acetylene torches, and when the reported cases are authoritatively investigated, as they always are, it is discovered that in nearly every instance the explosion was not an acetylene or an acetylene torch explosion at all. Sometimes, by way of injecting a little variety, it might appear the cause of an accident of the kind is given as an oxygen explosion. These reports do not occur so frequently as the ones attributing explosions to acetylene, but, like them, are found upon searching inquiry to be, in a majority of instances, entirely without foundation, in fact.

One does not read much of the danger of air and water as explosive agents. Of course when a boiler explodes the water has been converted into steam. But just simple, every-day *aqua pura*, the kind that comes from the well or the bathroom faucet, is explosive under certain conditions. And so is air explosive under the same conditions. Unfortunately, those conditions obtain under circumstances in which they are not always apparent. They (the conditions) are confinement and application of heat in sufficient degree for the expansion to burst the confining walls. Some of the circumstances in which these conditions are not apparent are evidenced from time to time in "acetylene explosions" where no acetylene is used and in "acetylene explosions" in which, though used for heating, acetylene did not explode. An example of an explosion of this kind in which acetylene was not used at all was an explosion recently in a New York welding shop where, because oxy-acetylene apparatus was a part of the plant equipment, the news sleuths deduced another "acetylene explosion." It was not reported in one but in all of the New York City dailies as an explosion of acetylene. The facts were these: An automobile tubular drive shaft was placed in the fire of an ordinary blacksmith's forge for heating preparatory to straightening the tube. Unknown to the workmen the tube contained confined air. Had there been so much as a pinhole the expanding air might have escaped without violence. It would have been a very simple matter to tap the tube with a drill. This precaution was not taken merely because the air inclusion was not obvious. The result was an explosion that sent several workmen to the hospital to be treated for burns sustained from the flying embers from the forge. No damage was done to the shop, but the force of the bursting tube and released air was sufficient to endanger the lives of the workmen.

A little knowledge, a little horse-sense and the caution these beget ought to go a long way toward eliminating the types of accidental explosion just noted.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* HENRY LEE, *Vice-Pres. and Treas.*
ROY V. WRIGHT, *Secretary*
JOHN E. BURKE, *Business Manager*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 341 The Arcade
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, east of the Mississippi, $2. West of the Mississippi, Canada and Foreign, $3.

WE GUARANTEE that of this issue 5,200 copies were printed; that of these 5,200 copies, 4,101 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 88 were mailed to advertisers, 66 were mailed to employees and correspondents, and 929 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 5,200, an average of 5,200 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

GENERAL: Page
A Revolution in Marine Boiler Construction 1
Bureau of Locomotive Inspection Report 5
Metal Cutting Properties of Gases 9
How the A. S. M. E. Boiler Code Works in Ohio 11
When a Contract Isn't a Contract 11
Elementary Mechanics for Boiler Makers 12
An Unusual Boiler Failure 15
Increasing the Capacity of Old Locomotives 16
Standardizing the Installation of Electrical Equipment 18
The Ratio of Heating Surface to Grate Area 18
Work of the A. S. M. E. Boiler Code Committee 19
Useful Information for Boiler Shop Apprentices 20
Why Pick on Acetylene? 20
EDITORIAL COMMENT 21
ENGINEERING SPECIALTIES FOR BOILER MAKING 22
QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Helical Pipe Construction 24
Plate Calculations for a Large Tank 24
Air Lift Pump 26
Boiler Repairs by Autogenous Welding 26
Welding Tubes in Horizontal Boilers 27
Stacks and Draft Pressure 27
BUSINESS NOTES 27
LETTERS FROM PRACTICAL BOILER MAKERS:
Inspection Incidents in Railroad Shops 28
Men with Broad Training Needed in Boiler Shops 28
Areas of Cylindrical Pipes or Ducts 29
Typical Examination Questions for Boiler Inspectors 29
The Apprenticeship Problem 30
PERSONALS 30
TRADE PUBLICATIONS 31
ASSOCIATIONS 31
SELECTED BOILER PATENTS 32

Welding of boilers is gradually coming into prominence in England as evidenced by the approval of the grooved construction of Scotch marine boilers by Lloyd's Bureau. This type boiler has both the front and back heads, back tube sheet and the back combustion chamber sheet, electrically welded into grooves in the shell. The work saved by this method of construction is one advantage in its favor.

In this country the welding of heating boilers up to 15 pounds pressure has already been approved by the American Society of Mechanical Engineers and at least one insurance company is prepared to underwrite them. The one great obstacle to the adoption of the process in power boiler construction has been the impossibility of determining the strength of a weld by inspection after the work has been completed. The skill and care of the operator are really the only guarantee of the finished weld.

Operators to be successful with the arc welding apparatus must have special qualifications for the work in addition to a thorough fundamental training in handling the equipment. Since methods of welding boilers satisfactorily have been developed in England, so that the strength of the work is never in question, it is quite certain that there can be no permanent obstacle in the way of the adoption of the process in this country. The next few months will, undoubtedly, see the clearing up of many difficulties that now exist and will lead to an early recognition of welding in boiler work.

Although the year 1921 has opened with industry at an extremely low point, the prospects are good for an early improvement of conditions. In the boiler making industry, this is especially true, for with the curtailment of building during the last three years and the deterioration of power equipment, the necessity for new boilers in heating systems and power replacement units has become imperative. Unfortunately, the general depression has thus far prevented the placing of orders since building could not be undertaken at the prevailing high costs. However, decreased output of unessential products and falling prices have combined to hasten the time when it will be possible to carry through construction on a fairly normal basis and this condition of the market will soon be reflected in the boiler making industry.

In spite of the general increase in accidents to locomotives, tenders and appurtenances during the fiscal year ending June 30, 1920, as compared with the previous year, it is especially noteworthy that the Bureau of Locomotive Inspection of the Interstate Commerce Commission reports that all accidents and casualties caused by the failure of boilers for the year showed a decrease over the accidents in 1912, when the inspection department was first organized. The total number of accidents from this cause decreased 47 percent, the number killed 48 percent, and the number injured 49 percent. As the report states:

"These decreases are especially gratifying when considering the increased number of locomotives in service and the increased traffic being handled, together with the increased duties imposed on the inspectors by the amendment to the boiler-inspection law, which extended their duties to the entire locomotive and tender and the parts and appurtenances, which has added greatly to their work. These decreases demonstrate the wisdom of complying with the requirements of the law and rules, and the wisdom and foresight of its advocates when requesting its enactment."

As is customary in the annual report, certain recommendations are made for the improvement of the inspection service and for decreasing the number of disasters due to locomotive failures. These suggestions are given on another page of this issue and should be studied carefully.

Probably the greatest single effort of the bureau during the year was the investigation conducted on water level indicating devices, the results of which were published in the September and October, 1920 issues of THE BOILER MAKER. The adoption of the suggestions made in this report will aid materially in decreasing the explosions caused by low water.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Machine for Operating Cutting Torch

A new machine for operating the oxy-acetylene cutting torch was given its trial test in industrial service recently at the Government proving grounds, Sandy Hook, New York, in the presence of engineers of the development department of the Linde Air Products Company, New York, and a group of practical cutting blowpipe operators from the Oxweld Acetylene Company's Newark, N. J., welding shop. The latter company some time previously had entered into a contract to reduce 4,000 tons of punctured armor plate to charging box sizes, and the new machine was developed with the co-operation of Linde engineers in an effort to effect economies in the oxy-acetylene process involved.

The particular problem involved in the Sandy Hook job was to devise, if possible, a semi-automatic mechanical means of cutting irregular surfaces. The conditions confronting the cutters were such that no straight-line cutting machine then on the market was adapted to the work. The arbor plate was badly warped by the impact of the shells which had pierced it in target practice, and the punctures (six in each plate) were mushroomed and ragged. Each of the plates, 3 inches thick by about 9 feet by 13 feet, weighed between seven and eight tons. Besides irregularity of surfaces, another difficulty loomed large in the metallurgical composition of the metal, which contained high percentages of nickel and chromium. This kind of steel yields a heavy and viscous slag that does not flow freely from the kerf in blowpipe cutting. This not only retards the cutting speed, but necessitates higher oxygen pressures than are required in cutting ordinary steel of the same thickness.

The engineering difficulties, however, were quickly overcome and a completed test machine was on the job within a week after the hand cutters started work.

The power for operating the machine is furnished by a General Phonograph Company spring motor. On the turntable spindle is a worm. In mesh with the worm is a 72-tooth worm wheel on a horizontal shaft running in two bearings. On the outboard end of this horizontal shaft is fastened a knurled groove pulley. Above is another and larger knurled groove pulley which is held down by spring tension. Through these two rollers pass jointed knurled pull-rods of which the outer end is attached to a torch carriage. A lever is attached which pivots on the idler roller shaft, and when raised to a vertical position applies a brake to the lower driving shaft, at the same time separating the two rollers, giving freedom to the knurled pull-rod. The usual phonograph speed control is used. A change is made in the governor weights of the motor to run faster. This, together with the large gear reduction provided, gives a greater towing power to the pull-rod. An Oxweld C-7 machine cutting torch is mounted on a two-wheel cart having wheels 3 inches in diameter.

The wheels are made of cast iron and the bearings and wheels are protected from sparks by metal shields. Runners are provided on each side set close to and inside of the wheels. The runners are three inches in length and are mounted to clear the plate ⅛ inch. Their function is to prevent the torch carriage from falling off the plate at the start and finish of the cut. The combination of the two-wheeled cart with swivel connection to the pull-rod keeps the tip of the torch at the correct distance from the surface of the plate at all times in spite of the irregular surfaces of the warped armor, and the cut is thus kept at the correct angle to the plate. A "C" clamp attaches the motor to the plate and may be moved to a new line of cut by releasing the hand set-screw.

The entire equipment does not weigh over 30 pounds. In "setting up," all that is necessary to adjust the alinement is to place the motor so that the pull-rod extends over the line of cut, as the rod is always in the direct line of cutting.

Bench Drill Stand

A new drilling stand especially designed for portable electric drills is being manufactured by the Black & Decker Manufacturing Company, Baltimore, Md. The vertical column for this stand is a solid steel shaft of 1 7/16 inches in diameter and the height from the bottom of the base to the top of the column is 30 inches. The drill has a vertical adjustment of 12 inches, a drilling radius of 7 inches and a horizontal adjustment for 360 degrees. When operated by

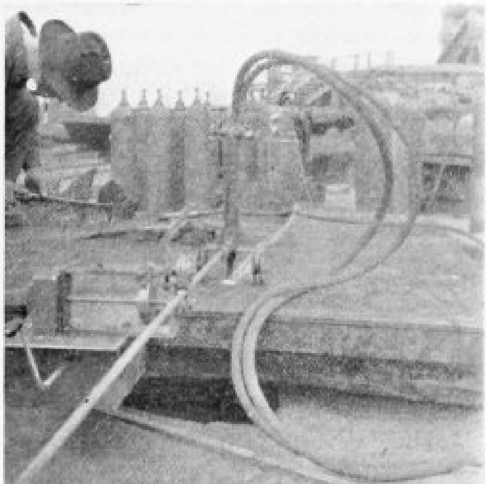


Fig. 1.—Semi-Automatic Device for OperatingOxy-Acetylene Cutting Torch

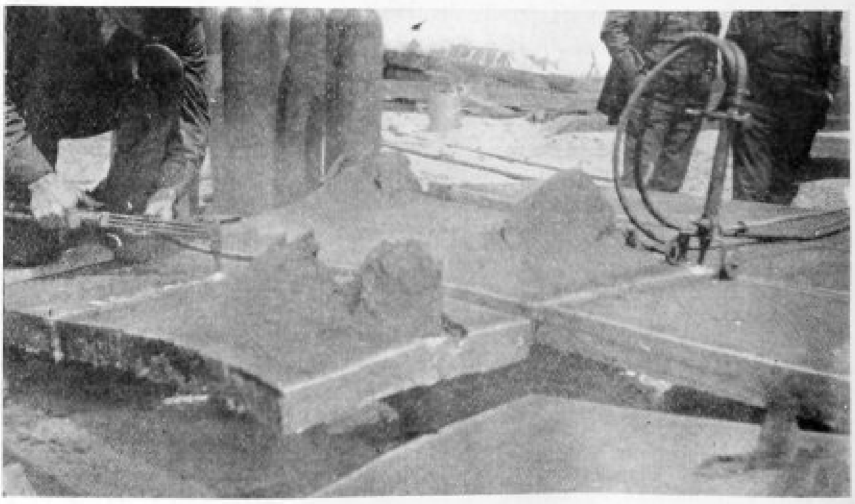
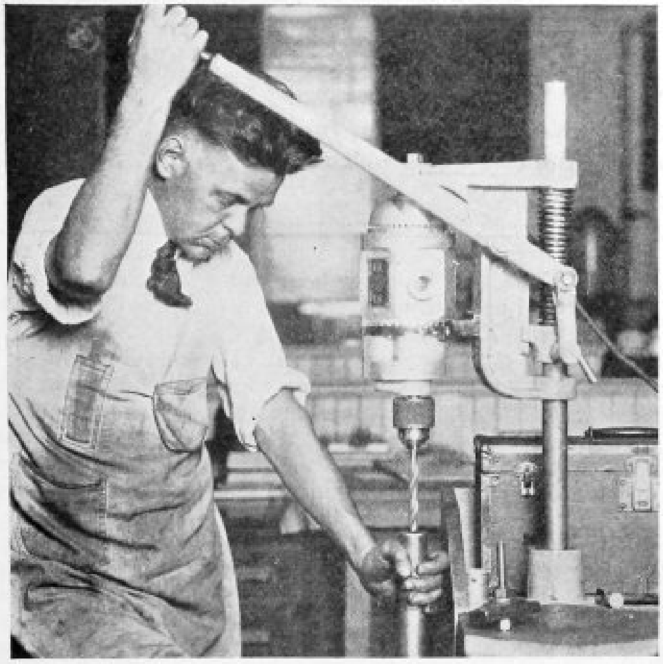


Fig. 2.—Relative Advantages of Hand and Machine Operated Torches Are Quite Marked in This Instance



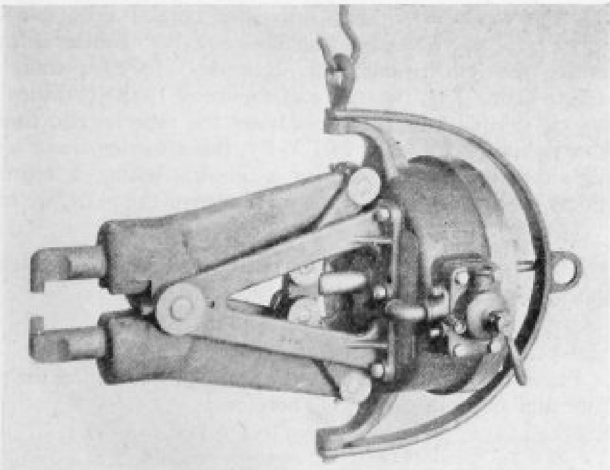
Bench Stand for Portable Electric Drill

the foot lever the vertical travel of the drill is 4 inches. The whole machine weighs 70 pounds.

The stand will accommodate Black & Decker drills 3/8-inch, 1/2-inch, 9/16-inch, 5/8-inch and 7/8-inch. The bracket carrying the drill can be raised or lowered on the vertical column and secured in any desired position by means of a split collar and clamping screw. The drill may also be swung clear of the base for such work as drilling the ends of shafts and other operations that cannot be accommodated on the bench.

Staybolt Cutter Adapted for Riveting

The machine in the accompanying illustration is a special riveter constructed along the lines of the staybolt cutter produced by the Baird Pneumatic Tool Company, Kansas City.



Riveter Originally Designed as Staybolt Cutter

The device has special arms and dies for extreme close corner work. The machine was particularly developed for the Railway Brake Specialties Company of Toledo, O. A pressure of 50 tons is exerted on the dies sufficient for driving 5/16-inch rivets cold.

In manufacture of the products of the Railway Brake Specialties Company rivets are driven in parts of the work that have hitherto been almost inaccessible to the hand hammer, but it is claimed that with this tool riveting is done uniformly without regard to where the rivet is placed.

Portable Electric Welding Outfit

A welding machine weighing 100 pounds complete and using 1/16-inch and 5/32-inch electrodes has been brought out by the Electric Arc Cutting & Welding Company, Newark, N. J. This machine operates on either 110 or 220 volt current of any desired frequency. The power supply must be of at least 5 K.V.A. in order to use this machine and come within the underwriters' requirements. Connections are quite simple; two wires are hooked from the machine to the power supply, and two other wires are attached to a plugging in board unit mounted on the machine for regulating purposes. In order to make the machine standard provisions are in-

Small Electric Welding Outfit for Repair Work

cluded for operating on voltages from 90 to 130 and from 180 to 260 volts. The machine is primarily designed for emergency repair work, but can be used for heavy work at a reduced rate of speed, although it is not economical in this capacity.

Pneumatic Rivet Buster

The engineering department of the Keller Pneumatic Tool Company, Grand Haven, Mich., has developed a practical air-operated tool for cutting off and backing out steel rivets. The tool is known as the "Iron Mule" rivet buster.

The device is simple in operation and requires no special skill on the part of the men using it. A gang of three men can work the tool to the best advantage—two on the throttle end and the other supporting the chisel end, holding it against the rivet. The air control handle is conveniently located at the right hand of the operator, and the force of the blow is entirely under his control at all times. A slight move of the handle permits the air to enter through the main air port, driving the striking piston against the chisel head. The force of the blow can be regulated so that heavy or light taps may be delivered as desired, to suit conditions of the work in hand. After the blow the handle is moved to the exhaust port, causing the piston to return to the head of the tool ready for the next blow. The machine has a capacity of cutting 7/8-inch and 1-inch rivet heads continuously in from four to six blows. The overall length of the tool is 67 inches, and its operating weight 82 pounds. The strike piston is 1 3/4 inches in diameter and 9 inches in length and has a stroke of 41 inches. The chisel projects 7 inches beyond the end of the tool.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th Street, New York City.*

Helical Pipe Construction

Q.—I have been called upon to lay out a cylindrical pipe which shows helical or twisted pipe constructions. How do you find the required full views for the pattern layouts and determine the twist on the miter lines? C. J. B.

A.—In work of this kind it is necessary to first establish a correct plan and elevation showing the relative position of the pipe's axes. From these foreshortened views full views are laid off showing the true angle between the adjoining pipes and also the amount that each section must be turned so as to produce the proper twist in the helical elbow. Unless this is determined the pipe sections would all lie in the same plane and would not make a helix.

In the example chosen to illustrate the problem the pitch (or rise and fall) in each pipe section is the same, but the principles in the development can be applied to any pitch of pipe sections. Pipe constructions of this kind arise often in blast furnace, blower piping and exhaust system work.

Construction Details

In Fig. 1 a plan and elevation show the pipe axes at *B-C-D-E* and *F*. Note that the axis *D* lies in a plane parallel with the vertical, hence it is shown in its true length in the elevation. The pipes are considered to be formed about a larger pipe and wound, so to speak, in the form of a helix. To the left of the elevation is a vertical base line divided into as many parts as required for the location of the pipe axis, in this case 5. To establish their position it is necessary to divide the semicircle 1-6 plan view into the same number of parts. Then from the points as 1-2-3-4 of the plan view draw vertical lines to intersect the corresponding horizontal lines drawn from the vertical base line. Connect the points 1-2, 2-3, 3-4, etc., in the elevation. The next step is to show a full view and true angles between the adjoining sections. This is done as follows:

Extend the axis *D* and draw an end view showing the position of the axes *C-D* and *E*. The axis for *D* will be a point and *C* and *E* two radial lines connecting it. With point *r* in this view as a center, draw a circle equal in diameter to the pipe sections *D*. On the line *D-r* set off the distance *a*, Fig. 1, which is measured at right angles to the axis *D* (line 3-4), thus locating a point *s*. Draw a line from this point and a right angle to line *D-r*. Parallel to the line *D-r* and from the points 2′ and 5′ of the elevation Fig. 1 draw projectors to intersect the end view in points 2″-5″. Where the radial lines *r-2* and *r-5* cross the circle locate points *o-o*. The arc length between these two points is the amount that sections *C* and *E* must be turned on their axes with respect to the axis *D* in order to secure the required twist in the elbow sections.

Fig. 2 is laid off next by first drawing a line parallel with *D* of Fig. 1. Projectors are drawn from points 3′-4′, Fig. 1, to Fig. 2, likewise from points 2′ and 5′ as shown. These lines, it will be noted, intersect as at *Y*-3″-4″ and *X*. From point *X* and *Y* set off the distances *Y*-2″ and *X*-5 equal to *r*-2″ or *r*-5″ of the end view, Fig. 1. The lines 2″-3″, 3″-4″, 4″-5″ are the full views of the pipe axes *C, D* and *E*, and this view also shows the true miters and angles between the pipes.

The patterns show the complete developments, but in this case only the top sections *B, C* and *D* are laid out; the lower sections would be developed in the same way. In this case the twist for the sections *C, D* and *E* can be made in the development of the section *D*, as illustrated. An end view, Fig. 2, is transferred from Fig. 1, but turned so as to bring the arc *o-o′* in its proper place with respect to the full view of the elevation. The preliminary work of dividing the profile and setting off the patterns will not be explained, as the patterns and views show the complete method.

Plate Calculations for a Large Tank

Q.—I am interested in constructing a large tank of about 100 feet in diameter. I would like to know how to deduce an empirical formula for finding the thickness of shell plates and also how to cover the tank properly. Please advise me whether you have such information available. S. K. K.

A.—A cylinder subjected to a pressure from either steam or water is strained equally in all parts. When rupture takes place it is in the direction of its length. Refer to the accompanying diagram which is a section of a cylinder or pipe. The internal diameter equals *D* and its thickness is *t*. Suppose it is subjected to a water pressure. This pressure acts in all directions, but the pressure in any direction is equal to the pressure on a plane at right angles to it.

For illustrating the principle, take the plane *V-W-X-Y*. The pressure is shown by arrows acting perpendicular to this plane. The width of *X-Y* equals the internal diameter *D* of the pipe and its length is equal to the pipe length. The area of the plane *V-W-X-Y* equals its width *D*, times its length *L*. The total pressure considered to be acting on it equals $D \times L \times p$. The pipe thickness equals *t*, and its ultimate tensile strength equals, for example, 55,000 pounds per square inch. The resistance of the metal to the pressure acting on it equals its thickness times the pipe length, times 2 (for the two sides *Y-W* and *X-V*), times the tensile or working strength. In the form of a formula letting *T* represent the tensile strength and *R* the resistance of the plate, we have:

$$R = t \times 2 \times L \times T.$$

The resistance of the metal must be at least equivalent to the pressure, hence:

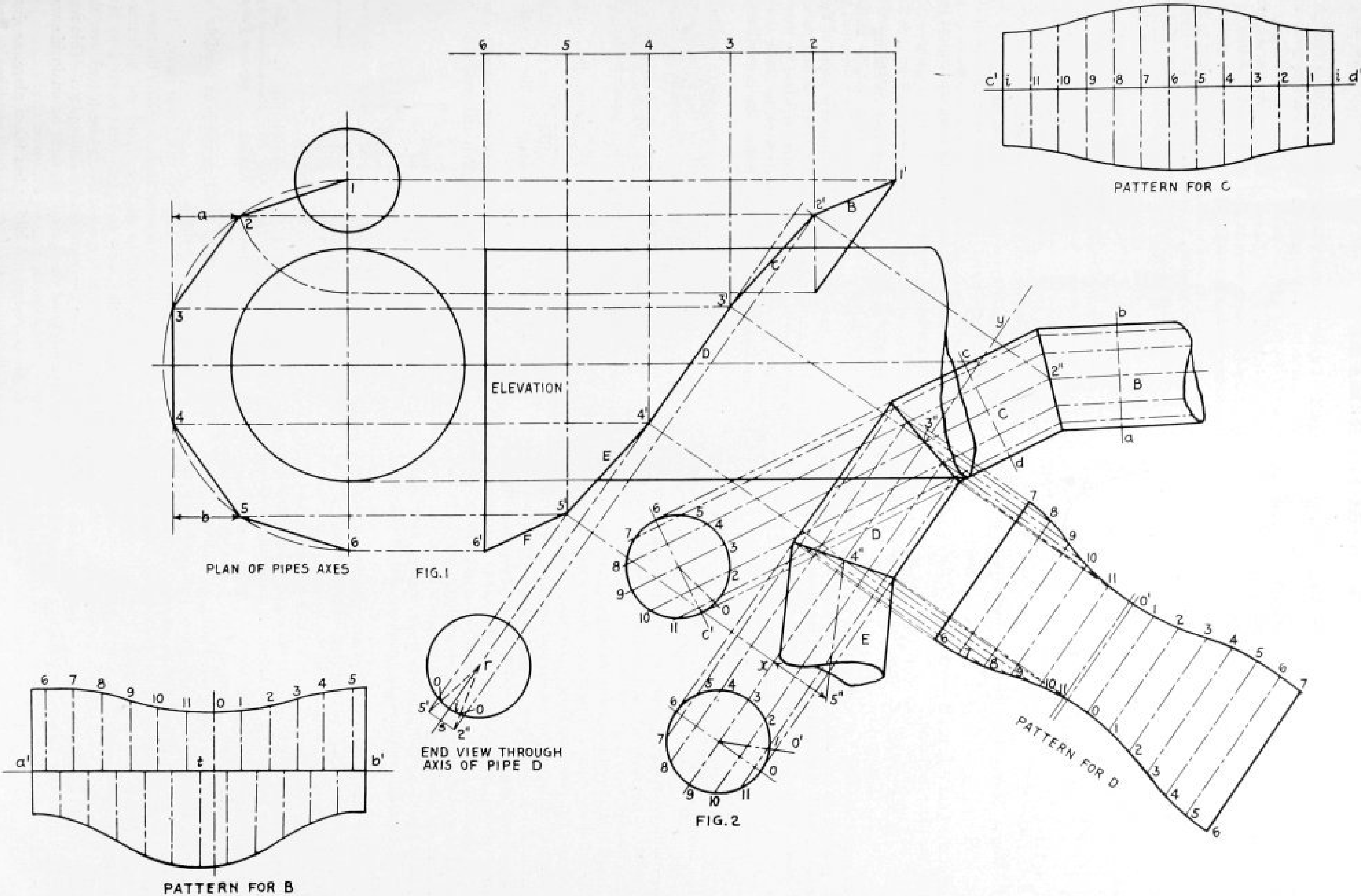
$$D \times L \times p = t \times 2 \times L \times T, \text{ or}$$
$$D \times p = t \times 2 \times T.$$

From this may be deduced the formula for finding the pressure and plate thickness. Therefore:

$$(1)\quad P = \frac{t \times 2 \times T}{D}, \text{ and}$$

$$(2)\quad t = \frac{P \times D}{2 \times T}.$$

In designing tanks, boilers, etc., the tensile strength of plate and factor of safety is usually specified, also the diameter and pressure per square inch. From these data the joint calculations are made. In the above deductions for the formula the cylinder was considered without seams. Where



General Layout of Cylindrical Pipe in the Form of a Helix seams occur use the factor of safety and the efficiency of joints in the calculations.

For example, consider a cylinder 30 inches in diameter, subjected to a pressure of 100 pounds per square inch. Effi-

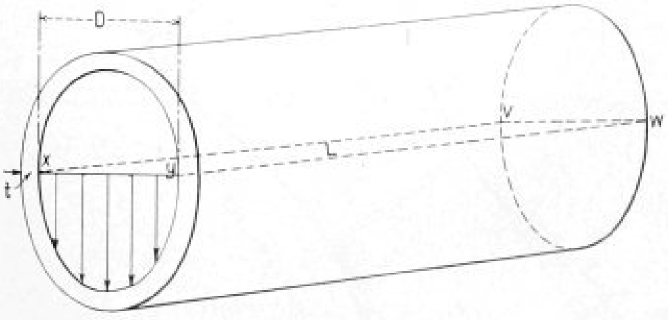


Fig. 1.—Diagram Showing How Internal Pressure Acts in a Cylinder or Pipe

ciency of the joint equals 50 percent and factor of safety 6. To find the plate thickness:

$$\frac{100 \times 30 \times 6}{2 \times 55{,}000 \times .50} = 0.334, \text{ say } 3/8 \text{ inch.}$$

The metal covering for such a tank would ordinarily be made pitched toward center in the form of a cone and the frame work built up self-supporting from structural members as I-beams, channels and angle irons.

Air Lift Pump

Q.—Could you furnish me with any information on the deep wells using compressed air for lifting the water? The problem with which I have to deal is in connection with three wells each 450 feet deep, air and discharge pipe down over 400 feet, water 70 feet from the surface. J. K. L.

A.—With reference to your inquiry on lifting water by compressed air, in Kent's Engineering Hand Book, pages 808 to 810 inclusive, data are given and reference made to articles published in engineering periodicals on this question.

The following quoted in part from Kent's will assist you:

"The air lift pump consists of a vertical water pipe with its lower end submerged in a well, and a smaller pipe delivering air into it at the bottom. The rising column in the pipe consists of air mingled with water, the air being in bubbles of various sizes, and is therefore lighter than a column of water of the same height; consequently, the water in the pipe is raised above the level of the surrounding water. The fact that there are absolutely no moving parts makes the pump especially fitted for handling dirty water, sewage, mine water and acid or alkali solutions in chemical and metallurgical works."

Numerous tests of air lift pumps are described in Greene's "Pumping Machinery." Greene says that the air pipe should be introduced near the bottom of the discharge pipe and should be immersed so that the ratio h_1-h is 3 to 1 at the start and 2.2 to 1 in operation. The h_1, given is the depth of immersion below the water level and h the height of the discharge at the top of the well measured above the water level.

In *Engineering News,* June 8, 1893, issue, details and theory of the pump are given. H. Tipper, *Engineering News,* January 16, 1908, mentions cases where 1-inch air lines supplied air for 6-inch wells, with the inside air pipe system; the length of the pipe was 300 feet from the well top, and another 350 feet to the compressor. The wells pumped 75 gallons per minute, using 200 cubic feet of air, the efficiency being 6½ percent. Changing the pipes to 2½ inches above the well and 2 inches in the well, and putting an air receiver near the compressor raised the efficiency to 23 percent. A large receivr capacity a large pipe above ground, a submergence of 55 percent, well piping proportioned for a friction loss of not over 5 percent, with lifts not over 200 feet, gave the best results, 1 gallon of water being raised per cubic foot of air. The utmost net efficiency of the air lift is not over 25 to 30 percent.

An article in *The Engineer* (Chicago), August 15, 1904, gives the following formula and rules for the design of air lifts of maximum efficiency. The authority is not given.

Ratio of area of air pipe to area of water pipe, 0.16.
Submerged portion equals 65 percent of total length of pipe.
Economical range of submersion ratio, 55 to 80 percent.
Velocity of air in air pipe, not over 4,000 feet per minute.
Volume of air to raise 1 cubic foot of water, 3.9 to 4.5 cubic feet.

C = cubic feet of water raised per minute.
A = cubic feet of air used.
L = lift above water levels.
D = submergence, in feet.

$$A = \frac{LC}{16.824}.$$

$$C = \frac{8.24AD}{L^2}.$$

Where L exceeds 180 feet it will be more economical to use two or more air lifts in series.

Boiler Repairs by Autogenous Welding

Q.—Will you explain some of the boiler repairs made by autogenous welding?

A.—The accompanying sketches illustrate some of the repairs often made. There are many other defects to which boilers are liable and that can be safely repaired by this process of welding. In handling repair work by either the oxy-acetylene or electric arc method, follow the inspection rules governing such work.

The aim should be to produce homogeneous welds, and if properly done the tensile strength of the weld is over 80 percent of that of the solid plate. To obtain such an efficiency in welding it is required:

(1) To prepare the joint properly, first by cutting a V in both joints which will have a net area equal to that of the plate section.

(2) To clean the edges, removing grease, dirt, rust and scale.

(3) To use filling material that will produce a good weld.

(4) To employ the proper amperage for the size of electrode used.

(5) To employ thoroughly experienced workmen who understand the stresses due to expansion and contraction which

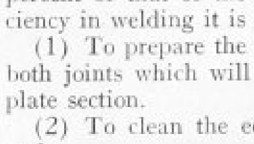


Fig. 1.—Corroded Plate Built Up by Welding Process

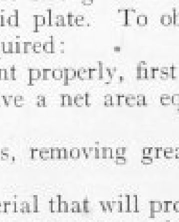


Fig. 2.—Corroded Lap Joint Also Repaired by Welding

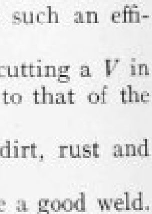


Fig. 3.—Tube Plate Reconditioned by Autogenous Process

must be taken care of, to avoid as much as possible strains in the work after it is welded.

To apply a patch, the defective part is cut away. The part removed can be used as a template for making the new patch. The new patch should be slightly dished and a clearance allowed between the patch and plate of at least ⅛ to ¼ inch. For a temporary repair a patch may be placed over the defective part and the edges welded to the plate. This repair is not recommended on heating surfaces as on inside wrapper sheets, crown sheets, etc., of fireboxes.

Where corrosion and pitting has taken place, as shown in Fig. 1, the damaged plate can be built up; likewise laps as in

Fig. 2. The effected plate should be scraped clean so as not to interfere with the welding process.

Cracks between stays and between tubes not exceeding 8 inches are easily repaired by welding. A *V*-groove is cut along the crack penetrating almost through the plate. Starting at one end, fill in the *V*, building the metal up from the vertex or bottom of the *V*-groove.

Corrosion of tube plates around tubes may be repaired by welding in new material in the corroded sections, as shown in Fig. 3.

Welding Tubes in Horizontal Boilers

Q.—What objections, if any, are there to welding over the beads on tubes in the rear head of horizontal return tubular boilers when the tubes leak and become crystallized? Are there any objections to using the same method on the front head of horizontal boilers? Where would it be possible to obtain a good text-book on the various methods of welding explaining the theory and practice as applied to the boiler making industry? W. S.

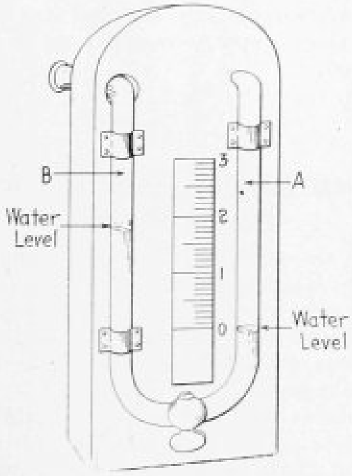
A.—Autogenous welding is now employed by many railroads in making repairs to boilers. Good judgment and care must be exercised in handling welding repair work to insure homogeneous welds. In tube welding such as re-ending tubes, welding in tubes in heads, welding light beads to stop leaks, etc., the electric method has proven very satisfactory.

When tubes are damaged inside the line of bead from corrosion or are crystallized they should not be welded, because it is impossible to determine to what extent they are damaged. Such tubes should be replaced. Welding over the bead will not give as satisfactory a weld as when the tube and plate are arranged for welding as shown in the accompanying sketch. The publishers of the *Welding Engineer*, Chicago, Ill., will advise you as to the best text-book on welding.

Stacks and Draft Pressure

Q.—I would like to learn the cause of draft in a chimney or stack and also of the general rules for proportioning a stack as to diameter and height.

A.—Natural draft in a chimney is due to the difference in weight between the hot gases in the chimney and the weight of an equal volume of cold air on the outside which causes the hot gases to move upwards. It is a well-known fact that gases when heated are lighter, volume for volume, than when cool. Heated gases entering a chimney have a temperature



Draft Pressure Gage

from 400 to 500 degrees, and the outside temperature is much less; hence the air on the outside weighs more, volume for volume, than the gases in the stack, thus causing the outside air to flow to a point of lower pressure—that is, through the furnace or firebox into the stack.

The draft pressure is measured by a water gage, which is a glass tube, usually made in the form of the letter *U*. One end is attached to the chimney and the other is open to the atmosphere. The sketch illustrates one form of a draft gage.

The principle of this gage is as follows: The leg *A* is open to the atmosphere and *B* is attached to the chimney. Air on the outside of the chimney being heavier than the gases inside forces the water in the glass to rise until the weight of the water balances the outside air pressure. The difference in height between the two water levels indicates the draft as measured in *inches* of water. One inch of water corresponds to a pressure of 0.036 pound per square inch.

Chimneys should be so designed that the gases may be discharged freely. Some stationary engineers base the cross-sectional area of a stack on a ratio of one square foot of stack to every eight feet of grate area. Bear in mind also that the grade of fuel to be burned is also a factor. Wood requires very little draft, about ½ inch of water, as measured on the test tube referred to.

Soft coal (bituminous) requires less draft than hard coal (anthracite). A draft pressure of 1¼ inches is required to burn anthracite, culm or slack coal.

The intensity of the draft depends on the height of the chimney and the difference in temperature between the outside air and gases within the chimney. The following formula expresses the relationship between height of chimney, gas temperature and draft pressure required:

$$d = H\left(\frac{7.6}{Ta} - \frac{7.9}{Tc}\right),$$

in which:

d = draft pressure, inches of water.
H = height of chimney, in feet.
Ta = absolute temperature of outside air.
Tc = absolute temperature of chimney gases.

BUSINESS NOTES

D. J. Crowley has been appointed Michigan sales agent of the Tacony Steel Company, Philadelphia, Pa. Mr. Crowley's office is in the Dime Bank building, Detroit, Mich. D. B. Carson has been appointed Cleveland district sales manager.

The Chicago Pneumatic Tool Company, Chicago, Ill., announces the removal of its rock drill plant from 864 East 72d street, Cleveland, Ohio, to the company's Boyer pneumatic hammer plant at 1301 Second Boulevard, Detroit, Mich. Location of the company's Little Giant air drill plant at 1241 East 49th street, Cleveland, remains unchanged.

E. P. Williams, formerly director of field work, Bureau of Market Analysis, Inc., has become associated with the Independent Pneumatic Tool Company, Chicago, Ill., manufacturer of "Thor" air and electric tools. Mr. Williams will have charge of the Direct by Mail Advertising and Sales Promotion Department of the company and will be located in the general offices at 600 West Jackson Boulevard, Chicago.

S. T. Callaway, of the firm of Callaway, Fish & Company, New York, and his associates have acquired a substantial interest in and are financing the Elvin Mechanical Stoker Company. Mr. Callaway has been elected president of the company. A. G. Elvin, the inventor of the Elvin mechanical stoker, who is largely interested in the company, has been elected vice-president and treasurer. Mr. Elvin is also the inventor of the Elvin driving box lubricator, the Franklin grate shaker and the Franklin fire door. S. T. Whitaker, of the law firm of Hardy, Stancliffe & Whitaker, attorneys for the company, has been elected secretary. The directorate of the company includes the officers as mentioned above and F. M. Richardson, of the Sherwin-Williams Company. A long-term contract has been entered into with the American Locomotive Company, under which the stoker will be manufactured for this company by the American Locomotive Company at its Schenectady works, thereby enabling the company to accept immediately contracts in quantity for stokers.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Inspection Incidents In Railroad Shops

I have read with much interest the letters of C. W. C. on page 339 of the November issue of THE BOILER MAKER, especially that part where, after examining the boilers, he compared notes with the other inspector and arrived at entirely different conclusions.

C. W. C. shows by his instructions to the chief engineer (to have bulged tubes removed) that he realized the danger of keeping such tubes in service any longer, while the other inspector was willing to take another chance, since he had been taking chances for many years. Incidentally, bulged tubes in service for ten years speaks highly for the material used in the tubes.

In tours of inspection I have seen tubes in light locomotives that have given fifteen years' service, but they had received the very best of care, in handling and the best of feed water. As a general rule, tubes ten years old are badly crystallized. When a tube is bulged its strength is gone and it is liable to break through at the highest point of bulge, then rip up and cause trouble in the boiler room or in the locomotive.

I have seen the tubes in a Cahill boiler badly bulged and iron bands put around them with asbestos under the bands, to stop the leak. This work was done by a so-called boiler maker in the owner's service and he got away with it for a time. When we were called in we ordered the removal of seven tubes.

I have followed inspectors of all kinds in my time and have found many glaring cases of lack of knowledge of the business they were supposed to be experts at. A case in point was that of a small vertical boiler used by stone masons on a construction job. This boiler was passed by the county inspector and a certificate to 90 pounds of steam given. Shortly after this state inspectors were called in, who condemned the boiler on account of the seams being badly grooved. Later the boiler was scrapped.

There is a wide divergence of opinion among practical boiler makers as to what constitutes a defect in a boiler, and when practical men who have served an apprenticeship and passed all the various branches of the trade differ, what can be expected of men who have gained their knowledge as stationary engineers or firemen. They may be good men at their particular calling, but when they begin to dabble in boiler work they are out of their element and have missed their vocations. The fact that they are able to work out the various formulas of strength of joints, etc., does not make up for their lack of knowledge of boiler construction.

I was very much interested also in "Essential Information for Boiler Shop Apprentices," by G. L. Price (page 316, November BOILER MAKER), and think that the subject is handled in a very able manner, but feel compelled to differ with him on the matter of the hammer test for fractured or broken staybolts. He asks the question, "Can fractured staybolts be discovered by the hammer test?" and answers the question in a very doubtful way by saying that he has never found it so and that the proper method of detecting fractured staybolts is by an internal examination, etc.

In differing with Mr. Price on the hammer test I want to say that it is quite possible to detect a fractured staybolt by the tap of the hammer, that I have used the hammer in all my staybolt examinations for the last thirty years, and so distinct is the sound given off that it is a rare occasion when I have to hit a bolt the second time before discovering that it is fractured.

Many inspectors today depend upon the telltale hole notifying them of a fracture, but when the telltale hole ceases to function (that is, when it is closed with rust or dirt), which it frequently does, then the never-failing hammer test discovers the fractured staybolt.

Flexible staybolts are the most difficult of all staybolts to inspect for breaks. Yet we have inspectors in our round houses who can locate a broken flexible staybolt by the tap of the hammer, even when the boiler is empty of water and without the boiler being under pressure, which is the usual way to test flexible staybolts between the periodical cap removal tests.

Internal examinations of staybolts can only be accomplished on the annual hydrostatic test, and then only a few of the rows of staybolts are visible, so that this method cannot be depended upon, for it would leave a lot of the staybolts uninspected. The back head would be out of the question, so would the greater part of the side sheets. In many types of boilers the throat sheet could not be seen unless the tubes were removed.

While on the subject of staybolts, I want to say that every railway shop or round house throughout the country contains one or more boiler makers who are company inspectors who are capable men not only in that line but in general inspection, and who are worthy of better positions, but lacking the education are debarred from promotion to something higher up. In conversation with an inspector on the flexible staybolt he told the writer that the only way to tell when such bolts were broken was to look along the side sheet for bulges. Another man, a foreman, told the writer that he had never seen a broken flexible staybolt, although he had worked on the New York Central Railroad from New York City to Chicago, that there was no need of testing such bolts, that they never break when properly installed. The flexible staybolts have a long life, but when improperly installed they break, for they have not been given proper room to expand or move with the expanding sheets.

Wilkinsburg, Pa. FLEX IBLE.

Men With Broad Training Needed in Boiler Shops

While there are very few, if any, inducements offered to a young man to enter the boiler shop today as an apprentice, to give up not only years to master the trade but to sacrifice his hearing as well, it would seem absolutely essential that some substitute be provided to take the place of the old-time apprentice and erstwhile "rivet boy."

The requirements demanded today of a boiler shop foreman or superintendent are greater and more exacting than ever. He must know not only how to do the work but also the "why" and the "wherefore" as well. The machines employed are more numerous and heavier than at any time in the history of the trade, and a knowledge of their operation and familiarity with the details of their construction are most essential. Added to all this is the seemingly endless number of regulations, and these the up-to-date man must know, almost in detail. If he is not thoroughly conversant with his work the drafting room is more than likely to put some new fangled idea across which, after a time, will so fasten itself to the uses of the trade as to become a part of it.

Moreover, while it does not seem logical that men who know only a side line of the trade should qualify as general foremen and superintendents, yet it is nevertheless a fact that such conditions are obtaining in very many of our boiler shops today. Draftsmen who know nothing of the practical end of the trade are put in charge of a body of men to guide and direct them in the building of boilers which must qualify under the law, and it can easily be imagined how humiliating it is to a "boiler maker" to ask these pseudo foremen how to do a certain piece of work and to be told "I don't know."

The old-time foreman was always able to show his men how he wanted the work done, and the most successful handler of labor today is the one who can lead rather than the one who attempts to drive his men.

Surely there will be found some way to develop "large" men in the boiler shops who will be able to qualify as foremen in the truest sense of the word, for we need them today more than ever before.

Cambridge, Mass. W. K. C.

Areas of Cylindrical Pipes or Ducts

The accompanying chart will be found handy for:

Determining the radiating surface of all kinds and sizes of pipe;

Determining the heating surfaces of boiler tubes, superheater flues, condenser tubes;

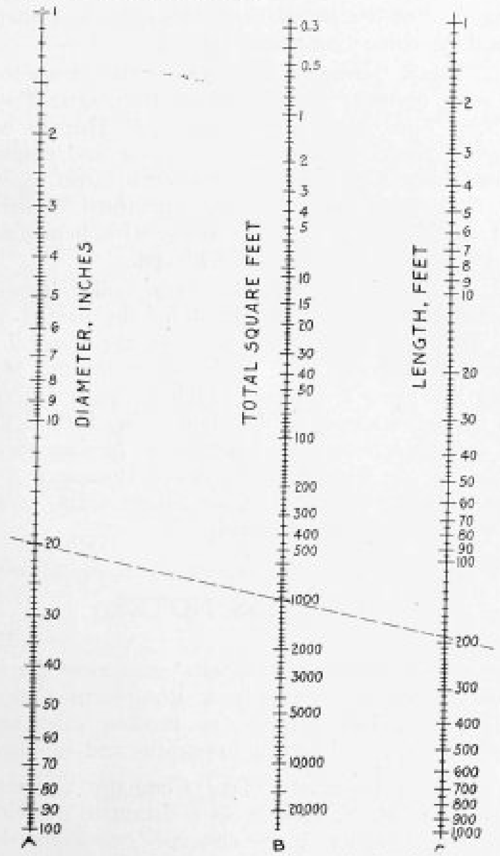


Diagram for Finding Areas of Cylindrical Pipes

Determining the square feet of surface of refrigerating coils;

Determining the square feet of metal needed for circular ventilating and heating ducts, etc.

In fact, wherever it is desired to find the area of a cylindrical structure of the shape of a common pipe, this chart will do the trick quickly and well.

As will be noted, its range is very wide—from 1 to 100 inches diametral measurement, and from 1 to 1,000 feet lineal measurement.

The dotted line drawn across the chart, for example, shows that where the diameter is 20 inches and the length 191 feet, the total area is 100 square feet.

The chart may also be used "backwards" to advantage. For example, if any figure in column *C* is known, and the total radiating area in column *B* is known, a straight line through the two points will give the correct diameter in column *A*.

Brooklyn, N. Y. WILLIAM F. SCHAPHORST.

Typical Examination Questions for Boiler Inspectors

The examination questions and answers in recent issues of THE BOILER MAKER have prompted the submission of the following series of questions and answers on the steam gage and safety valve as used in the examination of inspectors whose duty it is to care for these all-important appliances:

What is a steam gage?

It is a mechanical apparatus for determining the number of pounds pressure per square inch for each square inch on the inside of the boiler.

Does the steam gage register the absolute pressure?

No. It registers steam pressure alone; absolute pressure is the pressure registered on the gage plus 14.7 pounds atmospheric pressure.

Why is it necessary to test a steam gage before applying it to a boiler?

Because the rough handling of any steam gage is liable to change its reading, and when once applied to a boiler it is not subject to the rough usage it sometimes receives in shipping.

How often should a steam gage be tested?

Every thirty days or any time any irregularity is indicated in its reading.

In testing a gage, if you found the hand would lose or gain all the way up to the maximum working pressure, would you change its adjustment?

Yes. I would lengthen the linking movement if the gage hand gained in its reading and shorten the length in movement if the gage hand lost in its reading.

In testing a gage, if you found the hand 5 pounds fast or slow all the way up to the maximum working pressure, would you change the adjustment?

No. I would reset the hands.

Is a siphon necessary to a steam gage?

Yes. It insures the tube being full of water instead of steam, and it should be of sufficient capacity to keep the water as low as 140 degrees F.

Why is it necessary to keep the cocks and gages tight between the siphon and gage?

To insure the gage tubes being always full of water.

Will an improper fit between the siphon and socket to the gage have a tendency to make the gage read incorrectly?

Yes. This fit should be made so that it will not be necessary to draw excessively hard on the socket connection.

What is a safety valve?

An automatic appliance usually attached to the highest point of a boiler, and its function is to prevent the pressure of the boiler, to which it is applied, from rising above a definite point.

How many safety valves must a locomotive boiler have?

Not less than two and as many as is necessary to relieve the boiler under the most extreme strain to which the boiler may be subjected.

How are safety valves set?

With reference to the maximum working pressure of the boiler and the amount of blowback necessary to relieve the boiler.

What two factors determine the relieving capacity of all safety valves?

The diameter and the amount that the valve lifts.

How often should safety valves be set?

Each time the steam gage is tested.

Should safety valves be set independently of one another? Yes.

How much above highest working pressure of the boiler may the highest valve be set?

Six pounds.

Meadville, Pa. C. E. L.

The Apprenticeship Problem

The question of boiler maker apprentices should be brought up for discussion and we should try and find some means of inducing the young man of today to take up this important trade.

I believe one of the main reasons why there is little interest shown in this matter is that the average apprentice gets discouraged too quickly, as well as the fact that the good mechanics in the shops do not make it a point to help him along. The apprentice does not get all the assistance or instruction that he should in the railroad shops and receives very little information that should be given him. Then, too, when a young man becomes an apprentice he receives very little compensation during this period, and would be just as far ahead, if not farther, had he hired out as a helper. The helper is soon taught to be a one-class specialist and is soon rated as a boiler maker.

Go through the roster in our railroad shops today and see how many A-1 mechanics there are and how many have been classed as mechanics who are in fact most anything else. When an apprentice puts this question to himself, would it not be enough to discourage anyone: "What chance have I for advancement compared with the helper; he receives big money while I receive little or nothing; he gets just as good a show as I do, if not better, and in the end, as he has been at it longer than I have, receives the preference for advancement." There is an agreement in the railroad shops stating that the oldest man has seniority rights.

The younger man must stand back no matter how capable he is, just to satisfy the older one. The layer out is also very secretive about his work and will not show the apprentice anything.

I have been connected with the railroad shops for the past nine years and have done quite a bit of traveling and have taken an interest in observing what is being done for the good of the trade. I have seen men hire out who did not know what was meant by a wagon top boiler or a crown sheet, and would work until they could not bluff any longer, then off they would go.

To the readers of THE BOILER MAKER I would suggest that some action be taken to revive an interest in the apprenticeship question, and if there happen to be apprentices in the shop where you are located, give them a boost and increase their confidence in themselves.

Teach them the why and wherefore of everything, get them to study and learn laying out at home during spare hours, and after finding out there is someone taking an interest in them, I believe we will really accomplish something. If they make mistakes, show them how to correct the difficulties and I am sure that next time they will do better.

Olean, N. Y. CHARLES W. CARTER, JR.

The National Board of Boiler and Pressure Vessel Inspectors will hold its first annual meeting at the Statler Hotel, Detroit, Mich., Feb. 2, 3 and 4. Details of the programme will be furnished later.

G. W. Boschke has been appointed assistant chief engineer of the Southern Pacific, Lines West of Ogden, El Paso and Portland, with headquarters at San Francisco, effective January 1.

PERSONALS

G. A. Schneider, mechanical engineer with the Standard Steel Car Co., has returned from France and is now in Chicago.

John P. Bourke has been appointed eastern sales manager of the Ewald Iron Company, Louisville, Ky., in charge of their New York office, which has just been opened in the Aeolian Building at 33 West 42d Street, New York City.

H. G. Keller, manager of the Philadelphia, Pa., office of the Independent Pneumatic Tool Company, Chicago, has been promoted to manager of the New York office and F. H. Charbono, manager at St. Louis, Mo., has been promoted to manager of the Philadelphia office to succeed Mr. Keller.

A. L. Haas, well known to readers of THE BOILER MAKER as a contributor, has been appointed by the High Commissioner for India, Mechanical Engineer Store Department, Government of India. Mr. Haas is located at the India Store Dept., Belvedere Road, Lambeth, London, England.

Ethan Viall, editor of the *American Machinist,* and a member of their staff for ten years, has resigned to become a member of the firm of T. W. Minton & Co., Barbourville, Kentucky. Mr. Viall is a member of the A. S. M. E., A. I. E. E., S. A. E., and several others. He is author of Broaches and Broaching, Gas Torch and Thermit Welding, Electric Welding, United States Artillery Ammunition, United States Rifle and Machine Guns, and others.

H. L. Dean, formerly manager of the compressor and engine sales division of the Chicago Pneumatic Tool Company, New York, has resigned and J. F. Huvane has been appointed Eastern manager of compressor and engine sales, with headquarters at 6 East Forty-fourth Street, New York, and G. C. Vanden Boom has been appointed Western manager of compressor and engine sales, with headquarters at 300 North Michigan boulevard, Chicago.

J. H. Petherick, Jr., who has been boiler inspector for the United States Shipping Board for the past 3 years at Seattle, Wash., is now at the plant of the General Boilers Company, Waukeegan, Ill., as inspector for the Maryland Casualty Insurance Company, which company inspects and insures the entire output of the plant. Mr. Petherick is well known throughout the entire northwest, having been boiler inspector for the Fidelity & Casualty Insurance Company of New York, in that district for fifteen years, previous to going with the Shipping Board.

BUSINESS NOTES

The Oxweld Acetylene Company announces the appointment of the Standard Supply & Equipment Company of New York and Philadelphia, as Eastern sales agent for Eveready welding and cutting apparatus and supplies.

The Chicago Pneumatic Tool Company announces the appointment of R. F. Eissler, as assistant to the vice-president, with headquarters in the company's new office building at 6 East 44th street, New York. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburgh branch to succeed Mr. Eissler, and Ross Wyeth, formerly attached to the Pittsburgh branch, has been appointed district manager of the New Orlans branch to succeed Mr. Straub.

The Illinois Stoker Company, Alton, Ill., manufacturers of forced and natural draft chain grate stokers, announces the appointment of the Ernest E. Lee Company, as district representatives for Iowa, Wisconsin, Michigan, Northern Indiana and Northern Illinois, with offices at 115 South Dearborn street, Chicago, Ill.

TRADE PUBLICATION

PORTABLE CONVEYOR.—Brown Portable Conveying Machinery Co., 10 South La Salle Street, Chicago. Pamphlet. Illustrates and describes portable conveying machinery for packed or loose materials.

CONDULETS.—The Crouse-Hinds Company, Syracuse, N. Y., has issued bulletin 1000R, describing condulet fixture joints and extensions. The bulletin also includes specifications and price lists for various type joints.

HIGH SPEED FRICTION SAWS.—Bulletin 9,011 containing illustrated descriptions and specifications of Ryerson high speed saws, has been issued by Joseph T. Ryerson & Son, Chicago, Ill. These saws have been designed especially for the rapid cutting of structural steel.

THE P. & H. CHRONICLE.—A catalogue issued by the Pawling & Harnischfeger Company, Milwaukee, Wis., gives the story of the foundation and development of the company. Photographs of the personnel and of the plant as well as of the products give an idea of the organization and its work.

LIFTING JACKS.—The Duff Manufacturing Company, Pittsburgh, Pa., is distributing catalogue no. 104, a new 148-page book illustrating and describing the complete line of Duff lifting jacks. It includes jacks of all types for steam railway work—track jacks, car jacks, locomotive jacks, bridge jacks and journal box jacks.

LEATHER BELTING.—The manufacture and renovation of leather belting are treated in catalogue no. 12, of the Consolidated Belting Company, Philadelphia, Pa. A valuable feature of the catalogue is a concise discussion of belting problems and their solution and formulas for calculating the proper sizes and speeds for belts.

THE NATIONAL BULLETIN.—Number 14C bulletin of the National Tube Company, Pittsburgh, Pa., contains complete illustrated descriptions of the application of tubular steel poles to lighting, signalling, telegraph, telephone, and transmission line systems and for ornamental purposes. Tables stating the properties of pipe are also given as well as details of pole bases and tops.

ECONOMICS IN RAILROAD PROBLEMS.—This pamphlet published by William H. Wood, Media, Del. Co., Pa., states the necessity for increasing the flexibility of locomotive fireboxes, in order to obtain more economical operation. The description of a special corrugated firebox adaptable to practically any type locomotive and which was designed to accomplish savings in repairs and in operation is also given.

HOISTS.—The Wright Manufacturing Company of Lisbon, Ohio, manufacturers of high speed hoists, screws and differential blocks and steel trolleys, has issued a new catalogue descriptive of their line. It contains much data of use to those interested in hoists and a portion of the catalogue is devoted to a discussion of the various types of hoists and the field of usefulness of each.

CRANES.—Milwaukee Electric Crane & Mfg. Co., Milwaukee, has issued a catalogue devoted to the company's line of electric cranes, hoists and horizontal drills. The crane mechanisms, all-steel cranes for steel mill service and special cranes are illustrated and described and numerous views of cranes installed in industrial plants are shown. A number of pages are devoted to the company's horizontal drilling and boring machine, and monorail hoists of capacities of 3 to 10 tons.

INSTRUCTION BOOK FOR RAILROAD SHOPS.—The Metal & Thermit Corporation, New York, has just issued a Thermit railroad instruction book, no. 41, expressly prepared for use by men actually performing thermit welding railroad repairs. The pamphlet is of a convenient pocket size and the instructions have been condensed into the smallest possible space consistent with clearness.

ASSOCIATIONS

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.

Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton Avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.

Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue, Oak Park, Ill.

Secretary—Harry D. Vought, 95 Liberty street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.

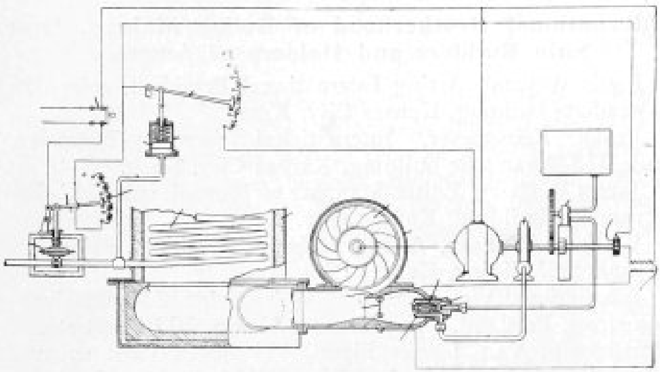
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,359,042. FUEL-CONTROL SYSTEM FOR BOILERS. WILLIAM A. DOBLE AND JOHN A. DOBLE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNORS TO DOBLE LABORATORIES, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

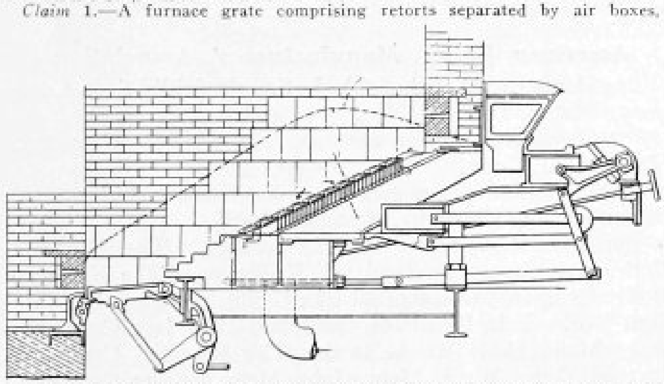
Claim 1.—The combination with means adapted to receive a heat-absorbing medium, of a fuel mixing device associated therewith, means for feeding fuel



to said device, means for feeding air to said device for atomizing said fuel, means for igniting said atomized fuel, means for feeding air to said ignited fuel, and means for synchronously driving said fuel feeding means and both of said air feeding means.

1,360,250. FURNACE-GRATE. ERNEST B. PRIEBE, OF INWOOD, NEW YORK, ASSIGNOR OF ONE-HALF TO WARREN C. DRAKE, OF INWOOD, NEW YORK.

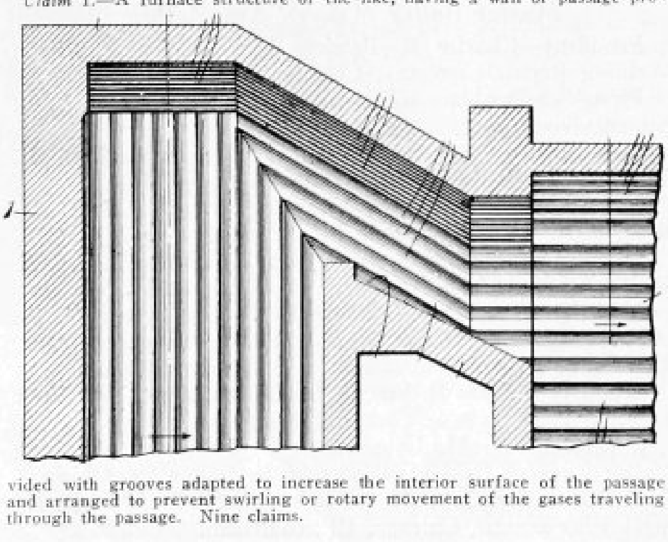
Claim 1.—A furnace grate comprising retorts separated by air boxes,



and above each air box a bank of outstanding hollow tuyere members, each member consisting of two opposite spaced-apart bars connected by a thinner web. Fifteen claims.

1,356,859. FURNACE. CHARLES D. FULLER, OF LATROBE, PENNSYLVANIA, ASSIGNOR OF FORTY PERCENT TO A. S. HENRY, OF NEW YORK, N. Y.

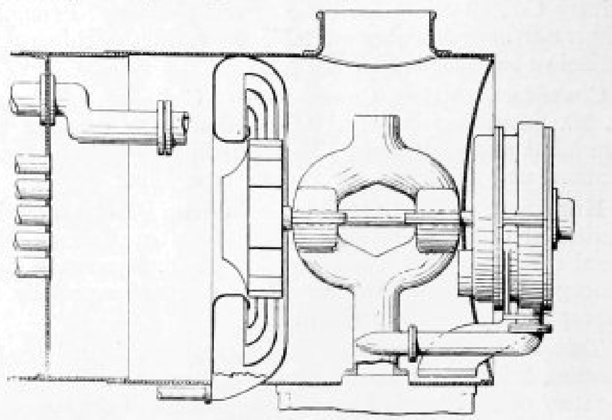
Claim 1.—A furnace structure or the like, having a wall or passage pro-



vided with grooves adapted to increase the interior surface of the passage and arranged to prevent swirling or rotary movement of the gases traveling through the passage. Nine claims.

1,356,809. LOCOMOTIVE DRAFT APPLIANCE. DAVID F. CRAWFORD AND ANTON K. KUSEBAUCH, OF PITTSBURGH, PEENSYLVANIA, ASSIGNORS TO LOCOMOTIVE STOKER CO., OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

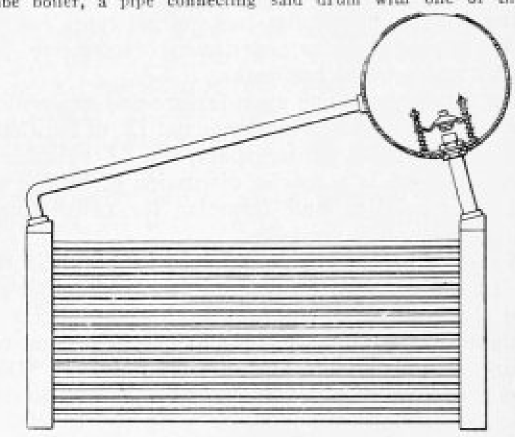
Claim 1.—A locomotive draft appliance comprising in combination means for producing a draft, an engine for driving the same operated by exhaust



steam from the cylinders, means for conveying exhaust steam thereto, a driving shaft, bearing means for said shaft, and independent means for subjecting said bearing means to a bath of exhaust steam. Eleven claims.

1,356,836. SAFETY-VALVE FOR WATER-TUBE BOILERS. JOSEPH STASINSKI, OF PHILADELPHIA, PENNSYLVANIA.

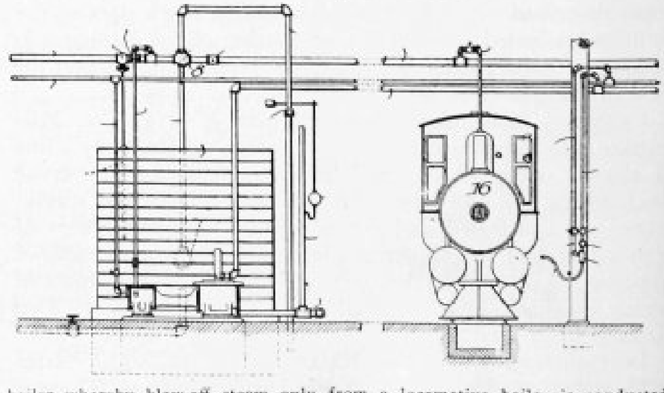
Claim 1.—The combination of a tube structure and steam drum of a watertube boiler, a pipe connecting said drum with one of the headers



of the tube structure, a valve seat on the inside of the drum communicating with said pipe, a valve adapted to close against said seat when the pressure within the drum exceeds that in the tube structure or its connections, guide wings projecting from said valve, a plate separate from the shell of the drum but disposed within the same, said plate having inwardly projecting posts which serve as guides for the projecting wings of the valve, and yielding means for normally retaining said valve in open relation to its seat. Three claims.

1,357,717. BOILER WASHING AND FILLING SYSTEM. FRANK MILLER, OF CHICAGO, ILLINIOIS.

Claim 1.—In a boiler washing and filling system, the combination of a tank adapted to contain water for wash-out and refilling purposes, means for supplying clean fresh water to said tank, a blow-or line connected with said tank below the water level therein and apated to be connected to a locomotive



boiler whereby blow-off steam only from a locomotive boiler is conducted to said tank to hat the water therein, thermostatically controlled means for maintaining the water in said tank at a predetermined temperaure suitable for wash-out purposes, means for conducting said water from said tank to the drops in a round house, an independent source of steam supply, and means at the drops whereby steam from said independent source is utilized to further heat said partially heated water to bring the same to a temperature suitable for refilling purposes. One claim.

THE BOILER MAKER

FEBRUARY, 1921

Organization and Work of the Ohio Boiler Inspection Department

BY C. O. MYERS*

About the same time that the Department of Locomotive Inspection of the Interstate Commerce Commission was formed, the state of Ohio, through the efforts of stationary engineers, made the inspection of boilers in the state compulsory. The Department of Inspection, which has since been highly developed, is described in the following article. So great has been the success of this organization that boilers built according to Ohio standards are accepted both in those states having boiler inspection laws and others enforcing no special requirements.

MANUFACTURERS of steam boilers for use in the state of Ohio are required to secure authority from the state inspection department to build boilers and are given a facsimile of the stamping to be placed upon each boiler they construct, in accordance with the Ohio law and rules, and are required to file with this department a manufacturer's data sheet for each Ohio standard boiler built. This data sheet gives all details of construction and is certified to by the qualified Ohio inspector who made the shop inspections.

The inspector is required to check up the plates before any work is started upon them and to make a record of the heat numbers, brand, tensile strength and quality of material, which he carefully compares with the mill test report. Another inspection is given the boiler after the rivet holes are made to see if it meets the requirements. After the boiler is completed and ready for testing, he makes his final inspection and witnesses the stamping of the Ohio standard facsimile.

Compulsory inspection of steam boilers became effective in the state of Ohio on January 1, 1912, and was the direct result of an active campaign on the part of stationary engineers, who for years had been entrusted with the care and management of steam boilers, and who were directly responsible for their safe and economical operation, but who were for various reasons, no doubt well known to all engineers, unable to obtain the supplies or repairs necessary to secure best results toward safety in their operation. These men took it upon themselves to bring together all the interests affected by compulsory boiler inspection and voluntarily financed the movement, with the result that today Ohio has a boiler inspection service that is second to none.
C. O. MYERS.

EXAMINATION STANDARDS FOR INSPECTORS

All boiler inspectors are required to pass a very rigid examination upon the construction, installation, inspection and operation of steam boilers and their appurtenances before the Ohio Board of Boiler Rules. To be eligible for this examination, the applicant is required to have had not less than five years' actual experience in an engine room, boiler room, boiler shop, or as a boiler inspector, or equivalent. The successful applicant is given a certificate of competency certifying that he has passed the required examination, but before he may legally make boiler inspections he must also secure a commission from the department of inspection authorizing him to make such inspections in accordance with the requirements of the Ohio boiler inspection law.

* Chief Inspector of the Department of Inspection, Industrial Commission of Ohio. Secretary of the National Board of Boiler and Pressure Vessel Inspectors.

The boiler inspectors are divided into two classes; those employed by the state of Ohio are called general inspectors, and those employed by boiler insurance companies authorized to do business in the state of Ohio are known as special inspectors. All boiler inspectors, however, are required to pass the same examination and work under the rules and regulations promulgated by the Ohio Board of Boiler Rules, and are further required to make reports of inspections to the department of inspections at Columbus, Ohio.

The facsimile issued to a boiler manufacturer, as well as the commission issued to a boiler inspector, may be revoked at any time for incompetence, untrustworthiness or for wilful falsification of any matter or statement contained in any report of inspection, and we find that boiler manufacturers and boiler inspectors place too high a value upon their authority to build boilers and inspect them to take any chance of having the authority revoked for any cause.

DUTIES OF THE BOARD OF BOILER RULES

The Ohio Board of Boiler Rules consists of five members, one to represent each of the following interests: Boiler manufacturers, boiler insurance companies, boiler users, operating engineers, and the fifth member is the chief inspector of steam boilers for the state, who acts as chairman and whose duty it is to enforce the rules and regulations of the board.

It is the duty of this board to formulate rules for the construction, installation, inspection and operation of steam boilers, as well as rules for ascertaining the safe working pressure to be carried on such boilers, together with rules governing the quality of materials to be used in their construction, and regulating the size and construction of safety valves, fusible plugs and other appliances used in connection with their safe operation, and also to examine applicants for certificates of competency as inspectors of steam boilers.

There are 57 shops in the state of Ohio and 93 located in other states—a total of 150 shops—authorized to manufacture Ohio standard boilers. There are 232 inspectors regularly qualified to make boiler inspections in accordance with our requirements. About one-half of these inspectors reside in the various states where Ohio standard boilers are built, and are in the employ of boiler insurance companies and they make the required shop inspections in those states.

Work of Inspection Staff

During the fiscal year ending June 30, 1920, 5,126 Ohio standard boilers were constructed and data reports for them filed with our department. The annual report for the Ohio Boiler Inspection Department shows that more than 25,000 reports of inspections were received. During that time 19,100 certificates of inspections were issued; 110 boilers were condemned as unsafe for further use, due to age, deterioration and defects in constructional requirements. It is interesting to note that out of this great number of boilers inspected only 2,958 repair orders had to be issued, showing that owners and users of steam boilers in Ohio are co-operating with us and are complying with every requirement of the Ohio boiler inspection law and rules.

With more than 20,000 boilers in use in the state of Ohio, only three boiler failures occurred during the year. Two of these were boilers that had been inspected and were the result of forms of construction not now permitted by the state of Ohio and were built before the passage of the Ohio law. The other was a cast-iron sectional boiler used for heating purposes and never had been inspected and was not equipped with the necessary safety devices required by the Ohio Board of Boiler Rules.

Board of Boiler Rules Made Part of Industrial Commission

The Ohio Board of Boiler Rules and the Inspection Department were made a part of the Industrial Commission of Ohio in 1913. At that time very few states had boiler inspection laws, and as time went on other states saw the necessity of boiler inspection and enacted similar laws, until we now have thirteen states, one county and eleven cities operating such laws.

These laws vary to a great extent in so far as the construction and installation is concerned, making it difficult for the manufacturer to build a standard boiler and for the user to interchange a boiler from one state to another. It is necessary for the manufacturer who is building a boiler to be used in another state to build it so that it complies with all the standards and stamp it with all such state standard stamps. Our attention has been called to some small boilers built in this manner on which twelve different stamps covering the entire fronts of the boilers were used.

The attention of the Industrial Commission of Ohio was called to this condition, and in order to promote uniformity and interchangeability between states this commission requested the governor of each state to appoint a representative to attend a uniform Boiler Code Congress at Washington, D. C., December 4 and 5, 1916. Twenty-four states and four cities accepted this invitation and the records of this meeting show that all the states and cities present signified a willingness to accept the code formulated by the Boiler Code Committee of the Council of the American Society of Mechanical Engineers when enacting such legislation in their respective states.

Adoption of Uniform Boiler Laws

Since that time a number of states have enacted boiler inspection laws and have accepted these rules for their standard construction, and it was thought by the adoption of this code that the question of uniformity and interchangeability between them would be solved, but after putting this code to the practical test of enforcing its provisions it has been found that perpetual interpretations are required. As these interpretations are merely the opinion of the boiler code committee it is not compulsory for the inspection departments to accept them, and this committee is not invested with the legal power and authority to enforce its rulings. This has created a condition which was not looked for at the time of the meeting of the Boiler Congress, and is causing a difference in enforcing the provisions of the American Society of Mechanical Engineers' boiler code, and is, therefore, destroying all the benefits to be derived from uniformity and interchangeability.

Duties of Inspectors

It will be my endeavor at this time to point out the position of a state official and the responsibility he assumes when taking his oath of office and the effect of enforcing rules which are formulated by persons not charged with these responsibilities. It must be remembered that a public official is responsible for the conditions that may exist in the locality under his supervision, and it is an easy matter for persons who have never been in such a capacity to assume that there are no limitations to the acceptance and enforcement of regulations. Further, the fact must not be lost sight of that the authority invested in a state official by law cannot be delegated by him to other persons, particularly when such persons are not residents of his community.

With these conditions existing it is only natural to expect that each official, after accepting the American Society of Mechanical Engineers' boiler code, will interpret and enforce it in accordance with his own individual ideas, and this is his right, as he, when accepting this code, accepted it as it is understood by him. Here is the condition that now confronts us. We have a code of rules formulated by persons who have not the legal authority to enforce them, and enforced by persons who have this authority. Inasmuch as the enforcement of rules is the most essential, it is necessary that there should be an association of these officials who are charged with the enforcement of these rules in order to accomplish uniformity. Before we can progress much farther some means must be provided whereby each official may know what every other is doing, and before any action is taken on any case separately the governing conditions should be thoroughly discussed collectively, and if its merits permit have it accepted and enforced.

The National Board of Boiler and Pressure Vessel Inspectors was formed in December, 1919, for the purpose of bringing about a better understanding between inspection departments in states enforcing uniform boiler laws. The future policy of this organization and its work are given in a report of the first annual convention, which was held February 2, 3 and 4 in Detroit.

American Engineering Council Meets

On Feb. 14, the executive board of the American Engineering Council of the Federated American Engineering Societies held a meeting in Syracuse, N. Y. President Herbert Hoover outlined the new council's plans for dealing with industrial relations and particularly with the waste of materials as it affects the present army of unemployed.

On Feb. 15, the national council of the American Society of Mechanical Engineers convened with the society's new president, Edwin S. Carman, Cleveland, presiding. This society, with its 13,000 members, is behind the movement to federate the country's engineers under the headship of Mr. Hoover.

The Syracuse meeting, it is understood, will mark the beginning of a movement to organize the engineers on a territorial basis. The plan comprehends the formation of state engineering councils.

Renewable Stay Heads for Fireboxes

British Practice of Replacing Defective Stay Heads Lengthens Period of Service Between Locomotive Boiler Repairs

BY E. W. FELL

In a recent issue of one of our engineering periodicals the following paragraph formed part of an article on riveting locomotive fireboxes: "One of the chief difficulties experienced in the maintenance of locomotive fireboxes is that due to the rapid burning away of stayheads on the inside, and various methods have been tried for the purpose of overcoming it, mostly by snapping the heads, a process which is fraught with the danger of necking the plates."

Now it may be interesting to your readers to know that a very successful and efficient method of renewing firebox stayheads is in use on one of the largest British railways.

It must be clearly understood that this device is not intended for repairing fractured stays, but for renewing small or defective stayheads. Fig. 1 gives a plan and elevation of one of these steel heads ready for insertion, while Fig. 2 shows the head in position. Since its introduction in December, 1916, various shapes of head have been tried, but the one shown in Figs. 1 and 2 has now been adopted as the standard. It will be noticed that a small lip is left around the outside of the head. This lip has proved to be of good service for fullering down, as shown in Fig. 3, if a stay should show any signs of leaking, or if the fire should show any tendency to burn the plate away underneath the edge of the head.

In cases where it is applied, the small or defective stayhead is hammered up in order to completely expand it in the hole, it is then centered, drilled and tapped to a depth of about 5/8 inch from the front side of the plate. The stay end and firebox plate are then lightly skimmed up with a facing cutter as shown in Fig. 4, the spindle of the cutter being screwed into the tapped hole to ensure obtaining a face that is perfectly true with the hole.

This operation completes the process of preparing the stay for the new head, which is now entered and tightly screwed in by means of a wrench on the square end, care being taken to bed the face of the head well up on the prepared surface of the stay and plate, thus obtaining a metal to metal joint.

Advantages of New Head

Many advantages can be claimed for these renewable heads. One is that of preserving the stayholes of the firebox at their original size. It is a well-known fact that when stays are renewed the holes have to be retapped, thus enlarging them, and in a few years these become very big, the diameter increasing from the original 1 inch or 1 1/16 inches up to 1 7/16 inches or 1½ inches. These sizes are far too large for good working results, stays of these dimensions being more rigid than is good for firebox plates, hence the holes rapidly deteriorate, small cracks developing from the side of the hole and leakage, etc., becoming frequent. A long experience in locomotive boiler repair shops has proved this point, that more often than not the outer steel wrapper plate is in good condition when the inner firebox requires renewing. There is, however, one great difficulty in the way of leaving this wrapper plate intact when renewing the inner firebox, and that is the considerable number of large stayholes in the lower part of the firebox—stayholes of such dimensions that it would be folly to start a new firebox out on its journey with its life heavily mortgaged by the large stays introduced. The outer plate is therefore frequently either wholly or partially renewed, even though its general condition may be very little below that of a new plate.

The introduction of these renewable heads will make such cases far less frequent, the stays being kept down to such dimensions as will not be out of harmony with the introduction of a new inner firebox when necessary, thus securing an important economy.

Another advantage that is very appropriate in these days when such enormous demands are being made on the haulage power of English railways is that of an extended life of many engines after each general repair.

While the condition of the boiler is not the only factor that determines the period which an engine is able to run without going into the repair shop for general repairs, it plays an important part and frequently it is necessary to withdraw engines from service for boiler repairs, although the remainder of the engine is in fair condition and capable of giving a few months more work without overhauling.

Installing Steam Tight Stays

In the past the custom adopted in engine sheds in regard to defective stays situated below the level of the engine frame has been to replace them with "steam tight stays" which are riveted over at one end only, i. e., in the firebox. As there is an objection, however, to the insertion of many of these stays in a cluster, their application has been limited, many cases arising in which it was found necessary to send the engine into the repair shop to have the boiler out of the frame for the necessary firebox repairs.

The introduction of these new heads, however, makes the repair of such boilers possible in position, thus lengthening the life until such time as the condition of the engine demands a general repair.

One or two examples will suffice to justify this claim for an extended period of running between each general repair. In one case forty-four renewable heads were inserted in a medium-sized passenger engine, and six months later, when it was found necessary to send the engine into the repair shops for a general overhauling, these heads were in such excellent condition that it was decided not to interfere with them, and when the necessary repairs had been carried out the engine was put into service again with the renewable heads undisturbed.

This boiler was in service until the early part of the present year, and during the whole of the period from April, 1917, to January, 1920, these heads were all that could be desired, there being a total absence of leakage, etc., a testimony that they are not only capable of doing the work for which they were designed, i. e., to run the firebox until a general overhauling was necessary, but even to exceed this, as they have done in this case, the engine having worked 2¼ years since the general repair mentioned above, or 2¾ years since the renewable heads were put in.

Effect of Bad Water on Stay Replacements

A second example is that of a small side tank engine, the boiler of which was built in February, 1915.

Working in a very bad district from a boiler standpoint, the feed water causing considerable trouble in the form of leaky stays, etc., it was soon found necessary to stop the boiler for minor repairs. In May, 1917, the boiler was taken out of service by the inspector on account of the large number of defective stayheads in the fire area of both sides of the firebox. Many of these heads were so badly wasted that it was absolutely essential they should be renewed, yet their number was well above the maximum allowed for steam tight stays, while their location was such that it was impossible to replace them with ordinary stays without dismantling the engine and lifting the boiler out of the frame. With this object in view the inspector recommended the engine to be sent into the repair shop, although the condition of the other parts of the engine was such as to justify the shed foreman in expecting to get several months more work out of the engine before a general overhauling was necessary.

Contrary to the inspector's recommendation, the necessary repairs were carried out without dismantling the engine, 47 of these renewable heads were fitted in place of the defective stay heads, 21 on the right side and 26 on the left, as will be seen from the diagram, Fig. 5, and the engine set to work again after only a short stoppage. As already mentioned, this engine was working in a very bad district, and a remarkable feature about the case is that while a number of stays were giving constant trouble through leaking freely, the stays fitted with renewable heads gave good results, there being a total absence of leakage.

Nine months later this engine was sent into the repair shop for a general overhauling, and the condition of these heads was so satisfactory that it was decided not to interfere with them.

In March of the present year the engine was again in the shop for repairs and it was necessary on this occasion to lift the boiler out of the frame for a new firebox tube plate. By this time the renewable heads, which during the period of almost three years had not given the slightest trouble, were getting the worse for wear and advantage was taken to replace these by stays 1/16 inch larger in diameter.

It is interesting to note that, although this engine was working in a bad water district, the boiler was a little over five years old before it had any firebox stays renewed, while three other boilers of the same class, built in the same month, had stays renewed as follows: One had 102 stays renewed in June, 1917, the second had 78 stays renewed in March, 1918, while the third had 50 stays renewed in January, 1919, or an average of 77 in each, a contrast that testifies very forcibly to the effectiveness of renewable heads.

TABLE I.—FRACTURE TESTS OF RENEWABLE STAY HEADS

Description of Stay and Result	Breaking Load		Efficiency of Repaired Stay Compared with Original		
	Actual, Tons	Per Square Inch, Tons	Same Diameter, Percent	1-Inch Diameter, Percent	1 1/16-Inch Diameter, Percent
1-inch copper stay riveted at both ends. Stay broke in center	8.5	15.18	....	....	....
1-inch copper stay fitted with renewable head 1/2-inch diameter. Stay broke at bottom of screwed hole	6.92	16	81.4	81.4	....
1 1/16-inch copper stay riveted at both ends. Stay broke in center	10.2	15.31	....	....	....
1 1/16-inch copper stay fitted with renewable head 1/2-inch diameter. Stripped thread of stay in copper plate and broke shank of renewable head	7.88	....	....	....	....
1 1/16-inch copper stay fitted with renewable head 1/2-inch diameter. Stay broke at bottom of screwed hole	7.82	15.34	76.6	92	76.6
1 1/4-inch copper stay riveted at both ends. Stay broke in center	14.5	15.02	....	....	....
1 1/4-inch copper stay fitted with renewable head 5/8-inch diameter. Stay broke at bottom of screwed hole	11.43	15.36	78.8	134.5	112

During last year 42 engines were fitted with these heads at the steam sheds to avoid sending them into the repair shops to have the boiler lifted out of the frame for the renewal of stays, and on December 31 the aggregate number of days these had been kept in traffic was 5,422, or an average of 129

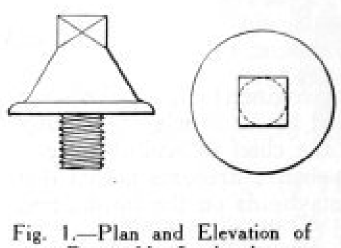


Fig. 1.—Plan and Elevation of Renewable Stayhead

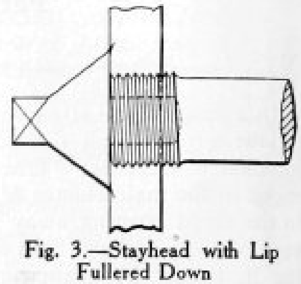


Fig. 3.—Stayhead with Lip Fullered Down

days per engine, and while this summary substantiates the claim for an extended life after each general repair, its value would have been still further enhanced had we been able to follow each engine through until a general overhauling was necessary, for on the same date, i. e., December 31, 1919, 32 of these engines were still in service, several of them having been running six or eight months after being fitted with renewable heads.

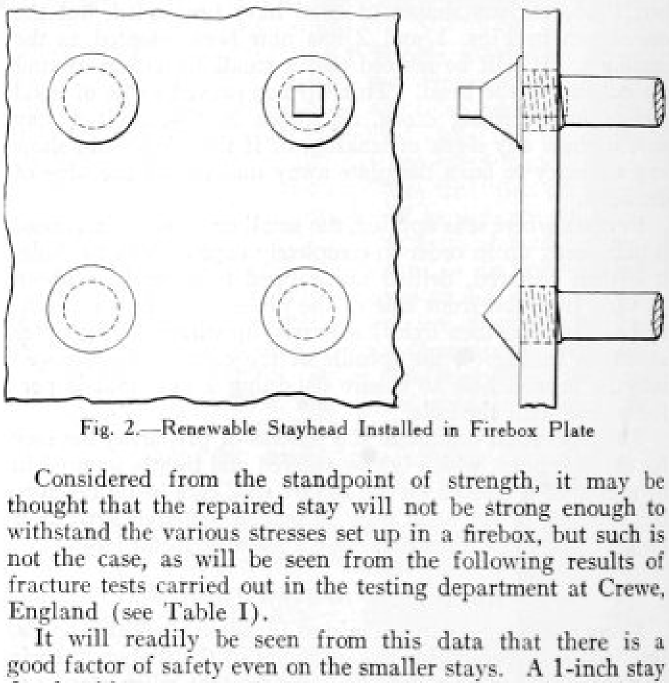


Fig. 2.—Renewable Stayhead Installed in Firebox Plate

Considered from the standpoint of strength, it may be thought that the repaired stay will not be strong enough to withstand the various stresses set up in a firebox, but such is not the case, as will be seen from the following results of fracture tests carried out in the testing department at Crewe, England (see Table I).

It will readily be seen from this data that there is a good factor of safety even on the smaller stays. A 1-inch stay fitted with a renewable head in a boiler working at 150

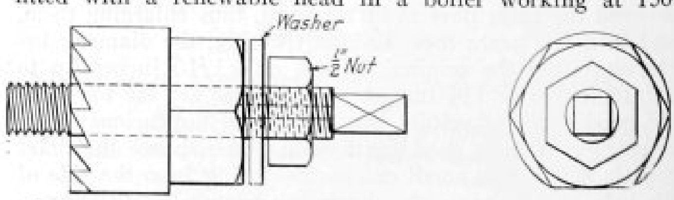


Fig. 4.—Facing Cutter Used to Surface Stay End and Firebox Plate

pounds pressure per square inch has a factor of safety between 6.5 and 7 when the stays are pitched 4 inches apart, while on stays 1 3/16 inches and 1 1/4 inches diameter the net section of the stay is greater and consequently stronger than the original 1-inch or 1 1/16-inch stay. The drilling of the larger stays will have a tendency to improve them, rather than the contrary, by making them more flexible.

Strength of Renewable Heads

As further proof of the strength of these renewable heads under working conditions, it may be mentioned that out of the many thousands now in use, not one of these heads has been discovered to be fractured even though severely tested under conditions varying from those obtaining in a locomotive stationary boiler to the conditions in a large high pressure express passenger engine.

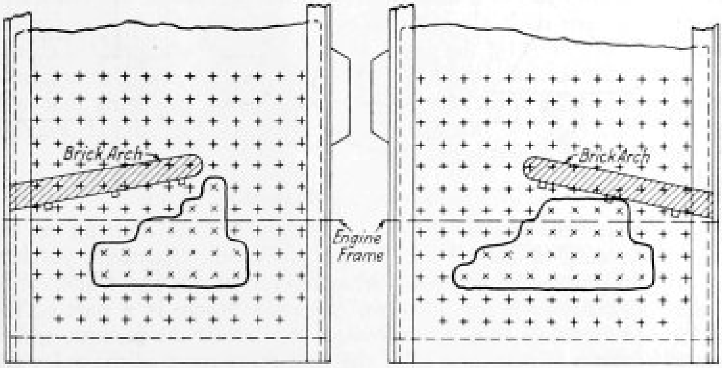


Fig. 5.—Firebox in Which 47 Renewable Stayheads Were Fitted in Place of Defective Heads

As already shown in the example of the small side tank engine, the heads stand up exceedingly well in face of the fierce action of a locomotive boiler fire—in fact, they resist the fire much better than the ordinary stayhead.

An interesting example of this point is shown in Fig. 6. When this boiler was built in November, 1917, 142 of these renewable heads were fitted, 71 on each side, but as this was a test case they were not all put in a cluster, a number of ordinary stays being intermixed as shown.

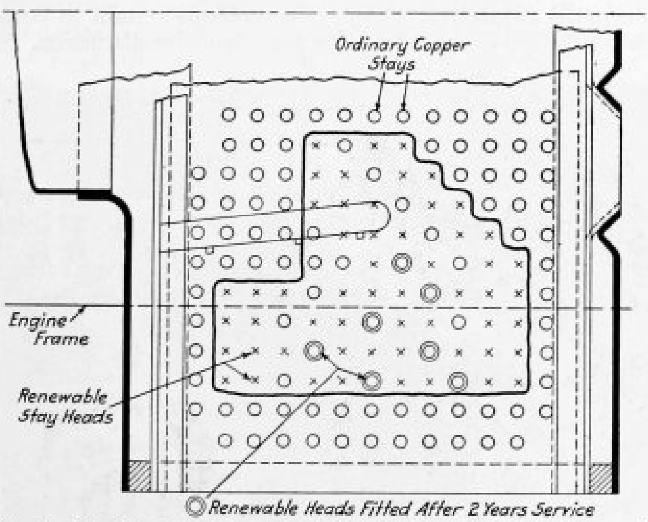


Fig. 6.—Fire Resisting Properties of Renewable Stayhead Demonstrated in Locomotive Firebox in Which 142 Were Installed

After two years work these renewable heads were still in excellent condition, while the ordinary stays that were intermixed were far worn and leaking, a number of them requiring changing or fitting with renewable heads.

Another case that appears to be a very good example of the durability of these heads is illustrated in Fig. 7. This is a very interesting example on account of the rapid deterioration of the firebox sides and stayheads in the particular part of the firebox where these heads were fitted.

When the boiler was only two years old many of the stay heads in the bottom corner of the firebox firehole end were wasted badly, a number of them being completely eaten away. The plates also in the same area showed signs of wastage, but not sufficient to necessitate patching. As this was a suitable case for the adoption of renewable heads, fourteen of them were fitted and the boiler set to work again. Nine months later, during which period the boiler had been heavily worked, it was necessary to stop the boiler for repairs. The side plates of the firebox in the area already referred to had wasted so badly as to necessitate renewal of certain parts, the defective plate only being approximately ⅛ inch thick in one or two places between the stays.

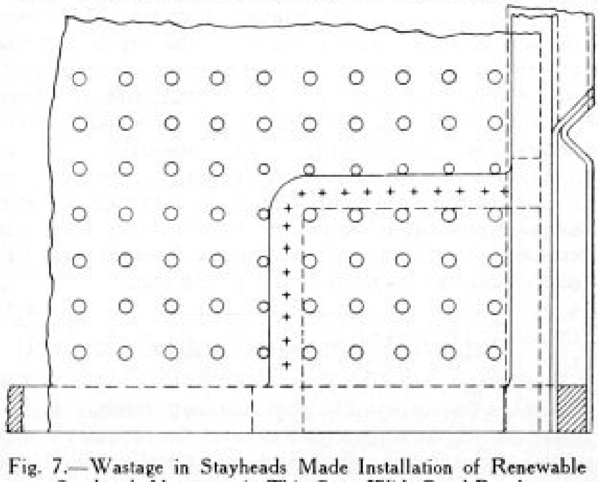


Fig. 7.—Wastage in Stayheads Made Installation of Renewable Stayheads Necessary in This Case, With Good Results

The ordinary stayheads in the same area had wasted away to such an extent as to necessitate renewal, and yet the renewable heads subjected to the same adverse conditions were practically unchanged, owing, it may be assumed, to the fact that while the softer metal, copper, of which the plates and stays consisted, could not resist the deteriorative conditions to which they were subject, the much harder steel head, assisted by the hardening effects of the mechanical treatment of forging, successfully resisted those adverse influences, a remarkable example of their value considered from the standpoint of durability.

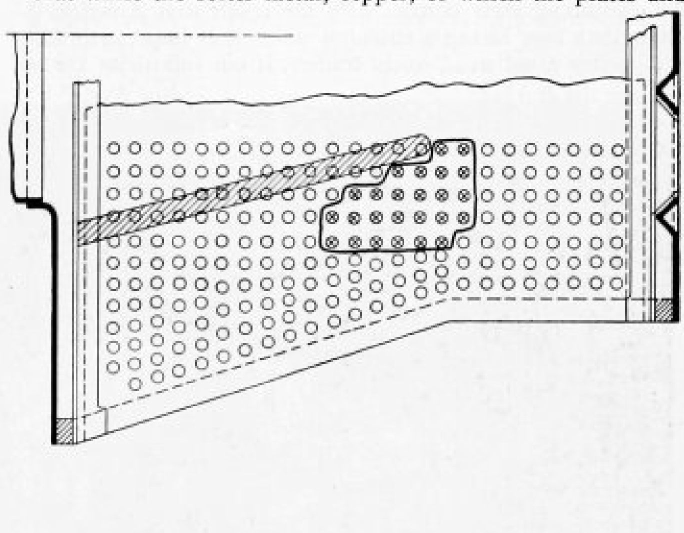


Fig. 8.—Diagram Showing Position of Renewable Stayheads in Passenger Engine Boiler

As this is an exceptional case, renewal of parts of the firebox sides being necessitated at a very early stage in the life of the firebox, it will perhaps be of interest to mention that this boiler supplies steam for one of the mills in the forge, and, of course, works night and day.

On the other hand, however, it will have short stoppages or intervals during meal hours, or waiting for heats, etc., during which time the fire would probably be banked under the firehole, a fact that has probably contributed among other influences to the rapid deterioration of the firebox sides in these two bottom corners.

Finally, these renewable heads have proved so successful that it has now been decided to fix twenty-five of them on each side of the firebox of every new boiler These are situated in that area where the fire is fiercest, and where defective stay heads are most common. Fig. 8 is a diagram showing the position of these heads as they are fixed in a passenger engine boiler of the "Claughton Class."

This innovation will in our opinion be amply justified, for, instead of having to renew these stays when the heads have become far worn, it will only necessitate removing the defective head and replacing with a new one.

National Foreign Trade Council

Realizing probably more keenly than ever before the imperative necessity of a permanent foreign trade as a stabilizer of American production, the country's exporters will doubtless attend in exceptional numbers the eighth annual convention of the National Foreign Trade Council, scheduled for Cleveland next May. The efforts of the convention will be directed toward securing more definite and aggressive co-ordination of the various trade activities and to reinforce them with the decisive co-operation of the foreign governmental agencies. Incidentally, it is non-partisan and non-political.

American industrial production during the last ten years has experienced a wonderful and unprecedented growth. Stimulated during the war period by an exceptional foreign demand, manufacturing plants generally increased their producing capacity far beyond their normal requirements. In many instances today their purely domestic trade falls short of consuming their output, with the result that America is more than ever facing a situation where it is imperative that we become a nation of world traders, if our industries are to continue in active operation and our prosperity as a nation is to endure. It is a radical departure from former conditions.

Under the stimulus of a war-made foreign demand American exports increased from less than two and one-half billions in 1913 to more than eight billions in 1920. The remarkable period of prosperity that attended this revolutionary condition fully awoke the American manufacturer to the tremendous possibilities of a well-developed and permanent foreign trade. But out of it all grew no really definite and lasting foreign connections for the great majority of those who profited chiefly from munition making. It is this class of manufacturer who should be most keenly interested in the problems that will come up for discussion before the next National Foreign Trade Council convention.

Necessity for Foreign Trade

In his address before the recent annual meeting of the Council in New York, James A. Farrell, chairman, particularly stressed the need of a permanent foreign trade. "In practically every business," he said, "there is a part of the production, roughly estimated as the last 20 percent, which cannot remain unsold if the first 80 percent of the sales are to prove profitable. Remove this last 20 percent and the whole operation ceases to show a profit. So it is with the productive capacity of the United States; a certain volume of foreign sales must be maintained or the industry of the country will suffer throughout."

With the industrial interests of Europe rapidly becoming rehabilitated and our exports on the decline, it behooves American industry to make speedy and exceptional effort to keep alive the friendly relationships formed when the world's markets were open to our products. A dependable foreign trade will provide a highly beneficial vehicle for carrying any line of manufacturing over periods of dullness at home, permit increased output and insure the plant constant operation, while enabling a lowering of overhead charges and making possible the manufacture of goods at a lower price through increased production. These are problems certain to come before the Cleveland convention for exhaustive discussion.

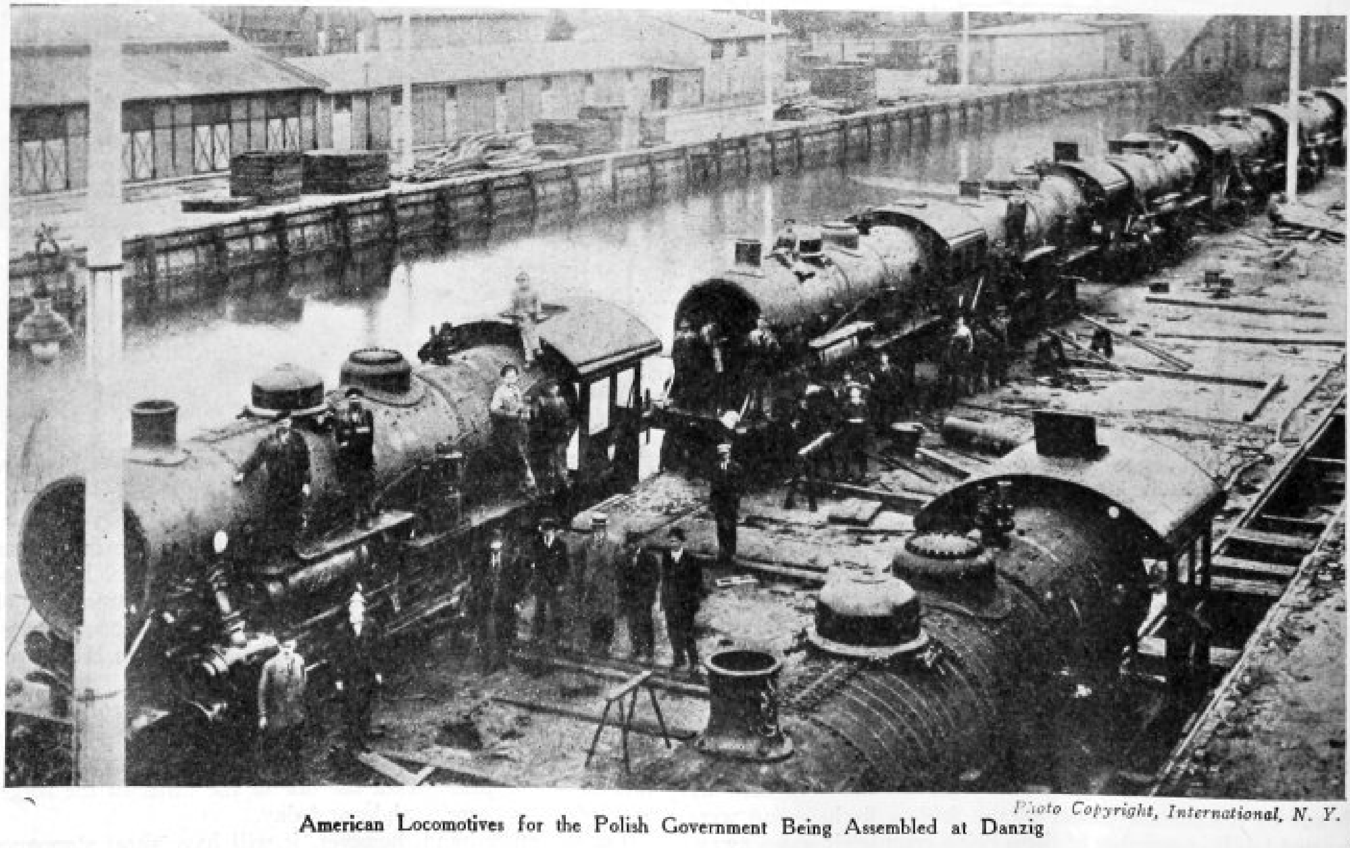


Photo Copyright, International, N. Y.

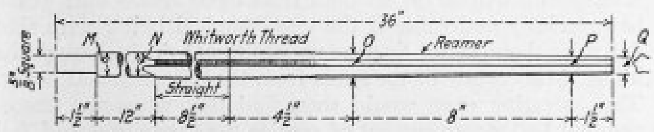
American Locomotives for the Polish Government Being Assembled at Danzig

Standardization of Boiler and Staybolt Taps

The following report covering the standardization of staybolt taps and boilers taps was presented by E. J. McKernan, chairman of a special investigation committee at the annual meeting of the Tool Foremen's Association in September, 1920:

Fig. 1 shows a 36-inch tap with Whitworth threads, 12 per inch, which is carried by tap manufacturers throughout the United States in regular stock. There is also made, to the same standard, spindle tap and spindle which is used for the same purpose as the 36-inch tap. This tap, known as style two, has been used to good advantage for applying staybolts back of the frame. These taps are 12-thread Whitworth and are manufactured by the S. W. Card & Company, or by Charles Besly & Company. Our reason for recommending the adoption of these taps is the fact that they are at present used successfully on many railroads and are giving better results than other types. The Whitworth thread has a great tensile strength and maintains its original diameter longer than the V or the United States Standard forms of thread.

A standard 24-inch staybolt tap is also required. This tap is also 12-thread Whitworth. These taps are at present carried in commercial lengths of 21 inches, 22 inches and 24 inches. We recommend the 24-inch tap because the reamer portion is extra long, giving a greater length and smaller diameter on the point, so that, when tapping from the outside, the small end of the tap protrudes through the inside sheet and acts as a guide, making it much easier for the operator and assuring a good thread on both the outer and inner sheets. The taper threaded portion of the tap has been lengthened, making the life of the tap much longer as well as eliminating a great deal of wear and tear on the air motor and consequently making it easier on the operator. We recommend that these taps be furnished in sizes from 15/16-inch to 1 5/16-inch, advancing by sixteenths if possible. We find that these sizes will conform to the government rulings, making 15/16-inch the smallest bolts and 1 5/16-inch the largest. These taps are all to be 12-thread Whitworth and should be furnished over-size with a minimum of .0015 inch and not to exceed .0035 inch. This will take all standard makes. The number of threads per inch should be 12 and in a distance of 6 inches there should not be more than 60¼ threads or be less than 59¾. The staybolt cutting machine should be checked very closely and the diameter kept to a standard so that the threads cut on the staybolt will be as accurate as the tap.



Size of Tap	Threads to inch	M	N	O	P	Q
15/16"	12	13/16"	15/16"	13/16"	11/16"	5/8"
1"	12	7/8"	1"	7/8"	3/4"	11/16"
1 1/16"	12	15/16"	1 1/16"	15/16"	13/16"	3/4"
1 1/8"	12	1"	1 1/8"	1"	7/8"	13/16"
1 3/16"	12	1 1/16"	1 3/16"	1 1/16"	15/16"	7/8"
1 1/4"	12	1 1/8"	1 1/4"	1 1/8"	1"	15/16"
1 5/16"	12	1 3/16"	1 5/16"	1 3/16"	1 1/16"	1"

Fig. 1.—Radial Staybolt Tap

Fig. 2 shows a standard button head radial staybolt tap. This tap is now commercially manufactured and is used very successfully on many railroads. It has a taper of 1½ inches in 12 inches and is 12-thread Whitworth. This tap is used for applying button head radial staybolts in the crown sheets of locomotives.

Fig. 3 shows boiler head and washout plug taps. These taps should be tapered ¾ inch in 12 inches and have 12 threads per inch, United States Standard. One taper and one thread should be maintained in all washout and mud plug

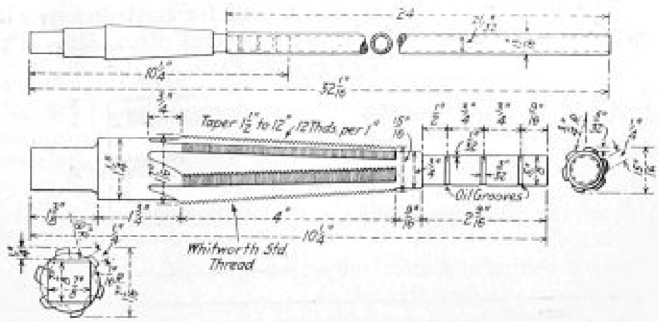
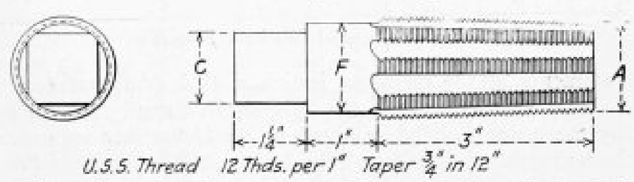


Fig. 2.—Button Head Radial Staybolt Taps

holes. It has been found that taps made with this taper give excellent results, not only assuring a good, tight plug, but one that is safe. We find that ¾-inch taper in 12 inches is



No.	A	C	F	Flutes	No.	A	C	F	Flutes
10	1¼"	1"	1 3/16"	5	24	3"	2"	2⅞"	8
11	1⅜"	1"	1 3/16"	5	25	3⅛"	2"	2⅞"	8
12	1½"	1"	1¼"	5	26	3¼"	2"	2⅞"	8
13	1⅝"	1"	1¼"	5	27	3⅜"	2"	2⅞"	8
14	1¾"	1"	1⅜"	5	28	3½"	2¼"	3¼"	8
15	1⅞"	1"	1½"	6	29	3⅝"	2¼"	3¼"	10
16	2"	1⅜"	1⅞"	6	30	3¾"	2¼"	3¼"	10
17	2⅛"	1⅜"	1⅞"	6	31	3⅞"	2¼"	3¼"	10
18	2¼"	1⅜"	1⅞"	6	32	4"	2¼"	3¼"	10
19	2⅜"	1⅜"	1⅞"	6	33	4⅛"	2½"	3⅝"	10
20	2½"	1⅜"	1⅞"	8	34	4¼"	2½"	3⅝"	10
21	2⅝"	1⅜"	2¼"	8	35	4⅜"	2½"	3⅝"	10
22	2¾"	1⅜"	2¼"	8	36	4½"	2½"	3⅝"	10
23	2⅞"	1⅜"	2¼"	8					

Fig. 3.—Boiler Head and Washout Plug Tap

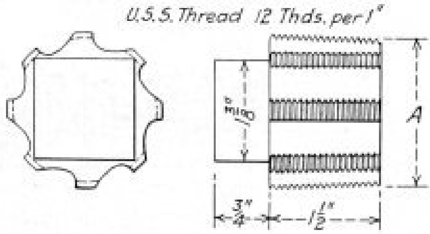
far more desirable than 1½ inches, and believe that it will eliminate the blowing out of washout plugs.

Fig. 4 shows a special washout or mud plug tap. This is only used in emergencies or in roundhouse service where it is not possible to insert a standard length tap. These taps conform to the standard tap with the exception that they are not as long. Fig. 5 shows boiler stud and patch bolt taps. These taps have ¾-inch taper in 12 inches, United States Standard form of threads, and run in such sizes that one tap will follow the other, the sizes being designated on the large end. The taper tap is recommended instead of the straight tap for boiler studs for the following reasons: First, we can get a more secure stud with the taper thread tap than with the straight thread tap; second, there is less liability of a leaky stud. It must be understood that when taper studs are applied they must penetrate the sheet. It is now the practice on many railroads to use a tap similar to the one described.

If these taps are adopted as standard they will eliminate many irregularities that now exist on the railroads throughout the United States. Furthermore, it simplifies the manufacturing of taps for this particular class of service. At present these taps can be secured from any first-class manufacturer at a much more reasonable price than they can be manufactured locally in a railroad shop.

Discussion

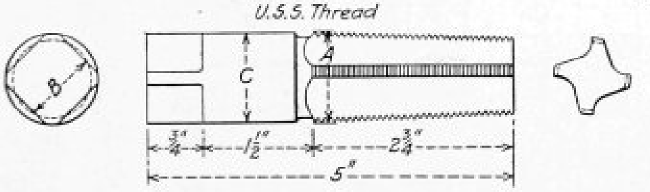
The question of what type of thread for staybolt taps will give the best results brought out a general discussion. The



No.	Diam. at A	Taper	Where Used	Remarks
1	2"	3/4" in 12"	Corner Plug back of Frame	
2	2 1/8"	" "	" "	
3	2 1/4"	" "	" "	
4	2 3/8"	" "	" "	

Fig. 4.—Special Washout Plug Tap

comments of the members indicated that comparatively few railroads have adopted the Whitworth thread recommended by the committee, while about an equal number appeared to be using the V thread and the United States standard thread. Expressing their personal opinions, however, few of the members considered V threads as satisfactory, as either of the other two kinds and the prevailing sentiment indicated that the Whitworth is the most desirable of the three types. Tests were referred to in which the pulling strength of the Whitworth type in the sheet has been demonstrated to be greater than either of the other two forms and the circular shape of the cutting edges of the Whitworth tap is less affected by wear than either of the other two, both of which have sharp



No.	Threads Per Inch	Taper in 12"	A	B	C
A	12	3/4"	7/16"	7/16"	1/2"
B	12	3/4"	9/16"	1/2"	5/8"
C	12	3/4"	5/8"	1/2"	5/8"
D	12	3/4"	11/16"	1/2"	5/8"
E	12	3/4"	3/4"	1/2"	3/4"
F	12	3/4"	13/16"	1/2	3/4"
G	12	3/4"	7/8"	3/4"	7/8"
H	12	3/4"	15/16"	3/4"	15/16"
I	12	3/4"	1"	3/4"	15/16"
J	12	3/4"	1 1/16"	3/4"	1"
K	12	3/4"	1 1/8"	3/4"	1"
L	12	3/4"	1 3/16"	3/4"	1"

Fig. 5.—Standard Patch Bolt Tap

corners. Taps with the V thread have been found to lose as much as .003 inch in diameter in tapping one hole under the heavy drive which these taps must withstand under modern conditions. Where a railroad makes its own taps, however, which is frequently done in the case of the plug and stud taps, either the United States Standard or the V type threads are more easily formed. For this reason the committee recommended the United States Standard type for plugs and stud taps.

Boilers and Economizers*

BY DR. D. S. JACOBUS†

During the year 1920 the trend in boiler design has been toward the use of a greater number of tubes in height for a given class of work. Adding to the height of the boiler adds to its efficiency with a relatively small increase in draft resistance. By adding to the height of a boiler, leaving the lower part of it and the stoker and furnace the same, the efficiency is materially increased for a given amount of steam produced, the curve of efficiency at different ratings being both raised and flattened. Among large boilers recently installed are some which evaporate in the neighborhood of 150,000 pounds of water per hour under actual conditions, this size being a convenient one to use in connection with the largest steam turbines.

Boiler pressures are also being gradually increased, a number of installations having been installed in which the working pressure is 350 pounds with a superheat of from 200 to 225 degrees, and with some changes in design there seems to be no reason why higher pressures are not perfectly feasible; in fact, test boilers have been built for 500 pounds pressure and over.

The question is often raised as to whether it will pay to install economizers. Each case must be considered by itself. As the price of fuel increases, naturally the use of economizers will increase. In considering the use of economizers, the additional efficiency secured through adding to the boiler surface by increasing the height of the boiler should be taken into account. If we start with a boiler, say, 14 tubes high, adding tubes so as to make the boiler 16, 18 or 20 tubes high, will, for a given amount of fuel burned per hour, result in each case in added efficiency. This additional efficiency is secured without a very great increase in the draft loss, as much of the draft loss in boilers comes through the turns that the gases make over the baffles. The higher boilers can in most cases be operated with natural draft up to the desired capacity, whereas should economizers be installed an induced draft is ordinarily required. In some cases the simplification of the plant by using the higher boilers as compared with one having economizers warrants the use of the higher boilers.

To show how misconceptions respecting boiler performances arise, consider the case of a small plant having several boilers, one of which is uneconomical with a low draft resistance. The flue gas temperature for this unit will be higher at a given rating than for the others, and the amount of power obtainable from it will be higher than from the others. This would be especially noticeable if the uneconomical boiler were shut down, as there would then be no additional draft through the higher temperature of the gases from the uneconomical boiler. The operating crew would soon find that when the uneconomical boiler was cut out of service the capacity would fall off more than in cutting off any of the others, and they might come to the conclusion that the most uneconomical boiler was the best one in their plant.

We are now at a point where we should not allow impression to take the place of facts, and we cannot afford to adopt the easiest way if this means an undue loss in economy. As the price of fuel increases, additional capital investment is warranted, and an equipment for securing a higher efficiency usually means more complication and necessitates a higher class of operation than the more simple arrangement. Our best run plants are already on a par with laboratories in the care with which they are operated and the skill and ability of those in charge. There are still, however, many plants where the fuel consumption is 50 to 100 percent higher than it might be. Each time a wasteful plant is replaced by an economical one we save fuel for future generations and practice real conservation.

* Reprinted from *Power*, January 4, 1921.
† Advisory engineer, Babcock & Wilcox Company, New York.

Fundamental Principles of Trigonometry

BY WILLIAM C. STROTT*

In designing boilers, plane trigonometry is continually referred to for the determination of stresses in members and the like. For the benefit of those who have not a working knowledge of the use of trigonometric functions the following simplified treatment of the subject has been prepared. The author states that, although the work is considerably condensed, the fundamental principles are explained carefully, so that simple problems may be solved by the application of the proper terms.

The solution of triangles is accomplished by means of that branch of mathematics known as trigonometry. By this process the length of one side and the magnitude of one angle (besides the 90-degree angle) must be known, or else the length of two sides, if none of the angles are given, in order to find the unknown terms of the triangle. For future reference Fig. 1 is presented, which illustrates and names the six terms of a right angle triangle.

In connection with Fig. 1 it will be stated that the naming of the base and altitude of a triangle is abitrary, although the base is generally considered that side on which the triangle is assumed to *stand*. If the position of the triangle were reversed so that side A became the base, it is evident that the properties of the triangle would remain unchanged. In order to avoid confusion, however, it has been necessary in trigonometry to distinguish the two short sides of a right angle triangle as *the side opposite* and *the side adjacent*, with reference to the angle in question. These terms may be explained as follows:

In Fig. 1 the side denoted by the letter B is termed the *side adjacent* to angle Φ and also as the *side opposite* to angle a. On the other hand, side A is termed the *side adjacent* to angle a, and also as the *side opposite* to angle Φ. The longer of the three sides, denoted by the letter H. in the illustration, is obviously adjacent to both angle a and Φ, but is always termed the *hypotenuse*.

When two of the three sides are known, the third side is found by application of the following fundamental law of geometry. "The square of the hypotenuse is equal to the sum of the squares of the other two sides."

The rule may be expressed in the form of an equation, thus:

(1) $$H^2 = A^2 + B^2.$$

Therefore, when A and B are known,

(2) $$H = \sqrt{A^2 + B^2}.$$

When A and H are known,

(3) $$B = \sqrt{H^2 - A^2}.$$

* Engineering department of the Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

TABLES OF TRIGONOMETRIC FUNCTIONS OF ANGLES FROM 0 TO 90 DEGREES

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
0	0	.000000	Infinite.	.000000	Infinite.	1.00000	1.000000	0	90
	10	.002909	343.77516	.002909	343.77371	1.00000	.999996	50	
	20	.005818	171.88831	.005818	171.88540	1.00002	.999983	40	
	30	.008727	114.59301	.008727	114.58865	1.00004	.999962	30	
	40	.011635	85.945609	.011636	85.939791	1.00007	.999932	20	
	50	.014544	68.757360	.014545	68.750087	1.00011	.999894	10	
1	0	.017452	57.298688	.017455	57.289962	1.00015	.999848	0	89
	10	.020361	49.114062	.020365	49.103881	1.00021	.999793	50	
	20	.023269	42.975713	.023275	42.964077	1.00027	.999729	40	
	30	.026177	38.201550	.026186	38.188459	1.00034	.999657	30	
	40	.029085	34.382316	.029097	34.367771	1.00042	.999577	20	
	50	.031992	31.257577	.032009	31.241577	1.00051	.999488	10	
2	0	.034899	28.653708	.034921	28.636253	1.00061	.999391	0	88
	10	.037806	26.450510	.037834	26.431600	1.00072	.999285	50	
	20	.040713	24.562123	.040747	24.541758	1.00083	.999171	40	
	30	.043619	22.925586	.043661	22.903766	1.00095	.999048	30	
	40	.046525	21.493676	.046576	21.470401	1.00108	.998917	20	
	50	.049431	20.230284	.049491	20.205553	1.00122	.998778	10	
3	0	.052336	19.107323	.052408	19.081137	1.00137	.998630	0	87
	10	.055241	18.102619	.055325	18.074977	1.00153	.998473	50	
	20	.058145	17.198434	.058243	17.169337	1.00169	.998308	40	
	30	.061049	16.380408	.061163	16.349855	1.00187	.998135	30	
	40	.063952	15.636793	.064083	15.604784	1.00205	.997953	20	
	50	.066854	14.957882	.067004	14.924417	1.00224	.997763	10	
4	0	.069756	14.335587	.069927	14.300666	1.00244	.997564	0	86
	10	.072658	13.763115	.072851	13.726738	1.00265	.997357	50	
	20	.075559	13.234717	.075776	13.196888	1.00287	.997141	40	
	30	.078459	12.745495	.078702	12.706205	1.00309	.996917	30	
	40	.081359	12.291252	.081629	12.250505	1.00333	.996685	20	
	50	.084258	11.868370	.084558	11.826167	1.00357	.996444	10	
5	0	.087156	11.473713	.087489	11.430052	1.00382	.996195	0	85
	10	.090053	11.104549	.090421	11.059431	1.00408	.995937	50	
	20	.092950	10.758488	.093354	10.711913	1.00435	.995671	40	
	30	.095846	10.433431	.096289	10.385397	1.00463	.995396	30	
	40	.098741	10.127522	.099226	10.078031	1.00491	.995113	20	
	50	.101635	9.8391227	.102164	9.7881732	1.00521	.994822	10	
6	0	.104528	9.5667722	.105104	9.5143645	1.00551	.994522	0	84
	10	.107421	9.3091699	.108046	9.2553035	1.00582	.994214	50	
	20	.110313	9.0651512	.110990	9.0098261	1.00614	.993897	40	83
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.		°

For functions from 83°-40′ to 90° read from bottom of table upward.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
6	30	.113203	8.8336715	.113936	8.7768874	1.00647	.993572	30	
	40	.116093	8.6137901	.116883	8.5555468	1.00681	.993238	20	
	50	.118982	8.4045586	.119833	8.3449558	1.00715	.992896	10	
7	0	.121869	8.2055090	.122785	8.1443464	1.00751	.992546	0	83
	10	.124756	8.0156450	.125738	7.9530224	1.00787	.992187	50	
	20	.127642	7.8344335	.128694	7.7703506	1.00825	.991820	40	
	30	.130526	7.6612976	.131653	7.5957541	1.00863	.991445	30	
	40	.133410	7.4957100	.134613	7.4287064	1.00902	.991061	20	
	50	.136292	7.3371909	.137576	7.2687255	1.00942	.990669	10	
8	0	.139173	7.1852965	.140541	7.1153697	1.00983	.990268	0	82
	10	.142053	7.0396220	.143508	6.9682335	1.01024	.989859	50	
	20	.144932	6.8997942	.146478	6.8269437	1.01067	.989442	40	
	30	.147809	6.7654691	.149451	6.6911562	1.01111	.989016	30	
	40	.150686	6.6363293	.152426	6.5605538	1.01155	.988582	20	
	50	.153561	6.5120812	.155404	6.4348428	1.01200	.988139	10	
9	0	.156434	6.3924532	.158384	6.3137515	1.01247	.987688	0	81
	10	.159307	6.2771933	.161368	6.1970279	1.01294	.987229	50	
	20	.162178	6.1660674	.164354	6.0844381	1.01342	.986762	40	
	30	.165048	6.0588583	.167343	5.9757644	1.01391	.986286	30	
	40	.167916	5.9553625	.170334	5.8708042	1.01440	.985801	20	
	50	.170783	5.8553921	.173329	5.7693688	1.01491	.985309	10	
10	0	.173648	5.7587705	.176327	5.6712818	1.01543	.984808	0	80
	10	.176512	5.6653331	.179328	5.5763786	1.01595	.984298	50	
	20	.179375	5.5749258	.182332	5.4845052	1.01649	.983781	40	
	30	.182236	5.4874043	.185339	5.3955172	1.01703	.983255	30	
	40	.185095	5.4026333	.188359	5.3092793	1.01758	.982721	20	
	50	.187953	5.3204860	.191363	5.2256647	1.01815	.982178	10	
11	0	.190809	5.2408431	.194380	5.1445540	1.01872	.981627	0	79
	10	.193664	5.1635924	.197401	5.0658352	1.01930	.981068	50	
	20	.196517	5.0886284	.200425	4.9894027	1.01989	.980500	40	
	30	.199368	5.0158517	.203452	4.9151570	1.02049	.979925	30	
	40	.202218	4.9451687	.206483	4.8430045	1.02110	.979341	20	
	50	.205065	4.8764907	.209518	4.7728568	1.02171	.978748	10	
12	0	.207912	4.8097343	.212557	4.7046301	1.02234	.978148	0	78
	10	.210756	4.7448206	.215599	4.6382457	1.02298	.977539	50	
	20	.213599	4.6816748	.218645	4.5736287	1.02362	.976921	40	
	30	.216440	4.6202263	.221695	4.5107085	1.02428	.976296	30	
	40	.219279	4.5604080	.224748	4.4494181	1.02494	.975662	20	
	50	.222116	4.5021565	.227806	4.3896940	1.02562	.975020	10	77
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 77°-10′ to 83°-30′ read from bottom of table upward.

When B and H are known, the formula may be as follows:

(4) $$A = \sqrt{H^2 - B^2}.$$

But when only one side and either one of the angles a or Φ is known, the solution is more complicated and necessitates the use of the trigonometric functions. These functions are known as the sine, cosine, tangent, cotangent, secant and cosecant of the angle* and simply represent a ratio which any two sides of a triangle bear to each other. A table of the trigonometric functions of angles from 10 minutes up to 89 degrees 50 minutes, varying by increments of 10 minutes or one-sixth of a degree, is given below.

Although a table giving the functions of angles for each minute of the quadrant will give closer results, a shorter one, such as the above table, is considered sufficiently accurate for most purposes—in fact, it will more than meet with the closest requirements of actual practice. Tables may also be had, varying by seconds, which, however, are of use only when the greatest accuracy is demanded.

Following are the ratios which any two sides of a right angle triangle bear to each other, together with their corresponding functions. The notations refer to Fig. 2.

$$\text{Sine of angle } \Phi = \frac{\text{side opposite}}{\text{hypotenuse}} \text{ or } \frac{B}{H} = \text{also cosine of angle } a.$$

$$\text{Sine of angle } a = \frac{\text{side opposite}}{\text{hypotenuse}} \text{ or } \frac{A}{H} = \text{also cosine of angle } \Phi.$$

$$\text{Tangent of angle } \Phi = \frac{\text{side opposite}}{\text{side adjacent}} \text{ or } \frac{B}{A} = \text{also cotangent of angle } a.$$

$$\text{Tangent of angle } a = \frac{\text{side opposite}}{\text{side adjacent}} \text{ or } \frac{A}{B} = \text{also cotangent of angle } \Phi.$$

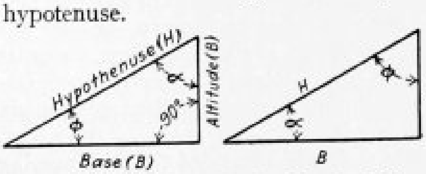
$$\text{Secant of angle } \Phi = \frac{\text{hypotenuse}}{\text{side adjacent}} \text{ or } \frac{H}{A} = \text{also cosecant of angle } a.$$

$$\text{Secant of angle } a = \frac{\text{hypotenuse}}{\text{side adjacent}} \text{ or } \frac{H}{B} = \text{also cosecant of angle } \Phi.$$

The following definitions must be committed to memory; if this is not done it will be necessary to always refer to the definitions when about to solve problems in trigonometry:

The sine of an angle is the side opposite divided by the hypotenuse.

The cosine of an angle is the adjacent side divided by the hypotenuse.



Figs. 1 and 2.—Terms Used in Naming Sides and Angles of Right Triangles and Symbols Designating Each

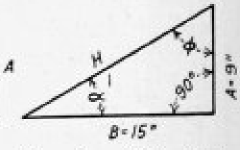


Fig. 3.—Typical Example of Right Triangle Solution

The tangent of an angle is the opposite side divided by the adjacent side.

The cotangent of an angle is the adjacent side divided by the hypotenuse.

The secant of an angle is the hypotenuse divided by the adjacent side.

The cosecant of an angle is the hypotenuse divided by the opposite side.

By transposing the functional ratios as given above, any

* Two other functions are the "versed sine" and the "conversed sine," but as these are so rarely used in practical trigonometry they are not considered here.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
13	0	.224951	4.4454115	.230868	4.3314759	1.02630	.974370	0	77
	10	.227784	4.3901158	.233934	4.2747066	1.02700	.973712	50	
	20	.230616	4.3362150	.237004	4.2193318	1.02770	.973045	40	
	30	.233445	4.2836576	.240079	4.1652998	1.02842	.972370	30	
	40	.236273	4.2323943	.243158	4.1125614	1.02914	.971687	20	
	50	.239098	4.1823785	.246241	4.0610700	1.02987	.970995	10	
14	0	.241922	4.1335655	.249328	4.0107809	1.03061	.970296	0	76
	10	.244743	4.0859130	.252420	3.9616518	1.03137	.969588	50	
	20	.247563	4.0393804	.255517	3.9136420	1.03213	.968872	40	
	30	.250380	3.9939292	.258618	3.8667131	1.03290	.968148	30	
	40	.253195	3.9495224	.261723	3.8208281	1.03368	.967415	20	
	50	.256008	3.9061250	.264834	3.7759519	1.03447	.966675	10	
15	0	.258819	3.8637033	.267949	3.7320508	1.03528	.965926	0	75
	10	.261628	3.8222251	.271069	3.6890927	1.03609	.965169	50	
	20	.264434	3.7816596	.274195	3.6470467	1.03691	.964404	40	
	30	.267238	3.7419775	.277325	3.6058835	1.03774	.963630	30	
	40	.270040	3.7031506	.280460	3.5655749	1.03858	.962849	20	
	50	.272840	3.6651518	.283600	3.5260938	1.03944	.962059	10	
16	0	.275637	3.6279553	.286745	3.4874144	1.04030	.961262	0	74
	10	.278432	3.5915363	.289896	3.4495120	1.04117	.960456	50	
	20	.281225	3.5558710	.293052	3.4123626	1.04206	.959642	40	
	30	.284015	3.5209365	.296214	3.3759434	1.04295	.958820	30	
	40	.286803	3.4867110	.299380	3.3402326	1.04385	.957990	20	
	50	.289589	3.4531735	.302553	3.3052091	1.04477	.957151	10	
17	0	.292372	3.4203036	.305731	3.2708526	1.04569	.956305	0	73
	10	.295152	3.3880820	.308914	3.2371438	1.04663	.955450	50	
	20	.297930	3.3564900	.312104	3.2040638	1.04757	.954588	40	
	30	.300706	3.3255095	.315299	3.1715948	1.04853	.953717	30	
	40	.303479	3.2951234	.318500	3.1397194	1.04950	.952838	20	
	50	.306249	3.2653149	.321707	3.1084210	1.05047	.951951	10	
18	0	.309017	3.2360680	.324920	3.0776835	1.05146	.951057	0	72
	10	.311782	3.2073673	.328139	3.0474915	1.05246	.950154	50	
	20	.314545	3.1791978	.331364	3.0178301	1.05347	.949243	40	
	30	.317305	3.1515453	.334595	2.9886850	1.05449	.948324	30	
	40	.320062	3.1243959	.337833	2.9600422	1.05552	.947397	20	
	50	.322816	3.0977363	.341077	2.9318885	1.05657	.946462	10	
19	0	.325568	3.0715535	.344328	2.9042109	1.05762	.945519	0	71
	10	.328317	3.0458352	.347585	2.8769970	1.05869	.944568	50	
	20	.331063	3.0205693	.350848	2.8502349	1.05976	.943609	40	70
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 70°-40′ to 77°-0′ read from bottom of table upward.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
19	30	.333807	2.9957443	.354119	2.8239129	1.06085	.942641	30	
	40	.336547	2.9713490	.357396	2.7980198	1.06195	.941666	20	
	50	.339285	2.9473724	.360680	2.7725448	1.06306	.940684	10	
20	0	.342020	2.9238044	.363970	2.7474774	1.06418	.939693	0	70
	10	.344752	2.9006346	.367268	2.7228076	1.06531	.938694	50	
	20	.347481	2.8778532	.370573	2.6985254	1.06645	.937687	40	
	30	.350207	2.8554510	.373885	2.6746215	1.06761	.936672	30	
	40	.352931	2.8334185	.377204	2.6510867	1.06878	.935650	20	
	50	.355651	2.8117471	.380530	2.6279121	1.06995	.934619	10	
21	0	.358368	2.7904281	.383864	2.6050891	1.07115	.933580	0	69
	10	.361082	2.7694532	.387205	2.5826094	1.07235	.932534	50	
	20	.363793	2.7488144	.390554	2.5604649	1.07356	.931480	40	
	30	.366501	2.7285038	.393911	2.5386479	1.07479	.930418	30	
	40	.369206	2.7085139	.397275	2.5171507	1.07602	.929348	20	
	50	.371908	2.6888374	.400647	2.4959661	1.07727	.928270	10	
22	0	.374607	2.6694672	.404026	2.4750869	1.07853	.927184	0	68
	10	.377302	2.6503962	.407414	2.4545061	1.07981	.926090	50	
	20	.379994	2.6316180	.410810	2.4342172	1.08109	.924989	40	
	30	.382683	2.6131259	.414214	2.4142136	1.08239	.923880	30	
	40	.385369	2.5949137	.417626	2.3944889	1.08370	.922762	20	
	50	.388052	2.5769753	.421046	2.3750372	1.08503	.921638	10	
23	0	.390731	2.5593047	.424475	2.3558524	1.08636	.920505	0	67
	10	.393407	2.5418961	.427912	2.3369287	1.08771	.919364	50	
	20	.396080	2.5247440	.431358	2.3182606	1.08907	.918216	40	
	30	.398749	2.5078428	.434812	2.2998425	1.09044	.917060	30	
	40	.401415	2.4911874	.438276	2.2816693	1.09183	.915896	20	
	50	.404078	2.4747726	.441748	2.2637357	1.09323	.914725	10	
24	0	.406737	2.4585933	.445229	2.2460368	1.09464	.913545	0	66
	10	.409392	2.4426448	.448719	2.2285676	1.09606	.912358	50	
	20	.412045	2.4269222	.452218	2.2113234	1.09750	.911164	40	
	30	.414693	2.4114210	.455726	2.1942997	1.09895	.909961	30	
	40	.417338	2.3961367	.459244	2.1774920	1.10041	.908751	20	
	50	.419980	2.3810650	.462771	2.1608958	1.10189	.907533	10	
25	0	.422618	2.3662016	.466308	2.1445069	1.10338	.906308	0	65
	10	.425253	2.3515424	.469854	2.1283213	1.10488	.905075	50	
	20	.427884	2.3370833	.473410	2.1123348	1.10640	.903834	40	
	30	.430511	2.3228205	.476976	2.0965436	1.10793	.902585	30	
	40	.433135	2.3087501	.480551	2.0809438	1.10947	.901329	20	
	50	.435755	2.2948685	.484137	2.0655318	1.11103	.900065	10	64
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 64°-10′ to 70°-30′ read from bottom of table upward.

right triangle may be solved for the unknown terms. For ready reference the following table of rules has been arranged, but it will be advisable for the student to commit them to memory, as well as those above:

With reference to any angle

- Side opposite =
  - The hypotenuse times the sine of the angle.
  - The side adjacent times the tangent of the angle.
  - The side adjacent divided by the cotangent of the angle.
  - The hypotenuse divided by the cosecant of the angle.
- Side adjacent =
  - Side opposite divided by the tangent of the angle.
  - Hypotenuse times the cosine of the angle.
  - Side opposite times the cotangent of the angle.
  - Hypotenuse divided by the secant of the angle.
- Hypotenuse =
  - Side opposite divided by the sine of the angle.
  - Side adjacent divided by the cosine of the angle.
  - Side adjacent times the secant of the angle.
  - Side opposite times the cosecant of the angle.

Several practical examples will now be given to thoroughly illustrate the application of the above equations and tables.

Example: Given, a right triangle having a base of 15 inches and an altitude of 9 inches, to find all the remaining terms of the triangle.

When solving problems in trigonometry, a sketch of the triangle should always be made, carefully marking both known and unknown terms as in Fig. 3, which, of course, applies to the present example.

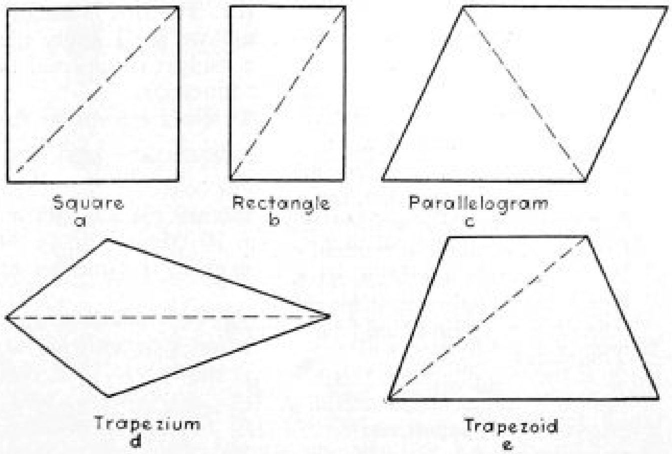


Fig. 4.—Types of Quadrilateral Polygons, or Four-Side Figures Which May Be Divided Into Triangles

H is found by applying formula (2):

$$H = \sqrt{(15 \times 15) + (9 \times 9)} \text{ or } 17.49 \text{ inches.}$$

Had side B been the unknown term, we would have applied formula (3), thus:

$$B = \sqrt{(17.49 \times 17.49) - (9 \times 9)} \text{ or } 15 \text{ inches.}$$

Had side A been the unknown term, we would have applied formula (4), thus:

$$A = \sqrt{(17.49 \times 17.49) - (15 \times 15)} \text{ or } 9 \text{ inches.}$$

To find the magnitude of angle Φ, any one of the six ratios or functions given for that angle may be employed, because

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
26	0	.438371	2.2811720	.487733	2.0503038	1.11260	.898794	0	64
	10	.440984	2.2676571	.491339	2.0352565	1.11419	.897515	50	
	20	.443593	2.2543204	.494955	2.0203862	1.11579	.896229	40	
	30	.446198	2.2411585	.498582	2.0056897	1.11740	.894934	30	
	40	.448799	2.2281681	.502219	1.9911637	1.11903	.893633	20	
	50	.451397	2.2153460	.505867	1.9768050	1.12067	.892323	10	
27	0	.453990	2.2026893	.509525	1.9626105	1.12233	.891007	0	63
	10	.456580	2.1901947	.513195	1.9485772	1.12400	.889682	50	
	20	.459166	2.1778395	.516876	1.9347020	1.12568	.888350	40	
	30	.461749	2.1656806	.520567	1.9209821	1.12738	.887011	30	
	40	.464327	2.1536553	.524270	1.9074147	1.12910	.885664	20	
	50	.466901	2.1417808	.527984	1.8939971	1.13083	.884309	10	
28	0	.469472	2.1300545	.531709	1.8807265	1.13257	.882948	0	62
	10	.472038	2.1184737	.535447	1.8676003	1.13433	.881578	50	
	20	.474600	2.1070359	.539195	1.8546159	1.13610	.880201	40	
	30	.477159	2.0957385	.542956	1.8417708	1.13789	.878817	30	
	40	.479713	2.0845792	.546728	1.8290628	1.13970	.877425	20	
	50	.482263	2.0735556	.550515	1.8164892	1.14152	.876026	10	
29	0	.484810	2.0626653	.554309	1.8040478	1.14335	.874620	0	61
	10	.487352	2.0519061	.558118	1.7917362	1.14521	.873206	50	
	20	.489890	2.0412757	.561939	1.7795524	1.14707	.871784	40	
	30	.492424	2.0307720	.565773	1.7674940	1.14896	.870356	30	
	40	.494953	2.0203929	.569619	1.7555590	1.15085	.868920	20	
	50	.497479	2.0101362	.573478	1.7437453	1.15277	.867476	10	
30	0	.500000	2.0000000	.577350	1.7320508	1.15470	.866025	0	60
	10	.502517	1.9899822	.581235	1.7204736	1.15665	.864567	50	
	20	.505030	1.9800810	.585134	1.7090116	1.15861	.863102	40	
	30	.507538	1.9702944	.589045	1.6976631	1.16059	.861629	30	
	40	.510043	1.9606206	.592970	1.6864261	1.16259	.860149	20	
	50	.512543	1.9510577	.596908	1.6752988	1.16460	.858662	10	
31	0	.515038	1.9416040	.600861	1.6642795	1.16663	.857167	0	59
	10	.517529	1.9322578	.604827	1.6533663	1.16868	.855665	50	
	20	.520016	1.9230173	.608807	1.6425576	1.17075	.854156	40	
	30	.522499	1.9138809	.612801	1.6318517	1.17283	.852640	30	
	40	.524977	1.9048469	.616809	1.6212469	1.17493	.851117	20	
	50	.527450	1.8959138	.620832	1.6107417	1.17704	.849586	10	
32	0	.529919	1.8870799	.624869	1.6003345	1.17918	.848048	0	58
	10	.532384	1.8783438	.628921	1.5900238	1.18133	.846503	50	
	20	.534844	1.8697040	.632988	1.5798079	1.18350	.844951	40	57
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 57°-40′ to 64°-0′ read from bottom of table upward.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
32	30	.537300	1.8611590	.637070	1.5696856	1.18569	.843391	30	
	40	.539751	1.8527073	.641167	1.5596552	1.18790	.841825	20	
	50	.542197	1.8443476	.645280	1.5497155	1.19012	.840251	10	
33	0	.544639	1.8360785	.649408	1.5398650	1.19236	.838671	0	57
	10	.547076	1.8278985	.653551	1.5301025	1.19463	.837083	50	
	20	.549509	1.8198065	.657710	1.5204261	1.19691	.835488	40	
	30	.551937	1.8118010	.661886	1.5108352	1.19920	.833886	30	
	40	.554360	1.8038809	.666077	1.5013282	1.20152	.832277	20	
	50	.556779	1.7960449	.670285	1.4919039	1.20386	.830661	10	
34	0	.559193	1.7882916	.674509	1.4825610	1.20622	.829038	0	56
	10	.561602	1.7806201	.678749	1.4732983	1.20859	.827407	50	
	20	.564007	1.7730290	.683007	1.4641147	1.21099	.825770	40	
	30	.566406	1.7655173	.687281	1.4550090	1.21341	.824126	30	
	40	.568801	1.7580837	.691573	1.4459801	1.21584	.822475	20	
	50	.571191	1.7507273	.695881	1.4370268	1.21830	.820817	10	
35	0	.573576	1.7434468	.700208	1.4281480	1.22077	.819152	0	55
	10	.575957	1.7362413	.704552	1.4193427	1.22327	.817480	50	
	20	.578332	1.7291096	.708913	1.4106098	1.22579	.815801	40	
	30	.580703	1.7220508	.713293	1.4019483	1.22833	.814116	30	
	40	.583069	1.7150639	.717691	1.3933571	1.23089	.812423	20	
	50	.585429	1.7081478	.722108	1.3848355	1.23347	.810723	10	
36	0	.587785	1.7013016	.726543	1.3763810	1.23607	.809017	0	54
	10	.590136	1.6945244	.730996	1.3679959	1.23869	.807304	50	
	20	.592482	1.6878151	.735469	1.3596764	1.24134	.805584	40	
	30	.594823	1.6811730	.739961	1.3514224	1.24400	.803857	30	
	40	.597159	1.6745970	.744472	1.3432331	1.24669	.802123	20	
	50	.599489	1.6680864	.749003	1.3351075	1.24940	.800383	10	
37	0	.601815	1.6616401	.753554	1.3270448	1.25214	.798636	0	53
	10	.604136	1.6552575	.758125	1.3190441	1.25489	.796882	50	
	20	.606451	1.6489376	.762716	1.3111046	1.25767	.795121	40	
	30	.608761	1.6426796	.767327	1.3032254	1.26047	.793353	30	
	40	.611067	1.6364828	.771959	1.2954057	1.26330	.791579	20	
	50	.613367	1.6303462	.776612	1.2876447	1.26615	.789798	10	
38	0	.615661	1.6242692	.781286	1.2799416	1.26902	.788011	0	52
	10	.617951	1.6182510	.785981	1.2722957	1.27191	.786217	50	
	20	.620235	1.6122908	.790698	1.2647062	1.27483	.784416	40	
	30	.622515	1.6063879	.795436	1.2571723	1.27778	.782608	30	
	40	.624789	1.6005416	.800196	1.2496933	1.28075	.780794	20	
	50	.627057	1.5947511	.804979	1.2422685	1.28374	.778973	10	51
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 51°-10′ to 57°-30′ read from bottom of table upward.

all three sides of the triangle are known. The sine is usually the most convenient to work with, and we shall apply the calculations accordingly, although the student is expected to check his solution by means of all six functions.

(Henceforth we shall abbreviate the terms expressing the functions of angle as follows):

Sine of angle *a* written, sin *a*.
Cosine of angle *a* written, cos *a*.
Tangent of angle *a* written, tan *a*.
Cotangent of angle *a* written, cot *a*.
Secant of angle *a* written, sct *a*.
Cosecant of angle *a* written, csct *a*.
The same notation is used for angle Φ.
Therefore:

$$\text{Sin } \Phi = \frac{\text{side opposite angle}}{\text{hypotenuse}} = \frac{B}{H} \text{ or } \frac{15}{17.49} = .8575.$$

We shall further emphasize the fact that the above numerical result is simply a certain ratio which sides *B* and *H* of Fig. 3 bear to each other. It should also be realized that under similar conditions in any triangle the magnitude of angle Φ will always be the same, regardless of the lengths of the sides. In short, we may say in any right angle triangle bearing the same notations as that of Fig. 3, when side *B*, divided by side *H* equals .8575, that the magnitude of angle Φ is a fixed quantity, or is "constant."

Referring now to the table of trigonometric functions and following down the columns headed "Sines," we find that the above value is not in evidence. This means that the corresponding angle for this ratio is greater than 45 degrees, in which case the functions are read from the *bottom* of the columns up. Therefore, we follow up the column headed "Sines" at the bottom of the tables until we come to the desired figure. It will be found that the nearest approach to our figure is .857167, and by following over on the same horizontal line to the two extreme *right hand* columns we find that this ratio corresponds to angle 59 degrees.

The sum of the three angles of any triangle is always 180 degrees, which may be most conveniently proved from the fact that a triangle is exactly one-half of a rectangle, or any other four-sided polygon, as clearly indicated in Fig. 4 (a) to (e). *(To be continued)*

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
39	0	.629320	1.5890457	.809784	1.2348972	1.28676	.777146	0	51
	10	.631578	1.5833318	.814612	1.2275786	1.28980	.775312	50	
	20	.633831	1.5777077	.819463	1.2203121	1.29287	.773472	40	
	30	.636078	1.5721337	.824336	1.2130970	1.29597	.771625	30	
	40	.638320	1.5666121	.829234	1.2059327	1.29909	.769771	20	
	50	.640557	1.5611424	.834155	1.1988184	1.30223	.767911	10	
40	0	.642788	1.5557238	.839100	1.1917536	1.30541	.766044	0	50
	10	.645013	1.5503558	.844069	1.1847376	1.30861	.764171	50	
	20	.647233	1.5450378	.849062	1.1777698	1.31183	.762292	40	
	30	.649448	1.5397690	.854081	1.1708496	1.31509	.760406	30	
	40	.651657	1.5345491	.859124	1.1639763	1.31837	.758514	20	
	50	.653861	1.5293773	.864193	1.1571495	1.32168	.756615	10	
41	0	.656059	1.5242531	.869287	1.1503684	1.32501	.754710	0	49
	10	.658252	1.5191759	.874407	1.1436326	1.32838	.752798	50	
	20	.660439	1.5141452	.879553	1.1369414	1.33177	.750880	40	
	30	.662620	1.5091605	.884725	1.1302944	1.33519	.748956	30	
	40	.664796	1.5042211	.889924	1.1236909	1.33864	.747025	20	
	50	.666966	1.4993267	.895151	1.1171305	1.34212	.745088	10	
42	0	.669131	1.4944765	.900404	1.1106125	1.34563	.743145	0	48
	10	.671289	1.4896703	.905685	1.1041365	1.34917	.741195	50	
	20	.673443	1.4849073	.910994	1.0977020	1.35274	.739239	40	
	30	.675590	1.4801872	.916331	1.0913085	1.35634	.737277	30	
	40	.677732	1.4755095	.921697	1.0849554	1.35997	.735309	20	
	50	.679868	1.4708736	.927091	1.0786423	1.36363	.733335	10	
43	0	.681998	1.4662792	.932515	1.0723687	1.36733	.731354	0	47
	10	.684123	1.4617257	.937968	1.0661341	1.37105	.729367	50	
	20	.686242	1.4572127	.943451	1.0599381	1.37481	.727374	40	
	30	.688355	1.4527397	.948965	1.0537801	1.37860	.725374	30	
	40	.690462	1.4483063	.954508	1.0476598	1.38242	.723369	20	
	50	.692563	1.4439120	.960083	1.0415767	1.38628	.721357	10	
44	0	.694658	1.4395565	.965689	1.0355303	1.39016	.719340	0	46
	10	.696748	1.4352393	.971326	1.0295203	1.39409	.717316	50	
	20	.698832	1.4309602	.976996	1.0235461	1.39804	.715286	40	
	30	.700909	1.4267182	.982697	1.0176074	1.40203	.713251	30	
	40	.702981	1.4225134	.988432	1.0117088	1.40606	.711209	20	
	50	.705047	1.4183454	.994199	1.0058348	1.41012	.709161	10	
45	0	.707107	1.4142136	1.000000	1.0000000	1.41421	.707107	0	45
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 45°-0′ to 51°-0′ read from bottom of table upward.

Oxygen and Acetylene Hose Markings

The necessity for adopting a general practice in the matter of standardizing the color markings of oxygen and acetylene hose and regulators was early appreciated, both by manufacturers of equipment and by the National Board of Fire Underwriters. The latter, in their rules and requirements (edition of 1910) dealt with the subject as related to hose in the following definite provision:

"In order to avoid confusion when attaching the hose to the connections, a red colored hose should be used for oxygen and a black colored hose for acetylene."

This recommendation was very generally adopted by manufacturers, not only in the color marking of hose, but also in the color marking of regulators, which were in every instance, if color marked, painted red for oxygen and black for acetylene, to correspond to the color of the hose to be connected to them. This practice worked admirably and was generally accepted wherever gas welding and cutting were used.

And now there is agitation in certain quarters to reverse the order, red being favored as a more natural color to indicate combustible gas. It is true that red is a common danger signal, but it is equally true that in the oxy-acetylene industry red has stood for oxygen ever since welding and cutting have been used to any appreciable extent in this country. It would seem unwise to unlearn now something that has become so fixed in thought-habit as has this old established practice, and all the more so considering the fact that the industries of the country have in service tens of thousands of welding and cutting units in which hose and regulators are color marked with red for oxygen and with black for acetylene. The change proposed would surely result in confusion and possibly serious accidents.

In line with this view of the matter is a resolution passed at the regular meeting of the executive board of the Compressed Gas Manufacturers' Association, November 18, 1920, which reads as follows:

"*Resolved:* Whereas, although it would have been a good thing for the industries if red had been adopted as the color for combustible gases at the inception of the business, grave results might follow such adoption at this time, and we therefore feel that it is desirable to go on record as against the changing of colors now in general use."

New York Boiler Inspectors Form Association

The Boiler Inspectors Association of the Capitol District was organized in the offices of the Travelers Insurance Company, at Albany, N. Y., on January 15. Membership is restricted to boiler inspectors working under the New York State Boiler Code, and includes inspectors of the various insurance companies and of the State Industrial Commission. The purpose is to secure cooperation and exchange of views that will help the individual inspector in his interpretation and enforcement of the state boiler law.

The following officers have been elected: President, B. Plant, Travelers Indemnity Company; vice-president, W. Scott, Royal Indemnity Company; secretary, F. Toener, Hartford Insurance Company; treasurer, E. Hall, State Bureau of Boilers and Explosives.

National Board of Boiler Inspectors' Convention

First Meeting of New Organization—Discussion of Matters Dealing with Uniform Boiler Regulations—Constitution Adopted

The first annual meeting of the National Board of Boiler and Pressure Vessel Inspectors brought together at the Hotel Statler, in Detroit, February 2, 3 and 4, a group of about sixty men, including members of the board itself, members of the Boiler Code Committee of the American Society of Mechanical Engineers and others interested in the standardization of boiler requirements.

The entire first day was devoted to addresses by men who have been most prominent in the advancement of uniformity in the state regulation of boilers. Because of the absence of Dr. D. S. Jacobus, acting chairman of the American Society of Mechanical Engineers' Boiler Code Committee, F. R. Low, editor of *Power,* read Dr. Jacobus' paper on the A. S. M. E. Boiler Code. Charles E. Gorton, chairman of the American Uniform Boiler Law Society, told of the development of this society. C. W. Bissel, chairman of the Michigan Board of Boiler Rules, delivered a paper on "The Necessity of Uniformity in the Regulation of Steam Boiler Construction and Operation." Other papers included one by J. C. McCabe, chief boiler inspector for the state of Michigan, on "Qualifications and Duties of the Boiler Inspectors"; E. R. Fish, of the Heine Safety Boiler Company, "The Necessity of Uniform Enforcement of the A. S. M. E. Boiler Code"; S. F. Jeter, chief engineer, the Hartford Steam Boiler Inspection and Insurance Company, "Necessity for Co-operation Between Insurance Companies and State Boiler Inspection Departments"; F. W. Herendeen, secretary, National Boiler and Radiator Manufacturers' Association, "Rules for Low Pressure Boilers"; F. R. Low, editor of *Power,* "Duties and Possibilities of the National Board of Boiler Inspectors."

On the second day the members of the board attended a meeting and took part in the deliberations of the Boiler Code Committee of the American Society of Mechanical Engineers. This meeting of the committee was held at Detroit instead of as usual at the headquarters of the society in New York, in order to give the committee the advantage of meeting and counseling with men from all over the country who are enforcing the code. Nineteen inspectors were present from almost as many different states in widely separated sections of the country. On the final day of the meeting the permanent organization of the board was formed, with Joseph F. Scott, inspector from New Jersey, as chairman of the board and C. O. Myers, chief boiler inspector of Ohio, as secretary-treasurer. The objects of the Board of Boiler and Pressure Vessel Inspectors as stated in the constitution adopted are as follows:

"To promote uniform boiler laws and rules throughout the jurisdiction of its members;

"To secure uniform approval of specific designs of boilers and other pressure vessels, as well as appurtenances and devices used in connection with their safe operation;

"To promote one universal code of boiler rules; and one standard stamp to be placed upon boilers constructed in accordance with requirements of that code; and one standard of qualifications and examinations for boiler inspectors who are to enforce the requirements of said code;

"To compile official statistics and other data."

A complete report of the proceedings and abstracts of papers not published in this issue will appear in later issues of The Boiler Maker, together with the constitution adopted at this meeting. Abstracts of several of the papers are given below:

The American Society of Mechanical Engineers' Boiler Code

BY DR. D. S. JACOBUS

The Boiler Code Committee was appointed by the council of the American Society of Mechanical Engineers September 15, 1911, to prepare specifications for the construction of steam boilers and other pressure vessels. It was not until February 13, 1915, that the first code which embodied that part of the work bearing on rules for the construction of stationary boilers and for allowable working pressures was submitted to the council of the society and accepted for publication. The primary object of the rules in this code was to secure safe boilers. The interests of the boiler users and manufacturers were carefully considered and the requirements made such that they would not entail undue hardship by departing too widely from the current practice.

A vast amount of work was done by the committee during the three and a half years which elapsed between its appointment and the time at which the first code was completed. It was appreciated from the beginning that all interests affected by the rules must have means of presenting their views for the consideration of the committee.

It was finally arranged that an advisory committee be appointed by the council representing the various industries affected by the code. This advisory committee was made up as follows:

4—Railroad Sub-Committee, A. S. M. E.
1—Boiler Manufacturers' Association Uniform Specifications for all types of boilers.
1—National Tubular Boiler Manufacturers' Association.
1—Watertube Boilers.
1—Scotch marine and other types of boilers.
1—National Association of Thresher and Tractor Manufacturers.
1—National Boiler and Radiator Manufacturers' Association.
2—Steel heating boilers.
2—Boiler users.
1—Boiler insurance.
1—Consulting engineers.
1—Engineering education.

Appreciating the fact that the strength of the code would depend on whether it would be one to which all could agree, the principle of unanimous action was adopted, and the code which was finally presented to the council represented complete unanimous action on the part of the Boiler Code Committee and the Advisory Committee.

Directly after the presentation of the first code to the council the members of the Advisory Committee were appointed members of the Boiler Code Committee and the Boiler Code Committee from then on has been made up in part of representatives of the various interests involved.

It was recognized that the code would require revision from time to time as the art advanced; also that questions would arise respecting the interpretation of parts of the code and the handling of constructions not fully covered by the code. The Boiler Code Committee was therefore continued by the society. In prosecuting its work each action has been submitted to the council for its approval, in consequence of which all of the actions of the Boiler Code Committee represent the official acts of the American Society of Mechanical Engineers.

Each state and municipality that adopted the code was invited to appoint a representative to act on a conference committee to the Boiler Code Committee and the invitation was in all cases accepted. The Boiler Code Committee and Conference Committee co-operated in the work of revising the code. The revisions were published and widely discussed before their final adoption.

The Boiler Code Committee and the Conference Committee meet monthly for the purpose of interpreting the code. The inquiries are submitted in written form before they are accepted for consideration. Copies of the inquiries are sent to all the members of the committee and of the Conference Committee. The interpretations are prepared at the regular monthly meetings and confidential copies, which are subject to revision, are sent to the members of the Boiler Code Committee, the Conference Committee and the council. If a single adverse vote or objection is received an interpretation is held over for consideration at the next meeting of the committee. The interpretations, therefore, also represent unanimous action.

Sub-committees of the Boiler Code Committee have been appointed by the council on the recommendation of the Boiler Code Committee to meet with committees of societies engaged in the formulation of specifications or codes, the subject matter of which would affect the boiler code. The sub-committees of the Boiler Code Committee and the committees appointed by the societies submit their joint recommendations to the Boiler Code Committee for action by the Boiler Code Committee, and the Boiler Code Committee in turn makes its recommendations to the council. Such sub-committees have been appointed to confer with the following societies and corresponding committees have been appointed by the societies:

American Society for Testing Materials.
Association of American Steel Manufacturers.
American Society of Heating and Ventilating Engineers.
American Welding Society.
American Society of Refrigerating Engineers.

As one after another of the states and municipalities have adopted the code, the problem of securing uniform enforcement has become more and more difficult. Without uniform enforcement the uniformity aimed for in the code cannot be accomplished and the Boiler Code Committee is as much of a party in interest as you are. We are all proud of the code and stand behind it. You have brought your troubles to us through your close relationship and they are our troubles just as much as yours. Co-operation has been the keynote of success in preparing the code, and co-operation in the present case will lead to success in securing uniformity through its enforcement.

Co-operation Between State Boiler Departments and Insuring Companies

BY S. F. JETER

The usual method adopted in making state boiler laws, which was first introduced by Massachusetts in 1907, is for the law making body (the legislature) to clothe a board, generally termed a board of boiler rules, with authority to make rules to govern the construction, operation and inspection of boilers that may be brought into the state. This board is also given authority to change its rules and regulations from time to time as may be found necessary. It is also provided that inspectors of insuring companies, licensed to operate in the state, when duly qualified in the manner prescribed by the board of boiler rules, shall become quasi-state inspectors. These inspectors make the inspections required by the rules, on such boilers as are covered by policies of insurance issued by the company employing the inspector. It can be readily appreciated that under these conditions the closest co-operation between the state departments and the insuring companies is not only necessary but is arranged for by the law.

In drafting boiler laws there has arisen, at times, a question as to the right to delegate authority to the employees of insuring companies to make inspections required under the law, but there are innumerable precedents in law establishing the right of such procedure. In fact, the delegation by the law making body of authority to a board of boiler rules to make rules that in effect become law is a practice similar in character, though probably more open to criticism from a legal viewpoint.

Boiler insurance, while not originating in the United States, was commenced in this country fifty-four years ago, and by its rapid growth reached a point of development in this country far outstripping any of the foreign companies engaged in similar work.

The benefits gained through boiler and pressure vessel insurance have become so well understood that no real business concern using boilers or pressure vessels would consider being without such protection any more than without protection against the fire hazard.

It is difficult to understand how an arrangement could be worked out that would tend to secure more reliable inspection work than by having the work performed by trained men, duly qualified by the state department and operating under their rules and who were additionally responsible to, and under the direction of a company who assumes large financial obligations should accident occur to the inspected boilers.

Without doubt proper co-operation between the boiler insuring companies and the state or municipal boiler departments is of advantage to the citizen as well as the first two parties.

Very often questions are discussed pro and con between a state boiler department and an insuring company or boiler manufacturer as to whether a given feature of the requirements has been met. In such discussions, particularly, where they relate only to the letter and not the spirit of the rules, the interest of the citizen should be most carefully considered. It is not desirable to discipline an inspector or a boiler manufacturer if the citizen purchaser, who is an innocent party to the affair, is to be made to suffer an equal or greater amount than the real offender.

One place where co-operation by the state department is of distinct advantage to the insuring company in securing proper construction and operating conditions is this: Without legal requirements governing the construction and operation of boilers the insuring company can only recommend changes that are necessary to secure safety. If the operator does not choose to follow these recommendations the insuring company has played its trump card when it announces it will retire from the risk unless its requirements are met. This leaves the way open to the owner to assume the hazard himself, or to try to procure financial protection against a possible accident from some other company doing a similar class of business. However, where certain procedure is prescribed by law and the inspector's requirements are backed up by the state department there can be no dodging the issue, compliance with the law must be observed no matter who may assume the hazard due to explosion.

It might be well here to point out the need for care on the part of boiler boards in drafting their regulations. Unless the regulations are grounded on safe practice, and safe practice only, there is always the possibility of their being overturned.

The advantages of uniform qualifications for boiler inspectors are many. If each state had a radically different set of rules to govern the construction and operation of boilers there might be some justification in requiring an individual test for each inspector operating under its rules. However, where one set of construction rules is to be enforced by all states there can be no justification for such procedure. There is no more logic in requiring that an inspector who is to examine boilers that are intended for use in a given state must be qualified by an examination held in that state than there would be to require that all tests of the material used in the boiler must be made in the state where the boiler is to be installed. A single test of an applicant's competency for inspectorship should be sufficient, and if satisfactorily met it should entitle him to inspect boilers for any state.

It is understood that one of the first problems that is to be solved by the National Board of Boiler Inspectors is what might be termed a national certificate of competency for inspectorship. It should be remembered in connection with this question of certificates of competency that if two states, not now doing so, would recognize the holding of certificates from another state having equally rigid requirements as their own as entitling the holder to be certified by their state, no hardship would exist at the present moment.

One of the features that will require proper safeguards if a single certificate is to replace the individual state certificates now issued is the revocation of such certificates. While no question can be raised against depriving a man of the right to inspect for all states if incompetent or untrustworthy in performing inspection work for one state, it is quite a serious matter to deprive a man of his means of livelihood. Certainly the revocation of any uniform certificate of competency for all states should be surrounded by adequate safeguards. It should be made positive that a just cause for the revocation exists before it becomes effective.

It might be thought from these statements that a uniform method of qualifying inspectors was considered inadvisable. Quite the contrary is the case, but the present plan in use by all but two states having boiler laws has been proven to be workable, and it should be made certain that any new plan is at least as good before discarding it.

Another point to be guarded against in uniform qualifications for inspectorship is the method of determining the applicant's qualifications. It would appear that the previous experience of the applicant, if duly certified to, should have considerable weight in deciding the question. While there might be a difference of opinion about the matter, many consider a written examination as the correct method for determining an applicant's qualifications. It certainly possesses the very admirable feature of presenting a record of what was done, so that the applicant may be shown at any time just why he failed, if not granted a certificate. If an examination is to be oral in its entirety, or partly so, a correct stenographic record should be made of all questions and answers.

Another feature should be borne in mind by those charged with the examination of applicants—the purpose should be to find out what a man knows that would tend to qualify him for inspectorship and if he possesses a proper amount of the required knowledge grant him a certificate.

As the members of the National Board of Boiler Inspectors must know, there is no school of training that can fit a man for inspectorship but the school of experience in inspection work. It is my belief that six months at inspecting boilers is worth more than ten years' experience in any other occupation in qualifying an inspector of boilers.

Those responsible for the examinations should also bear in mind that their long years of experience have placed them in possession of knowledge that the young inspector must acquire in much the same manner. A new recruit should certainly not be expected to be as well posted as an old head in the business. All that should be required is that he possesses the necessary qualifications to be entrusted with the performance of inspection work with safety to the public and is sufficiently conversant with the rules under which he is to work to detect violations.

There is not the least doubt but that with reasonable boiler laws, honestly administered, the state boiler inspection departments can count on the fullest co-operation of the insuring companies.

Qualifications and Duties of a Boiler Inspector

BY J. C. MC CABE

In the matter of qualifications there is practically no limit to the talent that an inspector should possess. A boiler inspector should not only be familiar with the physical and chemical character of boiler materials, but he should know when they are properly placed in a boiler and that the design is of such a character that it will withstand a long period of service without failure.

The necessity for this is made plain because of the enormous energy stored within a steam boiler. The hundreds of boiler accidents, loss of life and property occurring annually has, for years, made boiler inspection a matter of grave public concern. A vessel containing water within it with 10,000 foot pounds of energy, more or less, per pound of water is always a grave menace to safety.

The inspector should have an adequate conception of the physical effect of bending, rolling and hammering on boiler materials in the course of fabrication of a new boiler. To properly perform the duties of inspection he must be able to make necessary calculations to determine the reasonable safety on all parts of the pressure vessel.

The speaker has in mind an instance of a boiler of the watertube type said to have been designed for 200 pounds working pressure, but after a period of 15 years' use the boiler in question developed four cracks in one of the water legs, each about 2 feet long. Investigation disclosed that the vessel had been built for 200 pounds with a proper factor of safety, but that the wrapper plate was found to be safe at a pressure not over 100 pounds. Fortunately disaster did not occur in this case.

The Boiler Code Committee of the American Society of Mechanical Engineers has done much to standardize and make safe the construction of steam boilers, and with proper enforcement by responsible officers of states and cities the results desired can be accomplished.

In the work of the State Board of Boiler Rules for Michigan, with which the speaker is connected in examining of inspectors, it was found that in some cases commissions had been issued without examination and candidates were found utterly incompetent. It is desirable that the National Board of Boiler and Pressure Vessel Inspectors prepare a standard which all inspectors should meet who are inspecting boilers in the various states. The requirements should be reasonable, but broad and comprehensive, requiring such experience and knowledge that will leave no reasonable question as to the capabilities of a man receiving a commission.

In this connection it is the contention of the speaker that the salaries paid inspectors have not been sufficiently high to draw to the work a class of men who will give to the work the service required. However, it must be admitted that there are men in this class of service who are very capable and competent.

A successful inspector in the field must develop a large fund of intuition in order to foretell and forestall preventable accidents. This involves a knowledge of the effect of heat upon boiler materials and stresses incidental thereto.

The importance of this is disclosed in the case of horizontal tubular boilers which have bagged in service. In a boiler of this type, operating with a factor of safety of five, it is necessary to heat the plates to a temperature of 1,400 to 1,500 degrees Fahrenheit. In the case of tubes in watertube boilers under ordinary operating pressure and standard tubes, a temperature of 1,800 to 2,000 degrees Fahrenheit is necessary to bag and rupture such tubes. Failure of this kind, of course, cannot occur where boilers are kept properly clean and

(Continued on page 60)

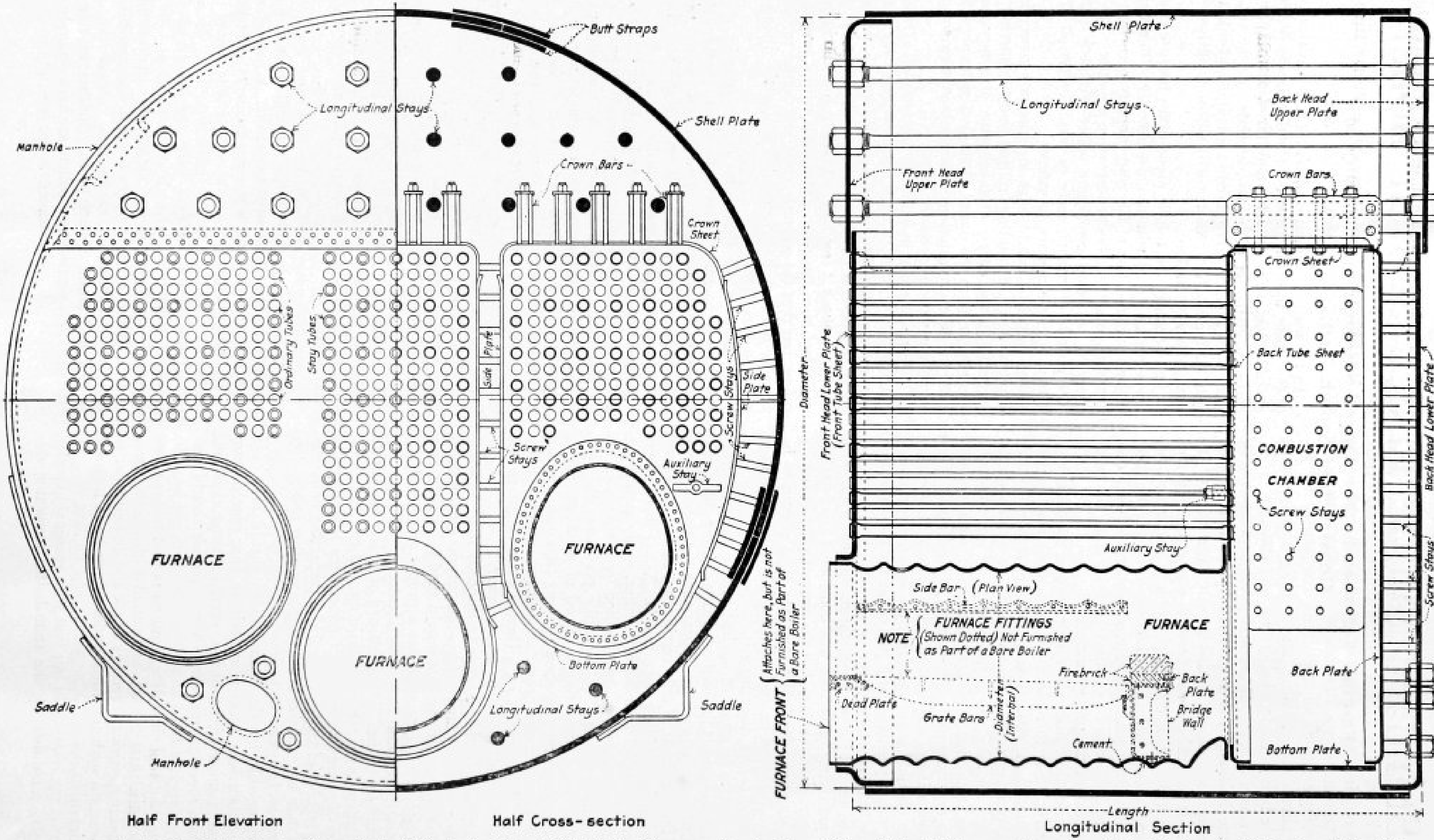


Fig. 1.—Standard Single Ended Scotch Marine Boiler Built by the Federal Shipbuilding Company, Showing Bare Boiler, Without Fittings or Accessories. This Drawing, in Conjunction With Tables Giving Diameter of Boiler, Number of Furnaces and Heating Surface, as Well as the Details of Construction, Provides an Accurate Description of All Standard Size Boilers Built by the Company

Standard Single Ended Scotch Boilers

Practice Followed by the Federal Shipbuilding Company in Constructing Scotch Marine Boilers

As a means of describing the standard Scotch marine boilers built by the Federal Shipbuilding Company, Kearney, N. J., to accompany specification descriptions of ships in which they may be used, the form given below has been developed. So far as known, this is the first time that an attempt has been made to present Scotch boiler data in so concise and complete a manner. The use of the table of boiler sizes in conjunction with the drawing of the bare boiler and the general details accurately describe the boiler products of the company.

We should like to hear from readers of THE BOILER MAKER just how such a form of boiler data appeals to them; whether or not it is complete or in what points it is open to criticism.

DETAILS OF CONSTRUCTION

Shell.—Plates in one width longitudinally of boiler, and in two or three lengths circumferentially. Edges of shell plates between outside butt straps and flanges of heads welded to ensure tightness. Reinforcing plate riveted to shell at manhole opening.

Front and Back Heads.—Each in two pieces, of sufficient thickness to omit doublers and reinforcements under through stays. Heads flanged inwards to save installation space. Front head flanged for furnaces and manholes.

Saddles.—Four undrilled saddles for supporting boilers riveted securely to shell, with calking strips between saddle and shell.

Manholes.—Covers and dogs furnished, one 12 inches by 16 inches in shell, and 11 inches by 15 inches in front head between furnaces. Faces of covers and edges of manholes machined where gaskets seat.

Pads.—Riveted securely to shell and back head respectively; calked, faced, drilled for standard extra heavy flanges and fitted with studs for attaching following mountings, the pipe sizes to be specified:

- One main and auxiliary steam.
- One safety valve.
- One main feed.
- One auxiliary feed.
- One surface blow.
- One bottom blow.
- Two water column.
- One circulator.

Tapped Holes.—Provided for the following mountings at locations to be specified:

- One ½-inch air cock, with nipple.
- Three ¾-inch try cocks, with nipples.
- One ¾-inch steam gage, with nipple.
- One ¾-inch salinometer cock, flanged.
- One ¾-inch fusible plug, with plug, in crown sheet of each combustion chamber, fitted from fire side.
- One 1¼-inch drain, with specially designed drain bolt.

Furnaces.—Morison suspension horse-collar type, removable through opening in front head, with front end extending beyond calking edge of front head for attachment of furnace front.

Combustion Chambers.—Independent for each furnace, made up of back plate, back tube sheet, and wrapper consisting of top plate or crown sheet, bottom plate and side plates. Back plate and back tube sheet parallel with back head and flanged inwards. Bottom plate sufficiently thick to be self-staying.

Crown Bars (Girders).—Shaped and fitted to bear evenly along combustion chamber crown sheets and to fit evenly upon heel of back sheet and back tube sheet, and riveted together in pairs through suitable pipe thimbles.

Riveted Joints.—Single lap, except in shell plates which are triple butt with inside and outside straps, and in front and back heads which are double lap.

Tubes.—Outside diameter 2¾ inches for forced or 3 inches for natural draft, of sufficient thickness for pressures. Ordinary tubes beaded at both ends. Stay tubes beaded at back end and upset at both ends.

Stays.—Longitudinal or through stays fitted with nuts inside and outside with ends upset. Crown sheet staybolts threaded through crown sheet and fitted with nuts. Screw stays drilled with 3/16-inch test hole extending ½ inch beyond inside of plate, screwed into plate and riveted over, except where combustion chamber surface requires additional staying when nuts are fitted on inside. If required to support front or back tube sheet, auxiliary dog stays are provided, tapped through plate and riveted over.

Materials.—Conform to requirements of United States Steamboat Inspection Service and of standard classification societies. Steel made by open hearth process. Minimum tensile strength in pounds per square inch:

Shell plates (marine steel)	60,000
Longitudinal stays................	62,720
Flanged plates....................	55,000
Rivets	58,240
Tubes	"National" steel

Shop Practice.—Plates fitted up metal to metal, and holes drilled while plates are in place. Burrs due to drilling removed and plates thoroughly cleaned before assembling for riveting. Rivets fill holes completely and are headed up hydraulically where possible. Plates bevelled for true calking edge and seams calked. Seams with two calking edges calked inside and outside. Longitudinal stays packed where they pass through heads. Material and workmanship of good commercial quality suitable for purpose, but without unnecessary finish to any part.

Accessibility.—Boiler parts arranged to give access for cleaning and repairs. Space between tube nests and between shell and tube nests gives access to tops of furnaces. Space between furnaces and bottom tubes permits cleaning furnaces. Calking edges of combustion chamber plates readily accessible.

Inspection and Tests.—Boilers built in accordance with rules of the United States Steamboat Inspection Service and classification society selected, and before shipment each boiler tested to ensure compliance therewith.

BARE BOILER AND ACCESSORIES

The "bare boiler" is shown by the diagram Fig. 1. It includes the shell, front and back heads, furnaces, combustion chambers, crown bars, tubes, stays, manhole covers and saddles, together with the connections specified above for mountings.

External fittings and retarders are not usually furnished by the company.

Internal fittings, furnace fittings for coal fuel, and furnace fronts, listed on the opposite page, are accessories furnished only under special agreement.

Boilers are so designed that superheaters may be fitted if required. Uptakes and smokestacks are supplied with the bare boiler when arrangements are specially made for them.

ACCESSORIES WHICH MAY BE INSTALLED WHEN REQUIRED

Internal Fittings

Dry pipe
Circulator pipes with ejector
Internal feed pipes
Scum pan with strainer
Surface blow pipe
Bottom blow pipe
Zincs
Zinc baskets
Hangers

Furnace Fittings

Dead plates (R. and L.)
Bridge wall, complete
Back plate
Side or wing bars (R. and L.)

Furnace Fittings (Cont.)

Grate bars
Firebrick
Asbestos or cement

Furnace Fronts

Front proper
Furnace door
Ashpit door
Top damper
Side dampers (R. and L.)
Top or arch baffle
Side baffles (R. and L.)
Door baffle
(Burners for fuel oil not included)

STANDARD SIZES OF SINGLE ENDED BOILERS

DESIGNED FOR FORCED DRAFT—11 FEET 6 INCHES LONG

Diameter	Square Feet Heating Surface		Number of
	Oil	Coal	Furnaces
10′-0″	1,292	1,254	2
10′-6″	1,401	1,360	2
11′-0″	1,519	1,475	2
11′-6″	1,580	1,536	2
12′-0″	1,667	1,620	2
12′-6″	1,750	1,700	2
13′-0″	1,859	1,807	2
13′-6″	2,258	2,195	3
14′-0″	2,445	2,377	3
14′-6″	2,501	2,432	3
15′-0″	2,622	2,548	3
15′-6″	2,800	2,720	3
16′-0″	3,155	3,072	4
16′-6″	3,388	3,292	4
17′-0″	3,478	3,380	4
17′-6″	3,655	3,551	4
18′-0″	3,769	3,660	4

DESIGNED FOR NATURAL DRAFT—11 FEET 3 INCHES LONG

Diameter	Square Feet Heating Surface		Number of
	Oil	Coal	Furnaces
10′-0″	1,129	1,092	2
10′-6″	1,234	1,193	2
11′-0″	1,291	1,249	2
11′-6″	1,390	1,344	2
12′-0″	1,479	1,430	2
12′-6″	1,789	1,729	3
13′-0″	1,897	1,836	3
13′-6″	2,045	1,978	3
14′-0″	2,125	2,055	3
14′-6″	2,282	2,207	3
15′-0″	2,381	2,301	3
15′-6″	2,702	2,616	4
16′-0″	2,788	2,697	4
16′-6″	2,952	2,856	4
17′-0″	3,100	2,996	4
17′-6″	3,221	3,115	4
18′-0″	3,311	3,200	4

Why Bearings Heat*

If a bearing on a new piece of machinery persists in heating and the operator is satisfied that the oil he is using is not too light or too heavy, then the bearing may be out of line, or perhaps it has been designed with insufficient clearance. Overheating may also result when the clearance is too great, and trouble may follow because the bearing has high and low spots upon its surface. A very frequent cause of bearings running hot is foreign matter, which may owe its presence in the bearing to any number of causes.

Faulty oil distribution is probably the cause of overheating as frequently as anything else. The oil may be fed into the bearing at the wrong point or perhaps the grooves do not convey the oil to all parts of the bearing. Again, the feed pipe may not be of sufficient size to supply the bearing with an adequate amount of oil or the oil reservoir may be too small to permit of proper cooling. We have known many cases where a hot bearing was caused through an obstruction in the oil supply pipe restricting the flow of oil.

Unsuitable bearing materials and bearings which are not large enough to carry the loads brought upon them are often the cause of heating. The sudden heating of an erstwhile well-behaved bearing may be due to recent rebabbitting or readjustment; that is, the clearance may be set carelessly, the interior surface may be imperfectly finished or the oil grooves may be improperly cut.

When the supply of oil is completely interrupted, overheating will prove especially serious and rapid. The supply of oil may be cut off through a feed pipe becoming plugged or through the oil reservoir running dry. Broken ring oilers, glazed pads, pads which have fallen away from the journal and the congealing of the oil in a system also cut off the oil supply. Dirt suddenly entering the bearing with the oil or from outside sources usually results in overheating. The more abrasive materials cause heating because they roughen the journal and bearing, but the softer materials are usually found to have plugged the oil grooves and cut off the oil supply.

MECHANICAL DISARRANGEMENT CAUSE OF OVERHEATING

If the proper oil in sufficient quantities is being fed to the bearing, overheating must be due to mechanical disarrangements. For example, a bearing may have become knocked out of line or the bearing cap may have worked loose. Overheating may result from the bearing having become badly worn due to the above causes. Excessive loads are a common cause of hot bearings. A tightened belt or a shaft which has been sprung through dirt building up between the teeth of gears might be mentioned in this connection. Excessive loads may be thrown on the main bearings of the steam engine through insufficient cushioning in the steam cylinder, and too high compression in the internal combustion engine has been known to bring about the same result.

The only way to obviate the continued heating of a bearing is to correct the underlying mechanical faults to which it is due. If sudden and unexpected heating occurs, any imperfections in the lubricating system should be set right, and when it is due to mechanical troubles these should be corrected at once. Do not try to "manage somehow" with a heated bearing. Many preparations and devices have been recommended for reducing the temperatures of hot bearings, but these makeshifts are as ineffective as medicines given to cure a broken leg. If a suitable oil will not keep a bearing cool, it is time to make some repairs.

* From *Lubrication.*

Training of Welding Operators

At a reorganization meeting of the American Bureau of Welding held November 22, 1920, in New York, a committee was appointed to deal with the training of welding operators.

This committee, with W. Spraragen as chairman, prepared a report covering the various steps necessary in the training of operators, which was submitted to the American Welding Society.

"The importance of the training of operators for both gas and electric welding cannot be overestimated. A very large number of welding experts regard it by far as the most important problem. Widely different ideas as to the proper procedure to follow in the training of welding operators prevail even among experts. For instance, the time required for the correct training of an operator, as stated by a number of authorities, varies from three weeks to two years. Nor is there any greater agreement of opinions as to what the training should include. Some say that the rudiments of a technical education is necessary, while others stoutly maintain that the operator should only be trained in the correct manipulation of the electrode or torch. In nearly every case where welding has been condemned or where severe legislation has been enacted to restrict its use, the case can be traced directly to poor welds made by unqualified operators."

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-Pres. and Treas.*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 341 The Arcade
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTTE that of this issue 5,000 copies were printed; that of these 5,000 copies, 3,887 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 88 were mailed to advertisers, 66 were mailed to employees and correspondents, and 943 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 10,200, an average of 5,100 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

	Page
GENERAL:	
Organization and Work of the Ohio Boiler Inspection Department	33
American Engineering Council Meets	34
Renewable Stay Heads for Fireboxes	35
National Foreign Trade Council	38
Standardization of Boiler and Staybolt Taps	39
Boilers and Economizers	40
Fundamental Principles of Trigonometry	41
Oxygen and Acetylene Hose Markings	44
New York Boiler Inspectors Form Association	44
National Board of Boiler Inspectors' Convention	45
The American Society of Mechanical Engineers' Boiler Code	45
Co-operation Between State Boiler Departments and Insuring Companies	46
Qualifications and Duties of a Boiler Inspector	47
Necessity of Uniformity in the Regulation of Steam Boiler Construction and Operation	60
Standard Single Ended Scotch Boilers	49
Why Bearings Heat	50
Training of Welding Operators	50
Rules for Staying of Plain Circular Furnaces	57
EDITORIAL COMMENT	51
ENGINEERING SPECIALTIES FOR BOILER MAKING	52
BUSINESS NOTES	53
QUESTIONS AND ANSWERS FOR BOILER MAKERS:	
Head Development	54
Elbow Intersected by a Cylinder	54
Boilers and Engines	55
Breeching Layout	56
Development of Hemispherical Head	56
Leaky Boilers	57
LETTERS FROM PRACTICAL BOILER MAKERS:	
Notes on the Fitting of Doubling Plates	58
Does Hydrostatic Pressure Count?	58
The Scotch Boiler Is Doomed	59
Cause of Cracks in Tube Sheet Flange	59
BOOK REVIEW	61
TRADE PUBLICATIONS	61
ASSOCIATIONS	61
SELECTED PATENTS FOR BOILER MAKERS	62

Every man in the boiler shops of this country who is interested in his trade has, in the course of his everyday work, discovered a lot of little time-savers which he believes good. While the improvement of methods goes along slowly in this way the industry as a whole does not profit particularly by the individual effort unless it is given publicity. Together with the development of new devices and methods, practical questions are continually coming up that require settlement.

At the conventions of the Master Boiler Makers' Association a comparatively few men who are fortunate to be at the top of the trade get together and exchange views on such matters as tend to increase the general knowledge of boiler construction and design. However, this chance comes to the chosen few and at that only once a year, so they, together with all the rest of the men in the boiler making industry, seem to forget that others are meeting the same problems and difficulties which they themselves are facing, and that these other individuals may possibly be solving their troubles in better ways.

At this point THE BOILER MAKER'S usefulness begins and the magazine attempts to fill the office of clearing house for all ideas that will in any way be of assistance to the industry. This duty is not at all difficult, for the volume of correspondence is not great—not nearly so much so as we want it to be. This condition can be very easily remedied by our readers.

When some difficulty occurs in the daily routine of the shop that cannot be cleared up right away, make a note of the problem and send it to us. Our Questions and Answers Department will take care of it. When you are doing your work in a certain way and there might be another and better method of reaching the same result, we can soon find out how the other fellow does it, if you tell us your way. If you are particularly pleased over the accomplishment of a difficult piece of work, write a short account of it, so we can tell the rest of the trade about it.

Our regular correspondents and contributors keep the industry informed of what is going on out in the field, but in addition every one of our readers should have something to tell once in a while, either in the way of discussion on topics that are being reviewed or stories of personal experiences. Articles on special features of contract and railroad boiler shops, of equipment and methods of production, can be made mighty valuable to the trade if those of our readers who are in a position to do so will write up the stories for us. If you cannot find time to write very much, at least send suggestions on subjects which you would like to hear discussed.

The first annual meeting at which the permanent organization of the National Board of Boiler and Pressure Vessel Inspectors was completed marks the third step in the promotion of uniform boiler construction in the United States. When the American Society of Mechanical Engineers' Boiler Code was first formulated a definite step towards the standardization of boiler and pressure vessel requirements was made. The code, by means of its revisions and interpretations, has since advanced the cause of safety in boiler construction to the mutual advantage of the manufacturer and user.

In order to extend the influence of the code, the Uniform Boiler Law Society took up the work of promulgating its adoption by state legislatures. The efforts of the society have met with success, and within a few years it is not improbable that boiler construction throughout the country will be governed uniformly.

With the extension of the A. S. M. E. Boiler Code, the society realized that its provisions must be enforced uniformly in the states that had adopted it or the real object of the law would be lost. Through efforts of the society, the National Board of Boiler and Pressure Vessel Inspectors was organized, having as its object the promotion of "greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances and to secure interchangeability between political subdivisions in the United States."

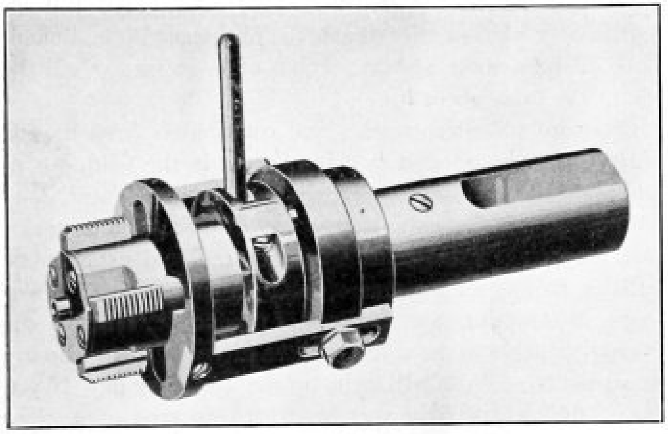
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Improved Automatic Collapsing Tap

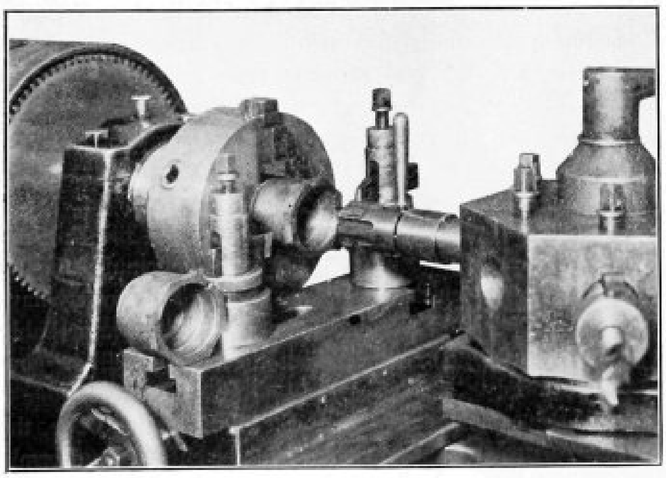
Automatic collapsing taps are becoming more and more a necessity for threading operations, and when introduced into railway shops, for example, will effect economies many times greater than their cost. Automatic taps are necessary because of the requirement for accurate work and as a safety feature to prevent spoiling work, but their greatest value lies in the greater production made possible.

The National Acme Company, Cleveland, Ohio, has re-



Namco Automatic Collapsing Tap

cently developed and placed on the market an automatic collapsing tap known as the Namco, which is designed to fulfill the requirements stated above. The taps are provided with an inside trip, or outside trip, as illustrated, and can be fur-



Collapsing Tap Used for Threading Operation on Turret Lathe

nished in all sizes for ordinary tapping operations. They are economical for use on general shop work because of their ease of adjustment and quick adaptability.

The illustrations show a general view of the tap and its use in a practical threading operation on a turret lathe. As an example of its adaptability, an inside trip Namco tap can be equipped with a cammed tripping sleeve and reamer blades for reaming instead of standard chasers for thread cutting. While this is strictly special equipment, it shows the adaptability of the collapsing principle to smooth and positive collapsing action, as simple as throwing a gear out of mesh, and as positive.

Testing Lap-Welded Boiler Tubes

The operations used in the manufacture of lap-welded boiler tubes are identical with those used in the manufacture of lap-welded pipe which consists in lapping the edges of the plate or skelp and welding them in this position. However, only open hearth steel is used by the National Tube Company, Pittsburgh, Pa., in the manufacture of modern welded boiler tubes, and the tests given are much more severe than those given to pipe. For example: Both crop ends from each "National" lap-welded boiler tube are given a flattening test, in addition to the flanging tests required by standard specifications and the regular hydrostatic pressure test of the tube itself. The specifications of the American Society of Mechanical Engineers and the American Society for Testing Materials call for a flattening test on the crop ends of but two tubes in each lot of 250 or less, but the National Tube Company continues this test to include every "National" lap-welded boiler tube manufactured. The flattening and flanging tests are very near the actual tests of the tube itself, as they are made on portions of the tube immediately contiguous to the flue sheet ends of the finished product. A large factor of safety and dependability is thus provided to meet the unusual demands often forced upon a boiler tube in service. There is perhaps no other class of tubular material which receives greater care and attention in manufacture, inspection and testing than boiler tubes, and likewise there is perhaps no other class of tubular material upon which the safety of life and limb is more dependent.

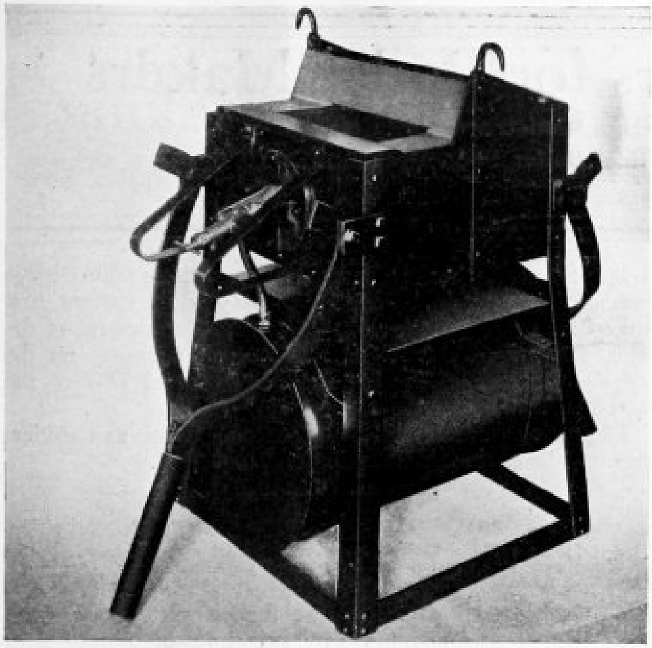
All boiler tubes are tested by internal hydrostatic pressure, varying from 500 to 1,000 pounds per square inch, according to the size of the tube and the fiber stress of the material of certain sizes. The tubes while under pressure are struck with a two-pound steel hand hammer or its equivalent.

The tubes, after being tested, are stenciled with the name of the manufacturer, kind of material from which they are made and the test pressure employed in pounds per square inch.

Portable Oil Burning Forge

A light-weight rivet forge, designed primarily for boiler shops, railroads, shipyards and structural steel shops, is being produced by the Norton Manufacturing Company, 18 Tremont street, Boston, Mass. The forge is built in two sizes—number one for rivets up to and including ¾-inch diameter, and number two for all sizes of rivets.

Number one weighs 135 pounds, has a height of 24 inches, capacity of two hundred ¾- by 3-inch rivets per hour; oil tank capacity, 5 gallons; oil consumption, 1 gallon per hour, and air consumption 4½ cubic feet per minute. Number two is similar to number one in operation, but weighs 190 pounds, has a height of 24 inches, capacity three hundred and fifty ¾- by 3-inch rivets per hour; oil tank capacity, 10 gallons;

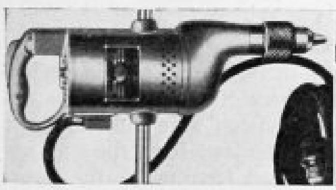


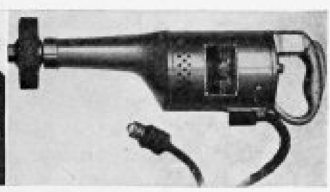
Lightweight Oil Fired Rivet Forge

oil consumption, 1 gallon per hour; air consumption, 4½ cubic feet per minute. The spent gases from the forge are vented through a top opening and pass upward and away from the operator, thus eliminating the need for the customary air curtain and decreasing the air consumption from 8 to 20 cubic feet of air per minute. Rivets are handled through the top opening and are always in plain view. Folding handles are arranged for carrying the forge. The forge is equipped with a vacuum burner which draws oil from the tank and eliminates the necessity of maintaining pressure in the fuel tank. Low grade fuel oils or kerosene may be used. All forges are lined with standard firebrick, which is easily replaced if necessary.

Electric Drills and Grinders

An automatic stop drill is being produced by the Wodack Electric Tool Corporation, 23 South Jefferson street, Chicago, Ill. The drill is motor driven, using either alternating or





Automatic Stop Drill and Portable Grinder

direct current, and automatically stops when not in use. This is accomplished by the use of a spring lever in the handle through which the current contact functions, and which is released as soon as the pressure of the operator's grip is removed in a manner similar to the valve on a pneumatic hammer. This drill is made in six two-speed sizes—3/16, 5/16, ⅜, ½, ⅝ and ¾ inch.

The same company manufactures a portable grinder having the same automatic control. The grinders are in three sizes, depending on the wheel capacity—3 by ½ inch, 4 by 1 inch and 8 by 1 inch.

Both the drill and grinder are fitted with Wodack universal motors.

BUSINESS NOTES

John R. LeVally, formerly sales engineer of the Locomotive Superheater Company, at Chicago, has been appointed district sales manager of the company at Pittsburgh, Pa., with offices in the Union Arcade building.

J. B. Shaver has been appointed sales manager of the Cleveland Crane & Engineering Company, Wickliffe, Ohio. He has been connected with the company several years in its sales and purchasing department.

F. K. Copeland, president, Sullivan Machinery Company, Chicago, has been made national councilor of the Compressed Air Society of New York, to represent it in the Chamber of Commerce of the United States.

Martin J. Root, formerly of the Fairbanks Company, New York, has been elected president of the United States High Speed Steel & Tool Corporation, which has been reorganized. The headquarters of the company are at 489 Fifth avenue, New York.

The Whiting Foundry Equipment Company, Harvey, Ill., has changed its name to Whiting Corporation. The Whiting Corporation remains under the same management and will make no change in its established operations or policies.

The Adamson Manufacturing Company, East Palestine, Ohio, has added a new department for manufacturing all kinds of storage, pneumatic and pressure tanks, welded pipe, battery casings, evaporators, condensers and a complete line of arc-welded products.

George H. Grundy, for many years connected with the Crucible Steel Company of America, as manager of its New York branch, is now associated with the Poldi Steel Corporation of America, 115 Broadway, New York, as general sales manager, with headquarters at New York.

The Black & Decker Manufacturing Company, Towson Heights, Baltimore, Md., has opened a new branch office and service station at 75 Fremont street, San Francisco, Cal. This office will have jurisdiction of the company's business over the entire Pacific coast territory and will be in charge of M. A. Johnson.

J. E. Cullen, New York, was elected president at the annual meeting of the Niles Tool Works Company, Hamilton, Ohio, on January 25. Charles L. Cornell and E. G. Rider were made vice-presidents; J. L. Blair, secretary, and John V. Cornell, treasurer. The above officers, with George W. Lewis, will comprise the board of directors.

Lloyd R. Wallis, who has been connected with the Youngstown Foundry & Machine Company for the past fifteen years, and for the past five years has been superintendent of the roll department, was advanced to secretary-treasurer following the annual meeting at Youngstown, Ohio. He succeeds Bertram G. Parker, promoted to general manager. William J. Wallis is president and Frank A. Williams vice-president and sales manager. The company is operating its plants at 50 percent, chiefly on repair and maintenance work.

At the annual election of the Union Railway Equipment Company, Chicago, the following officers were elected: W. B. Hall, president and treasurer; G. W. Clark, controller and secretary; A. F. O'Connor, mechanical engineer; E. S. Jubell, superintendent; H. O. Comstock, sales agent. Mr. Jubell was formerly in charge of the forge department for the Haskell & Barker Car Company. The company's new forging plant, located on the Indiana Harbor Belt, at Hammond, Ind., is now in operation.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Head Development

Q.—Please show the proper way of laying out the cut-off on the side of the hood Fig. 1, also the filling-in plate for the work. M. K.

A.—The plan and elevations, Fig. 2, show that the hood is the frustum of a cone. Therefore draw cones of which the frustum is a part by extending its outer elements to intersect as at point *O*. The flattened section may be considered as a vertical plane passed through the frustum as shown by the dotted line *AB* in the plan. The problem is to find the shape of the section of the frustum taken on this plane. This is shown to the right of the elevation. To obtain this view, divide the arc length between *A-B* of the plan into a number of parts—in this case four. Project them vertically to the base of the cone in the elevation. From point 1 of the elevation draw a radial line to point *O'*. Where it crosses the vertical dotted line which represents the cutting plane in the elevation the point *s* is located. Draw the view to the right of the elevation, which is a duplication of it, except that it is a view looking at the cone, taken at right angles to the cutting plane *AB*. From point *X* set off the distances *X*-1 and *X-A*, *X-B* equal to the lengths of the plan as measured at right angles to the line *O-X* of that view. Draw in the radial lines, and from points *v* and *s* of the elevation draw horizontal projectors to intersect the radial lines in the view to its right. Through points *B-S-r-s-A* draw in the curved line. This section is known as a *parabola*. In the pattern is shown its development in the flat. An arc is drawn first with a radius equal to *O″X* for the lower base of the pattern and for the upper base use *O-T* as a radius. Radial lines are drawn from points *A*-1-*X-B* to *O″*. The arc lengths between these points equal those of the plan view. To locate points *s'* in the pattern, first project the point *s* of the elevation to the outer element of the cone. Use *O'-S'* and set the distance off from *O″* on the radial line *O″*-1 of the pattern. *O″-v'* equal *O'-r* of the elevation.

The filling in plate will be of the same shape as the view showing the shape of the section on plane *A-B*.

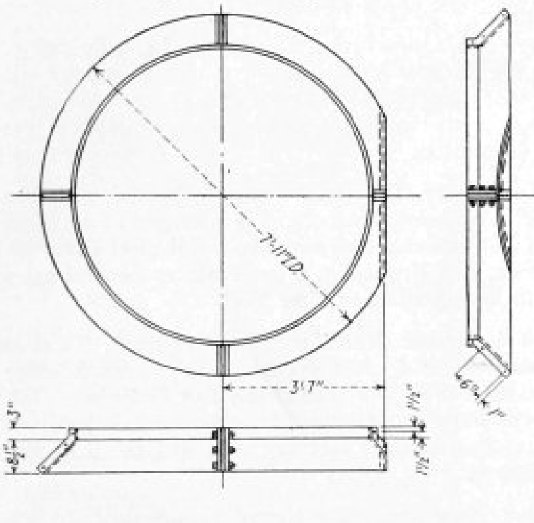


Fig. 1.—Cut-Out Section on Side of Hood

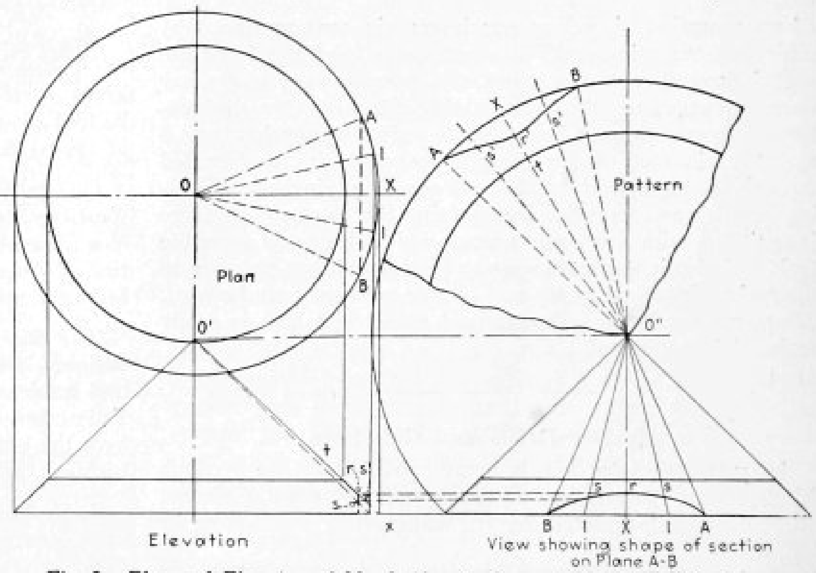


Fig. 2.—Plan and Elevation of Hood, Showing Layout of Cut-Out Section

Elbow Intersected by a Cylinder

Q.—I have a problem to lay out where a 5-piece elbow is intersected at the center by a pipe equal to the diameter of the elbow. How would such a layout be made? B. Y.

A.—The sketch Fig. 1 shows the complete layout and brings out to good advantage the principles of projection in elbow and pipe intersections. A full view of each elbow section *A*, *B*, *C*, *D* and *E* is indicated and also the cylinder at *F*. The first step that beginners in laying out should understand is the method of showing views of the object to be developed. Namely, top or plan view, front, side and end views commonly termed elevations. These views form the working drawing if they are fully dimensioned from which the layerout makes the required full size views and patterns.

In this problem the centerline of the elbow for the elevation should be drawn and from this line as a base fix the position of the sections and their miter lines. First divide the centerline into one less than the required number of sections in the elbow. This gives the size of the full sections. At each end of the elbow make ½ sections as at *A* and *E*. The remaining sections are full size. The miter lines are located by drawing radial lines from *w-x-y* and *Z* connecting with *O*. The sections *A*, *B*, *C*, etc., are next drawn in by extending their sides at right angles to a base line which is square with the respective centerlines. For example, section *D* is laid off by extending its sides parallel with its axis *Y-Z* and at right angles to the base line *a-c*. The circle drawn from point *K* indicates the position of the intersecting cylinder and the plan views shows how the miter line is obtained. This miter

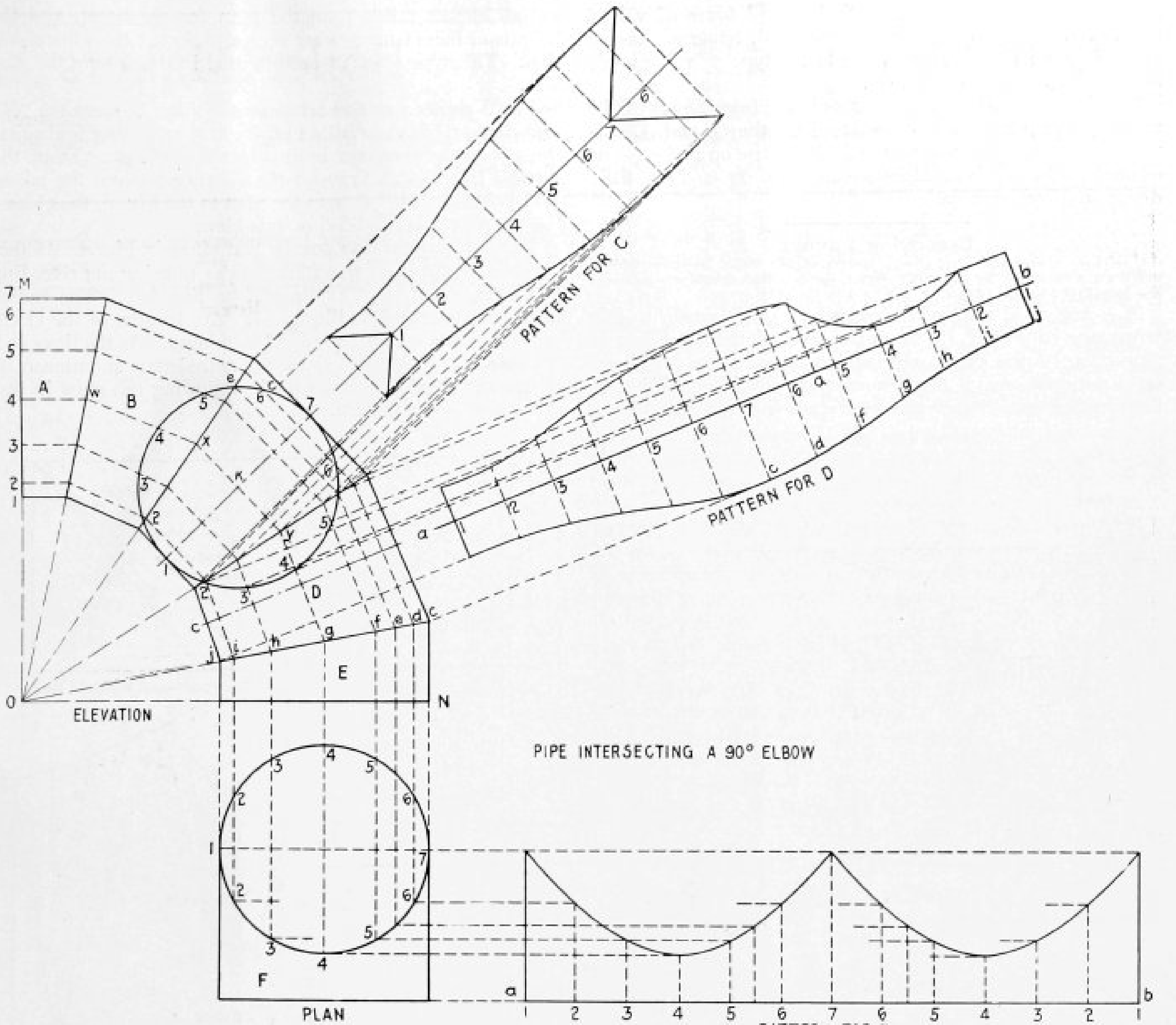


Fig. 1.—Complete Layout of Elbow Intersected by a Cylinder, Showing in Convenient Manner the Principles of Projection

between the elbow and cylinder would appear as straight, diagonal lines as shown in the view to the left of the elevation and by using the plan in this case it would not be necessary to make any additional views. Divide either circle into several equal parts, and from the points as 1-2-3-4, etc., draw lines parallel to the centerline as *x-y*, extending them to meet the miter lines. From the points on the miters carry these lines on until each section has been fully developed. In actual practice this is not done, but advised here for beginners to follow so that they may become familiar with the means of drawing parallel lines and to follow the steps in the development work.

Where the circle in the elevation crosses the miters, points are located at *e* and 2. In the pattern layouts these must be properly fixed for sections *B*, *C*, *D*. In the pattern work it is first required to lay off a base line as *a-b* for section *D*. Make the length of this line equal to the circumference of the elbow sections. If the elbow is made of light material, no allowance need be made in the stretch-out for the rolling of the plate; however, if heavy plate is used the circumference should be calculated from the diameter taken to the neutral layer of the plate.

Line *a-b* is now divided into the same number of equal spaces as in the circle numbered as shown, to correspond in both pattern and profile, which assists the beginner in following the layout work. The seams in the elbow sections should be broken so that the joints do not overlap. Lines called *projectors* are now drawn square to *a-b* and from the points 1-2-3, etc., set off the distances 1-*j*, 2-*i*, etc., equal to those of sections *D*.

As all construction lines are shown projected directly from the elevation to the patterns, the method of development should be readily followed. After the development work is complete make the plate allowances for laps.

Boilers and Engines

Q.—Will you please tell me the various differences in construction requirements for high and low pressure boilers and engines. J. M.

A.—In building boilers for either heating or power purposes the requirements are good design, materials and construction. Power boilers are designed to carry greater pressures than heating boilers; consequently, heavier plates, larger stays, rivets, etc., are needed. Specific rules are given by the respective states and Canada governing the building of boilers. Many states have adopted the American Society of Mechanical Engineers' Boiler Code.

There are numerous types of engines, classified as marine, stationary and locomotive. These may be classified further according to arrangement of cylinders and types of valves used. As, for example, simple, compound, triple expansion and duplex engines, or according to the type of valve used, as plain slide valve, corliss, etc.

To give the details and differences in the foregoing it would require more space than is prescribed for the Q. and A. column. You should procure some good treatise on boilers—for example, Peabody and Millers—also one on engines, their design and construction.

Breeching Layout

Q.—There are several men at our plant studying boiler layout problems, and the one shown of the breeching, Fig. 1, has bothered them for a solution. We hope that you will be able to help us with the development. E. C. L.

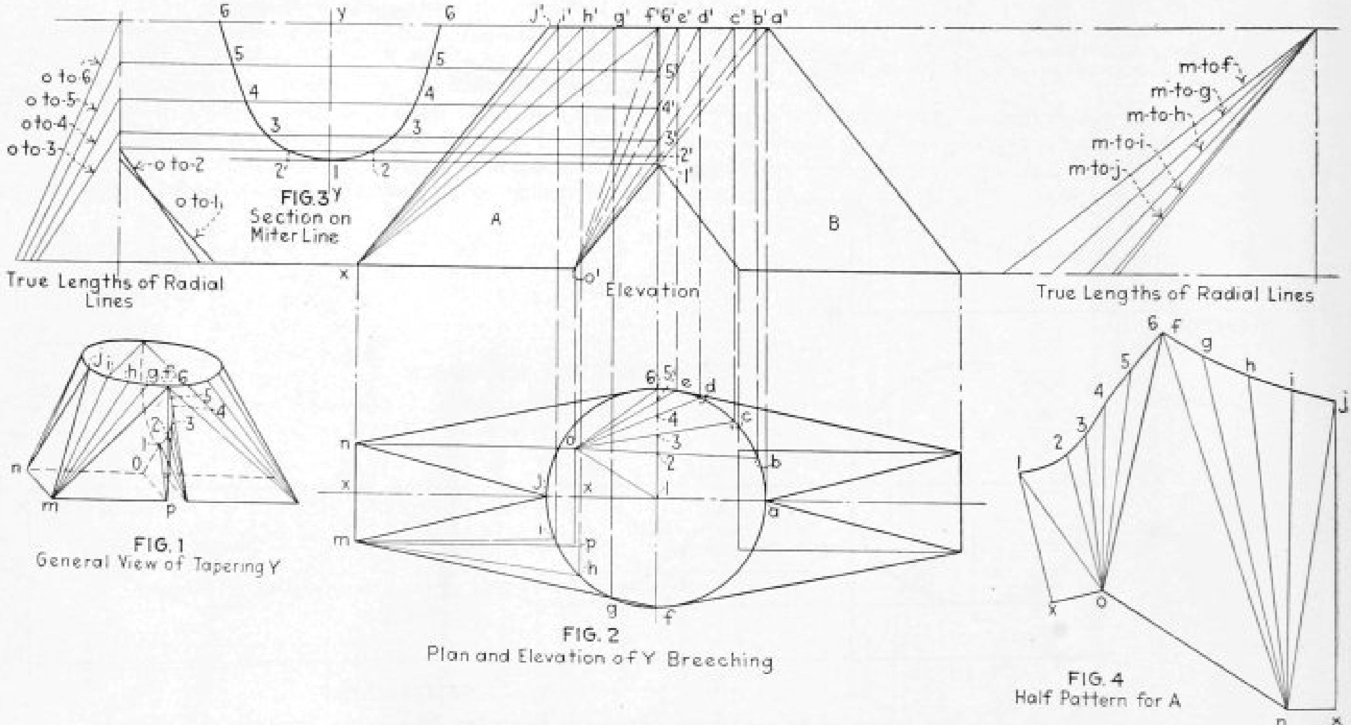
A.—A general view of the tapering "Y" is shown to fair advantage in Fig. 1. The upper part of the breeching is round and tapers off to rectangular bases. The combined cross-sectional area of these two sections should equal that of the circular top. Reference letters are indicated on Fig. 1 to correspond with those on Fig. 2, which will assist in following the steps in the development.

A plan and elevation must be drawn first showing the position of the branches *A* and *B* of the "Y" and the sections as they would appear in viewing them from the top. In the plan the circle and the two rectangles are laid off. Then divide one-half of the circle into any number of parts as *a-b*, *b-c*, *c-d*, etc. From the points *o* and *m* draw the radial lines *m-j*, *m-i*, *m-p*, *m-h*, *m-g* and *m-f*. From *o* draw *o-b*, *o-c*, *o-d*, *o-e*, and *o*-6. Where these radials cross the line *f*-1-6 locate points 2-3-4 and 5, which all lie on the miter between the parts *A* and *B*. In the elevation these radials must be drawn so as to locate the corresponding points on the miter in that view as at 2′-3′-4′-5′. This is done by projecting lines from points *a-b-c-d*, etc., from the plan, drawing them parallel with the vertical centerline. It will be noted from Fig. 1 that in each section of the breeching that there are flat sides tapering from the rectangular bases to a point at the circular top.

The sections between the flat sides taper from the circular shape to a point on the rectangular bases. To make the development of these shapes, first find the true length of the radial lines as shown to the right and left of the elevation. This is readily done by laying off right angles, using the radial lengths taken from the plan for the bases, and the heights of these triangles are shown projected from the elevation. The hypotenuse of each is used in developing the pattern.

Fig. 3 shows a section taken on the miter between the "Y" branches. This view is laid off by first projecting horizontal lines from the elevation from points 1′-2′-3′, etc. Draw the vertical line *Y-Y*. Transfer the distance between the points 1-2, 1-3, 1-4, 1-5, 1-6 from the plan to the Fig. 3, thus locating the points 1-2-3-4-5-6 of this view.

The half pattern may now be laid off as in Fig. 4. In this case the construction was started so as to bring the rivet line on the inside of the "Y" branch, on line 1-*X*. The radial lines are assembled as illustrated. Arc lengths of the circle and of the section Fig. 3 are also employed. As the lines and arc lengths are identified by the reference letters and numerals, no trouble should be met with in following the steps in development of the pattern.



Layout and Development of Tapering "Y" Having a Circular Top and Rectangular Bases

Development of Hemispherical Head

Q.—Kindly show the method of developing sections of the hemispherical head, Fig. 1. W. H.

A.—First construct a partial plan and elevation showing the shape of the gore in the plan, as shown at *a-f*-1′-6′ of Fig. 2. These two views should be drawn to the neutral layer of the plate that is to the center of the plate thickness. The dished head is shown at 1-*x*-1 and the gores are riveted to it. From the sketch it is evident that the gores are so arranged that the outside ones overlap on both sides of those on the inside, hence the plate thickness must be taken into consideration when developing the pattern for the inside gores. The arc from 1 to 6 is divided into any desired number of parts, and the points projected to the horizontal axis plan view, locating points 1′-2′-3′-4′-5′-6′. With *X*′ of the plan as a center draw arcs passing through the gores. Where these arcs intersect the miter *a-f* establishes points *a-b-c-d-e* and *f*.

The pattern for the outside gores is shown in Fig. 3. Set off on the line *X-Z* the arc lengths *X* to 1, 1 to 2, 2 to 3, 3 to 4, etc., of the elevation Fig. 2. With *X* as a center, draw arcs through points 1-2-3-4, etc., in the pattern. Make the arc lengths *a-a*, *b-b*, *c-c*, *d-d*, etc., equal to the corresponding arcs of the plan Fig. 2. Allow for the necessary laps. Con-

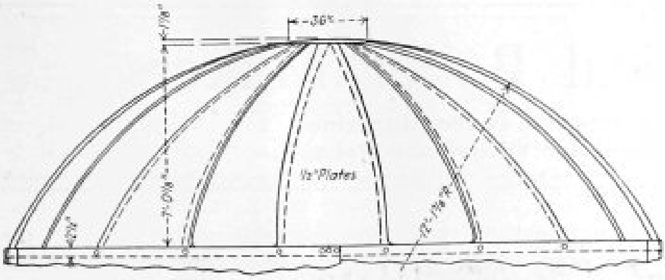


Fig. 1.—General View of Hemispherical Head

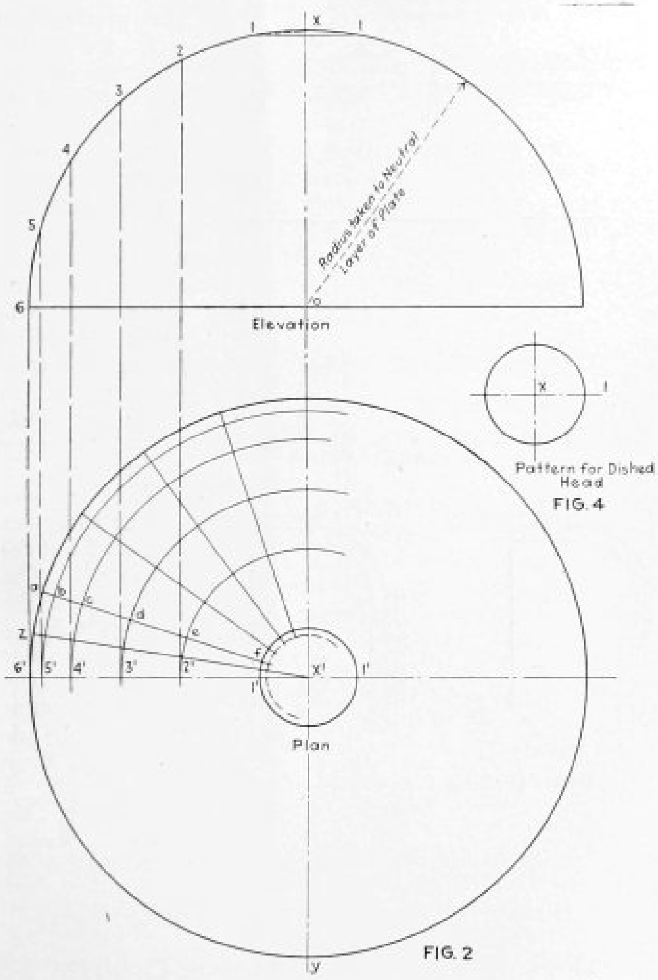


Fig. 2.—Plan and Elevation of Head With Plan of Gore Shown

traction and expansion of the metal arise in dishing the sections, but if the work is done on a hydraulic press the pattern described will be sufficient. Forming by hand requires

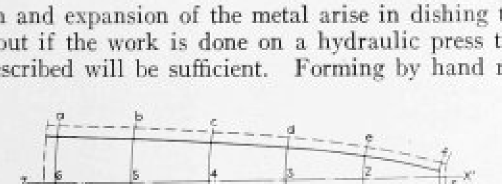


Fig. 3.—Pattern for Outside Gore

a number of heats, and in shaping the sections the plate will contract in one part and expand in another, whereas by press forming the heat is applied uniformly and the plate is shaped or dished in one operation, and in cooling the plate contracts more uniformly. The pattern for the dished head is shown in Fig. 4, and it is drawn with a radius equal to X-1 of the elevation.

Leaky Boilers

Q.—For some time I have been interested in knowing more about why superheater units leaking will cause side sheets to leak. I have watched this with interest while I served as an apprentice, and through ten years of experience. I contend that the side sheet that gives trouble is caused from something besides leaky units. Will The Boiler Maker give me something on this subject and can it be put up to some of the readers for discussion in the magazine? J. B.

A.—Leaky side sheets in the seams or stays or any other part of the boiler may be due to either of the following:

Poor construction, defective material or expansion and contraction stresses which strain the boiler parts sometimes as to leave a permanent set in the material. Overheating of the plate due to low water, scale or grease on the metals will also produce leaky joints, tubes, etc., and very often blistered or bulged plates, burned tubes or the metal may crack.

Rules for the Staying of Plain Circular Furnaces

The attention of the chief boiler inspectors in the states and municipalities where the American Society of Mechanical Engineers Boiler Code is effective has been called to the fact that the question of the rules for the staying of plain circular funaces has been under consideration by the Boiler Code Committee for several months as a result of certain features that have been noted in Cases Nos. 256 and 293, in their relation to the special allowance made in Par. 212c of the Boiler Code.

A special sub-committee to the Boiler Code Committee was appointed at the October meeting of the committee to thoroughly investigate this matter, and as a result of the discussion of the matter at the December meeting, it was decided that it would be advisable to inform them of this situation and suggest that in view of a possible revision of Par. 212c, this rule of the Boiler Code should not be used until the committee's investigation can be completed and reported upon.

Fundamental Principles of Handling Men

In a talk to foremen published in *Industrial Management*, George D. Halsey lays down the following principles as requisite for securing best results in handling men:

1. Delegate and supervise the work.
2. Keep compensation fair and strictly proportional to output or general value to the company.
3. Study each individual carefully and fit the method of handling to the individual.
4. Make a careful subdivision of all duties based on a study of individual abilities.
5. Prepare careful and, whenever possible, written instructions showing just how each job should be done, and fair time in which to do it.
6. Plan and schedule your work carefully and always let the workmen see plenty of work ahead.
7. Co-operate with and use staff aids as much as possible.
8. Maintain proper dignity.
9. Endeavor, whenever possible without intruding, to lead your employees into habits of right and sound thinking and clean living.
10. Cultivate in yourself a real and unselfish desire to be of help to your employees.

L. W. Wallace has taken up the duties of the American Engineering Council's new committee on the elimination of waste in industry. He has been director of the Red Cross Institute for the Blind in Baltimore.

Joseph Markham, formerly railway sales representative of the E. I. Dupont de Nemours & Company, Inc., has been appointed sales agent of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with office in the Peoples Gas building, Chicago.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Notes on the Fitting of Doubling Plates

Like many other matters that at first glance seem of slight importance, but which are actually very essential, the question of whether doubling plates should be fitted inside a plate to be stiffened, or on the outside, is one that should be decided correctly.

Only few individuals, who have control over the manufacture of boilers, make any ruling on this point, but those who do, specify that the doubling plate should be riveted on the outside. The solitary argument in favor of putting the doubling plate inside is that if the rivets in the doubling plate should leak when the hydrostatic test is applied to the boiler they can be calked on the outside.

If the doubling plate is on the outside and any one of the rivets is leaking, it is sometimes difficult to determine which is giving the trouble, especially if it happens to be in the center of the doubling plate and the leak only shows through from between the plates.

In any event, with the outside doubling plate, when a leak occurs, the water must be emptied out of the boiler and the bad rivets calked inside or new ones driven.

The leak might be stopped by calking all around the doubling plate, but as this allows the steam pressure to get between the two plates, this procedure, as will be seen from what follows, defeats the very purpose for which the doubling plate is fitted and should never be allowed under any circumstances.

We will now investigate the reasons why the doubling plates should not be fitted on the inside of the plate to be stiffened. Referring to Fig. 1, it is evidently impossible to calk the doubling plate steam-tight, owing to the space between the calking edge of the doubling plate and the shell being too confined. Even if it were possible to calk the doubling plate, one could never be sure that it would remain steam-tight, since a leak allowing the steam to get between the two plates would not show itself on the outside of the boiler.

Assuming that the steam gets between the two plates, as we have shown is likely to happen, the effect is to neutralize the pressure on the doubling plate by reason of it having pressure on both sides. This will throw the whole pressure on the head of the boiler, which is practically no stronger than if there were no doubling plate.

It may be argued that if the rivets in the doubling plate are closely pitched the doubling plate will be compelled to deflect with the head and so take its proportion of the load, notwithstanding that the pressure is equal on each side of the doubling plate. While this is true, the extra holes required will weaken the plate, and in the end we have not nearly as strong and dependable a job as we would have if the doubling plate were on the outside.

Another defect in the inside doubling plate is that, as can be seen in Fig. 1, the stiffening effect of the doubling plate is active only as far as the centerline of the rivets. With the outside doubling plate, the gain in stiffness extends to the extreme edge of the plate. The outside doubling plate also has the advantage in the matter of freedom for expansion, as can be seen by reference to Fig. 2.

With the tubes and the stays at a higher temperature than the outside shell, the head must deflect sufficiently to accommodate the difference in expansion. An inside doubling plate has only the space outside the edge of the doubling plate in which to expand, while the outside doubling plate, on the other hand, has the distance outside the centers of the rivets in which to take care of the expansion. Since this distance is about 50 percent greater than with the inside plate, the head is not subjected to as great a stress.

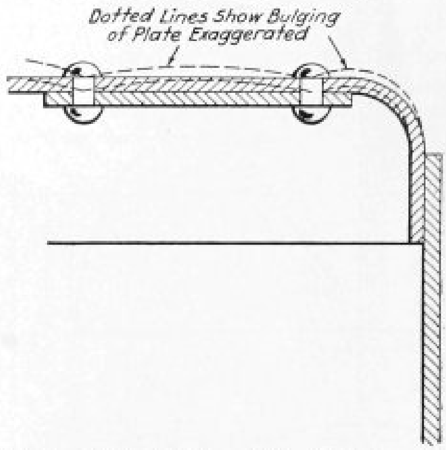
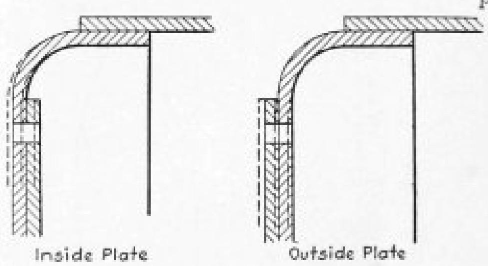


Fig. 1.—Inside Doubling Plate, Not Accessible for Calking



. 2.—Outside Doubling Plate, Readily Calked and Free to Expand

Rules for the construction of boilers generally leave the spacing of the rivets to the designer. In the case of outside doubling plates, all that is necessary is to space the rivets around the edge of the plate, at a pitch of not over four times the diameter of the rivet. The diameter of the rivets may as well be that used for the circumferential joints. In addition, there should be a circle of six rivets around each through stay in order to insure sufficient stiffness in the plates.

New Glasgow, N. S. JOHN S. WATTS.

Does Hydrostatic Pressure Count?

A locomotive boiler was brought into the shops where the writer is employed last month for repairs. The inspector gave the boiler what we termed a very thorough examination, the repairs which were thought to be necessary were completed and the boiler prepared for a hydrostatic pressure test of 25 percent in excess of the working pressure (205 pounds), or 257 pounds. A small spray of water was found coming out of the dome near the base by the officer in charge of the test, so after the test a rivet was cut out of the dome flange ring and this revealed a crack at the rivet hole. Finally all the rivets were ordered cut out and the dome was removed, disclosing the fact that out of the 36 rivet holes 22 had cracks ranging from ½ to over 3 inches in length. In some places the cracks had opened up over 1/16 inch on the inside.

Strict examination revealed that these cracks had been calked by somebody before who should have reported this condition, but, being ignorant of the danger covered up the defect.

Fig. 1 is a sketch of the dome base showing how the cracks looked. There were no cracks at the side, but at the front and back of the dome.

Some people are of the opinion that the hydrostatic pressure is not much of a success, but after seeing some of the defects which show up only under a hydrostatic test, as in this case, where the inside of the dome sheet was covered with a thin

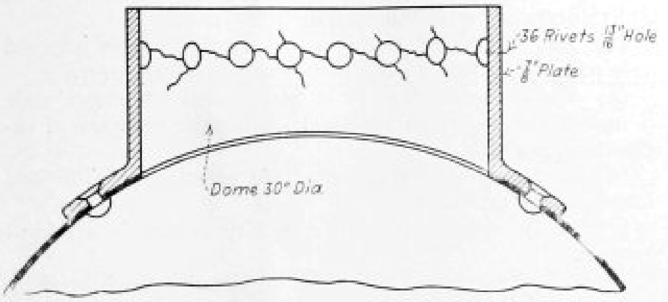


Fig. 1.—Dome Base Showing Cracks Discovered by Hydrostatic Test

layer of scale which hid the defect, it certainly seems to be successful. I would like to have some of the readers of THE BOILER MAKER state what they would consider caused this dome ring to crack and why the rivet holes at the sides did not crack as well as those at the front and back.

Olean, N. Y. CHARLES W. CARTER, JR.

The Scotch Boiler is Doomed

The Scotch boiler for marine purposes is doomed. There is no question about it in the writer's mind and in the minds of consulting, marine and operating engineers who have given the matter careful thought.

I do not claim that the Scotch boiler will be entirely eliminated because I do not believe that myself. The sail boat still survives and will no doubt always be with us, but we do not hear anybody claim superiority for the sailing vessel any more. In the old days the superiority of the steam boat was just as questionable as is the superiority of the watertube boiler today.

The watertube boiler is making rapid headway, as it justly should. It has many advantages over the Scotch. The Scotch has its good talking points, that is true, but my point is that prejudice should not be permitted to outweigh facts. Simply because the Scotch has been used for years and years and years is no reason why it should continue to predominate. It didn't take business men long to adopt the auto truck as soon as it was proved superior to the horse. The horse will always exist because it is superior in some respects for several purposes. But it is not likely that the horse will ever "come back" for heavy hauls, long distance hauls, high speed hauls, etc.

RELATIVE COSTS OF SCOTCH AND WATERTUBE BOILERS

At the present time the Scotch costs nearly twice as much as the watertube boiler per square foot of heating surface. This is because it weighs nearly twice as much. The Scotch is less efficient, requiring more fuel for propulsion. The watertube can carry higher steam pressure and permits superheating more readily.

The Scotch, on the other hand, possesses advantages as regards repairs. It is more easily cleaned. It gives drier steam because of the greater steam space. It is internally fired and consequently eliminates air in leakage.

Some of these advantages will perhaps never be taken from the Scotch, hence it will always find preference for one reason or another. It is quite possible that the watertube boiler will soon surpass the Scotch in point of repairs. It will be more easily cleaned. It will give drier steam. A lining material will be developed that will replace brick work and give the watertube boiler the advantage there or at least place it on an equal footing. Perhaps some of these things have already been done or are being done because engineering developments are now proceeding at a more and more rapid rate. The war has done more for the watertube boiler than many years of ordinary peaceful development would have done. In the emergency the watertube boiler proved itself capable.

To the writer it therefore appears to be the duty of the shipbuilder to recognize the watertube boiler, to assist in improving it wherever improvement is possible, to turn it inside out and study every merit and demerit, and then, if the facts prove it to be the better boiler, to adopt it.

Some shipbuilders will, many shipbuilders may—in fact, all shipbuilders may go back to the Scotch boiler—but eventually, I say, in view of its advantages, the watertube boiler will be the boiler.

Brooklyn, N. Y. W. F. SCHAPHORST.

Cause of Cracks in Tube Sheet Flange

The tube sheet of a locomotive boiler was flanged, using a hard coal fire, and the flanging was done by hand. After the flanging was completed it was found that the outside of the flange was a network of cracks, these cracks extending in from the surface to a depth of from 1/16 to 1/8 of an inch. The surface of the plate resembled a piece of glass that had been struck a blow with a hammer, which, while not breaking the glass in pieces, caused the surface to be shattered.

The plate used on this job was of standard make, 1/2 inch thick, stamped by the maker to 55,000 pounds tensile stress, and was supposed to be of the best quality, hence the failure could not be accounted for. Standard test pieces were then cut from the plate flanged and submitted to the tests as required of standard boiler plate. Each test failed to show any of the characteristics of good plate, as in each test the plate proved very brittle and was unable to stand anything like the required strain.

Test pieces were then cut from another sheet of the same lot and were given the same tests as before, and in every case were found to have stood the tests required.

This seemed to convince the officials in charge that the material was all right, and another sheet was ordered marked off and flanged. After flanging it was found that the results were identically the same as in the first case.

Several small pieces were then cut from the plate and flanged, and in each case the same results were obtained—that is, a cracked flange.

DISCOVERY OF CAUSE OF FLANGE FAILURE

Being unable to locate the cause of these failures, it was decided to try another sheet, and in the event of this one being the same as the others the whole shipment of plate was to be condemned, although the plate itself stood all tests satisfactorily. In the flanging of this plate, instead of using hemlock wood as a covering while heating spruce was used. When the sheet was completed the flange showed no signs of any cracks. This led to the belief that the hemlock wood was the cause of the failures in flanging the first two sheets.

A number of smaller pieces were then cut and heated, some with hemlock as a covering and others with another kind of soft wood. In every case where hemlock was used the results were cracked flanges, while when the other soft woods were used the flanges were in every case satisfactory.

This established beyond doubt that the wood in some way had caused the material to become very brittle and unable to withstand the required tests.

What chemical or other action set up in the metal has never been determined, therefore the real cause of the failure is unknown. If similar cases are on record anywhere the writer would be grateful for any information as to the results of any investigation that might indicate the cause of this failure.

Moncton, N. B. CHAS. A. NORTON.

National Board of Boiler Inspectors' Convention

(*Continued from page 47*)

proper means are taken to prevent sediment and accumulation.

An inspector with a liking for inspection work will soon develop a power of discernment that will make him valuable to the state or insurance company who may employ him.

With the boiler code of the American Society of Mechanical Engineers, containing the best engineering practices adapted to commercial needs and a proper enforcement of its provisions by the National Board of Boiler and Pressure Vessel Inspectors, will begin a new era in the prevention of accidents in the use of steam boilers.

Necessity of Uniformity in the Regulation of Steam Boiler Construction and Operation

BY G. W. BISSEL

From the introduction to the *"Progress Report"* of the American Society of Mechanical Engineers' Boiler Code Committee, printed in 1916, I quote the following:

"At the present time *ten* states and nineteen municipalities have in force laws for the compulsory inspection of steam boilers in which are comprised a code of practical rules for their construction and operation, and a number of other states and municipalities either have prepared or are preparing similar laws for enactment.

"The laws now in force all differ from one another in a number of material aspects, and unless some relief can be obtained each new law as enacted will differ from all the others.

"By reason of the differences in these laws a boiler built in one state having such a law may not be shipped into another state having such a law—not because the boiler is any less safe in one state than in another, but solely because it does not meet the requirements of construction in both states. Worse than this, a state which has no such law becomes a common dumping ground for all the worn-out and unsafe boilers that are condemned and put out of service by the states that have such laws.

"On account of this lack of uniformity in these laws intolerable confusion has resulted. It is a practical impossibility for boiler manufacturers to comply with all of the various rules of construction embodied in so many different state laws. This condition seriously affects virtually every manufacturing interest in the United States.

"It affects every purchaser of a steam boiler because it increases in an unnecessary and unwarranted manner the cost of boiler construction; it affects all manufacturers of boiler material because boiler plate and other material cannot be made to uniform specifications, and it affects the makers of boiler fittings and safety appliances because they cannot be standardized.

"The urgent need, therefore, of uniform laws for the construction and safe operation of boilers is apparent."

Confusion and economic waste are therefore still in evidence and the problem yet awaits its logical solution. But I believe that progress has been made because a study of the situation reveals the following facts:

1. Among the states which have enacted boiler laws since the appearance of the American Society of Mechanical Engineers' code, some have specifically legalized that code and others through their boards or commissions have adopted the code.

2. Many, if not all, of the states which had boiler regulation laws prior to the appearance of the American Society of Mechanical Engineers' code have recognized that code as an alternate to existing codes.

3. States considering legislation in this field will doubtless designate the code in terms of the law or by action of the regulatory board.

4. Powerful educational forces are at work in the support of the American Society of Mechanical Engineers' code. For example:

(a) A large body of inspectors of insurance companies know and follow the code in connection with their work on boilers destined for or existing in code territory.

(b) The service of trade in code territory has imposed code practice on boiler manufacturers the country over.

(c) The American Society of Mechanical Engineers' code is used quite largely in technical schools for mechanical engineering students.

(d) The insurance companies are exerting a wide and favorable influence.

(e) Public opinion favors uniformity of law in all legal matters.

I feel, therefore, that we have a right to be encouraged by the outlook for uniform boiler laws enforcing the American Society of Mechanical Engineers' code.

But uniform laws are not the whole of the problem confronting us. Our visions will be but bad dreams if we cannot also secure uniform administration and enforcement of the laws which are enacted.

It seems to me that, in addition to support of the American Society of Mechanical Engineers' code by legal enactment, we must have:

(1) Administration of the law by men "of recognized knowledge of the use and construction of steam boilers"—quoting from the Michigan law—who should be also tactful and gifted with common sense and backbone.

(2) An inspection force qualified by experience in shop and field, letter perfect in the American Society of Mechanical Engineers' boiler code, and of unquestioned integrity.

(3) Suitably impressive penalties for infractions of the law.

The individual inspector carries a real responsibility and he should be carefully selected and properly backed up in his work.

The Michigan rules provide that:

"Certificates of competency as inspector of steam boilers shall be issued to persons who pass examination as to their knowledge of the construction, installation, maintenance and repair of steam boilers and their appurtenances. Provided, however, that a person holding a certificate of competency as an inspector of steam boilers for a state that has adopted the American Society of Mechanical Engineers' boiler code shall upon request be granted a certificate of competency for the state of Michigan without further examination," and that "the inspector's commission and certificate of competency may be revoked by the chief inspector of the board of boiler rules when there is evidence of neglect or failure to enforce compliance with the American Society of Mechanical Engineers' boiler code. The inspector affected by such revocation may appeal to the board of boiler rules for reconsideration of the revocation."

I quote the above as an introduction to the statement that the Michigan Board of Boiler Rules has reached the conclusion that the reciprocity clause of our rules presents a loophole through which incompetent men may enter the service of the state of Michigan. An inquiry has been instituted to determine the nature of examinations or other tests imposed upon candidates for inspectorships in the other states with which we have relations. This is being done not entirely with a view to withdrawing or modifying reciprocal relations, but fully as much for the purpose of determining the merit of the standards for candidates examined by the Michigan board. If the man at the lathe or bench is careless, incompetent or dishonest no amount of good engineering in the office will produce a saleable output.

So, uniform boiler laws will not promote the cause championed by the American Society of Mechanical Engineers and the Uniform Boiler Law Society as expressed in the code without the qualified inspector.

BOOK REVIEW

PROCEEDINGS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS FOR 1920. Two volumes 6 inches by 9 inches, 1,360 pages. Bound in cloth. Published by the American Society for Testing Materials. 1315 Spruce street, Philadelphia, Pa.

These volumes contain the proceedings of the twenty-third annual meeting which was held at Asbury Park, N. J., on June 22-25, 1920. The first volume contains the committee reports and tentative standards. Among the reports of particular interest to railway men are those on the Proposed Revisions in Standards and Tentative Standards for Steel, Corrosion of Iron and Steel, Cement, Reinforced Concrete, Concrete and Concrete Aggregate, Preservative Coatings for Structural Material, Methods of Sampling and Analysis of Coal, and Shipping Containers. Among the tentative standards incorporated in this volume are those for steel, tie plates, boiler and firebox steel for stationary service, carbon tool steel, low carbon steel track bolts, non-ferrous alloys for railway equipment, bronze bearing metals for turntables and movable railroad bridges, and babbitt metal. The second volume contains the technical papers presented before the convention, including one on The Shattered Zone in Certain Steel Rails with Notes on the Interior Origin of Transverse Fissures, by J. E. Howard, and another on the Effect of Hydrated Lime.

TRADE PUBLICATIONS

RIVETERS.—In this catalogue the Hanna Engineering Works, Chicago, Ill., describes compression yoke type riveters. In order to fully explain the action of Hanna riveters, details of each step in the process of heading a rivet are given. Typical installations of riveters of various types and sizes are shown in operation, together with tables of useful rivet data and specifications of Hanna equipment.

FACTORIES THAT FIT.—This booklet has been prepared by Frank D. Chase, Inc., Chicago, Ill., for the purpose of explaining the Chase idea of sound engineering design in factory construction. This idea is essentially that a manufacturer should have his plant so arranged and equipped that the processes of production may be accomplished in an orderly fashion at a minimum cost. Photographs of forty factories in various parts of the country designed by Frank Chase, Inc., are shown in the booklet.

DIE BLOCKS.—Catalogue No. 3 has been issued by the Pennsylvania Forge Company, Philadelphia, Pa. The catalogue explains that quality and uniformity should be the first consideration in ordering die blocks. The first cost of the steel is negligible compared with the expense of sinking and the risk of cracking in hardening. It is stated that die blocks made by this company are made of acid open hearth steel in 10-ton furnaces, insuring uniformity of product. A description of the various grades of die blocks is given in the catalogue, together with recommended heat treatment. A complete table of the weights of die blocks is shown, also a table of draft angles for die sinkers.

SKIN SORES AND BOILS.—"Causes of Skin Sores and Boils Among Metal Workers" is the title of a booklet issued recently by E. F. Houghton & Co., Philadelphia, Pa. One of the serious problems confronting the metal-cutting industries is that of boils and skin sores among operators, and this booklet presents the results of a complete investigation of the subject made by the Houghton research staff. The work is thoroughly practical and shows that wherever the suggestions for prevention of infection have been applied in a common sense manner the infection has been cut down and in some cases eliminated. The investigation also showed no grounds for the widespread belief that cutting compounds are primarily responsible for the various forms of infection among metal-cutting operators.

ASSOCIATIONS

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.

Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer suite 315 Wyandotte building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.

Firth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue, Oak Park, Ill.

Secretary—Harry D. Vought, 95 Liberty street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.

Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

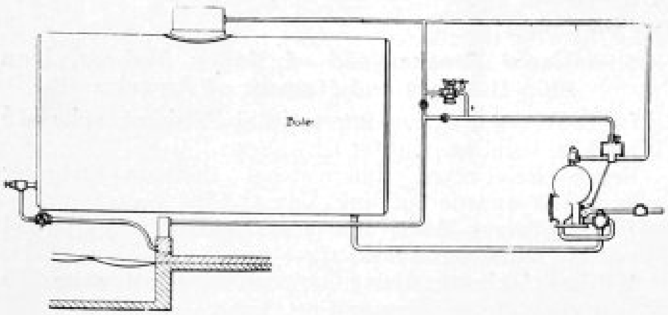
Washington Loan and Trust Building,

Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,364,856. APPARATUS FOR RETURNING WATER OF CONDENSATION TO STEAM BOILERS. JOSEPH H. BANKS, OF NEW YORK, N. Y.

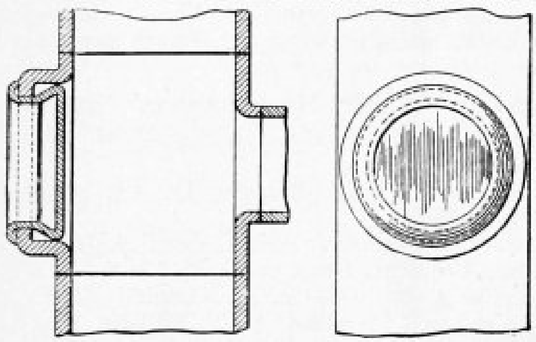
Claim 1.—An apparatus of the class described, comprising in combination,



a water receiving vessel; means for introducing water into said vessel, a boiler, a conduit establishing communication between said boiler and said vessel, an auxiliary steam generator, and means operable to place said generator alternately in communication with said vessel, to create a pressure in the latter in excess of that in the boiler to force water from the vessel through said conduit into said boiler, and with said boiler, whereby steam from the generator may pass to the boiler when it is not being admitted to the vessel. Sixteen claims.

1,363,153. CLOSURE FOR OPENINGS IN BOILER-HEADERS. THOMAS E. MURRAY, OF BROOKLYN, NEW YORK.

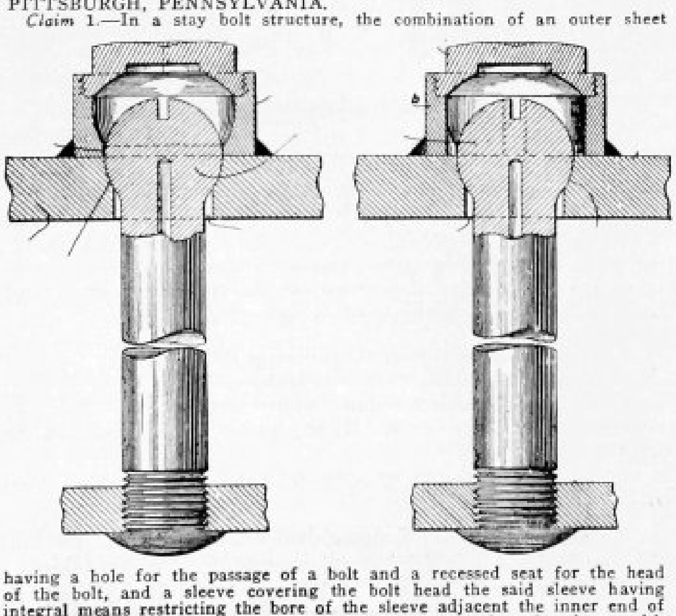
Claim 1.—A header for steam boilers having on its exposed side a tubular



projection with an inwardly turned flange thereon, and a cup-shaped plug having a straight cylindrical portion fitting in the opening surrounded by said flange and a flared inner portion of greater diameter than said opening, and disposed within said tubular projection. Two claims.

1,359,588. INSTALLATION OF STAYBOLT STRUCTURES FOR BOILERS. JOHN ROGERS FLANNERY, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

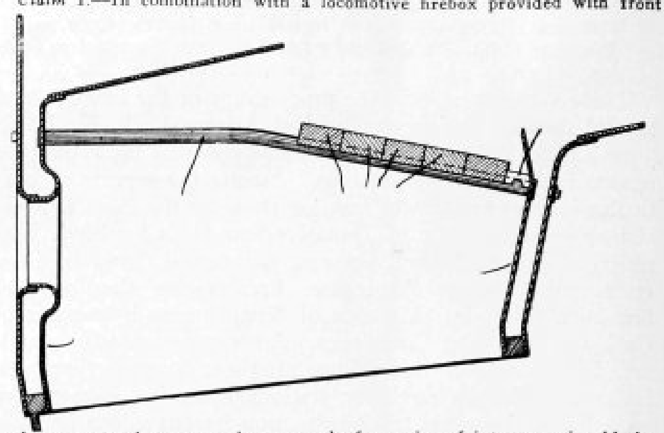
Claim 1.—In a stay bolt structure, the combination of an outer sheet



having a hole for the passage of a bolt and a recessed seat for the head of the bolt, and a sleeve covering the bolt head the said sleeve having integral means restricting the bore of the sleeve adjacent the inner end of the latter and adapted to engage the head or centering the sleeve with relation to the said head. Three claims.

1,357,575. LOCOMOTIVE FIREBOX ARCH. EDGAR M. McLEAN AND CHARLES B. YODER, OF ST. LOUIS, MISSOURI, ASSIGNORS TO EVENS & HOWARD FIRE BRICK COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

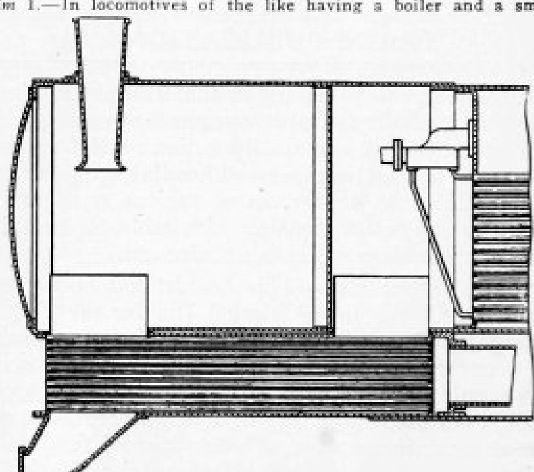
Claim 1.—In combination with a locomotive firebox provided with front



and rear water legs, an arch composed of a series of inter-engaging blocks, the ends of the adjacent blocks being cut away so as to form substantially semi-circular grooves when said blocks are assembled, and a series of water tubes traversing the grooves, the diameter of the watertubes being substantially smaller than the width of the grooves.

1,360,546. AIR-PREHEATER FOR LOCOMOTIVES AND THE LIKE. FREDRIK LJUNGSTROM, OF BREVIK, LIDINGON, AND ISIDOR BROBERG, OF SKARSATRA, LIDINGON, SWEDEN, ASSIGNORS TO AKTIEBOLAGET LJUNGSTROMS ANGTURBIN, OF STOCKHOLM, SWEDEN, A CORPORATION.

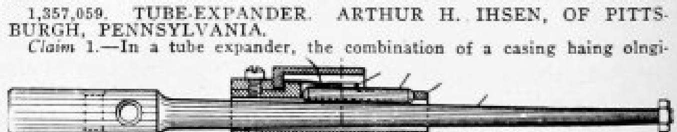
Claim 1.—In locomotives of the like having a boiler and a smoke box,



a preheater arranged longitudinally in front of the boiler and beneath the smoke box and consisting of a plurality of longitudinally disposed tubes. Six claims.

1,357,059. TUBE-EXPANDER. ARTHUR H. IHSEN, OF PITTSBURGH, PENNSYLVANIA.

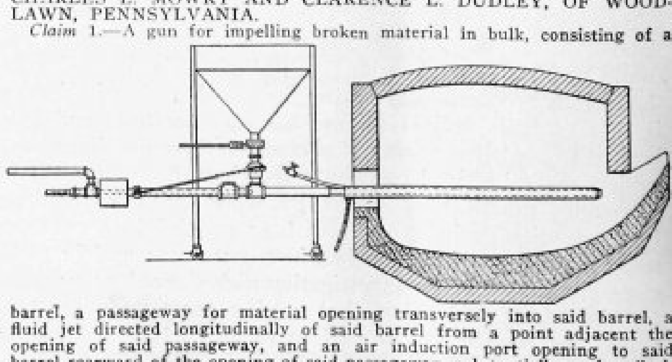
Claim 1.—In a tube expander, the combination of a casing haing olngi-



tudinal recesses, rollers fitting within the recesses, a tapered rod fitting within the bore of the casing and bearing against the rollers, a housing secured to said casing and inclosing the rear ends of said rollers, and a collar mounted o nthe casing within said housing and having resilient tongues which bear on the rear ends of said rollers sufficiently to prevent their escape.

1,363,610. APPARATUS FOR REPAIRING FURNACE-LININGS. CHARLES L. MOWRY AND CLARENCE L. DUDLEY, OF WOODLAWN, PENNSYLVANIA.

Claim 1.—A gun for impelling broken material in bulk, consisting of a



barrel, a passageway for material opening transversely into said barrel, a fluid jet directed longitudinally of said barrel from a point adjacent the opening of said passageway, and an air induction port opening to said barrel rearward of the opening of said passageway, substantially as described. Three claims.

THE BOILER MAKER

MARCH, 1921

Quantity Production of Scotch Marine Boilers

With a normal output of three Scotch marine boilers a week, the boiler shop of the Federal Shipbuilding Company ranks with the most efficient shops in the country. The methods and equipment employed in the accomplishment of this construction, which for boilers of this type might be termed quantity production, are outlined in the accompanying article. While boilers for the ships under construction in the shipyard are being built, the stacks, uptakes and tanks for these ships are also fabricated in the boiler shop.

The boiler shop of the Federal Shipbuilding Company, Kearny N. J., primarily intended for Scotch marine boiler stack, tank, uptake and light plate fabrication, is one of the largest in the country and is equipped with the best types of modern machinery for the efficient handling of work through the shop. Working normally with one eight-hour shift of 250 men, the output of the plant is three boilers a week. With the addition of another shift of about 100 men it is possible for the plant to turn out boilers on the basis of 200 a year. Since September, 1919, up to the present time, 235 boilers, most of them in excess of 15 feet in diameter, have been built in the shop. In addition, the stack, tank and uptake work for all vessels built in the Federal shipyard was carried on at the same time as the construction of boiler equipment.

The whole object in the arrangement of the shop, its equipment and the routing of material in the process of fabrication has been with the view to maintaining work on a production basis.

Structural Details of Shop

The building is a steel and terra cotta structure 585 feet long and 161 feet 6 inches wide, comprising a center bay 63 feet wide and 70 feet high below the roof truss. Two side bays, each 63 feet wide and 40 feet high flank the center. Partial extensions are arranged on the west end and south side for heating furnaces, and on the opposite side for the office, tool room, locker room and wash room.

For a distance of 85 feet the west end of the shop is free from columns and forms the flanging department. Next to this space central columns divide the main bay into two runs. For a distance of about 50 feet this section forms the riveting department. The middle stretch of the main aisle contains shell drilling equipment and forms the assembly floor. At the east end is the department in which hydraulic testing of the completed boilers is carried on. The north bay of the shop forms a department for the fabrication of light plate work. Standard gage railroad tracks enter each bay of the shop at the east end, and the north bay of the shop at the west end. Transverse 36-inch gage tracks connect the main aisle with the two side aisles.

Routing of Material

The shop is laid out for a straight line flow of materials, the direction being from the east end of the south bay to the west bay and then back through the main bay to the testing floor. When it reaches this point, the boiler is ready for shipment or installation in a vessel. The shell plates are brought into the shop to the layout table and are marked off for size, rivet and manhole positions, calking edges and the like. They are then drilled, burrs removed, the edges planed and the plates otherwise made ready for rolling. The narrow gage tracks running transversely of the shop are now made use of in carrying the shell plates to the vertical bending rolls in the center bay.

The inside and outside butt straps are marked out on the laying

Fig. 1.—Boiler Shop of the Federal Shipbuilding Company

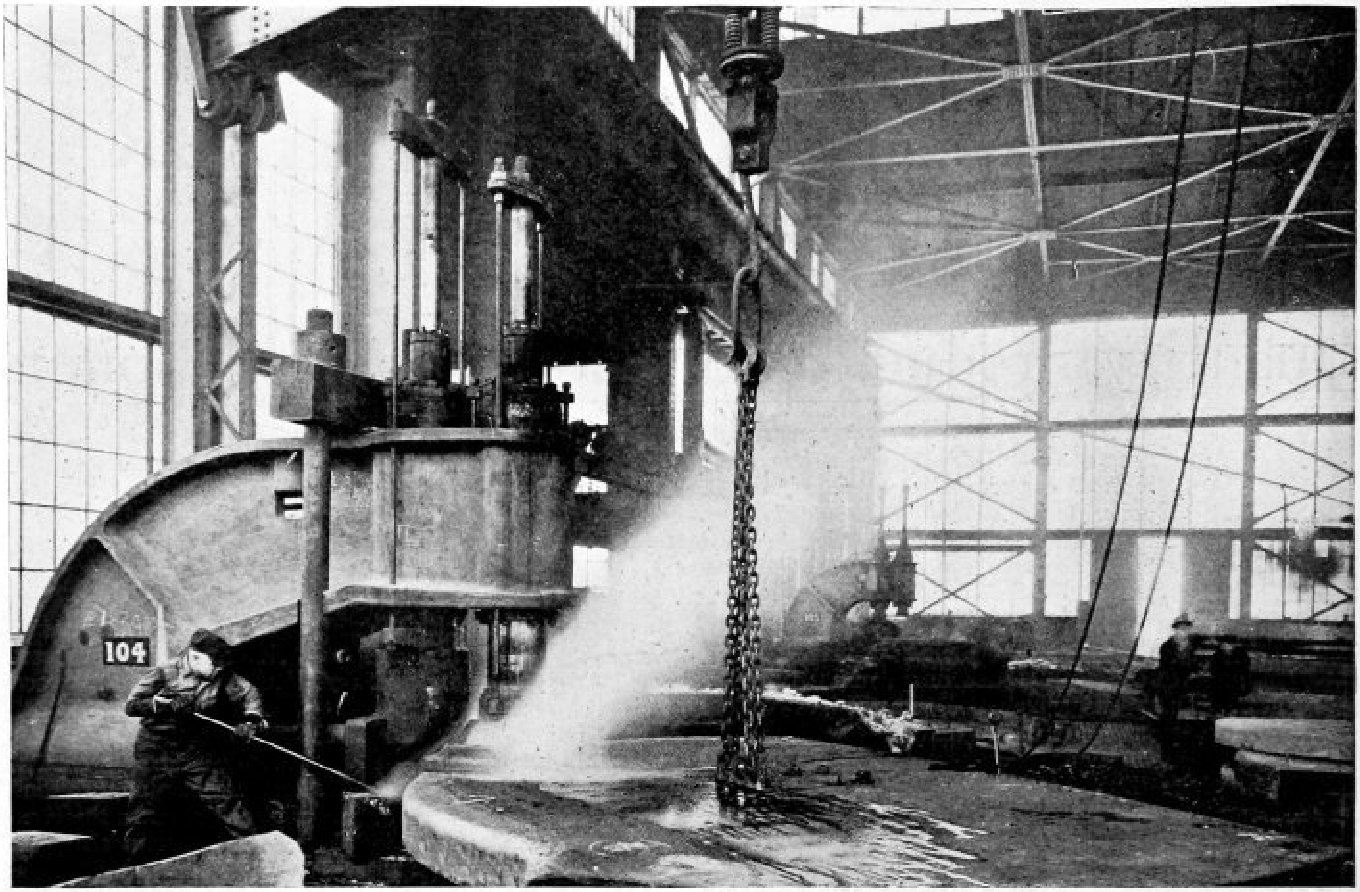


Fig. 2.—One of the 200-Ton Flanging Presses in Action

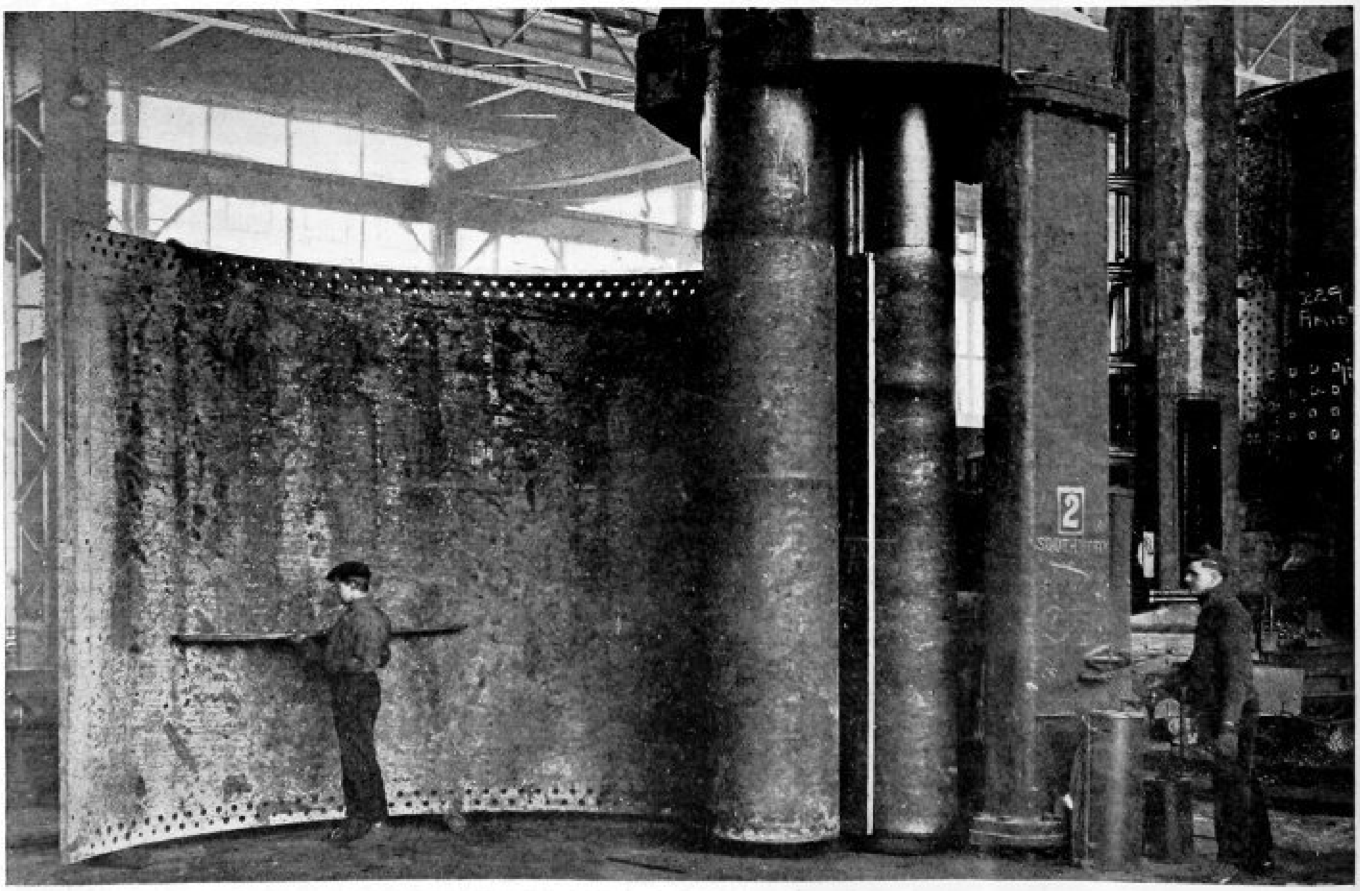


Fig. 3.—Vertical Bending Rolls Which Will Take Plates Up to 162 Inches Wide by 1⅞ Inches Thick

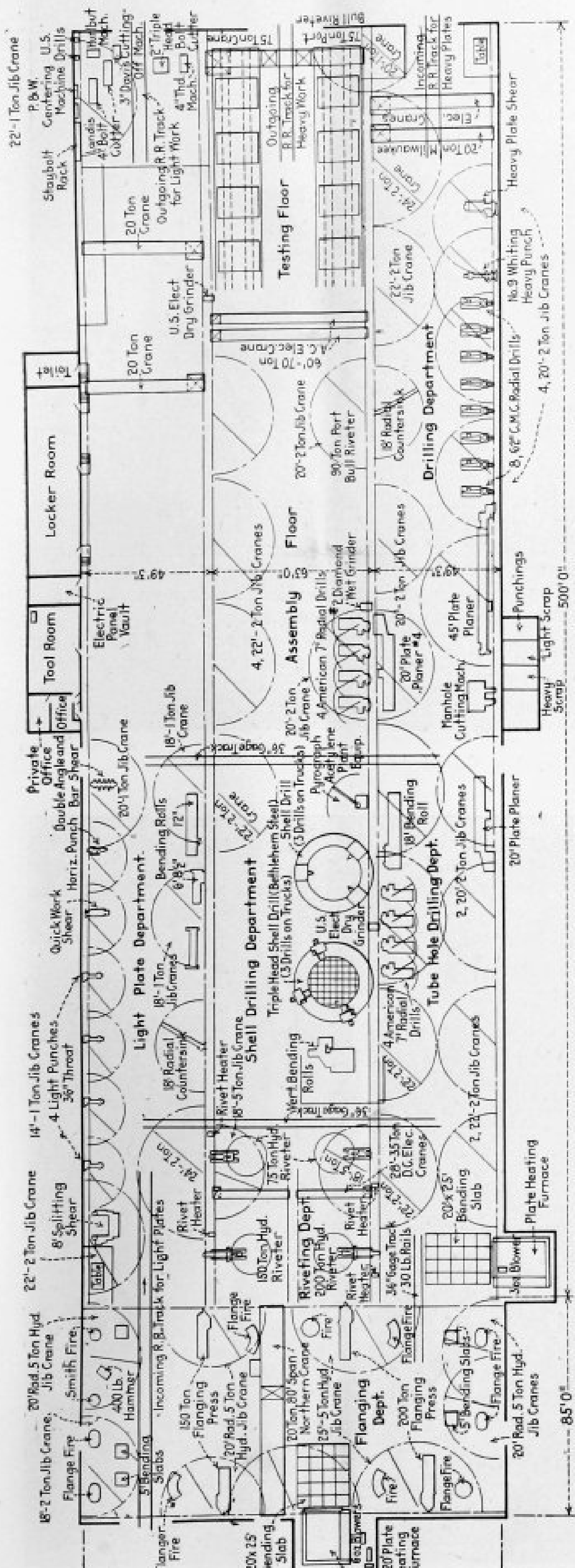


Fig. 4.—Arrangement of Departments and Tool Equipment in the Federal Shipbuilding Company Boiler Shop

out table and taken to the first battery of radial drills, where they are drilled for tack holes and are pressed to radius. The edges are then planed, after which they are bolted to the shell and the assembled parts set up in the triple head shell drill and drilled in position. The manhole stiffening plate, after being laid off, is fitted to the shell, bolted in place and drilled through the holes in the shell, which serves as a template.

In the meantime, the plates forming the heads have been laid out at the east end of the south bay for flanging, stays, tubes, furnaces, manholes and the like. They are then taken to the flanging bay at the west end of the shop and the flanges turned on the hydraulic presses. All heads are annealed after flanging to relieve stresses in the metal. Each head is in two pieces of sufficient thickness to omit doublers and reinforcements under the through stays. The front head is flanged for manholes and furnaces.

Tube sheets are laid off for flanges, tube holes, braces and rivets. The plates are then flanged, annealed and drilled for tube holes and rivets. Back combustion chamber heads are laid out, flanged, the edges trimmed by means of the pyrograph, annealed, drilled and the holes burred. The sections of the front and back heads are riveted, the heads tack-bolted to the shell in the triple head drill and the rivet holes drilled through the holes in the shell, so that when finally assembled all holes will line up properly.

The combustion chamber wrapper sheets are laid out, the edges planed, drilled for rivets and screw stays and then shaped in the rolls. The back tube sheet, the back combustion chamber sheet, and the wrapper sheets are then tack-bolted together, rivet holes drilled and burred out, the connections assembled, riveted and calked. The bottom plate of the combustion chamber is self-staying; the Morison type furnaces which are used in the boilers are the only parts not fabricated in the yard. These furnaces are assembled and riveted to the connections at this point in the construction operations. The center and wing combustion chambers are arranged in correct alinement and screw stays fitted in the plates so that they are ready for installation.

While the connections have been assembled, the shell, butt straps and back head have been bolted together and carried to the riveting department by one of the main cranes. The smaller cranes in this department then come into action and serve the material to the bull riveters. After this part of the riveting is completed, the shell is taken back to the assembly floor, the connections dropped into place, the holes lined up and the stays inserted. The front head is fitted and riveted, plain tubes and stay tubes fitted and expanded, and the through stays bolted up. The necessary calking is done around the stays and tubes and the edges of the shell plate between the outside butt straps and flanges of the heads are welded to insure tightness.

Internal fittings, furnace fittings, furnace fronts and accessories may be installed or not, according to the required specifications. All this work is done on the assembly floor, after which the boiler is taken to the testing department and subjected to hydrostatic tests by the United States Steamboat Inspection Service and by a representative of the classification society under whose jurisdiction the ship in which the boiler is to be installed comes.

A complete outline of the structural details of the boilers built at the Federal boiler shop was given on page 49 of the February issue of THE BOILER MAKER.

The north bay of the shop is utilized for tanks, stacks, uptake and other light plate fabrication. Production processes are carried out completely in this bay from the plates which enter the plant at the west end to the finished product which is taken from the plant on railroad trucks at the east end.

MACHINE EQUIPMENT OF PLANT

Power at 13,000 volts is supplied to a central sub-station

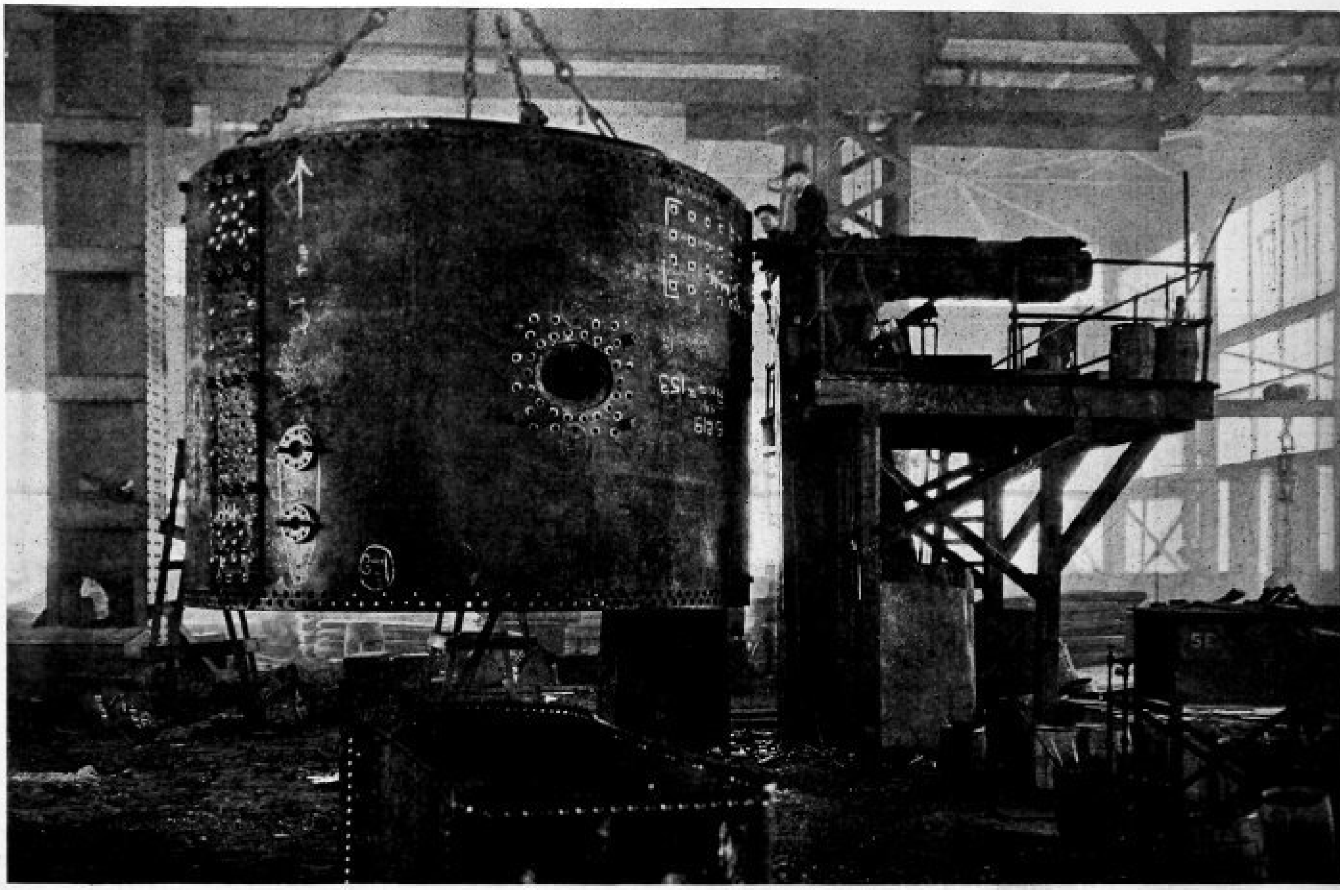


Fig. 5.—Head, Butt Straps and Manhole Plates Being Riveted on One of the 200-Ton Hydraulic Riveters

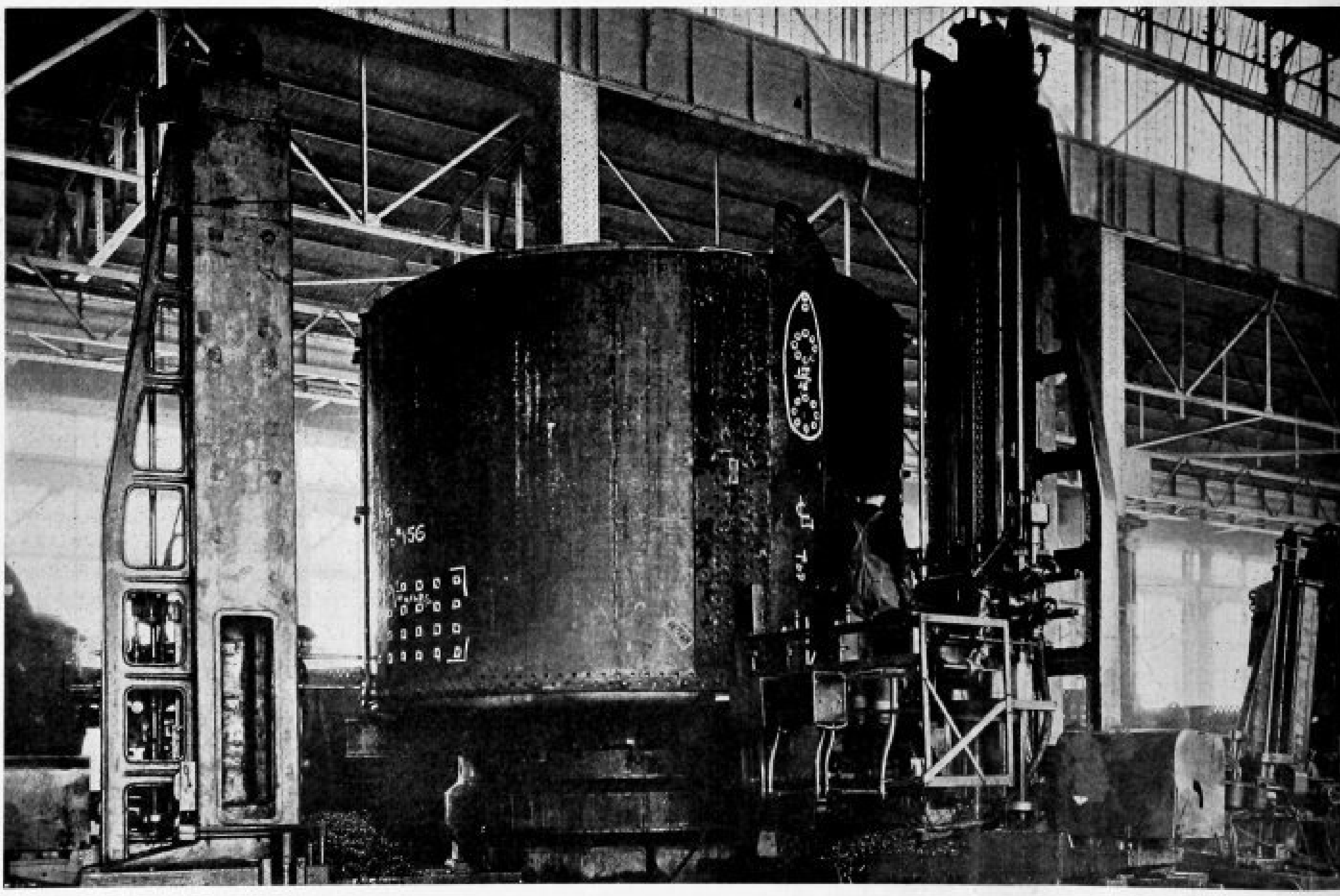


Fig. 6.—Triple Head Shell Drill, Having a Capacity of Shells from 8 Feet to 18 Feet in Diameter and 14 Feet Long

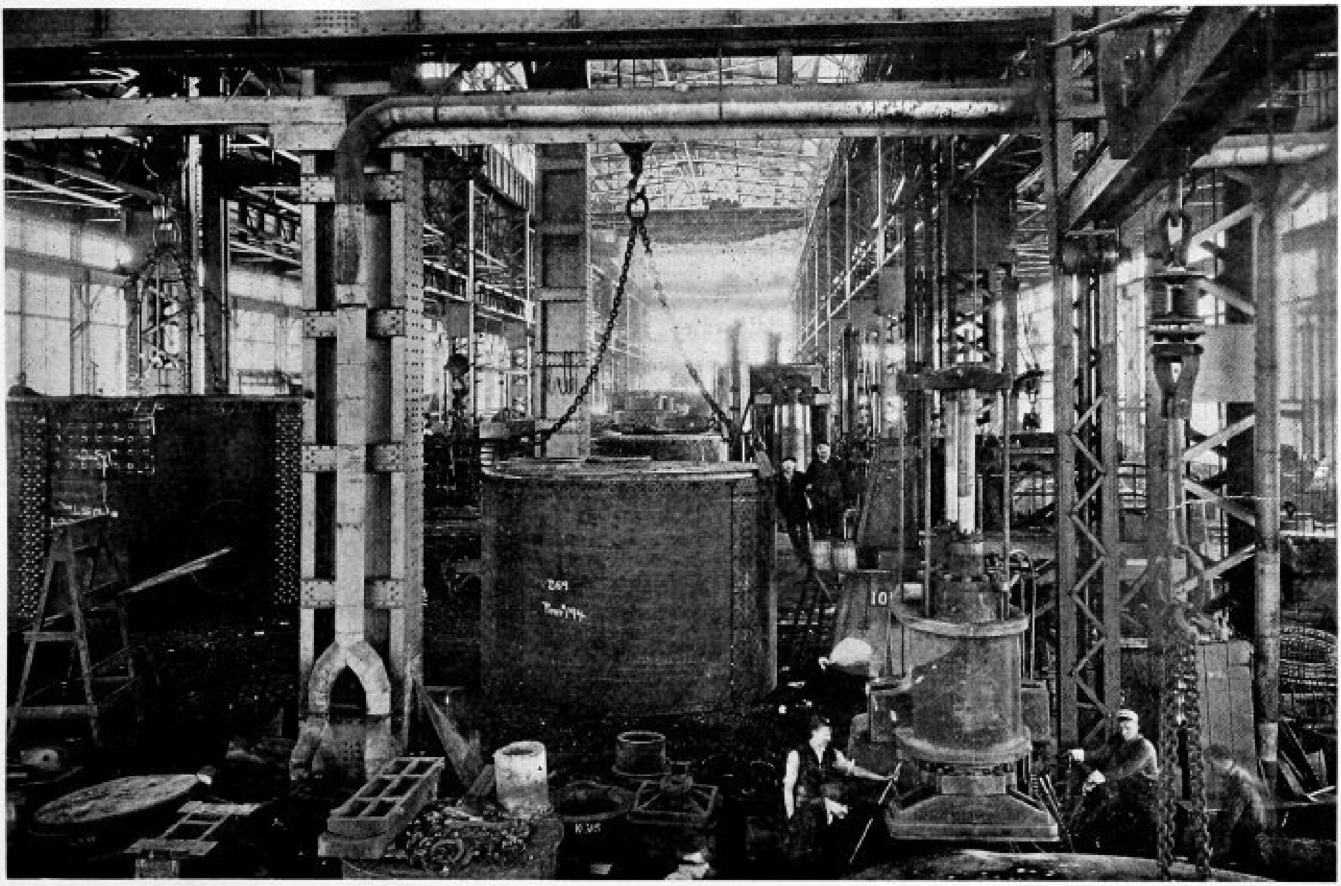


Fig. 7.—Looking East in the Main Bay, Showing the Riveting and Assembly Departments

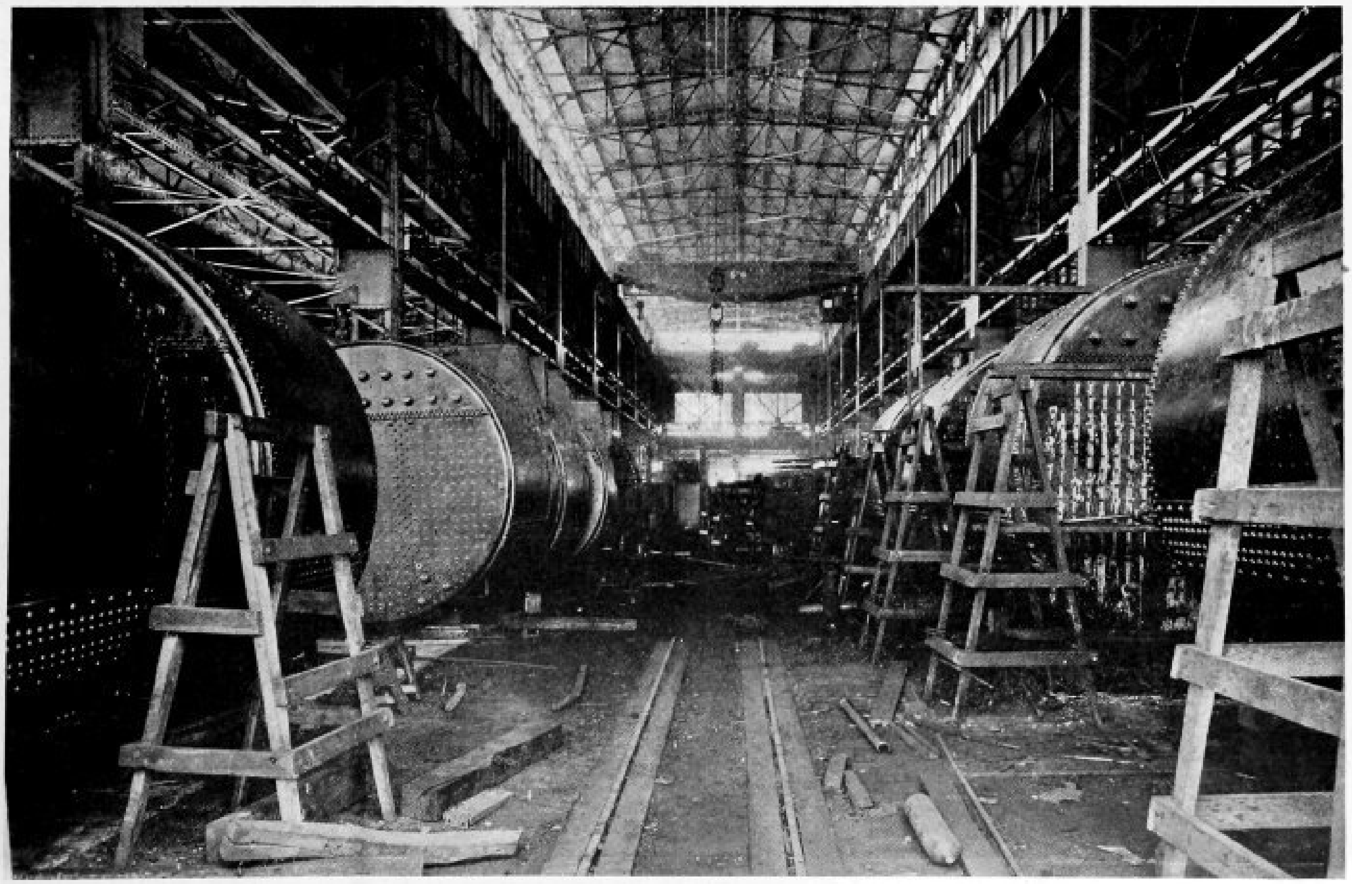


Fig. 8.—Eastern End of the Main Bay, Where Hydraulic Testing of Finished Boilers is Carried Out

in which current is transformed, converted and distributed to the entire shipyard. The boiler shop uses 400-volt, 3-phase, 60-cycle alternating current as well as 230-volt direct current. All electric cranes are operated at 230 volts. The lighting current is 110-volt. The oxy-acetylene and electric welding processes are used extensively in the shop on both boiler and plate work. Flanges on heads and tube sheets are trimmed with the pyrograph, an automatic oxy-acetylene cutting machine specially designed for this class of plate work. The radiograph is used for making circular and irregular cuts in plates. A special feature of the shop is the jib crane equipment, which consists of nine hydraulic and thirty-eight hand jib cranes of from 1 to 5 tons capacity and with radiuses of action from 14 to 24 feet. The shop is piped for compressed air, which is used at a pressure of from 90 to 100 pounds. Hydraulic pressure of 1,500 pounds is available for operating the flanging presses, bull riveters and other hydraulic machinery.

Part of the cranes and other heavy equipment have been previously mentioned in describing the production processes, but given in detail, the east bay is served by two 20-ton Milwaukee electric cranes which handle material the length of the shop as far as the flanging department. Ranging along the south side of the south bay there are a set of heavy plate shears, a number 9 Whiting heavy punch, eight 62-inch C. M. C. radial drills, a 45-foot plate planer, a manhole cutting machine and a 20-foot plate planer. In addition, this bay contains one 18-foot radial countersink, a second 20-foot plate planer, a set of 18-foot horizontal bending rolls and four American 7-foot radial drills which are used for drilling tube holes and the like. A 20-foot by 25-foot bending slab is also located in the north bay immediately in front of a 14-foot by 20 foot plate-heating furnace in which the heads are annealed. The flanging department at the west end of the plant is served by one 20-ton, 80-foot span, Northern electric crane. Two 200-ton flange presses which will turn a 12-inch flange on 1½-inch plate and two 150-ton hydraulic presses are installed here. This department also has one 400-pound hammer, a 14-foot by 20-foot plate heating furnace and a 20-foot by 25-foot bending slab, as well as five 5-foot bending slabs and ten flange fires.

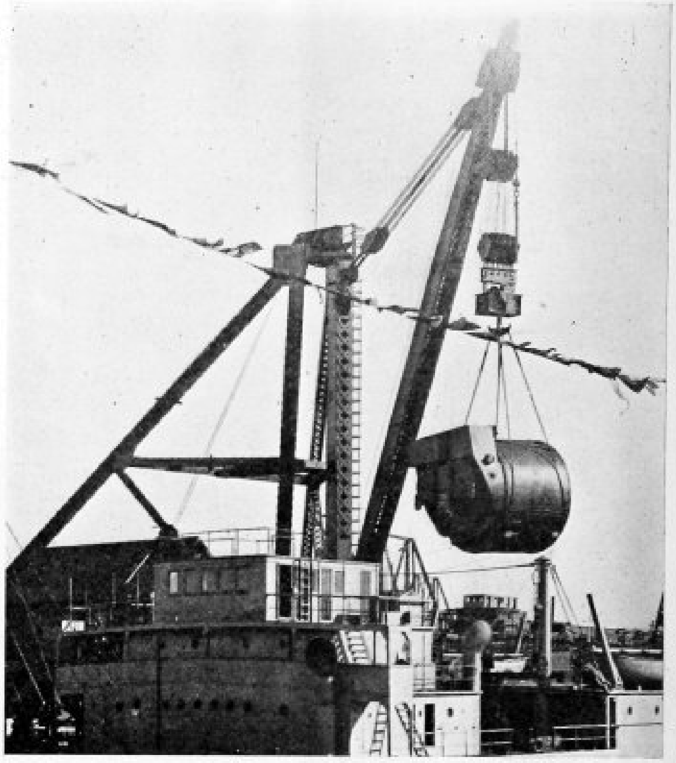


Fig. 9.—One of the Boilers of the U. S. S. *Duquesne* Being Dropped Into Place by Fitting-Out Crane

In the riveting department there are two 75-ton hydraulic riveters one 150 ton and one 200-ton riveter; the latter has a gap of 14 feet 6 inches and a stroke of 12 inches. Rivet heaters are located adjacent to each riveter. In addition, two 90-ton portable riveters are available in the shop wherever they are needed.

This department is served by two 28-foot span, 35-ton cranes. The arrangement of the rails for these cranes permits the full span cranes of the main bay to drop material

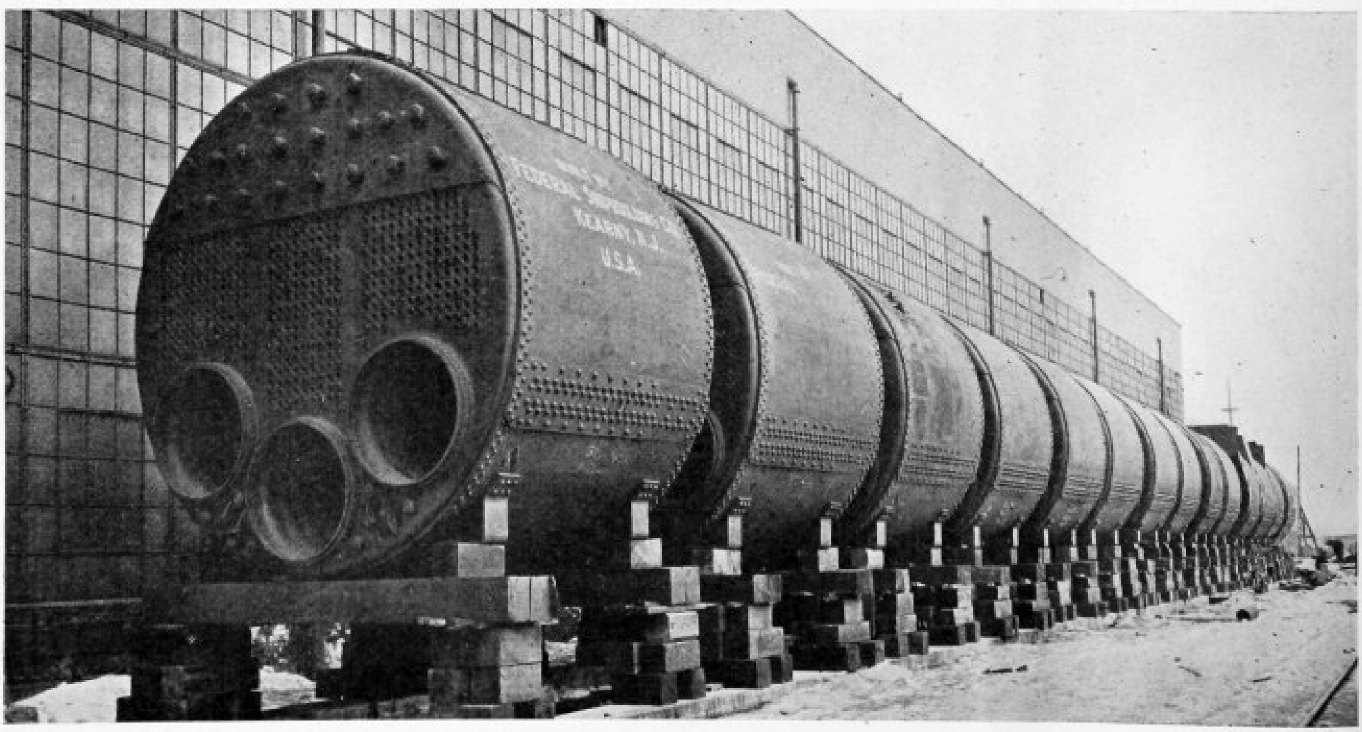


Fig. 10.—Storage for Boilers, Where They Are Held Until Installed in Vessels Under Construction in the Shipyard

within the reach of the two cranes in the riveting department, so that the main cranes are released for other work, where in most shops they are utilized for handling material, being worked in the bull riveters.

The remaining equipment in the main bay includes a set of vertical bending rolls for shell plates up to 162 inches wide by 1⅞ inches thick; two sets of triple-head shell drills are installed, one of which was built in the yard and the other of Bethlehem make. The latter will take shells from 8 feet to 18 feet in diameter and 14 feet long without reversing ends. A Davis-Bournonville pyrograph for oxy-acetylene cutting of flanges on heads and the like is located near the shell drills. The main bay is served by two 70-ton electric cranes which have a 60-foot span and two 35-ton trolleys, and one 75-ton Northern electric crane having two 50-ton trolleys. Several United States dry grinders and Diamond wet grinders are located through the shop. A battery of four American 7-inch radial drills completes the equipment in this section.

MACHINERY IN LIGHT PLATE DEPARTMENT

In the north bay, used for light plate fabrication, the laying-out table is located on the west end, and from this point following through the department there are a set of 8-foot gate shears, an 18-foot radial countersinking machine, four light punches having 36-inch throats, one Quickwork shear, one horizontal punch, one double angle and bar shear, one brake bender, one 6-foot 8½-inch bending roll, two 20-ton Milwaukee electric cranes. The east end of this bay contains machines for making staybolts, threading stay tubes and the like. The equipment here includes one P. & W. centering machine, two United States drills, one Hurlbut machine, two Landis 4-inch bolt cutters, one 3-inch Davis cutting-off machine, one 2-inch triple-head bolt cutter and one 4-inch threading machine.

Every precaution has been taken throughout the shop to guard machine operators against accident. Locker and wash-room facilities are very complete for the convenience of the men. The central dispensary service of the shipyard is always available for the men in the boiler shop as well as all of the other shops in the yard.

The photographs used in this article are by Lionel Dottin.

Testing Welds in Steel Plates*

BY S. W. MILLER†

There have been many failures of welds in the past, some not explained and some very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds both from a standpoint of security, service and cost. While some of the methods employed at present are beyond the reach of the ordinary welding shop, yet they are of great value and, in fact, necessary in order to determine correctly what has occurred during the welding operation and what results may be expected under given conditions. Most of the published results are incomplete in one or more respects and one of the objects of the American Welding Society is to put the testing of welds on a firm and safe foundation.

COMMON METHODS OF TESTING

The testing of metals, aside from welds, is quite well developed both in theory and practice. The usual test is the tensile test that gives the tensile strength per square inch, the yield point or elastic limit in pounds per square inch, the elongation in percent of the original gage length and the reduction of area in percent of the original section. Compression, torsion, shock and alternating stress tests are also used, and the two latter are beginning to be used much more than they have in the past because it has been found that materials may give high results in the tensile test and yet be entirely unsuitable to resist service where shock or alternating stresses are met. Another of the common tests is bending to a certain radius either hot or cold, and it has been found that it is a very valuable test of certain qualities.

Chemical analysis is another powerful method of investigation, and many specifications have been made in which its use is vital.

The microscope has been found to be of tremendous help in the study of metals, and, in fact, it is now a necessary instrument in all laboratories. Its principal function is to determine the extent and location of impurities in a metal, to decide whether the structure is proper for the purpose desired and to decide whether various heat treatments will give satisfactory results. While no one method of test shows everything desired to be known, the microscope is probably the most powerful single method of investigation in the case of metals, and in the study of welds it is particularly valuable because of the method of their formation. A weld is a casting and is subject to all the defects found in castings, which are, however, exaggerated in the case of welds.

WELDS IN STEEL PLATES ONLY CONSIDERED

This paper is confined to defects in the welding of steel plate by the oxy-acetylene and metal electrode processes. The welds considered are those in some important structure where soundness and high quality are necessary. By soundness, I mean freedom from mechanical imperfections such as lack of fusion, the presence of films or other inclusions, gas pockets, slag, etc. Welds of inferior quality may answer some purposes admirably, and if they do, there is no use in making better ones, but this is not the goal at which to aim for one who desires to make really good welds. The welding of steel is frequently considered as not being especially difficult, and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common today than it was several years ago, but it is still too prevalent for the good of the art. A comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is 0.12 percent or less, the material is soft, ductile and yields readily to any strain that may be put on it. Such material is frequently used for tanks, and because of its ductility and comparative freedom from damage by heating is admirably suited for welding. Structural steel, bar steel and boiler plate contain about 0.15 percent to 0.25 percent carbon and have a tensile strength of about 60,000 pounds, while the soft low carbon material has only about 52,000 to 55,000. Ship plate is required to have a tensile strength of from 58,000 to 68,000 pounds, and in order to secure this characteristic the heavier sections require as high as 0.30 percent carbon.

It has been found by experience that the higher the carbon the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. From a metallurgical point of view this is entirely natural and to be expected. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An

* Paper read before the September meeting of the Chicago Section of the American Welding Society.
† Rochester Welding Works, Rochester, N. Y.

oxy-acetylene weld made with ordinary low carbon welding wire will have a tensile strength of about 52,000 pounds. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an oxy-acetylene weld of about 50,000 pounds. Neither of these materials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece. Therefore, in making tests of welded pieces, it is necessary to know accurately the character of the material being welded, because if Welder Jones makes a weld in soft tank steel and Smith makes one in bar steel, the first will break outside of the weld and the latter in the weld, with a probable adverse criticism of Smith's work.

Recommended Physical Tests

The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made, but that an alternating stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests, but it is advisable, whenever possible, to follow those of the American Society for Testing Materials. Inasmuch as a welded piece is not of uniform character, it is not possible to use the elongation and reduction of area as commonly measured. Where the break occurs in the weld, the elongation of the whole test piece tells very little about the quality of the weld, and I have been in the habit of taking the elongation in each inch, two inches, etc., of the gage length, beginning at the center inch, which includes the weld, and plotting these figures against the gage length. Evidently, when the break is outside the weld, the various physical characteristics are those of the original material and not at all of the weld. The best test, in my opinion, to determine quickly the general character of a weld is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the V toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throws more of the strain into the weld, while soft, ductile material will itself take considerable of the bend. In the case of defective welds—that is, those not fused along the V or which contain slag or other inclusions—this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot—such as, for instance, in a locomotive firebox crown sheet—it would be entirely proper to test the weld at a good red heat, and I believe that it would be of much interest to all of you if you would test some of your welds by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the table or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before with a sledge.

If such welds are made in half-inch by two-inch bar steel, a 90-degree single V being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

Conditions Affecting Quality of Welds

There seems to be quite a definite relation between the thickness of metal, the size of tip and the size of the welding wire, in the case of gas welding, and between the thickness of metal, the diameter of the electrode, and the current used, in electric welding. It is also to be understood that electric welds, except possibly those made with covered electrodes, will not stand as much bending as oxy-acetylene welds.

In many cases the defects in welds are easily visible to the naked eye when tested. In other cases they are not, and, while it would seem plausible that the visible ones were more dangerous, yet, to my mind, the hidden danger due to the ones that are hard to see is a matter that must not be overlooked. For many years the dangerous defects in steel rails have been those which were not visible and which have usually been very small at the start.

Effects of Strain

Some of the defects in welds are visible under the microscope, but others are not visible until the weld is strained. A small bending machine that can be placed on the microscope stage is very useful, because after etching, the piece can be bent and examined to see what the effect of the strain is. In the case of bare wire electric welds the rupture, as far as my experience goes, always occurs at the grain boundaries, even where no defects are visible there at the highest powers of the microscope. Of course, where there are visible defects, the rupture takes place first at these. Where there are no defects, the distortion occurs by slipping in the grains as in normal steel. The causes of these defects are, to my mind, almost always oxides of one or another constituent of the metal, but usually of iron. There is no positive proof of this as yet, but there are indirect proofs. An electric weld that will bend very little may be made much more ductile by heating in a reducing atmosphere at a low red heat for one or two hours, indicating that the weakness at the grain boundaries has been removed. The reducing atmosphere would seem to make it clear that the material at the grain boundaries was an oxide. Again, heating an electric weld in an oxidizing atmosphere makes it more brittle.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design, and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating stress tests.

Conclusion

A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds, but after they have been seen a number of times an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly welded. The appearance in a gas weld of porosities on top indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger tip than is necessary to produce thorough fusion. This means that the catalogue speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material which has been seriously overheated should be more brittle and weaker than the material which has been properly melted. I have found in a number of cases that very great improvements in the quality of the work were made by using regularly a bending test and by carefully instructing the welders until their welds meet this test with unfailing regularity.

Fundamental Principles of Trigonometry*

Applying the Trigonometric Functions to the Solution of Problems in Triangulation

BY WILLIAM C. STROTT†

Since the square and rectangle Fig. 4 (see page 43 of the February issue) both contain four right angles, it is obvious that the sum of their angles is (4 × 90) or 360 degrees; hence a triangle contains one-half that amount, or 180 degrees. (Note that although Figs. 4c, 4d and 4e do not contain any right angles, they are nevertheless distorted rectangles or squares; also, that any of these four-sided polygons may be distorted into a polygon of any number of sides, and still have the magnitude of four right angles.)

Therefore, angle a of Fig. 3, which refers to our problem, is equal to $180° - (90° + 59°)$, or 31 degrees. We shall now proceed to prove this by means of the trigonometric functions, as follows:

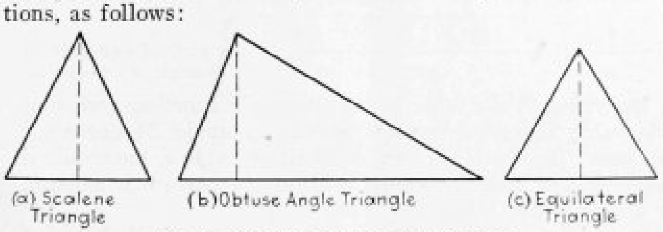


Fig. 5.—Various Forms of Triangles

From the previous tabular arrangement of the functional ratios it will be seen that sin a is also equal to cos ϕ; hence, having determined sin a, it only remains to follow the columns headed "cosines" until we come to the desired numerical value, and the corresponding angle may be read from either the right or the left hand column of the table, depending on whether we are reading up or down on the columns, as was previously explained.

In our example, then, cos a also equals sin ϕ, or 0.85748. The figure in the tables corresponding to this value is as before, 0.357167, which, reading from the left hand column of the table, we find corresponds to an angle of 31 degrees.

The foregoing work should be very clear to the student, and with a little patience and practice he should soon be able to solve any right angled triangle without difficulty.

Solution of Oblique Triangles

Very frequently the problem encountered will be that of an "oblique" triangle—that is, a triangle which does not contain a right or 90-degree angle. Fig. 5 (a) to (c) illustrates various forms of oblique triangles.

Any oblique triangle may be cut into two imaginary right triangles as indicated by the dotted lines in the above illustrations. A line so drawn evidently forms the altitude of the oblique triangle as well as a side common to both imaginary right triangles.

The foregoing principles relating to the solution of right triangles may also be very readily applied to the solution of oblique triangles, with the exception that three terms of the triangle must be known. At least one of the known terms must be the length of a side. There are four distinct cases of oblique triangles, described as follows:

Case (1)—Given one side and two angles.
Case (2)—Given two sides and the angle opposite one of the sides.
Case (3)—Given two sides and the included angle.
Case (4)—Given the three sides.

An example of Case 1 will be given first.

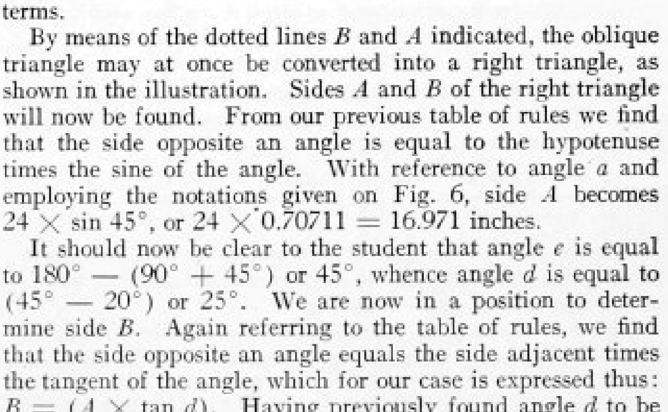
Example.—Given an oblique triangle similar to Fig. 6, in which the longest side is 24 inches and the two smaller angles are 45 degrees and 20 degrees, respectively, find the unknown terms.

By means of the dotted lines B and A indicated, the oblique triangle may at once be converted into a right triangle, as shown in the illustration. Sides A and B of the right triangle will now be found. From our previous table of rules we find that the side opposite an angle is equal to the hypotenuse times the sine of the angle. With reference to angle a and employing the notations given on Fig. 6, side A becomes $24 \times \sin 45°$, or $24 \times 0.70711 = 16.971$ inches.

It should now be clear to the student that angle e is equal to $180° - (90° + 45°)$ or 45°, whence angle d is equal to $(45° - 20°)$ or 25°. We are now in a position to determine side B. Again referring to the table of rules, we find that the side opposite an angle equals the side adjacent times the tangent of the angle, which for our case is expressed thus: $B = (A \times \tan d)$. Having previously found angle d to be 25 degrees, and now looking up the table of trigonometric functions for tan 25 degrees, which is 0.4663, side B then becomes (16.971×0.4663) or 7.9 inches.

Side D equals the side opposite angle a times the tangent of the angle, or $16.971 \times 1 = 16.971$ inches. Then side C of the oblique triangle is $(16.971 - 7.9)$ or 9.07 inches.

Hypotenuse F equals the side adjacent times the secant of angle d, whence: $F = A \times$ secant 25 degrees, or $(16.971 \times 1.1034) = 18.626$ inches.



Figs. 6 and 7.—Oblique Triangle Problems

The only unknown term remaining in the triangle is the magnitude of angle C, and this may at once be determined by subtraction, and is found to be $180° - (45° + 20°)$, or 115 degrees.

The magnitude of angle f is not required, because it did not enter into the solution of the problem, neither is it a term of the oblique triangle. However, the magnitude of this angle is simply 180 degrees − angle C, or (180 degrees − 115 degrees) = 65 degrees.

Solution Where Two Sides and Angle Opposite One Side Are Known

Example.—Given an oblique triangle similar to Fig. 7, in which two of its sides are 18 inches and 13 inches long

* Continuation of article commenced in February issue of The Boiler Maker.

† Engineering department of the Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

respectively, and the angle opposite the shorter side is 30 degrees. (Note also that the given angle is adjacent to the longer side.)

First make a right triangle out of the oblique triangle as indicated by the dotted lines B and A. Sides A and B of the right triangle will now be found:

$\sin a = \frac{\text{side opposite}}{\text{hypotenuse}} = \frac{A}{E}$, or $0.5 = \frac{A}{18}$, whence $A = (18 \times 0.5)$, or 9 inches. (See also previous table of rules.)

$D = \sqrt{E^2 - A^2}$, or $\sqrt{(18 \times 18) - (9 \times 9)} = 15.588$ inches. (Can also be found by means of the rules previously given and as applied to the solution of example for Case 1.)

$B = \sqrt{F^2 - A^2}$, or $\sqrt{(13 \times 13) - (9 \times 9)} = 9.38$ inches. (Can also be found by means of the rules previously given and as applied to the solution of example for Case 1.)

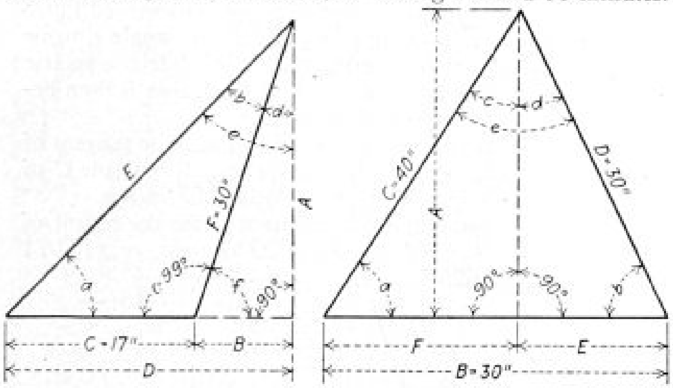
$C = (D - B)$, or $(15.58 - 9.38) = 6.20$ inches.

Angle d of the projected right triangle must now be determined, after which the two unknown terms of the oblique triangle can be readily found:

$\sin d = \frac{\text{side opposite}}{\text{hypotenuse}} = \frac{B}{13}$, or $\frac{9.38}{13} = 0.72154$ inch. (See also table of rules.)

From the table of the functions of angles we find this figure to correspond to an angle of 46 degrees and 10 minutes, which is the magnitude of angle d in Fig. 6.

Angle b of the oblique triangle is then evidently 60 degrees minus 46 degrees 10 minutes, or 13 degrees and 50 minutes.



Figs. 8 and 9.—Further Practical Examples of Oblique Triangle Solutions

Finally, since it was said that the sum of the angles of any triangle is equal to 180 degrees, then angle c must be 180 degrees — (90 degrees + 13 degrees 50 minutes) or 76 degrees 10 minutes.

A detailed solution of examples relating to cases 2 and 3 will not be necessary, as the two previous problems have covered practically all of the calculations involved in the solution of any oblique triangle. However, in order that nothing may be omitted, problems involving these two additional cases will be presented, together with detailed directions for carrying out the necessary calculations.

When Two Sides and the Included Angle Are Given

Example.—Given an oblique triangle similar to Fig. 8, in which the two shorter sides of the triangle are 17 inches and 30 inches respectively, and the magnitude of the included angle between these two sides is 99 degrees. Find the remaining three terms of the triangle.

Method of procedure for solution:

Angle $f = (180^\circ - c)$, or $(180^\circ - 99^\circ) = 81$ degrees.

Angle $d = 180^\circ - (90^\circ + f)$, or $180^\circ - (90^\circ + 81^\circ) = 9$ degrees.

Side $A = F \times \cos d$, or $30 \times 0.9877 = 29.631$ inches.

Side $B = F \times \sin d$, or $30 \times 0.1564 = 4.692$ inches.

Side $D = C + B$, or $17 + 4.692 = 21.692$ inches.

$\tan a = \frac{A}{D}$, or $\frac{29.631}{21.692} = 1.366$, which from the table of functions of angles is found to correspond to angle 53 degrees 47 minutes.

Angle $c = 180^\circ - (90^\circ + a)$, or $180^\circ - (90^\circ + 53^\circ\ 47') = 36$ degrees 13 minutes.

When Three Sides of a Triangle Are Known

Example.—Given an oblique triangle similar to Fig. 9, in which the three sides are 30 inches, 40 inches and 30 inches respectively, to find the three unknown angles.

Problems of this kind, where none of the angles are known, are not as easily solved as in the previous cases. Without going into any discussion of details, the following formula is presented, but suffice to say that this was derived through an analytical process. The notations in the formula refer to Fig. 9.

(5) $\sin \frac{a}{2} = \sqrt{\frac{(s-B) \times (s-C)}{B \times C}}$ (in which s equals one-half the sum of the three sides).

Substituting figures for letters, we have:

$\sin \frac{a}{2} = \sqrt{\frac{(50-30) \times (50-40)}{30 \times 40}}$, or the sine of one-half of angle $a = 0.40816$.

Referring to the table of trigonometric functions, we find this value to correspond to the sine of angle 24 degrees 5 minutes. But as this is only one-half of angle a, the required magnitude of that angle must evidently be twice that amount, or 48 degrees 10 minutes.

Having now determined one of the angles, the balance of the calculations are identical with the previous examples. In fact, the work is even more simple, since the problem now involves the solution of two distinct right triangles.

$A = C \times \sin a$, or $40 \times 0.7451 = 29.804$ inches.

$F = C \times \cos a$, or $40 \times 0.6670 = 26.68$ inches.

$E = (B - F)$, or (30 inches — 26.28 inches) $= 3.72$ inches.

Angle $c = 180$ degrees — (90 degrees + a), or 180 degrees — (90 degrees + 48 degrees 10 minutes) = 41 degrees 50 minutes.

$\sin d = \frac{A}{D}$, or $\frac{29.804}{30} = 0.99346$, which from the tables is sin 83 degrees 25 minutes.

Angle $e = 180$ degrees — $(a + b)$, or 180 degrees — (48 degrees 10 minutes + 83 degrees 25 minutes) = 48 degrees 25 minutes.

An example of each of the four different cases of oblique triangles has now been given, but the student should realize that there are at least two separate conditions for each case. For instance, in our example of Case 1, Fig. 6, the magnitude of two angles, a and b, were given, and also the length of side E. Now, it is evident that the conditions required by Case 1 would also be fulfilled if side F, together with angles a and c, had been given; likewise, side c, together with either angles a and b, a and c, or c and b. There are, in fact, nine possible variations for Case 1; but, nevertheless, the solution is the same for any condition regardless of the combinations.

Soon after taking over the patents and business of the Locomotive Feed Water Heater Company, the Locomotive Superheater Company, New York, changed its name to The Superheater Company.

Together with its production of superheaters for all manner of steam power generators, the organization has also become actively engaged in the intensive development of feed water heating equipment for locomotive and marine application. The Superheater Company wishes to renew its assurance of service to all companies with whom it has been able to co-operate in the past and also to offer the facilities of its organization to any company having problems in fuel conservation to solve.

A Fatal Boiler Explosion*

One of the most important duties of a fireman or engineer in a boiler plant is to keep the water in the boiler at the proper level; and it is particularly important to see that there is sufficient water in the boiler before starting up the fire after it has been banked for the night or over a holiday. Failure to take this precaution was probably the cause of the explosion which is here described, and as a result of which two men were killed and five others were injured. The explosion also caused damage to the surrounding property to an amount estimated at from $7,000 to $10,000.

The exploded boiler was of the horizontal return tubular type and was built in 1904. It was 72 inches in diameter and 16 feet long, and contained 80 tubes each 4 inches in diameter. The longitudinal seams were of the lap joint type, and a working steam pressure of 100 pounds per square inch was allowed on the boiler.

We are informed that the man in charge of the boiler arrived at the plant on the day of the explosion at about 5:30 A. M., and soon after this, aided by some other employees, he proceeded to start up the fire, which had been banked over night. When he had worked for about half an hour without being able to raise more than a few pounds pressure (as shown by the steam gage), the engineer, apparently for the first time, looked at the water gage glass and discovered that no water was visible. He then attempted to start the feed pump, but found difficulty in doing so on account of the low steam pressure. He therefore returned to the front of the boiler, intending to haul the fire. Just at this moment one of the factory employees, who was in the boiler room, called attention to the fact that the steam gage registered a pressure of 80 pounds, and almost immediately thereafter the boiler exploded. The setting was demolished and the walls of the room were badly damaged. The rear end of the boiler was moved about four feet to the right, and the front end about six feet in the same direction.

Seven men were in the boiler room when the explosion occurred. Two of them died from the injuries received, another was seriously hurt, and the remaining four men escaped with only slight injuries.

The master mechanic of the plant arrived on the scene about twenty minutes after the explosion, and he is said to have stated that at that time the boiler and the tubes were still red hot.

A subsequent examination of the wrecked boiler showed evidence of overheating in all the tubes and in that portion of the shell exposed to the fire. The soot was all burned off these parts, and the metal had the appearance characteristic of overheating. A rupture extended the entire length of the middle course, and the edges of the break were drawn down very thin. A second opening about four inches long was found near the large rupture, and for several feet from each end of this opening the metal was stretched almost to the breaking point.

This accident emphasizes several facts of importance in connection with the safe operation of steam boilers. First, it shows the need of observing the gage glass and testing the water level by trying the gage cocks before stirring up the fire. It also demonstrates the danger of starting the feed pump when the gage indicates that the water has fallen below the safe working level.

At such a time the natural impulse is to pump more water into the boiler as quickly as possible, but this practice is distinctly dangerous and should never be followed. The violent strains caused by the chilling action of cold water on the overheated metal, when added to the stresses already existing in consequence of the pressure in the boiler, are quite likely to cause something to give way. Hence the thing to do when low water is observed is to cool off the boiler gradually and with as little disturbance as possible.

Before starting up in the morning, make sure that the gage glass shows the water to be at the right height. Blow down the water column next, and see that the water promptly returns to its proper level when the blow cock on the column is closed again. Try the gage cocks also and see that the water level as indicated by them agrees with that shown in the glass.

If the water is low, do not introduce feed water, and if the feed pump (or injector) is running, stop it immediately. If the boiler is one of a battery, shut off the feed pipe running to it and close the stop valve in the steam pipe leading from the affected boiler to the steam main. As soon as these things have been done cover the fire with a thick layer of ashes. If ashes are not handy, or if there is but a small quantity of them available, shovel in fresh coal, taking care to cover the fire at every point, until the boiler is effectively screened from the hot fuel on the grates. It is far better to bury the fire in this way than to haul it out of the furnace, because a great deal of heat would be given off to the boiler before the hauling could be completed.

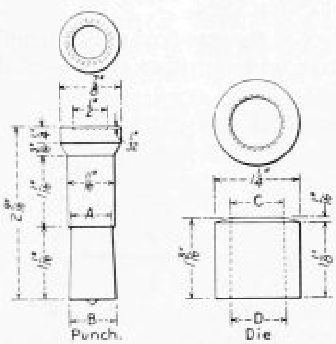
* From *The Travelers Standard*, Travelers Indemnity Company.

Power Punches and Dies*

The punch and die is one of the most abused tools in the shop. It has to work under all kinds of conditions. Sometimes it has lubrication and more times not, and seldom does the operator take pains to see that the punch is central with the die.

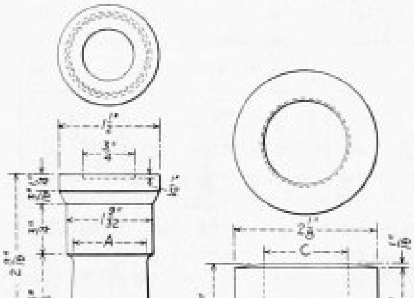
C. M. & St. P. Practice

Fig. 1 shows Chicago, Milwaukee & St. Paul standard punches and dies. The punches are made on automatic machines, the large ones at a labor cost on the machine of 4½



Size of Holes Punched	A	B	C	D
11/16" Diam.	5/8"	11/16"	3/4"	13/16"
9/16" Diam.	1/2"	9/16"	5/8"	11/16"
13/32" Diam.	3/8"	13/32"	7/16"	15/32"
11/32" Diam.	5/16"	11/32"	3/8"	13/32"
5/16" Diam.	9/32"	5/16"	11/32"	3/8"

Tool Steel



Size of Holes Punched	A	B	C	D
1 3/16" Diam.	1 1/8"	1 3/16"	1 1/4"	1 5/16"
1 1/8" Diam.	1 1/16"	1 1/8"	1 3/16"	1 1/4"
1 1/16" Diam.	1"	1 1/16"	1 1/8"	1 3/16"
1" Diam.	15/16"	1"	1 1/16"	1 1/8"
15/16" Diam.	7/8"	15/16"	1"	1 1/16"
7/8" Diam.	13/16"	7/8"	15/16"	1"
13/16" Diam.	3/4"	13/16"	7/8"	15/16"
3/4" Diam.	11/16"	3/4"	13/16"	7/8"
9/16" Diam.	1/2"	9/16"	5/8"	11/16"
13/32" Diam.	3/8"	13/32"	7/16"	1/2"
11/32" Diam.	5/16"	11/32"	3/8"	13/32"
5/16" Diam.	9/32"	5/16"	11/32"	3/8"

Tool Steel

Fig. 1.—Large and Small Shank Punches and Dies, C., M. & St. P.

cents each, and the small ones at 3½ cents each, and one cent each for tempering them.

Fig. 2 shows a punch and die for punching convex steel staybolt nuts. These nuts are used in the firebox on radial staybolts, and on crown sheets. The nuts are punched from boiler steel and tapped in a nut tapping machine. Some

* From a paper read before the American Railway Tool Foremen's Association.

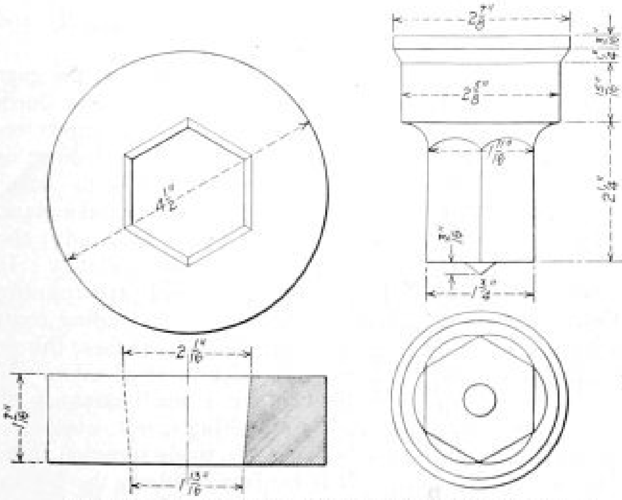


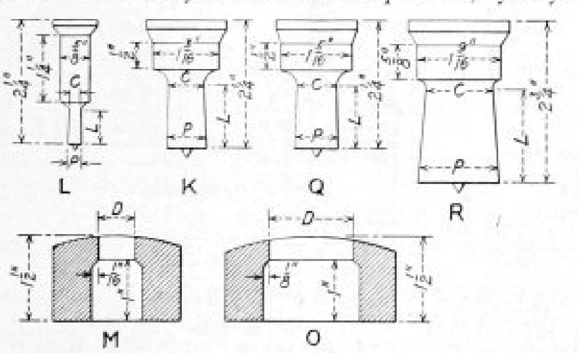
Fig. 2.—Punch and Die for Convex Steel Staybolt Nut

trouble has been experienced on these punches, the face of the punch pulling off in the stripping. This has been overcome by putting a double taper on the body of the punch; that is, giving it the regular clearance for half of the body and reversing the taper on the other half, so that the punch will act as a drift to open the top of the sheet where it has drawn in. This makes the sheet strip from the punch very easily. More damage is done to a punch in stripping than in punching.

The punches are made of 90 to 100-point carbon tool steel. The larger sizes, when in bad condition on the cutting end, are annealed and reclaimed to a smaller size.

A. T. & S. F. Practice

The sketches Fig. 3 show sizes of the standard punches and dies used. These may be ordered on requisition, by a symbol number from one central point—Topeka, Kan.—where a sufficient stock is kept on hand to meet the requirements of the different shops along the line. These tools are mostly bought from the manufacturers.



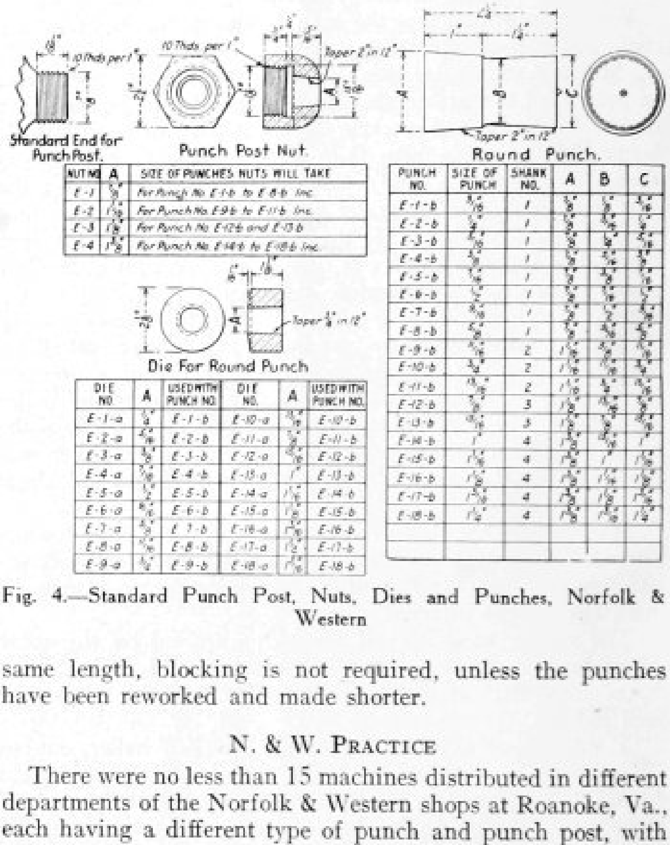
Punch				Die		Punch				Die	
Sym. No.	P	C	L	Sym. No.	D	Sym. No.	P	C	L	Sym. No.	D
L102	3/16"	5/32"	33/64"	M102	7/32"	K113	7/8"	27/32"	1 13/64"	M113	23/32"
L103	1/4"	7/32"	35/64"	M103	9/32"	K114	15/16"	29/32"	1 15/64"	M114	31/32"
L104	5/16"	9/32"	37/64"	M104	11/32"	K115	1"	31/32"	1 17/64"	M115	1 1/16"
L105	3/8"	11/32"	39/64"	M105	13/32"	K116	1 1/16"	1 1/32"	1 19/64"	M116	1 1/8"
L106	7/16"	13/32"	41/64"	M106	15/32"	K117	1 1/8"	1 3/32"	1 21/64"	M117	1 3/16"
L107	1/2"	15/32"	43/64"	M107	17/32"	K118	1 3/16"	1 5/32"	1 23/64"	M118	1 1/4"
L108	9/16"	17/32"	45/64"	M108	19/32"	Q119	1 1/4"	1 7/32"	1 41/64"	M119	1 5/16"
L109	5/8"	19/32"	47/64"	M109	21/32"	Q120	1 5/16"	1 9/32"	1 43/64"	M120	1 7/16"
K110	11/16"	21/32"	1 7/64"	M110	23/32"	R121	1 3/8"	1 11/32"	1 45/64"	O121	1 1/2"
K111	3/4"	23/32"	1 9/64"	M111	25/32"	R122	1 7/16"	1 13/32"	1 47/64"	O122	1 9/16"
K112	13/16"	25/32"	1 11/64"	M112	27/32"	R123	1 1/2"	1 15/32"	1 49/64"	O123	1 5/8"

Fig. 3.—Standard Punches and Dies—A. T. & S. F.

In establishing a standard, the size and shape of the body of the punches and the diameter of the die are the essential points to consider, as the length in a good many cases will depend on the nature of the work and the construction and style of the machine.

Four different sizes of punches and two of dies are shown, although in practice the larger sizes are not much used, as the average punching machine will not handle work large enough to require them.

For the ordinary boiler shop punch the coupling nut for the holder is made to fit the larger punch and a bushing or reducer is used to adapt the smaller, or symbol *L* punch, to the same coupling nut. As the punches and dies are of the same length, blocking is not required, unless the punches have been reworked and made shorter.



NUT No.	A	SIZE OF PUNCHES NUTS WILL TAKE
E-1	7/8"	For Punch No. E-1-b to E-8-b Inc.
E-2	1 1/16"	For Punch No. E-9-b to E-11-b Inc.
E-3	1 1/8"	For Punch No. E-12-b and E-13-b
E-4	1 3/8"	For Punch No. E-14-b to E-18-b Inc.

DIE NO.	A	USED WITH PUNCH NO.	DIE NO.	A	USED WITH PUNCH NO.
E-1-a	[illegible]	E-1-b	E-10-a	[illegible]	E-10-b
E-2-a	[illegible]	E-2-b	E-11-a	[illegible]	E-11-b
E-3-a	[illegible]	E-3-b	E-12-a	[illegible]	E-12-b
E-4-a	[illegible]	E-4-b	E-13-a	1"	E-13-b
E-5-a	[illegible]	E-5-b	E-14-a	[illegible]	E-14-b
E-6-a	[illegible]	E-6-b	E-15-a	[illegible]	E-15-b
E-7-a	[illegible]	E-7-b	E-16-a	[illegible]	E-16-b
E-8-a	[illegible]	E-8-b	E-17-a	[illegible]	E-17-b
E-9-a	[illegible]	E-9-b	E-18-a	[illegible]	E-18-b

PUNCH NO.	SIZE OF PUNCH	SHANK NO.	A	B	C
E-1-b	3/16"	1	[illegible]	[illegible]	[illegible]
E-2-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-3-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-4-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-5-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-6-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-7-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-8-b	[illegible]	1	[illegible]	[illegible]	[illegible]
E-9-b	[illegible]	2	[illegible]	[illegible]	[illegible]
E-10-b	[illegible]	2	[illegible]	[illegible]	[illegible]
E-11-b	[illegible]	2	[illegible]	[illegible]	[illegible]
E-12-b	[illegible]	3	[illegible]	[illegible]	[illegible]
E-13-b	[illegible]	3	[illegible]	[illegible]	[illegible]
E-14-b	1"	4	[illegible]	[illegible]	1"
E-15-b	1 1/16"	4	[illegible]	1"	[illegible]
E-16-b	[illegible]	4	[illegible]	[illegible]	[illegible]
E-17-b	[illegible]	4	[illegible]	[illegible]	[illegible]
E-18-b	1 1/4"	4	[illegible]	[illegible]	1 1/4"

Fig. 4.—Standard Punch Post, Nuts, Dies and Punches, Norfolk & Western

N. & W. Practice

There were no less than 15 machines distributed in different departments of the Norfolk & Western shops at Roanoke, Va., each having a different type of punch and punch post, with coupling nuts ranging from 1½ inches in diameter to 2¼ inches in diameter, with threads 10 to 14 per inch. Some held the punch in place with set screws, which often could neither be tightened nor loosened. An outfit for one machine was designed that could be standardized and all the machines have been fitted with the standard equipment.

All punch posts have threaded ends 1⅞ inches in diameter, 10 threads per inch. The standard punch is 2¼ inches long. Four sizes of coupling nuts are used:

No. 1 nut taking size 3/16 inch to 5/16 inch—⅞-inch stock.

No. 2 nut taking size 11/16 inch to 13/16 inch—1 1/16-inch stock.

No. 3 nut taking size ⅞ inch to 15/16 inch—1⅛-inch stock.

No. 4 nut taking size 1 inch to 1¼ inch—1⅜-inch stock.

The details of this equipment are shown in Fig. 4.

Discussion

The discussion was confined largely to the operation of punches rather than to the development of a standard type of punches, couplings and dies. Owing to the difficulty of getting satisfactory production in drilling flue holes in front tube sheets the St. Louis-San Francisco is experimenting with a spiral punch, sized to leave 1/16-inch stock in the hole to be finished by reaming. So far it has been found that this punch does not disturb the metal as much as had been expected. No other railroad represented at the convention has taken up this proposition. The Santa Fe practice is to punch a 1 5/16-inch hole and then run through a reamer or two-lip drill. At one time sixty of these holes were drilled an hour, but when the war broke out the schedule was cut to forty an hour and actual production now does not exceed twenty-five an hour.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, C. W. Obert, 29 West 39th Street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval.

Case No. 312 (reopened).—Is it necessary in the construction of small Star-type watertube boilers for steam heating which are to carry more than 15 pounds pressure at times to drill the inside and outside ends of staybolts? It is believed that it was the intent of the Committee to cover in this requirement the waterlegs at front and back ends which are considered as headers.

If the grate area is more than 15 square feet, the staybolts are less than 8 inches in length and the pressure exceeds 15 pounds, it will be necessary to drill the staybolts in order to comply with the Code requirements. It is the opinion of the Committee that the staybolts in the side sheets and that portion of the tube sheets below the tubes of boilers of this type need only be drilled on the outside ends as required in a boiler of the locomotive type, but that the staybolts in that portion of the tube sheets containing the tubes should be hollow or drilled at both ends as required for the waterlegs of watertube boilers.

Case No. 313.—Is it permissible under the requirements of paragraph 186 of the Boiler Code to join by autogenous or fusion welding the butting edges of flanged plates to form the waterlegs of detached smokeless fireboxes, where the stress due to the steam pressure is fully carried by staybolting?

The welded construction described is allowable under the rules of the Code provided the strength of the structure is sufficient to meet the Code Rules without making any allowance for the holding power of the weld.

Case No. 318.—Is it permissible under paragraph 331 of the Boiler Code to omit the stamping from completed shells of miniature boilers which are formed by a cupping or hot-drawing process in which the stamping is necessarily obliterated?

It is the opinion of the Committee that the intent of paragraph 331 would be met if a record of the heat numbers taken from the plates were checked with the mill test reports, and if found to meet the Code requirements, the inspector may authorize the manufacturer to proceed with cupping the plates, after which the manufacturer is to stamp the shell, in the presence of the inspector, with a lot number which will identify the sheet with the test sheet record.

Case No. 322.—What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety valve body, for safety valves to be operated at a pressure of 225 pounds? May cast iron be used for this purpose?

Under the requirement of paragraph 9 it is necessary that the Y-fitting be constructed of steel, but the safety valve body need not be of steel unless to operate with superheated steam (see paragraph 289).

Case No. 323.—Does paragraph 380 cover all classes of lap seam boilers, including boilers of the locomotive type, or does it apply solely to horizontal return tubular boilers? Is it the intent of the Boiler Code that the drums of watertube boilers over 36 inches in diameter and over 20 years of age come under the requirements of paragraph 380?

It was the intent of the Committee that the application of paragraph 380 should be limited to horizontal return tubular and similar types of firetube boilers, the shells of which are exposed to the fire or products of combustion. It was not intended that paragraph 380 should apply to the drums of watertube boilers, or boilers of the locomotive type.

Case No. 325.—Is it necessary in existing installations that, under the requirements of paragraph 315, the feedwater delivery pipe shall be carried through the shell of an horizontal return tubular boiler near the front end in all cases? With scale-forming water it is found that with the delivery pipes carried through the shell near the back end they could be easily removed for cleaning out scale, etc.

Attention is called to the fact that paragraph 315 appears in Part I, Section I, of the Boiler Code and therefore does not apply to existing installations.

Case No. 327.—Is it necessary under paragraph 430d that the fusible plug must be located in a tube not less than one-third the length of the tube above the lower tube sheet where such a boiler is fitted with an extra head and a water heating compartment at the top of the shell?

It is the opinion of the Committee that where a top compartment is utilized for preheating of feedwater, the measurement of the tube may be construed as applying to that portion of the tube between the firebox tube sheet and the point where the tube enters the top compartment.

Case No. 329.—What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

It is the opinion of the Committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in paragraph 88 of the Code.

Case No. 330.—Is it permissible to repair cracks in the tube sheets of watertube boilers by autogenous or fusion welding? In the recommendations in the Appendix it is stated that no welding shall be allowed in cracks in shell plates or other plates subject to tensile strain, yet it is stated that where tube sheets of boilers have deteriorated not to exceed 25 percent of their original thickness the same may be reinforced and repaired by any process of autogenous welding.

It is the opinion of the Committee that such process of reinforcing and repairing may only be used on tube sheets which are not subject to tensile strain, as permitted by the Appendix.

Robert N. Todd, formerly with the Bethlehem Steel Company, South Bethlehem, Pa., has been appointed New York district representative of cranes for the Pawling & Harnischfeger Company, succeeding S. I. Roth, who has been appointed district representative of the company's line of trench and drag line excavators, back fillers and excavating cranes Both Mr. Todd and Mr. Roth will continue in the office at 50 Church street.

Proceedings at Boiler Inspectors' Convention

Abstracts of Papers and General Discussions Outline Objects of the Board and Present Methods of Inspection

The most important work undertaken by the National Board of Boiler and Pressure Vessel Inspectors at the convention held in February was the adoption of the constitution by which the Board will be governed. The general proceedings of this organization meeting were not available at the time the February issue of THE BOILER MAKER was published, so that abstracts of papers and discussions not previously given are published in the following account.

The meeting was called to order by Chairman Joseph F. Scott, of New Jersey, who announced the purpose of the convention and introduced Police Commissioner Dr. James W. Inches, who welcomed the members of the Board to the city.

Purpose of the Formation of the National Board of Boiler Inspectors

BY JOSEPH F. SCOTT

We are all acquainted with the purpose of the Boiler Code Committee of the American Society of Mechanical Engineers, and how, in the last number of years, it has prepared the Code covering construction, installation and general maintenance of steam boilers of both high and low pressure.

This meeting has been called with two objects in view. First, that those of us who are charged with the safety of boilers may become better acquainted, and, secondly, for educational purposes.

After the Boiler Code of the American Society of Mechanical Engineers was made public it was very soon appreciated by a great many people, engineers in particular, that it was an excellent authority to govern the construction of steam boilers and that if generally adopted would give that uniformity of practice which is so desirable. However, as there are a great number of minor questions that are continually arising with which the Code Committee cannot and should not have to deal, and inasmuch as these questions very frequently arise in more than one of our jurisdictions, it is highly desirable that the same action be taken by all concerned so as to avoid embarrassment to the manufacturers, each of whom is likely to be a resident in the territory of some one of us and which affects the interests of the citizens in our respective jurisdictions.

The American Uniform Boiler Law Society

BY CHARLES E. GORTON

It is the duty of the Administrative Council of the American Uniform Boiler Law Society to go to the sister states, get in touch with those who are actively interested in a boiler standard and to help them in every way possible to establish the standard.

Our Society has not only tried to be of help to the states, but we have tried to be of help to the inspection departments of the states after they have adopted the Code. We have also tried to have the Society act as a clearing house. By that I mean there are manufacturers and users and engineers and all those who may be interested directly or indirectly in the Code. They have written to us for information and we have tried to furnish the information.

Dr. Jacobus has spoken of the Conference Committee. The Conference Committee, at the time it was organized, seemed to fill a long-felt want, but as time went on we found that there was not the close connection that there should be between the states and cities that have adopted the Code and the American Society of Mechanical Engineers through the Boiler Code Committee.

Having that in mind, the American Uniform Boiler Law Society was instrumental in calling a meeting of the heads of the state boiler inspection departments, by issuing an invitation to them to meet in New York City on December 2, 1919, at the time of the annual meeting of the American Society of Mechanical Engineers. Nine representatives responded to the call. At this meeting a constitution and by-laws was adopted, and the following officers elected for a term of two years: Mr. Scott, of New Jersey, chairman; Mr. Neil, of Pennsylvania, vice-chairman; Mr. Meyers, of Ohio, secretary-treasurer. Since that time the work has broadened out to such an extent that I think those who have had the management of the National Board in charge were wise in having issued a call for this convention.

This meeting is the result of that call, the object being to place the National Board on a firm foundation. The objects of the National Board are, first to promote and enforce uniform boiler laws and rules throughout the jurisdictions of its members; second, to secure uniform approval of specific designs of boilers and other pressure vessels as well as appurtenances and devices used in connection with their safe operation.

Third, to promote one universal code of boiler rules, and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for boiler inspectors who are to enforce the requirements of said code. I had the pleasure of seeing a boiler with twenty-two stamps. This had every state standard, wherever there is a boiler law, and if it was necessary to put on two more they would have had to build an extension on the boiler in order to hold the stamps.

Manufacturers should work heart and soul with the inspection department, and the inspection department should work heart and soul with the manufacturers.

That brings us down to one of the most important objects of the Board, namely, the uniform examination of inspectors. Some states have their own examinations, which is all right, so far as the inspections within the state are concerned; but the national examination fills a long-felt want. If a man inspecting boilers in a shop takes the National Board examination, a certificate is issued to him by the National Board which gives that man the right to make examinations or inspections in any state or municipality that has adopted the American Society of Mechanical Engineers' Code.

If we can have uniform examinations, uniform stamping of boilers, uniform passing of design, and the uniform administration of your inspection laws, it seems to me that we will have reached as near the ideal as it is possible to reach.

BOILER REGULATIONS IN CANADA

Following Mr. Gorton's paper, D. M. Medcalf, chief inspector of the Province of Ontario, outlined the requirements enforced in the construction of boilers throughout Canada in the following talk:

"Years ago we had a conference of chief boiler inspectors for the Dominion of Canada, in Winnipeg, when proposed uniform regulations were brought forward, and they have been practically adopted in British Columbia, Alberta, Saskatchewan, Manitoba and are almost approved in the Province of Ontario, and I believe will be approved in the Province of Nova Scotia very shortly, and also Quebec, where they will accept any boiler.

"But at this meeting in Winnipeg, if any of you gentlemen have noticed, in the proposed regulations you can see underneath every line the A. S. M. E. Code. It does not say it there, but it means the A. S. M. E. Code.

"We have arranged to accept the shop inspection made by any person employed by an insurance company authorized to inspect boilers in the United States, but that inspection must not be an individual inspection—it must go through the insurance company's office.

"We will also accept the inspection of any person employed by any state in the Union. That inspection would consist of examining the plate before any work is done, after the holes have been made before any riveting is commenced, and, of course, the final inspection, and the inspector sees that the boiler has been built according to the approved design and specifications. He then stamps the boiler with the manufacturer's name, the maker of the steel, the tensile strength, the Ontario record number, his initials and the date of inspection, and he fills out a report. When it is received we issue a certificate and there is no inspection after the boiler reaches its destination. That is the confidence we place in the inspection of the United States. The same thing applies to the inspection made in Ontario.

"All second-hand work must be inspected by one of our inspectors, the pressure fixed and the certificate issued.

"Our work also covers repairs. If a man wishes to repair a boiler he notifies the department and the chief inspector considers those repairs. That is a matter entirely up to the inspector. It is a difficult matter if a man has a bulge on a boiler, for we do not like that. I do not know how you are on patches over here, but we discourage the use of patches on return tubular boilers. They invariably come off.

"We go further than that in our work, where I think we are way ahead of the American Society of Mechanical Engineers. It is unlawful for a man to erect a high pressure steam line unless his specifications have been approved and given a registration number, and I hope that some day the American Society of Mechanical Engineers' Code will make some suggestions on that line."

C. W. Bissel, chairman of the Michigan Board of Boiler Rules, read a paper on the "Interchange of Opinions Between Boiler Boards," which appeared on page 60 of the February issue of The Boiler Maker. On page 41 of the same issue is given J. C. McCabe's paper on "Qualifications and Duties of Boiler Inspectors."

At the opening of the Wednesday afternoon session, E. R. Fish, of the Heine Safety Boiler Company, St. Louis, Mo., gave a talk on the:

Necessity for Standard Stamping of Boilers

BY E. R. FISH

The boiler manufacturers have been up against a pretty hard proposition. In our own line we do not make many boilers for stock, as we usually know just what state the boiler is to go into and to what rules it must be built, and so do not have such a very hard time of it. The manufacturers who make other types of boilers in quantities and who build for stock never know when they build a boiler just where it is going to land.

As Mr. Gorton said in his paper, boilers built in that way often have to be covered with stamps. A situation of this sort is impractical and is entirely unnecessary, but as a matter of fact, and it has been a fact, many manufacturers do not know just what to do and how to do it. That one item would seem to answer the subject of this little talk on the necessity of uniform inspection.

As regards the Code, of course I feel that that is the one logical basis of construction to be universally accepted. All our boilers are inspected whether or not they are to go into a Code state, to the Code requirements, so that they may have no fear but what the boiler will be accepted no matter where it goes. I think a great many manufacturers do the same thing. It is becoming more and more common for boiler makers to follow that procedure. Of course, such a practice will undoubtedly increase the cost of the boiler and make it necessary for more thorough work in the test, and if one keeps track of the plates and fittings it means more authoritative work than was necessary before, but in the end it undoubtedly pays because all work is safe from the first and according to the Code.

Now the use of the A. S. M. E. Code by public officials is, generally, one of the best things that could happen, rather than for a state to make up its own code. Here is one that is gotten up, formulated through discussion by a large number of men, men of different opinions, men from different walks of life, with various experiences. It seems to me to be so much broader and so much better than rules that are formulated in a restricted territory; the application is broad and one that can hardly be questioned.

It is a little hard to talk on the necessity for this because it seems so self-evident that there is not very much argument. The manufacturers in general, I believe, are all in favor of the Code, in favor of the adoption of the Code, and are willing to stand and work for it.

Co-operation in Inspection Work

S. F. Jeter's paper on "Necessity for Co-operation Between Insurance Companies and Boiler Inspection Departments" was given in the February issue, page 46.

Uniform Rules for Low Pressure Boilers

BY F. W. HERENDEEN

The low pressure boiler manufacturers have been together now as a National Association for six years. We have in our membership about 95 percent of all manufacturers of low pressure cast iron boilers and radiators, and we represent an output of perhaps 85 to 90 percent of the total tonnage.

We have been a firm believer in the American Society of Mechanical Engineers' Code. We believe that it is a constructive code of the highest order, and we have lent our influence to backing that Code and we have accepted that Code individually and collectively as the Code under which we will make our boilers. The Code Committee and the American Uniform Boiler Law Society have gone very far in helping uniformity of laws.

We believe that the low pressure cast iron boiler built in accordance with the Code should be free from state inspection and should not require licensed firemen to operate it. We believe that adequate safety devices should be put on boilers.

To that end we have subscribed a large sum of money for a number of years to the research bureau conducted under the auspices of the American Society of Heating and Ventilating Engineers because we believe that original research conducted now under the leadership of Professor Scipio and previously under the leadership of Doctor Allen, who unfortunately died last fall, is a direct movement for progress and for safety to the great heating industry.

Duties and Possibilities of the National Board of Boiler Inspectors

BY FRED R. LOW

If you had been asked six months ago to tell what the economic and industrial condition is to-day, or if you ask to-day what it is likely to be six months from now, you would only give a fairly more or less intelligent guess.

I do not suppose it would prevent a war or stay off a panic, but it does seem to me that a concise, circumstantial, correct and up-to-date census of the boiler powers of the country is an essential feature in an enumeration of the industrial resources of the country.

One of the incidental services which I see that your Association can render to the country with little effort and expense is the providing of such census, because any legislation ought to provide that every boiler under your jurisdiction should be reported to you, and all that you have to provide for is a uniform method of record and the bringing together of these uniform records in your secretary's office would enable your Board, when it becomes complete by the adoption of the inspection laws by all the states, to keep a complete census of the boilers of the country—their number, capacity and age and condition, and up to date.

Another opportunity that impresses me with regard to this Board is the chance that it will have for raising the status of boiler inspection and the boiler inspector.

I understand that you are going to take up the approval of specific designs and appliances, and there is, of course, a great service to be done in that line.

Another advantage, of course, is the bringing about of uniformity of treatment with regard to boilers in existing installations. In thirty odd years that I have been interested in trying to have boiler legislation adopted, most opposition has come from men who had their money invested in steam boilers and who expressed the opinion that they did not want any political man to come round and condemn their boilers and put unreasonable restrictions upon them.

If you can get over to those owners of boilers the conception of the boiler inspector in the light of a man full of special knowledge and training, you have the problem solved.

Those of us who are interested particularly in the Boiler Code welcome this movement as a means for its uniformity of enforcement. We have had the advantage in the Boiler Code Committee of the assistance of a number of state inspectors as members of the Conference Committee, and the Boiler Code Committee has profited very much by the part which they have taken in its deliberations.

To those members who habitually attend meetings, the Board will have less trouble in enforcing the Code than others less intimately acquainted with it, because they understand the considerations which have led to the adoption of its provisions which can be administered.

The Code has eventually to stand on its usefulness and applicability to the boiler manufacturers of the country, and you are the men who are doing the practising and doing the application. Of course there are a lot of things which have been spoken of which are more important, and these incidental things which I am suggesting are things which others would not talk about, such as uniform acceptability of inspection.

General Discussion

An outline of the discussions dealing with various problems experienced by members of the Board in pursuing their inspection duties is given below. The most advantageous method of reporting these statements is in giving a brief of each individuals' remarks, and this is the form which will be used.

Mr. R. L. Hemingway, Industrial Accident Commission, California.—California, as you know, has gone through a strenuous time in the last few months, mainly because users of boilers object to what we consider would be reasonable factors of safety for existing installations. They would much prefer to have old lap seam boilers operate on one fixed factor of safety through their usable life.

The lap seam boiler is subject to an inherent defect which, while it does not very frequently manifest itself, is at all times present. There is no getting away from the fact that from the day a lap seam boiler is put in service it begins to breathe, just as a human being does, and that breathing action reverts back to where it parts from the structure. If the lap seam boiler could be operated under a constant pressure it would be just as safe within its limits of percentage as is the butt strap boiler, but it cannot.

I personally hope that I can succeed in making my Commission see that the lap seam boiler is a menace; that while it is not to be legislated out of existence suddenly or with any great rush, it should be legislated out gradually, and where an opportunity to accelerate that elimination occurs in the second-hand boiler no effort should be spared to apply that extra speed to the elimination, especially where the second-hand boilers constitute less than one percent of all the boilers in the United States.

I believe the influence of this body is to be of material help in establishing uniform rules, so that the interchange of boilers between states will apply not only to new boilers but also to used ones.

Mr. W. P. Eales, Travelers Insurance Company.—We have always been ready to recognize and encourage uniformity in standardization. I make several hundred thousand reports a year under fifty-seven varieties of boiler laws, and you cannot begin to conceive what a problem it is. The American Society of Mechanical Engineers' Code looks like the solution of it. It works very well on boilers in Code states.

Second-hand boilers have gotten on our nerves. I think they are a nuisance, and have told our policyholders so, by having nothing to do with second-hand boilers. The purchaser of a second-hand boiler generally places the responsibility of that boiler on the insurance company—not only its safety, but durability.

Unless a man has had actual shop experience he is of doubtful competence to inspect boilers. I do not mean in the matter of driving rivets. I mean the fits. It is pretty hard to get a man that is a competent shop inspector for us to also be a competent inspector for the field.

I believe it would be a good thing to have two grades of certificates for boiler inspection—one for shop men and one for field men.

One of our men, who is now 37 or 40 years of age, has put in 15 years in a boiler shop. He was the superintendent in two shops and he has failed on four examinations on boiler construction. He said on the fourth examination he was asked what he knew of an indicator, and said he never saw one.

When it comes to examining inspectors, I think that it would do to examine men as shop inspectors and also as field inspectors. We consider the examinations of inspectors as a good thing, because it makes them better men.

In Pennsylvania we have always emphasized experience—experience as given in judgment—and practically disregarded a lot of the theoretical stuff.

Mr. H. G. Baumhart, member, Ohio Board of Boiler Rules.—I have been an inspector for a good many years. I am one of the original members of the Ohio Board of Boiler Rules, and I think Ohio was one of the first of the twenty-three states in the Union to adopt the Code.

We have examined a good many candidates in Ohio. We use the written examination and also make use of the oral examination. I have taken the Massachusetts examination and therefore I am familiar with it, and I believe from my experience in the line of examining applicants or candidates that neither the oral nor the written is sufficient. I think we ought to have some of each.

We issue certificates in Ohio to many applicants who never intend to inspect boilers, who came there to see if they could pass the examination. Now there are others who have received certificates of competency who will never make good inspectors because they have not the adaptability.

I believe, too, it would be a good plan if we could have two classes of certificates, and yet the subject never occurred to me until today—until it was brought up. I will admit that I know of many inspectors who are in the field doing good service—making better inspections than if they were brought into the shop unexpectedly to pass on an A. S. M. E. Code boiler.

Then I think, too, that there has been some unnecessary criticism made by the field men on Code laws. Now we all know that rivets in a butt joint are subject to shearing stress.

If the head of a rivet happens to be pushed over an eighth of an inch it will not be held up in the shop. Yet it looks like a blemish, and an inspector in the field finding it has something to criticize. Oftentimes criticisms are brought to the attention of the state authorities as unjust and unnecessary.

Mr. L. E. Connelly, member, Ohio Board of Boiler Rules.—I would like to see the members of this inspection department or of the different inspection departments offer suggestions to the chairman and discuss each one of these suggestions thoroughly before taking up any other suggestion.

Now I believe that these suggestions, to start with, should be subjects not to be taken up by the A. S. M. E. Boiler Code, and in listening to the different speakers here I have made notes of a few suggestions:

1. Providing some means for enforcing the Boiler Code.
2. Standard stampings.
3. Examination of applicants for competency. They should be examined orally and also have the written examination as to whether any credit should be given to an applicant for experience.
4. The next subject that I had in mind to bring up was the use of second-hand boilers that are not Code boilers, and interstate traffic of second-hand boilers that are not Code boilers.
5. The next question of whether or not general high pressure piping arrangements and engines should not come under the jurisdiction of this inspection department.
6. The sixth subject that I would like to offer in the general discussion would be parts of the A. S. M. E. Boiler Code that some members here might take exception to and see whether they can be ironed out and explained in order that such objections could be removed.

Our greatest opposition. I think, you will find throughout the country is the various interpretations and the different regulations that each state and city try to put into effect.

It should be the duty of the National Board of Boiler and Pressure Vessel Inspectors, by all means, to adopt a programme of simplicity, which means efficiency. They should have a constructive programme and do away with the destructive and uneconomic conditions prevailing throughout the United States in the enforcement of the inspection law.

Mr. C. O. Myers, chief inspector of the state of Ohio, then outlined the organization and work of the boiler inspection department of that state. An article covering this subject was published on page 33 of the February issue of The Boiler Maker.

Mr. W. E. Murray, Seattle, Wash.: We used to have at one time a proviso whereby any boiler inspected by an insurance company was absolutely exempt from our jurisdiction.

This regulation proved disastrous, so we had our ordinance changed so that the insurance inspector became a deputy from the office and had all the rights and privileges of any other deputy, with the exception that his reports must be filed under an affidavit. Inspectors were warned that the first time they were caught making affidavits to any report which was not thoroughly reliable in every way they would be barred from making inspections in the city of Seattle.

Our inspectors and insurance inspectors have absolute police authority. They make arrests and prosecute without any delay whatsoever, and I believe that all inspectors should be given that authority.

Appointment of Committees

Various committees for handling the work of the Board were appointed, after which the discussion was continued.

Mr. L. E. Connelly, member, Ohio Board of Boiler Rules.

Before a boiler is put into service in Ohio, the owner of that boiler must secure a state certificate, and when he secures that state certificate, that particular boiler is stamped with a state serial number. That gives him authority to use that boiler. We have now in the state of Ohio some 38,000 boilers that are handled by the department. The certificate that is issued by the state permitting the owner to use a boiler goes for a period of one year. At the end of that year it is necessary for him to get another certificate, and by means of a card system at the department in Columbus a record of the boiler is maintained. Once a year it is compulsory that a new certificate be issued, and at the same time an inspection must be made.

Mr. G. A. O'Rourke, chief engineer, Department of Labor, New York: In regard to stamping of boilers, as the chief of the inspection department of New York, that subject has come before me many times and my method in administering the whole law has been, at all times, to bear in mind the law so as to assist business interests in every possible manner and it is to be twisted, if necessary, so that it will never interfere with them.

There are many manufacturers who do not know at the time of manufacture where their boilers are going. I have told them immediately after due consideration that if they are going to build them all strictly A. S. M. E. standard I do not care if the New York State Standard is on it. If they have an A. S. M. E. stamp and have a data sheet of that boiler prepared by the inspector holding a certificate of competency recognized by the state of New York, whether he was in New York, Ohio, Pennsylvania or any other state which operates under the A. S. M. E. Code, it will be perfectly satisfactory to me.

I then ask them if they will be able to furnish me with a data sheet to prove that the boiler was built to the A. S. M. E. Standard. If they are able to furnish me with such a data sheet signed by the inspector, I promise to take care of the New York State Standard. As soon as the data sheet is forwarded to me and shows that the boiler is A. S. M. E. Standard, I simply notify my inspector to go there and mark it N. Y. S. Standard, because I know, and I have a data sheet proving, that it is A. S. M. E. Standard. As to the time it was built, that makes no difference.

Mr. H. A. Baumhart, member, Ohio Board of Boiler Rules. While our laws state specifically that a boiler has to be stamped Ohio Standard by the inspector and the builder's facsimile, I do not think we would have any trouble in changing that in our Legislature to conform with A. S. M. E. requirements. I do not see why the A. S. M. E. symbol and the builder's facsimile and his serial number would not be sufficient on any boiler, and when he sells that boiler let the data sheet follow the boiler. Let the man who has the boiler produce that data sheet to the inspector who makes the inspection, let him check the data with the stamping on the boiler—with the A. S. M. E. or National Board symbol, or whatever it happens to be—and the only thing then to be determined is whether the inspector who made the inspection is qualified by the uniform examination of the Board to make the inspection.

The general discussion was continued by the members through the remainder of the afternoon and evening sessions.

Thursday the Boiler Code Committee of the A. S. M. E. held the regular meeting for discussing matters pertaining to the Code. Members of the National Board took part in the deliberations.

Friday the permanent organization of the Board was completed and the constitution and by-laws accepted.

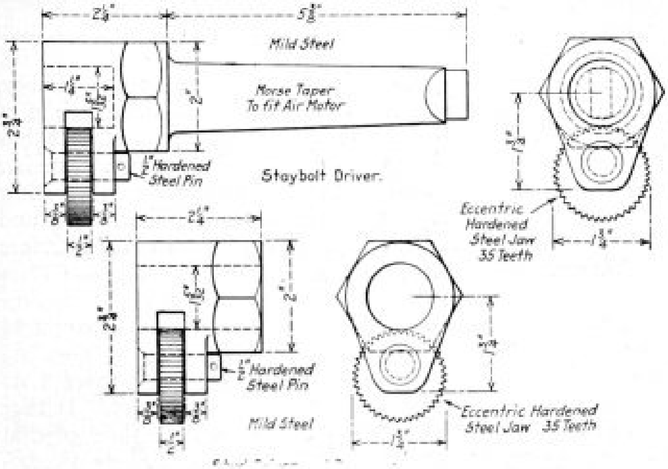
Officers Elected

Joseph F. Scott, of New Jersey, was continued as chairman and C. O. Myers, of Ohio, as secretary-treasurer. R. L. Hemingway, of California, was elected vice-chairman in place of James Neil, who has left the inspection service for the Bureau of Mines, and William E. Murray, of Seattle, Wash., to the newly created office of statistician. Charles E. Gorton, chairman of the American Uniform Boiler Law Society, and F. R. Low, editor of *Power*, were elected honorary members.

Staybolt and Stud Driver and Remover

BY F. OSBOURNE

It is the practice in some railroad shops to square the ends of staybolts for the purpose of driving with a box wrench or chuck driven by an air motor. This means that staybolts



Tools for Driving Studs and Staybolts Without Squared Ends

have to be squared in a forging machine or by some other method. The use of the devices illustrated eliminates the need for squared ends, thus saving a considerable amount of time and labor. The staybolt driver will drive 1-inch, 1 1/16-inch and 1⅛-inch staybolts. If a bolt does not fit properly it can be taken out with this driver by moving the eccentric steel jaw to grip the bolt, then reversing the motor.

Part of the staybolt driver is made hexagonal to fit a wrench and the other part is made a standard Morse taper to suit an air motor spindle. To use a stud driver or remover, the device is made up without a Morse taper shank and has a hole bored through the driver. This will allow the eccentric jaw to grip any part of the stud and a wrench may be used. The stud driver shown will drive in or will remove old studs ¾ inch, ⅞ inch, 1 inch and 1⅛ inches in diameter.

Eliminating the Smoke Nuisance and Conserving Fuel

Two billions can be added to the nation's wealth and the smokeless city achieved if coal waste, called mediaeval and inexcusable, is checked by municipalities, according to a statement of the Committee on Information and Service of the American Society of Mechanical Engineers' Fuel Section.

Advance of engineering science and high prices of domestic and industrial coal and gas challenge the municipalities to put a stop to this mediaeval way of using raw coal. Bituminous coal even of poor grades can be distilled at low temperature and yield fertilizer and ammonia, benzol, a superior substitute for gasoline, tar, a basis of most of our dyes, medicines, chemicals and perfumes and surplus of gas.

After these commodities are extracted, 1,400 pounds of smokeless, dustless, odorless and tough artificial anthracite are left out of every short ton of raw coal.

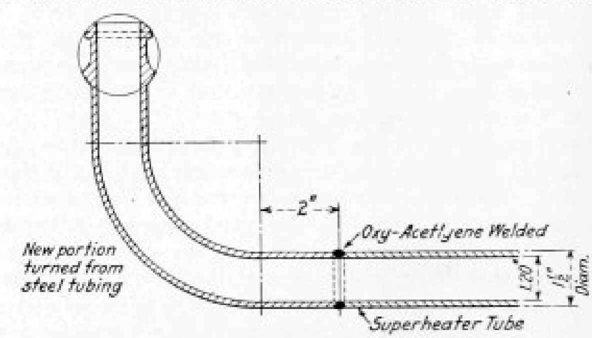
If the 400 million tons of coal annually burned in this country is so treated, the following products will be obtained: 1,200,000,000,000 cubic feet of fuel gas; 4,000,000 tons of ammonia sulphate; 1,000,000,000 gallons of crude benzol; 3,600,000,000 gallons of tar, and 288,000,000 tons of artificial anthracite. The use value of all these commodities will be nearly four billion dollars instead of two billions' worth of raw coal. Thus about two billion dollars could be added to our national wealth in the form of wages and profits.

Private concerns are slow to realize all these advantages because of the need of large investments and new franchises. Municipalities, by underwriting such integrated multiple-production plants, can serve the urban and suburban population with enormous economy by offering smokeless coal for domestic and industrial purposes; gas pre-eminently suitable for cooking, heating and lighting under mantles; tar for road surfacing, waterproofing, roofing, etc., and for chemical industries; benzol for automobiles and trucks; fertilizer for nearby farms, and ammonia for ice plants, cleaning, hospitals, etc.

The smokeless city will thus be achieved. At the same time large sums now spent for smoke abatement will be saved, as well as gas, oil and gasoline, and the price of coal and gas can be materially cheapened. District heating, electric service, power for trolleys and buses can be similarly included in this comprehensive plan of organizing cities to conserve our foundation of wealth—fuel.

Repairing Superheater Units*

Superheater units become worn at the front end between the bends and the ball joints. After considerable study and trial it was found that the best method of repair is first to determine if unit is worn through to cause a failure, or so that they will not last until another shopping. If they pass this inspection, then apply a hydrostatic test of cold water up to 400 pounds. While under this pressure the inspector should hammer test parts which show corrosion, especially around the return bend. If the return bends leak and are worn too



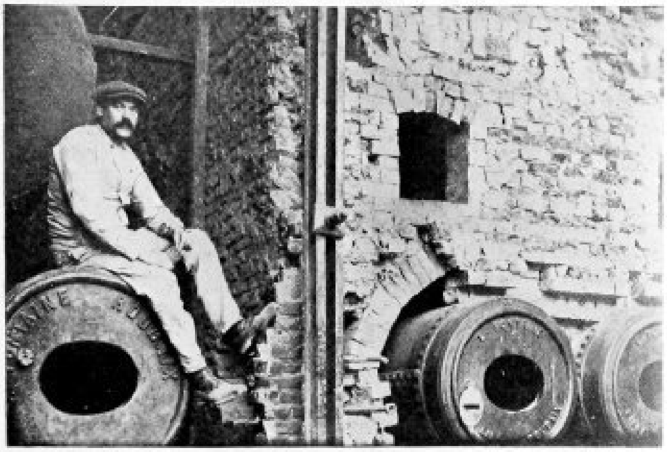
Method of Renewing Ends for Superheater Units—A. T. & S. F.

badly they can be repaired by acetylene welding. If worn, there are two ways to repair them economically.

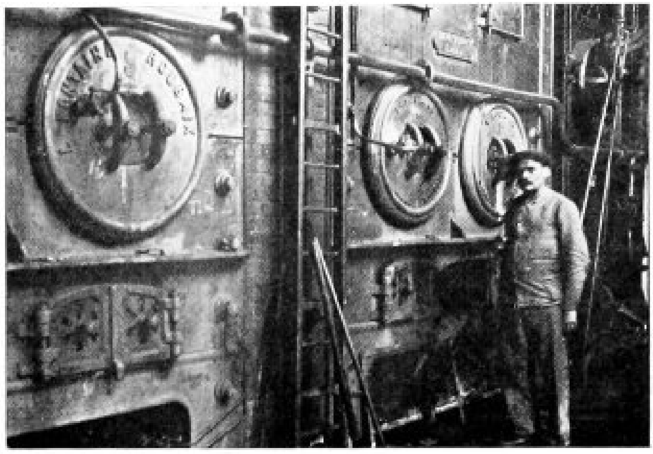
On the old style units the tubes can be cut off with acetylene next to the bend, rethreaded and new bends applied. The new units should be cut off at the return bend with acetylene on an angle of 45 degrees, and then by the aid of two air cylinders, with the jaws facing each other, press the ends of the unit, heated to a cherry red, together to form a bend. Then weld the tubes together, using plenty of material to reinforce them on the flat surface and on the end of the bend. After this is done, again apply 400 pounds hydrostatic pressure and hammer test.

To repair the ball joint ends of units they should be cut off back of the bend, say five to eight inches, with acetylene gas and then belled out to half the thickness of the tube, back 1⅝ inches. To make the new ends, the balls are forged on each end of a piece of tubing. This is done in two operations of the forging machine. After being forged the ball joint is turned on a turret lathe and the tube is cut to whatever length is desired, the end being turned to fit the ball end of the tube. These new ends can be made 50 or 100 at a time, machined, ready to apply, and can be distributed to roundhouses or other than main shops, which will save considerable time in getting power into service. After the new end is ready it can be welded by acetylene in a few minutes. The 400-pound hydrostatic pressure should then be applied to

* Paper read at the September meeting of the General Foremen's Association, at Chicago, by W. L. Jury, chairman of special investigating committee.



Boiler Plant in Lace Mill, Avesnes, France, as it Was Before Reconstruction Period



The Same Boiler Plant Shortly After the Mill Had Been Rebuilt and in Operation

test the unit. After unit is tested, band should be applied and spot welded on each side by the electric or acetylene process to keep the band from slipping. This need not be over 3/8 inch in diameter and 1/8 inch high.

To get the best results in reapplying superheater units to header, the ball joints should be thoroughly cleaned and polished with emery cloth. The joint should then be tried with a standard gage, and if found to be out, should be ground with a mixture of oil and cut steel, using a soft metal grinding form and a small air motor. If joints are badly damaged they should be trued up with a milling cutter and then ground with oil and cut steel. The joints on the header casting should be thoroughly inspected, and if found to need machining a milling tool opposite to the one used on ball joint should be used and then ground with oil and cut steel, using a form the same shape as the milling tool. Slots in the superheater header should be carefully inspected to see that they are free from sand or scale and have a square surface, and that the bolt heads are square, so that there will be no chance of the bolts slipping. Threads on the bolts should be carefully examined, and if found to be elongated they should not be used. Steel bolts with strength of not less than 74,000 pounds should be used. After superheaters are applied they should be pumped to the steam pressure of the boiler and thoroughly inspected to see that all joints are tight.

Methods Employed on the "Big Four"

Two plants are used for the repairing of superheater units. The plant in the machine shop consists of a reservoir 30 inches by 36 inches which contains two-thirds water and one-third air when charged for service. There is a hydrostatic pump and gage in connection with this reservoir and a sealing cylinder used for sealing the ends of units when testing. A three-way valve having seven ports is specially designed to complete the entire operation of testing by three movements or positions. These positions of the valve admit air to the unit from the main reservoir to charge and seal the unit; this is the first step taken in this operation. The next is lap position, which is also the exhaust position, and the other position is known as water position.

The sealing cylinder is specially designed to seal both ends of the unit and form an unrestricted communication between the main reservoir and atmosphere at the lower end of the operating valve. It is provided with a "T" head piston, hollowed out to slip over each unit, coming in contact with the back of the unit head, bringing it against the rubber insertion in the bottom head of the cylinder. The operation is as follows:

Air is admitted to the unit by placing operating valve in "air" position, the air passing from the main air supply through the operating valve, the unit and into the main reservoir. As the air passes through the sealing cylinder the piston is raised by air pressure and seals the unit to the cylinder. Pressure is allowed to accumulate in the main reservoir and unit. The operating valve is then placed in the water position and the exhaust valve under the operating valve opened, allowing air from the unit to escape to the atmosphere. The air pressure in the main reservoir forces water into the unit when the air is released. When water shows at the exhaust port it is then closed and the hydrostatic pump applies 350 pounds pressure. To release the water from the unit, the operating valve is placed in the air position, the valve on the main reservoir is opened to allow the pressure to escape and air from the line drives the water back into the main reservoir, leaving the unit free from water. Air from main line is then closed, the exhaust valve opened and unit unsealed.

For repair of units which are bent, at the opposite end of this unit table are two air cylinders placed vertically, one placed over the other, but having separate pistons. The upper cylinder is provided with a continuous piston, traveling through both heads, and is used as a ram to give the bottom cylinder a blow when the air pressure in the lower cylinder is insufficient to straighten the bend in the unit. The lower cylinder also has a double end piston that gives the upper cylinder contact outside of the cylinder. The lower cylinder is used as a squeeze to straighten all four lines of the unit pipes at one time, these lines being separated by sheet metal shims laid horizontally and vertically, adjusted near the point where the piston of the cylinder comes in contact with the unit, properly spacing the four lines of pipe.

If leaks develop under hydrostatic test, these leaks are thoroughly sand blasted, removing all carbon and scale, and the leak is repaired with the acetylene torch.

A portable testing outfit is provided that can be taken to places throughout the shop where units have been removed for testing and grinding only. On either of these plants the actual time taken for testing a unit is not over two minutes.

In the heavy repair plant, located in the boiler shop, there is a forging machine, with suitable dies for renewing the return bends, and a similar testing plant to the one mentioned above. There are also metal cutting saws for sawing off defective return bends, a sand blasting device for removing all foreign matter from the ends of the units, and a reaming device for reaming the ball ends of the units to the proper radius, preparing them for grinding.

From past experience it has not been profitable to use header bolts with a tensile strength less than 74,000 pounds. These bolts are tested for elongation by gaging the thread.

The first superheater equipment was applied in July, 1911, and it is impossible to give the average life of units, as the first ones applied are still in service. Units are not scrapped due to loss of weight. The use of micrometer calipers has indicated that the deterioration of the unit is very uniform, there being scarcely any variation between the front end and back end of unit. The most common failures are right at the end of unit where it comes in contact with cinders, and where it is subjected to the greatest temperature. When renewing return bends, only enough is cut off to renew the bend. It is not necessary to make any sacrifice in the length of tubing because of the deteriorated condition of that part of the unit.

The report was prepared by the following committee: W. L. Jury (A. T. & S. F.), chairman; J. E. Stone (Sou. Pac.), J. Martin (Big Four), E. P. McDonald (Sou. Pac.), and C. L. Walters (Gt. Nor.).

Discussion

There was considerable discussion of the methods of taking care of header joints. While much of this dealt with the ball and cone joint, it developed that a number of roads still use only the ball socket joint in the header. In the discussion on methods of grinding the ball and cone joints, a question was raised as to the necessity of grinding this type of joint, since it is evident that the ball has a line joint in the header. With the ball drawn up tight, this is bound to crease the joint, and a great deal of care in grinding seems unnecessary. It has actually been found unnecessary to grind the joints more than just to clean them up. On the Grand Trunk, where this practice has been followed, only two units have been found to leak out of 800 tested. This experience has confirmed the belief that it does not pay to test the units on the erecting floor, as the few leaks that develop on the hydrostatic tests can then be touched up without much trouble. Others considered the floor test desirable, however, for the sake of safety and to detect leaks in the back end of the units, which, should they develop under hydrostatic tests, might make necessary the removal of several units in order to get at the defective one.

Attention was also given to the application of the units in the superheater flues, some members considering improper application as the greatest source of leaky joints, and therefore that attention to the fit of the unit in the tube and to the location of the header, which must be properly lined up with respect to the tube sheet, is of greater importance than attention to the joint itself. Trouble has also been caused by the accumulation of corrosion on the surfaces of the slots in the header, the crushing of which causes the joints to loosen up and leak.

The Locomotive Repair Shop the Key to the Transportation Problem

One reason our railroads find it difficult to cope with the traffic requirements of the country is that they lack locomotives. During pre-war years, American railroads acquired approximately 3,000 new locomotives annually. In 1917 and 1918 the number acquired each year was less than 2,500, and in 1919 the three leading locomotive-building companies constructed less than 1,000 locomotives for the standard gage steam railroads in the United States. These companies supply at least 75 percent of all the locomotives used on such roads, and their figures indicate a shortage at the present time of more than 2,500 locomotives. The railroads acquired during 1920 about 1,800 new locomotives at a cost of more than $100,000,000, so that even this year there will be a shortage of new locomotives as compared with pre-war figures, and because of this shortage more service must be obtained from the locomotives now available.

There are several ways in which this can be accomplished, but the most important is that the locomotives now in use be kept in first-class condition through efficiently managed and well equipped repair shops. It is fully as important that the railroads appropriate some of their millions for new and up-to-date equipment for their repair shops as for new locomotives. If the latter are not kept in service with a minimum loss of time due to breakdowns the available motive power will not increase in proportion to the outlay.

A locomotive held in the repair shop longer than absolutely necessary because of lack of proper machine tool equipment represents a double loss—one on the investment, earning nothing, another on the shipments which may be held up in the plants waiting for the material. Evidently the repair shop is the key to the situation.

Meeting of American Boiler Manufacturers' Association

The second of the special meetings of the American Boiler Manufacturers' Association since the 1920 convention was held at the Hollenden Hotel, Cleveland, on Tuesday, February 22. The attendance included about sixty of the association members. The committee reports and discussions occupied the morning session. Important matters were brought out in the reports of the commercial committee covering the standardization of specifications for setting horizontal return tubular and watertube boilers, etc. Special attention was given to the report of Charles E. Gorton, chairman of the Uniform Boiler Law Society on the recent convention of the National Board of Boiler and Pressure Vessel Inspectors held in Detroit. The executive committee of the American Boiler Manufacturers' Association prepared a resolution commending the plans of the National Board for bringing about the simplification of stamping, registration and inspection of boilers and the standardization of requirements, examinations and certificates for inspectors and for promoting the uniform interpretations of the Boiler Code.

A. F. Lazarus, of the United States Chamber of Commerce, delivered an address on "Overhead Expense." This matter has always been one of very great interest to the manufacturers and is especially important now when readjustments are being made in every industry. John D. Strain, secretary of the American Plan Association of Cleveland, addressed the association upon the subject of "The Open Shop."

The policy of the association in the matter of purchasing current for the operation of the shops of member companies was discussed in connection with a communication from the Worcester Electric Light Company's power department. The sentiment prevailed that every power user in the interest of efficiency and out of justice to the ultimate user of his products should obtain the power for lighting his plant and operating his equipment from the most economical source possible. In a plant where a considerable amount of exhaust steam is necessary for heating and other purposes in various manufacturing processes, the individual power station can be operated successfully. In any case, where it is advisable to generate power in a plant, fuel consumption and operating labor should be cut down by the installation of a model power plant.

The policy of the association has always been to co-operate with the Boiler Code Committee of the American Society of Mechanical Engineers, and provisions were made at this meeting to work even more closely with the committee in the matter of interpretations and revisions of the Code, as well as to tolerances in its enforcement.

A vote of sympathy was extended to J. D. Duggers, of the Kewanee Boiler Company, on account of his recent physical disability, and votes of thanks were passed for the speakers.

The annual meeting will be held at Bedford Springs, Pa., June 20-22.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-Pres. and Treas.*

6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 341 The Arcade
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 5,500 copies were printed; that of these 5,500 copies, 4,319 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 88 were mailed to advertisers, 66 were mailed to employees and correspondents, and 1,011 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 15,700, an average of 5,233 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

GENERAL:
Quantity Production of Scotch Marine Boilers 63
Testing Welds in Steel Plates 69
Fundamental Principles of Trigonometry 71
Power Punches and Dies 73
A Fatal Boiler Explosion 73
Work of the A. S. M. E. Boiler Code Committee 75
Proceedings at Boiler Inspectors' Convention 76
The American Uniform Boiler Law Society 76
Necessity for Standard Stamping of Boilers 77
Uniform Rules for Low Pressure Boilers 77
Duties and Possibilities of the National Board of Boiler Inspectors 77
Staybolt and Stud Driver and Remover 80
Eliminating the Smoke Nuisance and Conserving Fuel 80
Repairing Superheater Units 80
The Locomotive Repair Shop the Key to the Transportation Problem. 82
Problem 82
Meeting of American Boiler Manufacturers 82
EDITORIAL COMMENT 83
ENGINEERING SPECIALTIES FOR BOILER MAKING 84
BUSINESS NOTES 85
QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Oval Pipe Layout 87
Scalene Cone Development 87
Boiler Repairs and Welding 88
Plate Calculations and Camber Layout for Slight Taper 88
Layout of Y Connection 89
BOOK REVIEW 89
LETTERS FROM PRACTICAL BOILER MAKERS:
Checking up Shop Orders 90
Requirements for Boiler Inspectors 90
Effect of Cold Air on Heated Locomotive Boiler 91
Don't Lengthen Your Wrenches 91
Lack of Standardization in Oxygen and Acetylene Hose Markings 91
A Reader's Comment on the Magazine 91
PERSONALS 92
ASSOCIATIONS 93
TRADE PUBLICATIONS 93
SELECTED BOILER PATENTS 94

Reports from the secretary's office of the Master Boiler Makers' Association indicate that practically every member of the Association has made arrangements to attend the convention to be held this year at the Planters Hotel, St. Louis, May 23-26.

Although the programme is not yet complete, it will include a very thorough review of oxy-acetylene and electric welding, as used in the railroad shops throughout the country. The committee appointed at the 1920 convention to investigate the practice of the most important railroad shops in this connection has gone into the matter exhaustively and the results brought out in the report, together with the discussions on the subject, will aid materially in determining the future status of autogenous welding. Another matter that will be discussed is the treatment of feed water.

The Supply Men's Association is making arrangements to have one of the most complete series of exhibits at the convention ever provided for the inspection of the members of the Association. This feature was badly missed last year, but the omission will be more than compensated by the display of equipment at this convention.

A recent report by E. D. Gardner of the Department of Commerce, Bureau of Mines, on high pressure compressed air line explosions suggests certain precautions in the maintenance of compressors, which may well be followed wherever air is used in high and low pressure service.

An explosive mixture of vaporized oil and air coming in contact with deposited carbon in the cylinder of a compressor where it is raised to the ignition point, is probably responsible for the majority of airline explosions. The proper adjustment of compressors is vitally important in keeping the temperature of the air in the line below the danger point. Leaky valves are dangerous in that air, having been compressed in the last stage cylinder and raised to a high temperature, might be drawn back through an improperly seated discharge valve and recompressed with the possibility of a further rise in temperature sufficient to vaporize the lubricating oil. An inefficient oil trap may become a source of danger by permitting an unusually large amount of oil to enter the pipe lines with the air.

To prevent explosions in air lines high grade lubricating oils should be used in compressors to eliminate carbon formations. In addition the compressor valves and intercooling system should be maintained in good order at all times. Care should be taken that only fresh air is drawn through the intake of the compressor.

The work of the A. S. M. E. Boiler Code Committee, and of the Uniform Boiler Law Society, in standardizing boiler construction requirements throughout the country, will be greatly facilitated by the support of the members of the National Board of Boiler Inspectors. In addition to promoting the work of the Code, other benefits to the industry will result as soon as the Board is functioning properly.

With the new order of inspection, boilers coming under the jurisdiction of members of the Board will be reported to the secretary's office and recorded. The next logical step is for a permanent record to be maintained as part of the routine of this office. Such a running report of the condition of power equipment in the country will prove invaluable in determining our industrial resources.

The standard stamping of boilers will, undoubtedly, be one of the first objects of the Board in order to eliminate the confusion attending the present system of stamping a boiler for every state in which it may be used. Under this arrangement, manufacturers will have the satisfaction of knowing that once accepted by the inspection department of a state enforcing the A. S. M. E. Code, a boiler will be equally acceptable wherever the jurisdiction of the Code extends.

One proposed function of the Board is the approval of specific boiler designs. When these have been passed on favorably by the members, such designs will become standard in Code states.

The attainment of these objects, and the standardization of requirements for boiler inspectors, will fully justify the formation of the National Board of Inspectors.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Details of New Semi-Automatic Spacing Table

The semi-automatic spacing table built by the Cleveland Punch & Shear Works Company, Cleveland, Ohio, embodies several new features. The machine is adaptable to either vertical open gap punches or multiple punches and can be used for plates, angles, beams, girders, channels or other structural shapes.

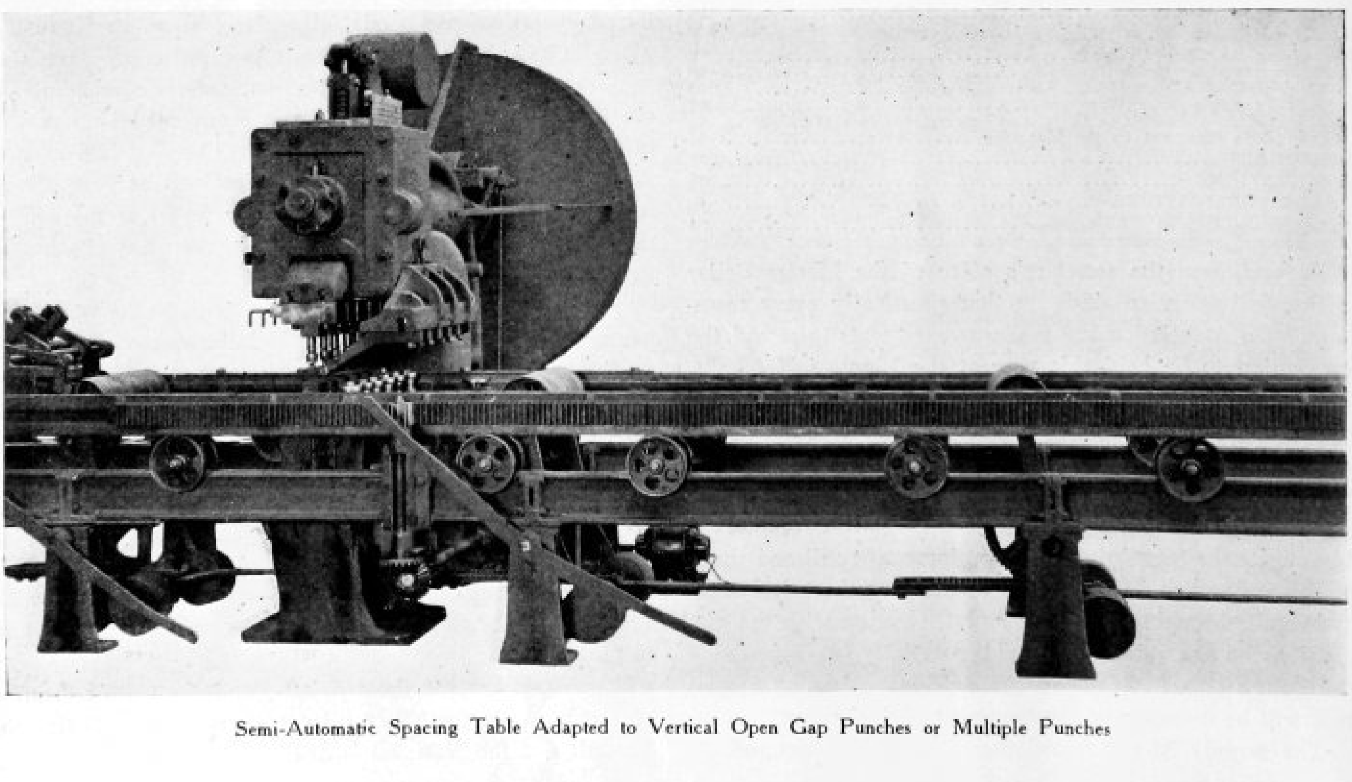
While the machine illustrated has a runway of 100 feet and a movable table to handle material up to 50 feet long, it can be furnished in lengths to suit requirements. Provision is made for adding additional units to the runway and table should it be necessary to do so at some future time.

The table moves on rollers of large diameter and is propelled by a rack and pinion on each side. An adjustable tie casting is provided for each end of the movable table, which is adjustable to take minimum and maximum length materials. The tie castings are fitted with improved clamps for gripping various styles and kinds of material. The clamps are so designed that punched material can be released and the table returned for loading. This permits of unloading and loading going on at the same time. The construction of the table is such that material may be fed through the machine from left to right or right to left as shop conditions permit. Strippers and gags may be placed on either side of the machine.

The rollers which support the material are counterbalanced by weights and have an adjustment of 24 inches from the top of the dies so that material ranging from plates to 24-inch beams can be handled. The rollers are raised and lowered through rack and gear segment by hand. The material supporting rollers may be so adjusted that all material will ride clear of the dies to eliminate friction. When the rollers have been set to the desired level they are securely locked in position by means of jaws located at the extreme end of the runway. The lever for locking and releasing this device is located close to the levers for raising and lowering the rollers. Provision is made to take up the clearance allowed between the dies and material when the punch is in operation. Springs located near the locking device act as a cushion when the punches force material down on the dies. This spring cushion also absorbs the shock when material is loaded onto the table.

Continuous rollers are provided at intervals for the convenient setting up of angles when being punched in multiple. When these plate-supporting rollers are in their topmost position for the punching of plates they extend above the movable table, so that plates wider than the table and equal to the throat depth of the machine may be punched. When this width of material is punched it is necessary to unload before the table can be run backward for a new load. Adjustable roller guides are provided just ahead of the die sockets so as to correctly gage angles as they pass under the punches.

The movable table is propelled by a motor through double friction clutches and is controlled by push buttons. For obtaining the correct pitch or spacing of holes a notched bar or adjustable stops may be used. In feeding the material through the machine a friction clutch lever is thrown forward. To start the material on its way, the operator releases the stop pin which starts the motor. He then allows the pin to ride along the edge of the notched bar until a notch is reached, at which point the stop pin shoots into the notch, pushing the top button, which brakes the circuit and dynamically brakes the material, bringing the table to a stop. If the notched bar has not quite reached the stop pin when the motor has come to rest, due to the varying load on the table, an additional push button is provided for "inching," which allows the operator to move the table fractionally as desired. When the



Semi-Automatic Spacing Table Adapted to Vertical Open Gap Punches or Multiple Punches material is finished, the friction clutch lever is reversed, and by pulling out the stop pin the table travels back at high speed.

The feeding speed has been figured at 10 feet per minute, and the quick return at 35 feet per minute.

Brush Attachment for Electric Grinder

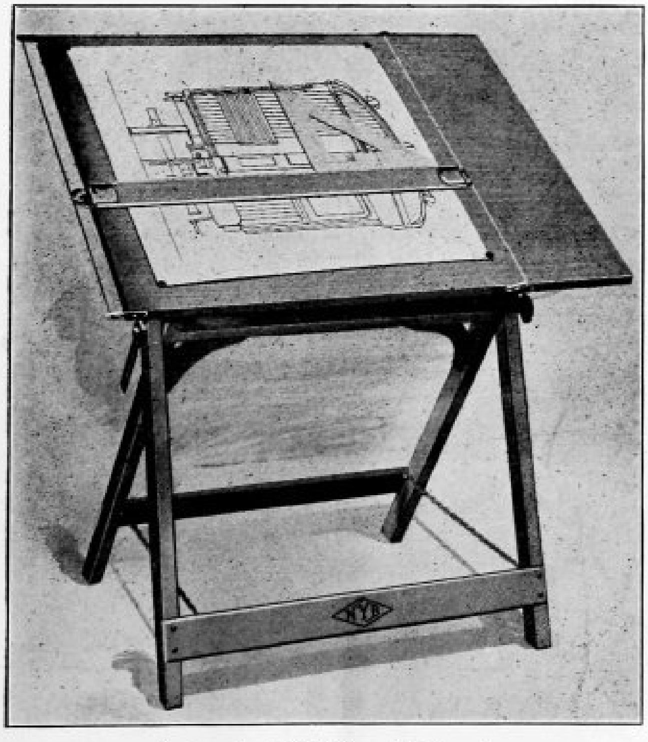
The Independent Pneumatic Tool Company, Chicago, Ill., has produced a special Thor Rotary wire brush for use on the No. 71 portable pneumatic grinder and No. 6 electric grinder. The brush attachment makes two tools in one, because the No. 71 grinder can be used with an emery wheel, and with very few changes the brush attachment can be added. The brush which is attached to the No. 6 electric grinder is smaller, because of a higher number of revolutions per minute, and requires a few attachments not necessary on the No. 71 pneumatic grinder.

The wires of the brush are all of equal length, interchangeable, and are made of specially treated steel. The concave wood back, which in turn is fitted inside a metal cover, secures the brushes in position, which also permits of tapered ends or working surface, allowing the wires to bend under pressure without breaking. The brushes are useful for removing paint, rust, scale, grit, dirt, sand, etc.

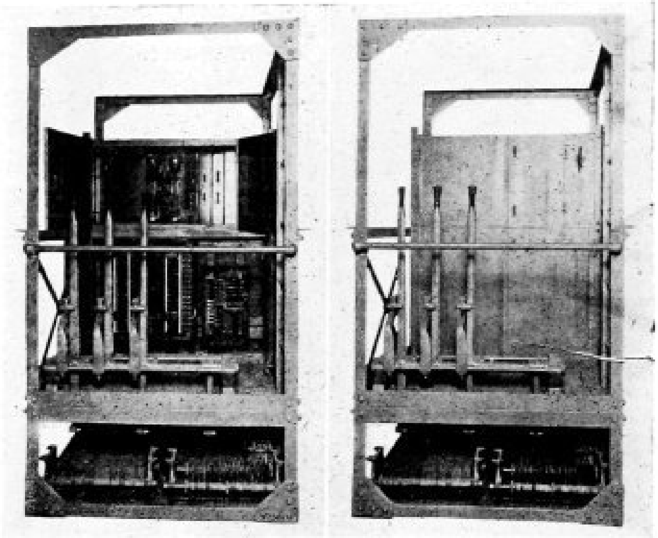
Parallel Ruling Attachment for Drawing Boards

The New York Blue Print Paper Company, 102 Reade Street, New York, manufacturers of drawing and tracing papers and drafting room equipment, has developed a parallel ruling attachment which may be applied to any drawing board, large or small, with the complete elimination of cords or wires on the surface of the board. Similar cords are also done away with on the under side of the board together with the metal parts which have been necessary to give the straight edge the required accuracy in producing parallel lines.

The Precise parallel attachment consists of a double pulley plate, a plate with two small pulleys which are fastened at either end of the straight edge and four metal brackets to which the cords are attached and a small grip to hold the cords firmly. The combined weight of the attachment parts is about two ounces.



Precise Parallel Ruling Attachment



Crane Cage With Panel Open, Showing Control Parts and Closed as Cage Appears in Operation

Controller and Crane Control Parts Inclosed in New Cab

A new type safety crane cage has been produced by the Pawling & Harnischfeger Company, Milwaukee, Wis. Exposed knife switches, magnetic control parts and resistors have been inclosed to eliminate danger to the operator. In previous Pawling & Harnischfeger crane cages a false bottom in the cab was provided for the resistors, but in the new cage, with front lever control, the entire controller equipment and crane carrying parts have been inclosed without interfering with the efficiency of the control. The levers, which operate radially (backward and forward) are placed at the front of the cage and allow the operator to have an unobstructed view of the floor and of the crane hook.

The main knife switch is operated from the exterior of the cabinet by means of handles shown on the top of the right-hand doors in the accompanying illustrations. When the hinge doors of the cabinet are opened, all parts are exposed for inspection and adjustment, while the wiring on the rear of the board is accessible by the removal of a steel panel. The new cage was given a year's trial on various cranes before its final standardization for Pawling & Harnischfeger cranes.

BUSINESS NOTES

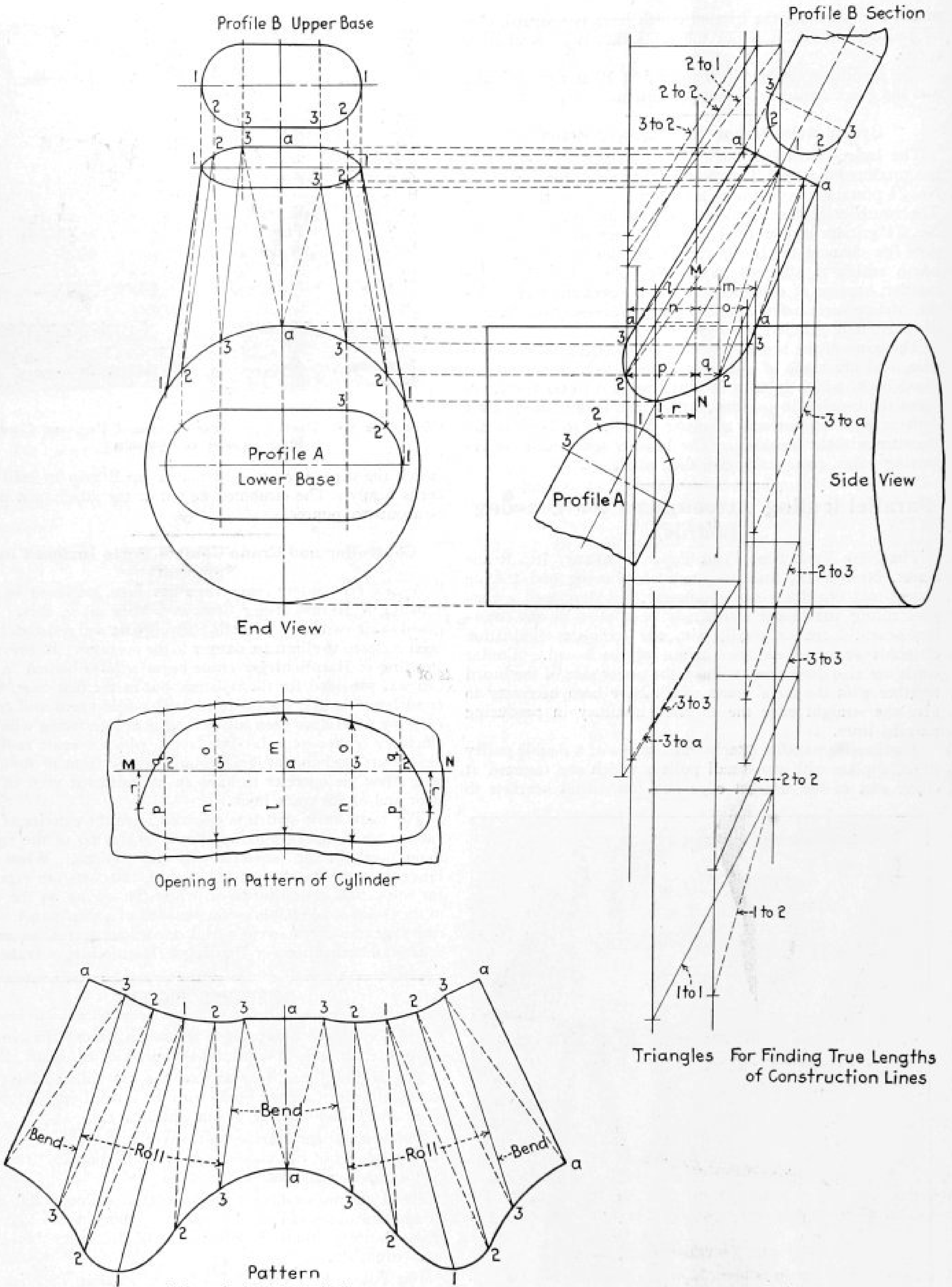
The Key Boiler Equipment Company has moved its general offices to 27th and McCausland avenue, East St. Louis, Ill.

The firm of John Mohr & Sons has consolidated the Chicago and South Chicago works with the general offices at 96th street and Calumet River, South Chicago.

The Connecticut Marine Boiler Works, Bridgeport, Conn., is now located at 62 Kossuth street. The company formerly was located at the foot of Pembroke street.

The Pittsburgh office of the Independent Pneumatic Tool Company was moved on February 26 from the old address, 1208 Farmers Bank building, to 718 Bessemer building, Pittsburgh, Pa.

The Vulcan Soot Cleaner Company, Du Bois, Pa., has announced the appointment of G. L. Simonds as vice-president in charge of Western sales, with headquarters at 828 Transportation building, Chicago, Ill., succeeding the Ernest E. Lee Company.



Elevations and Patterns of Oval Pipe Problem

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th Street, New York City.*

Oval Pipe Layout

Q.—Would you please show me how to make the drawings to get the connection points and also to lay out the pattern for an oval pipe to be placed on a 42-inch drum and having a pitch 6 inches per foot? W. F.

A.—Owing to the shape of this connection the triangulation method is used in laying off the pattern. Draw an end and side elevation, using the profiles of the upper and lower bases of the branch pipe and arrange them in the positions as shown. Both profiles are drawn at right angles to the axis of the branch pipe. The side view shows that the upper section of the pipe is cut off at right angles to its axis. The profile section for both top and bottom are of a wash boiler pattern. In the end view this upper section is foreshortened and its outline is established by projecting the points 1-2-3-*a* of the side view to intersect vertical lines drawn from the profile of the end view. Locate the profile of the lower base in the end view and divide its outline into a number of parts as shown. Project these points to intersect the circle which represents a view of the duct. The next step is to find the shape of the miter line side view. On the axis 1-1 of this view draw a section of the profile *A*. Extend projectors from the points 1-2-3 parallel with axis 1-1 to intersect the horizontal lines drawn from the points on the circle end view. Through the points 1-2-3 on the miter draw in the miter outline. Connect the points 1-1-2-2-3-3, etc., of the branch with solid lines and 1-2, 2-3, 3-*a* with dotted lines. Do this in both views.

TRIANGLE LAYOUT

The triangles are the means for getting the true lengths of the lines used in the pattern development. The respective heights for these triangles are taken from the side view and the bases from the end view. As all constructions for this work show the projection in the side view and in addition the numerical references, it is not necessary to describe the steps in drawing the triangles.

Before the pattern can be laid off it is required to show the true shape of the opening in the cylinder pattern for the intersection between cylinder and branch pipe. This view is developed to the left of the end view. Transfer the arc lengths of the circle, end view locating points 1-2-3-*a*, at right angles to *M-N*, and through these points draw the construction lines shown. Transfer the distances *l*, *m*, *n*, *o*, *p*, *q* and *r* from the side view, locating them in the pattern of the opening as indicated. The arc lengths in this view between the points on the curved outline are used in the pattern layout.

PATTERN DEVELOPMENT

In this case the seam is brought on the outer flat section of the branch. A vertical line *a-a* equal to *a-a* of the side view is drawn first. From *a* at the top lay off the width of the flat side, thus locating points 3-3. Set the dividers to the arc length between *l-n* of the opening and with *a* in the pattern draw arcs. With the trammels set to 3-3 of the triangles and with points 3 at the top of the pattern as centers draw arcs to cut the arcs drawn from point *a*. Continue in this manner, using the arc lengths of the upper base of the outline of the opening in the cylinder and the diagonals of the triangles. As all lines are numbered, which is advisable in work of this kind, no confusion should arise in following the steps in the layout. Only a small number of points and lines are used in this problem, but better results will be had by increasing them as the amount of error in arc and diagonal line lengths is reduced by doing so.

Scalene Cone Development

Q.—Kindly show me the best method of laying out the eccentric cone shown in Fig. 1. H. B.

A.—Lay off a plan and elevation. Divide the circle representing the base into any number of equal parts. Project the

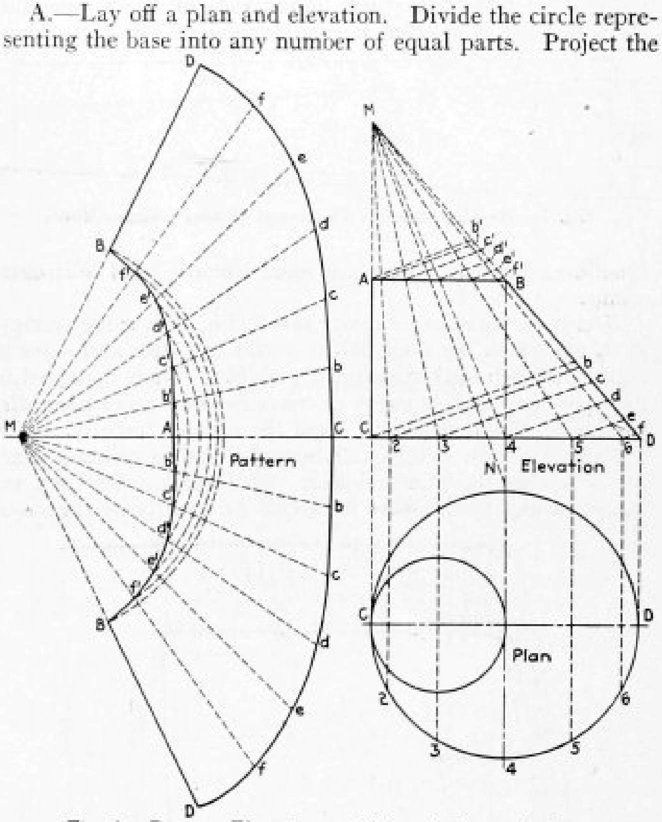


Fig. 1.—Pattern, Elevation and Plan of Eccentric Cone

points 2-3-4-5 and 6 to the base in the elevation and draw in the radial lines. At right angles to the centerline *M-N* draw lines 2-*b*, 3-*c*, 4-*d*, 5-*e* and 6-*f*. Do the same from the upper base, locating points *b'*, *c'*, *d'*, *e'*, etc. The radial lines *M-b*, *M-c*, *M-d*, etc., are used in the pattern layout, as these are all shown in their true length.

PATTERN DEVELOPMENT

Draw a centerline *M-A-C* equal to *M-C* of the elevation. Set the trammels to *M-b* of the elevation, and with point *M* of the pattern as a center draw an arc each side of the centerline. With point *c* of the pattern as a center and *C-2* of the plan as a radius draw an arc, thus locating point *b*. Continue in this way, using the radials M-c, M-d, M-e, M-f and M-D and the arc lengths of the plan until the lower base has been developed. Draw in the radial lines of the pattern. Transfer the radials M-A, M-b', M-c', etc., of the elevation, locating them on their respective lines in the pattern.

Boiler Repairs and Welding

Q.—I have a few questions I would like answered. The first is about a patch on a horizontal return tubular boiler, as shown in Fig. 1. I am a young boiler maker in the game, but never saw such a patch put on a boiler before. I asked an old boiler maker the reason and he said he did not know, only it was right. I have heard of putting on half-round patches and round ones, but never heard of one like this. If it is all right, why not make it 12 inches wide on both ends instead of 12 inches and 6 inches? Suppose, for instance, we wanted to weld the patch, could it be done? If it could, it would save quite a little labor, and if it cannot, what is the reason? Welding in a firebox in an upright boiler is allowed, so why should not the process be permitted here?

Fig. 2 shows a patch bolt on a locomotive boiler. How would you drill the mouthpiece to put in patch bolts? Would the outside one be much bigger than the inside, and how can you draw the plates up tight?

The next question is on tube welding. I have heard a lot of engineers discuss this question. When an old tube is cut off about 10 or 12 inches and a new length added on, I have been told to use at least one-third new tubes and two-thirds of the re-ended tubes in retubing an upright boiler.

Which is the best method of welding this kind of work—oxy-acetylene welding, electric welding or the furnace welding? F. B. P.

A.—In patching boilers it is the practice to make the patches so that the seams are diagonally across the boiler section. This is done for the reason that the joint is much stronger than when placed horizontally. The effective efficiency of a horizontal (longitudinal) seam is only one-half the efficiency of a circumferential seam of the same kind;

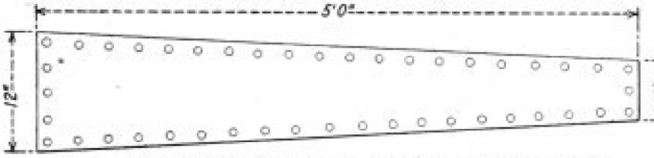


Fig. 1.—Repair Patch for Horizontal Return Tubular Boiler

therefore, diagonal seams are more efficient than horizontal seams.

You have not shown in your sketch Fig. 1 how the patch is to be placed on the shell, but it would be better and safer to make the patch oval in shape, if possible. There appeared in the Questions and Answers columns recently a complete discussion on boiler patches. Read the article carefully.

Patches can be welded satisfactorily, and in railroad practice it is often done on fireboxes. Such patches, however, are stayed so that the pressure is carried practically by the stays.

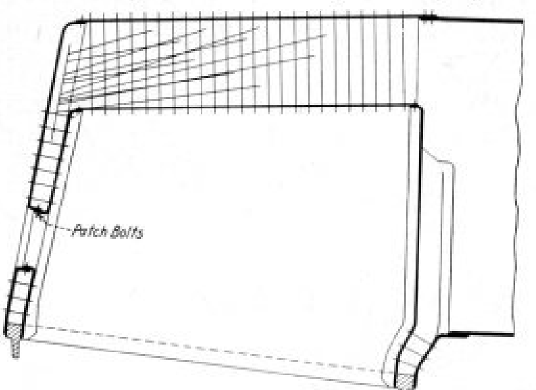


Fig. 2.—Method of Drilling Firedoor Laps for Patch Bolts

It would not be advisable in high pressure work to weld in patches without staying.

In using patch bolts, drill through the two overlapping plates. Tap the inner lap and countersink the outer lap. By screwing in the patch bolt, the threaded part draws the head of the bolt down into its countersunk seat, thus drawing the plates up tight.

Welding, whether by hand, as in blacksmithing, electric or gas methods, cannot produce joints of the same strength as the original metal. A good weld depends on the operator making it and the proper kind of materials. Re-ended tubes properly welded are safe to use again at the pressure applied on the boiler. The furnace method of re-ending tubes has proven practical and employed for years. The electric method is being used and has also proven satisfactory. Which is the better is a matter that will require time and use to decide.

Plate Calculations and Camber Layout for Slight Taper

Q.—Kindly answer the following questions: What is the best manner or best practice in locating the camber line on a cylindrical tank; also, is three times the thickness of iron accurate in allowing one ring to slip over another that is to make the connection between them? Please give me a quick and accurate method for laying out a dished still head. The still head is supposed to have a dish 6 inches at center of head. This head is 12 feet outside diameter and is to be made in two parts. Give me a method of laying out this head in one part; give me a quick and accurate method of laying out a ring to slip over another—say a stack ring. We will assume that the ring is 42¼ inches neutral diameter and 5 feet long ¼-inch plate, 11/16-inch holes, 2¾ inches diameter in seam and 2¼ inches on roundabout, 1¼-inch lap all around. W. J. K.

A.—There are several methods of laying off the camber line in the pattern for tapering objects. In light stack work where the sections are telescopic—that is, each section has a small and large end, no allowance need be made for the camber, as the ends can be drawn in sufficiently for riveting. But if heavy plate is used the camber must be laid off and the rivet holes marked on this line. For most practical purposes the method shown for Fig. 1 can be used. In this case three sections of *abcd* are laid off as shown in Fig. 2. Transfer the section *abcd* directly from Fig. 1, taken on the neutral layer of the plate. Through the points *a*, *b*, *ab* draw a curved line with the use of a batten or a pliable stick of good quality. Do the same at the large end and extend these curved lines beyond the points *a*-*c*-*b*-*d*. From the center line *x*-*y*, and with a traveling wheel, measure off the stretchout for the top and bottom.

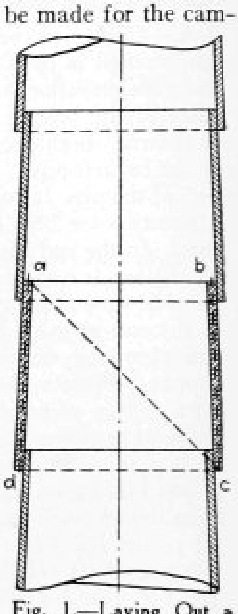


Fig. 1.—Laying Out a Stack Ring

Some layerouts work from the neutral layer of the plate in making calculations and developments for heavy plate work. Others in calculating for the stretchout of a ring that fits over another multiply the inside diameter by 3.1416 and add three times the plate thickness for take-up in rolling. Some

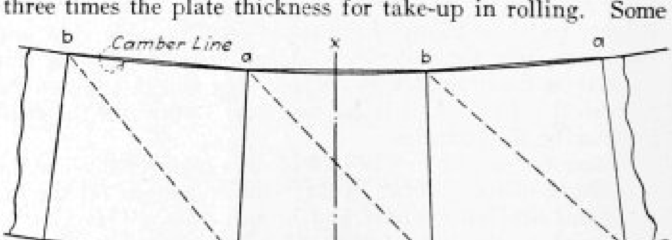


Fig. 2.—Pattern for Section of Stack

multiply the outside diameter by 3.1416 and take from the product three times the plate thickness for the stretch of the metal during the rolling operation.

We will apply these rules to a concrete case and note the results.

Consider a plate ½ inch in thickness rolled to an inside diameter of 40 inches. Find the required stretchout of the plate.

The neutral diameter taken to the center of the plate equals 40½ inches.

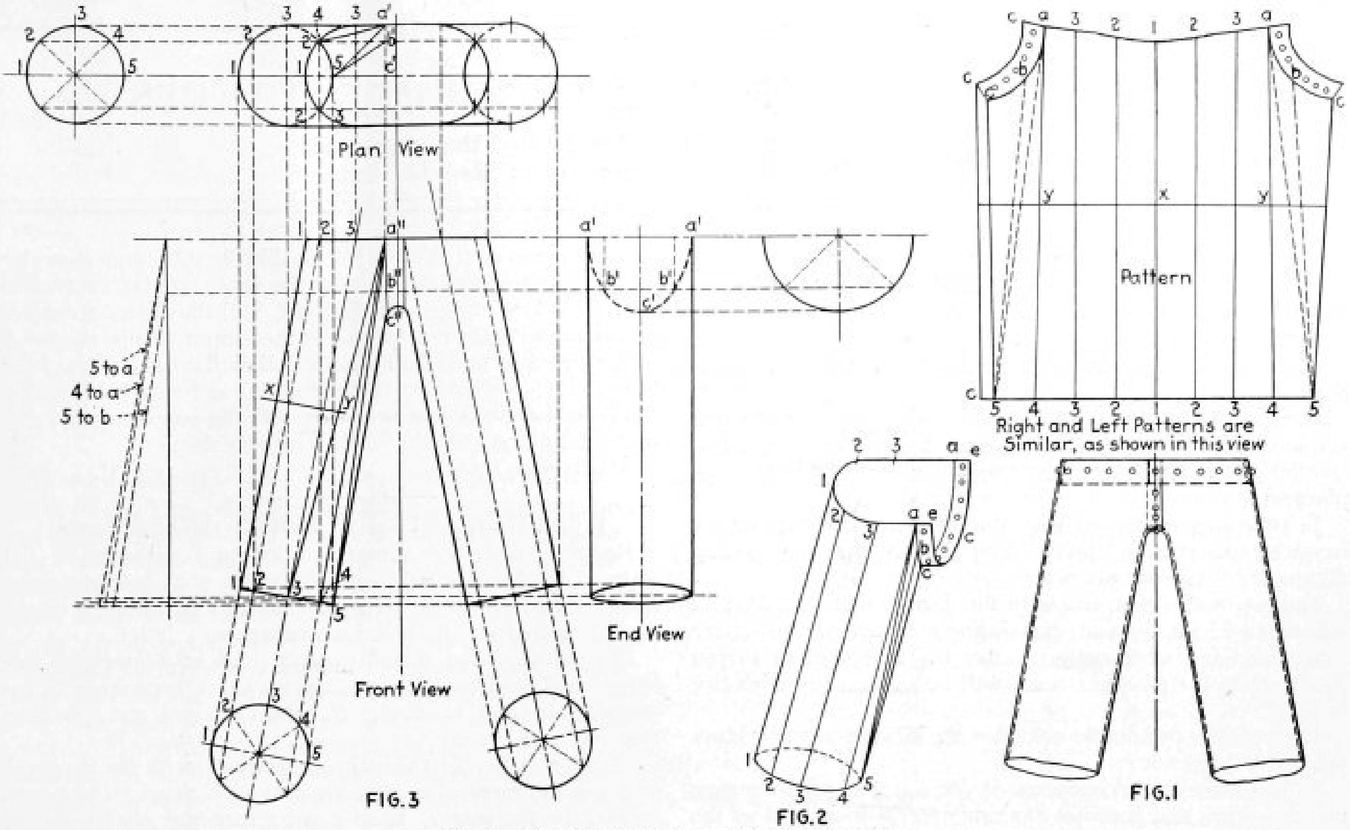


Fig. 1.—Method of Laying Out "Y" Connection

3.1416 × 40.5 = 127.23 inches, according to Rule 1.
3.1416 × 40 + (3 × ½) = 127.16 inches, according to Rule 2.
3.1416 × 41 — (3 × ½) = 127.31 inches, according to Rule 3.

The difference between the results Rule 1 and Rule 2:

127.23 — 127.16 = 0.07 inch, a fraction over 1/16 inch.

Between Rules 2 and 3:

127.31 — 127.16 = 0.15 inch, nearly 3/16 inch.

Between Rules 1 and 3:

127.31 — 127.23 = 0.04 inch, a trifle over 1/32 inch.

From these rules you will find that Rule 1 is the easiest and quickest to apply and there is less liability for error in the work.

A number of answers to questions on dished head calculations have been given in recent issues. Refer to page 337 of the November, 1920, issue. The layout for the pattern of a dished head in one piece may be made by first determining the diagonal line *ab* as shown in Fig 1, page 338, of the November issue of THE BOILER MAKER. Use this length found as a radius for describing the circle and add additional material for the flange.

Layout of Y-Connection

Q.—How would the development of a Y-branch be made of the form shown in Fig. 1? C. D.

A.—A general view of the leg of the Y is illustrated in Fig. 2. Lines of construction are indicated to correspond with the layout in Fig. 3. Fig. 3 shows a plan, front, end view and pattern complete. Where the legs of the Y join, the shape of the miter is found by triangulation, but the other part of the pattern is laid off by projection. If additional information is required, please advise us.

BOOK REVIEWS

ELEMENTARY MACHINE SHOP PRACTICE. By James A. Pratt. Size, 5½ by 8 inches. Pages, 320. Illustrations, 205. New York, 1921. D. Van Nostrand Company.

This book presents the fundamentals of the machinist trade. Extended details of the large machine shop are based on a certain number of elementary principles which are applied to the doing of bench work and the operation of machine tools, and this work is devoted to the presentation of these elementary principles. The processes described are related to the bench, lathe, drill press, shaper, slotter, grinder, miller and planer. The text has been prepared with the special object of making it readily usuable by apprentices, students, workmen and teachers.

BOILER BOOK. By H. E. Dart. Published by the Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn. 1920. Size, 7 by 10 inches. Pages, 65. Illustrations, 20.

This book is made up in loose leaf form and contains reliable data for use in the design and installation of boilers and other pressure vessels. So great has been the demand for data on boiler design and installation from the Hartford Company by boiler shops, steam fitters and brick masons in the United States, Canada and England that it was thought advisable to publish the information collected from time to time by the engineering department so that it would be available in a convenient form to anyone desiring data for boilers. All drawings, tables and other data have been designed in accordance with the provisions of the Boiler Code of the American Society of Mechanical Engineers. In general, the book is not intended as a treatise on boiler design, but merely as a collection, in convenient form, of data which has been found valuable in the engineering department. The designs contained in the book represent the company's ideas as to good practice in boiler construction. Additional material on pages to be clipped into the binder will be issued from time to time.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Checking Up Shop Orders

Do you like these new fangled notions or are you one of the old school who believes the way a thing has always been done is the best?

Are you keeping pace with the times in your shop operation?

Are your methods of applying new fireboxes the same as you have always been following, or are you one of the progressive fellows who sees the advantage of new methods and appliances?

Is your shop equipped with the electric arc welder or the oxy-acetylene cutting and welding outfit? Are you getting all that you can out of them?

Did you notice that article in the January BOILER MAKER relative to the new manner of building a Scotch marine boiler? Look it up if you do not remember it. Did it occur to you that some of the practices could well be applied to locomotive boilers?

Have you a pneumatic cold flanger in your shop? Have you tried to get one?

If you have one, do you use it for all your cold flanging under ½ inch and your hot flanging over ½ inch, or does the machine stand idle while your flanging gang of four or five men sits around five hours out of eight waiting for heats and then beating the flanges down in the old way?

Do you take any of your trade papers? Do you read them from front to back—advertisements, editorials and contributions? Do you ever see anything there that appeals to you? If it was something that you yourself could do, did you try it out? Have you been after the "big boss" to get you one of those "thingumbobs" that Bill Jones is using and getting out more work than you with less men? Do you keep any cost records? Are you getting out more work this year than you did last for the same or less money? Don't you see any place where you can cut out item of expense? What happens to all your shear cuttings? Does it all go in the scrap or is the most of it cut up into liners, washers, etc? What did Bill Brown do with those twenty-five ¾-inch bolts that were in that firebox he drove last week? Jim Smith was just in for an order for twenty-five more to bolt up another box.

Why did that flue setter get an order for 275 copper ferrules for that engine when you know there are but 270 flues in the boiler? What is he going to do with the other five coppers? You know that they will be found in the pit or scrap a little later, or find their illegitimate way into the hands of a crooked scrap dealer. Why did you give that front end man an order for a box of fifty ½-inch bolts when you know that it takes but about thirty-five to bolt up a draft rigging of that kind?

Just saw your signature on a stores order for fifty flexible caps for engine 900. This engine is in for cap removal only, and each bolt had a cap on when the engine came in. Surely there were not fifty stripped out of about 250. What became of the remainder? What about that boiler maker calking all day with a helper holding the light? How much is that helper doing toward getting your output for this month? He is absolutely non-productive and you are spending $4.96 in eight hours and getting nothing in return.

An inspection of locomotive 222 just before the engine came into shop showed a fine set of grates—practically new. The same engine was just observed in the back shop with the grates in the pit and nearly every one with from two to six fingers broken off. Who is responsible for this careless work?

Did it ever occur to you that the new material applied to an engine does not help production? All the orders given for new material adds not one bit to the output of the shop. A dollar saved in material means a dollar that can be spent for labor. Labor produces. Save material and spend the money for labor in increasing your output. Do you recognize any of the conditions mentioned in your own shop?

Meadeville, Pa. C. E. L.

Requirements for Boiler Inspectors

Recently there was introduced in the Legislature of the state of Washington a bill providing for state boiler inspection. There are two provisos in the bill to which I would draw attention and make a few comments.

"Section 2. The chief inspector shall be a practical mechanic and shall have had at least ten years' experience in the construction and repairing of steam boilers and pressure vessels."

"Section 3. The chief inspector shall, with the approval of the department of safety, appoint such district inspectors as may be necessary. Each district inspector shall have at least seven years' experience as a practical boiler maker."

The first and main object of boiler and pressure vessel inspection is to ascertain the safe maximum pressure that may be carried. This pressure is calculated first of all in the office of the manufacturer. The boiler maker in the shop has nothing to do with it, and the office force is not looking for boiler inspection jobs.

The subsequent safe pressure is impaired in many ways, one being defective installation. Installation is always done by engineers, steam fitters or brick masons, who often work to a blue print furnished by the manufacturer, but as often as not blue prints are not available. The boiler maker has little or no experience in this line.

Natural deterioration soon follows when a boiler is put into active service, such as incrustation, corrosion, pitting, grooving, blisters, bags, buckles, cracks, leaks at seams and rivets, or defective steam gages, safety valve, water columns or blow-off pipes. All of these come under the actual observation of the engineer in charge, who operates the boiler year in and year out. It is he who is held responsible, who must watch and guard against all of it. The inspector comes in, has his attention drawn to defects by the engineer, and then, owing to his authority, orders repairs, reduction of pressure or boiler out of service, as the case may warrant. The boiler maker has no experience in the operation of steam boilers or their management in service.

Again, what experience has the boiler maker in regard to the operation of steam engines, pumps, injectors and many other devices so necessary for the safe operation of steam boilers in every high pressure steam power plant?

It must be granted that the boiler maker is a handy man with the hammer, drill, cold chisel, calking chisel and expanding tools, and that he can qualify for a good and efficient boiler inspector is not questioned at all, but why select him as the only qualified person to inspect boilers and pressure vessels and exclude all others, no matter what their position or experience may be, because they have not worked seven years in a boiler shop?

Spokane, Wash. CHARLES J. VEDDER,
City Boiler and Elevator Inspector.

Effect of Cold Air on Heated Locomotive Boiler

A case has recently come to my notice in which a new locomotive was shipped dead*, with main rods connected, from builder's plant to purchaser, a distance of approximately ten miles, in below zero weather. The boiler was warm and empty when the locomotive started on its trip.

I would like to have the opinion of readers of THE BOILER MAKER as to whether they consider the injection of cold air through the cylinders detrimental to the efficiency of the boiler in question.

It would be interesting to learn from correspondents the probable defects which might be caused through the above method of shipment.

Montreal, Quebec, Canada. WALTER J. A. GRAINGE.

Don't Lengthen Your Wrenches†

I have several times seen the "kink" in print which shows how to make a wrench longer by slipping a gas pipe over the handle. It is a very simple procedure, and it may look and sound good to some, but I don't believe in making a wrench longer in order to put nuts on tighter.

As you doubtless have observed, wrenches for small nuts are invariably short; for medium nuts, medium in length, and for large nuts they are long. The manufacturers therefore seem to have some system in making wrench lengths—and they have. The pitch of the thread is considered, the cross-sectional area of the bolt at the bottom of the threads is considered, and the strength of the man who does the tightening is also considered.

To make a wrench twice as long you therefore increase the tension on the bolt to twice the amount, the force of pull on the wrench being the same. By increasing wrench lengths I have frequently actually "stretched" bolts until they broke in two, or I stopped turning as soon as I felt the bolt begin to stretch. This is poor practice and I do not do it any more. I do not increase the wrench's length any more because I realize that the elastic limit of a bolt should never be reached.

If you feel like making a wrench longer for "unscrewing" a nut—all right. But don't make it longer for tightening.

Newark, N. J. W. F. SCHAPHORST.

Lack of Standardization in Oxygen and Acetylene Hose Markings

In the January issue of THE BOILER MAKER an article on page 44 referred to distinguishing colors of hose for oxygen and acetylene with welding and cutting apparatus, specifying "*red for oxygen, black for acetylene,*" stating that these colors had been generally adopted by the manufacturers and that a change would result in confusion and possible serious accidents, although the Compressed Gas Manufacturers' Association, as quoted in the article, stated: "It would be a good thing for the industries if red had been adopted as the color for combustible gases at the inception of the business," etc.

The Davis-Bournonville Company has manufactured and marketed oxy-acetylene apparatus and supplies since the introduction of the process in this country. It has always recommended and supplied red hose for acetylene and the black hose for oxygen; the monthly supply lists, mailed generally to users of oxy-acetylene apparatus, so designate acetylene and oxygen hose; all torch units sold by the company are supplied with red hose fitted with acetylene regulator and torch connections, and with black hose fitted with oxygen connections, the connections being differently threaded to avoid wrong connection to regulator or torch.

The writer is not fully informed of the general practice in this respect by other oxy-acetylene apparatus manufacturers, most of whom have engaged in the business since the Davis-Bournonville Company established the practice it has consistently followed. Possibly some of them do not employ distinguishing colors.

Referring again to the opinion of the Compressed Gas Manufacturers' committee, it might be said also that "it would have been a good thing if red had been adopted as the color" for acetylene tanks or cylinders, as well as for hose, but it is not unlikely that this was avoided as an undesirable danger signal, at a time in the earlier use of acetylene, when it was considered a more dangerous hazard than now, when its use is more common.

The writer, therefore, disagrees with the statement that "in the oxy-acetylene industry red has stood for oxygen ever since welding and cutting have been used to any appreciable extent in this country." One very large producer of oxygen colors its portable tanks gray with green tops, while another large oxygen producer and distributor employs a different color—yellow.

Doubtless there is an inconsistency and absence of standardization in color marking which might well be remedied, to the advantage of all concerned, by employing uniform and characteristic colors which would indicate the inflammability or non-inflammability of the gases used in welding and cutting.

Jersey City, N. J. DAVIS-BOURNONVILLE COMPANY.

A Reader's Comment on the Magazine

In the Letters from Practical Boiler Makers, January issue, there is much that is interesting and instructive. "Flex Ible's" remarks concerning boiler inspectors and staybolt inspection are good and to the point.

We are taking out broken flexible staybolts right along, found by the hammer test, in empty boilers, and not waiting for the sheets to bulge. Flexible bolts do break whether properly applied or not, and we have found them broken clean for a distance of 1½ inches from the ball head, but the majority are broken close under the head.

The column of Questions and Answers for Boiler Makers by C. E. Lindstrom is good and should be digested by boiler inspectors, especially some of our war-time inspectors, whose tenure of office is going to be very brief unless they can produce the goods.

The apprenticeship problem as presented by W. J. Carter claims a little more consideration for the apprentice than is shown at present. Something should be done to encourage his efforts to learn the trade. Well—at one time I looked at that question from the same point of view, but have changed my opinion. The apprentice of today has more useful information and help waiting ready at hand than was ever known in the history of the trade. If he is serving his time in a well-equipped shop he has through every hour of his working day the practical side of the business before him. Outside of his working hours there's the public library in every town, whose shelves in most of them hold books that will give him the why and wherefore of every trade under the sun, and if there is any apprentice who doesn't know of THE BOILER MAKER, I'd like to know where he lives; the price is low, the information valuable, the best minds in the business are giving us of their knowledge and experience, and if the apprentice has sense enough to stay at home three or four nights a week and study the pages of THE BOILER MAKER alone he will soon overcome any supposed handicap the helper has over him.

Lorain, Ohio. JOSEPH SMITH.

* The reason for not shipping the locomotive under steam was that the locomotive was a very large one, and it is a question whether the bridges, which were the property of another railroad, would have been strong enough to carry the engines.

PERSONALS

C. E. LESTER, formerly with the Erie Railroad, has been holding the position of general foreman boiler maker with the Baltimore & Ohio Railroad at Pittsburgh, Pa., for the past three months.

WALTER H. BAKER, secretary-treasurer and general manager of the Universal Steel Company, Bridgeville, Pa., was recently elected to the board of directors of the Electric Alloy Steel Company, Youngstown, Ohio.

E. R. LEWIS, editor of the Maintenance of Way Cyclopedia, one of the publications of the Simmons-Boardman Publishing Company, has been appointed office engineer of the Michigan Central, with headquarters at Detroit.

CHARLES H. TRUE has been elected vice-president of The Suprheater Company, in charge of production, with offices at East Chicago, Ind. Mr. True was born in Boston, Mass. He was educated at the public schools of Schuyler, Neb., and the University of Nebraska, graduating in 1898, with the degree of electrical engineer. Immediately upon graduation he entered the service of the Union Pacific Railway, at Omaha, and served in both the locomotive and car shops. In 1902 he became roundhouse foreman at Grand Island, Neb., and in 1903 resigned from the Union Pacific to take a similar position at Trenton, Mo., with the Chicago, Rock Island & Pacific Railway. In October of the same year he was transferred to the Silvis shops as assistant superintendent of shops. In 1905 he accepted the position of mechanical engineer with the Railway Materials Company at Chicago and was engaged in the design of metallurgical furnaces for blacksmith shops and boiler shops. In 1910 he refitted and took charge of the Phoenixville, Pa., plant of this company. In 1912 he resigned his position with the Railway Materials Company to become works manager of the Locomotive Superheater Company at East Chicago, Ind., which position he held at the time of his recent election to the vice-presidency. During the time he was works manager he was actively associated in the mechanical development of superheaters for locomotive, marine and stationary boilers. Mr. True is a member of the American Society of Mechanical Engineers and other engineering societies.

C. H. True

HARRY L. OVIATT has been appointed traveling representative of the Armstrong Manufacturing Company, of Bridgeport, Conn., manufacturers of pipe threading tools and taps. Mr. Oviatt has been with the Bullard Machine Tool Company for the past thirteen years; for the past three years connected with the advertising department.

GEORGE J. BLANTEN who for the past four years has been connected with the engineering sales department of the Chain Belt Company, Milwaukee, has been made New York district manager. Mr. Blanton was previously associated with the General Electric Company for eight years, three years of which were spent in Schenectady, N. Y.

HENRY B. OATLEY was recently elected vice-president in charge of engineering of The Superheater Company, with offices at 30 Church street, New York. Mr. Oatley was born at Rochester, N. Y., and attended the public schools at that place. He received his engineering education at the University of Rochester and the University of Vermont, graduating from the latter in 1900 with the degree of mechanical engineer. Upon graduation he entered the service of the Schenectady Locomotive Works. His experience while on this work was very broad, embracing locomotive design and shop testing. He was associated with F. W. Cole in the early development of the superheater for locomotives by that company. In 1910, upon the formation of the Locomotive Superheater Company, he accepted the position of mechanical engineer, and in 1916 was appointed chief engineer for this company, which position he held at the time of his election as vice-president. In April, 1917, he was granted a leave of absence and served as an officer in the United States Navy on the battleships *Ohio* and *Indiana*. Mr. Oatley is a recognized authority on superheating, and has been an active factor in its development. He is in a large measure responsible for putting superheater design upon a practical operating and manufacturing basis in locomotive, marine and stationary practice, and without sacrifice to efficiency has developed uniformity of sizes and design.

H. B. Oatley

GILBERT E. RYDER has been elected vice-president of The Superheater Company, in charge of sales, with office in New York. He was born in Minneapolis, Minn., in 1880. He studied engineering at the University of Wisconsin and also at the University of Illinois. His railroad experience began with apprenticeship on the Chicago, Milwaukee & Saint Paul Railway and included service as a journeyman in the mechanical department of that road at Dubuque, Ia., Ottumwa, Ia., and West Milwaukee, covering five years. Engineering experience followed in the fuel testing bureau of the technologic branch of the United States Geological Survey. He later served the city of Chicago as deputy smoke inspector in charge of locomotives, which placed him again in intimate contact with the locomotive fuel conservation problem. This was followed by editorship of the Railway Review of Chicago, after which he entered the service of the Locomotive Superheater Company ten years ago. He became a member of the service department and later took charge of that department, which today is responsible for the operation of 30,000 superheaters on locomotives in this country alone, in addition to stationary and marine applications.

G. E. Ryder

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; A. G. Pratt, Babcock and Wilcox Company, Bayonne, N. J.; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, Systm G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

Through an oversight on the part of the proofreaders, A. G. Pratt's (of the Babcock & Wilcox Company) name was omitted from the executive committee of the American Boiler Manufacturers' Association in the association section of the January issue of THE BOILER MAKER.

TRADE PUBLICATIONS

METALLIC PACKING.—This booklet, prepared by Julian N. Walton for the Crane Packing Company, Chicago, Ill., while essentially a catalogue of Crane flexible metallic packing, is also intended to assist the operating engineer to understand packing problems and to point out the way by which packing troubles may be overcome. Pressures of any intensity may be taken care of by proper depth of stuffing boxes, but for temperatures above that of maximum steam saturation require special treatment. The discussion in this book is limited to the ordinary packing requirements found in present practice.

PIPE FOR REFRIGERATING SYSTEMS.—The latest bulletin of the National Tube Company, Pittsburgh, Pa., contains a description of the construction and operation of refrigeration systems. The first consideration in all refrigeration installations is the dependability of the wrought pipe entering into its construction. This bulletin gives a brief description of the specific advantages of National pipe for general refrigerating purposes and such statistical data as might be found of service in designing, working and operating a refrigerating plant.

WROUGHT IRON PIPE.—Bulletin No. 2 of the Reading Iron Company, Reading, Pa., contains an outline of the structural differences between wrought iron and steel. For purposes of comparison photo-micrographs are reproduced which show the relative compositions of steel and wrought iron. The relation of these types of pipe to the field of welded pipe is also given. This bulletin has been written to interest the layman as well as the engineer and is the first bulletin on this subject that has so far been prepared.

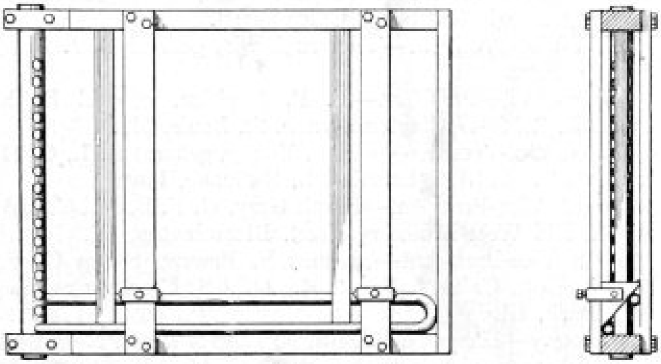
Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,350,236. BOILER-UNIT-ASSEMBLING RACK. JOHN PIERCE, JR., OF SOUTH NORWALK, CONNECTICUT, ASSIGNOR OF ONE-HALF TO DICKINSON S. CUMMINGS, OF STAMFORD, CONNECTICUT.

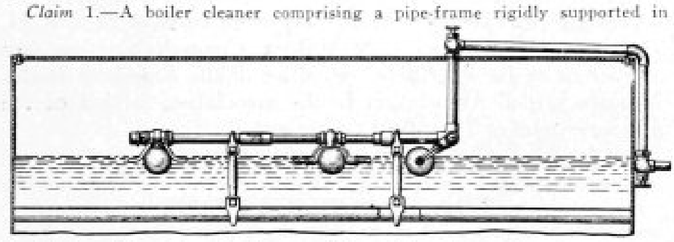
Claim 1.—In a work holder, a frame, means carried by the frame for supporting an element at one end of the frame, pairs of bars secured to the



opposite faces of the frame and between which, elements, each including a pair of legs to be assembled with the first mentioned element, are arranged, and vertically adjustable blocks mounted between each pair of bars and adapted to engage both legs of the element to clamp the same in proper position with respect to the first mentioned element while said legs are being secured thereto. Six claims.

1,363,269. SKIMMER FOR BOILERS. EDMUND RANKIN, OF LINCOLN, ILLINOIS.

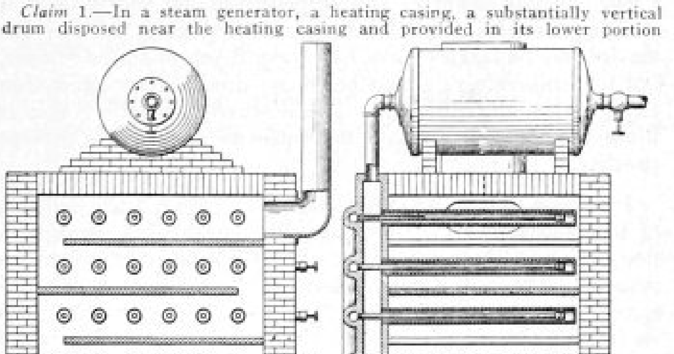
Claim 1.—A boiler cleaner comprising a pipe-frame rigidly supported in



the boiler and forming a discharge conduit, a blow-off valve for said discharge conduit, and a plurality of float controlled skimmers pivoted axially and separately on said pipe frame and mounted in communication therewith, whereby they can operate independently of each other. Six claims.

1,350,554. STEAM GENERATOR. ROLAND B. MANNING AND LEE R. MOORE, OF DALLAS, TEXAS.

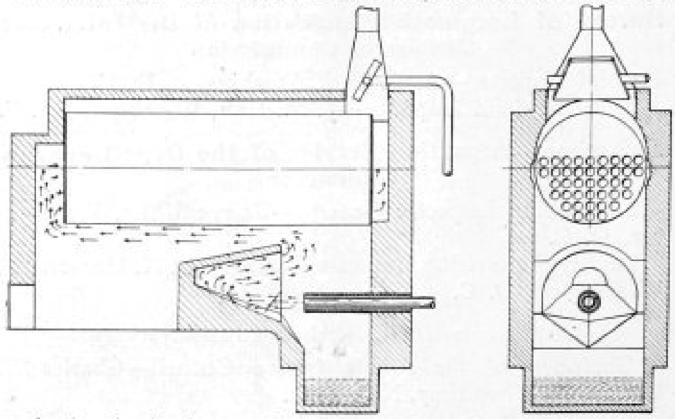
Claim 1.—In a steam generator, a heating casing, a substantially vertical drum disposed near the heating casing and provided in its lower portion



with a cross partition forming a separate chamber, preheating tubes arranged within the heating casing and leading into the separate chamber, heating means for the heating casing, spaced tubular fingers arranged in superposed relation within the heating casing above the preheating tubes and leading into the drum, supply tubes extending longitudinally within the tubular fingers and provided with outlet means, separate means of communication between the outer ends of the supply tubes and the separate chamber, and steam outlet means having communication with the upper portion of the drum. Seven claims.

1,349,971. FURNACE. JOHN URBAN McDONALD, OF DECATUR, ILLINOIS.

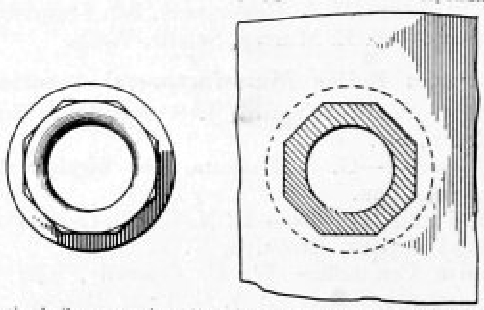
Claim 1.—An apparatus for burning powdered fuel comprising a front wall, a rearwardly tapering ignition chamber spaced from said wall and a



combustion chamber between them, and an injector for powdered fuel and air mounted in said wall and extending partially across the combustion chamber toward the ignition chamber and having its discharge end substantially level with the bottom of the ignition chamber so that the air and fuel will impinge thereon and the flame from the fuel may be deflected upwardly and forwardly and pass out over and pre-heat the incoming mixture before passing upwardly and rearwardly over the top of the ignition chamber. Five claims.

1,360,815. BOILER AND TANK SPUD. ALBERT G. SUTTILL, OF WATERTOWN, MASSACHUSETTS, ASSIGNOR TO RIVERSIDE BOILER WORKS, INC., OF CAMBRIDGE, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

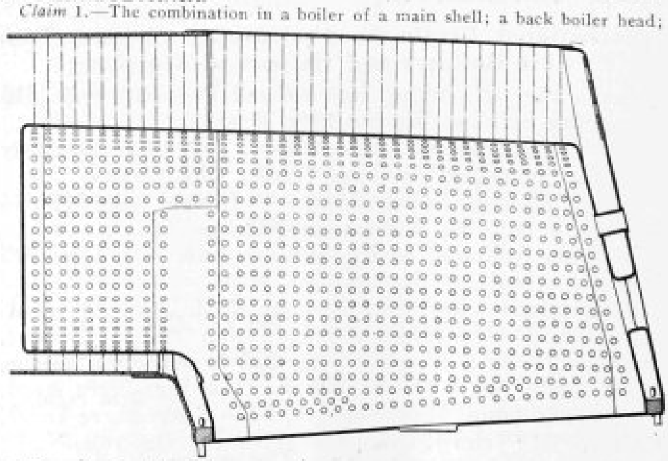
Claim.—A spud for use in boilers and tanks, comprising a shouldered head adapted to lie against the face of the wall of a boiler or tank and having a substantially cylindrical shank projecting from the head and adapted for insertion through a polygonally formed opening in said wall of the boiler or tank, said shank having exterior polygonal faces corresponding to said



opening in the boiler or tank wall and extending from said shouldered head and being of a width substantially equal to the thickness of said boiler or tank wall and adapted to fit in the polygonl opening thereof to hold the shank from turning in the opening, the outer portion of the shank being substantially cylindrical and having an endwise flaring inner wall, the bottom of the latter being adapted to lie substantially in line with the surface of the boiler or tank wall, reducing the thickness of the end of the shank, whereby said reduced and cylindrically formed end of the shank may be easily and uniformly swaged and rounded over against the opposite face of said boiler or tank wall.

1,363,944. BOILER. HENRY V. WILLE, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim 1.—The combination in a boiler of a main shell; a back boiler head;



a firebox having side walls; a crown sheet; a back head having a deep flange secured by welding to the crown sheet and forming the firebox; a series of rows of staybolts securing the firebox to the main shell of the boiler, one series of staybolts being secured to the deep flange of the back head so that the welded joint is between the first and second rows of staybolts. Two claims.

THE BOILER MAKER

APRIL, 1921

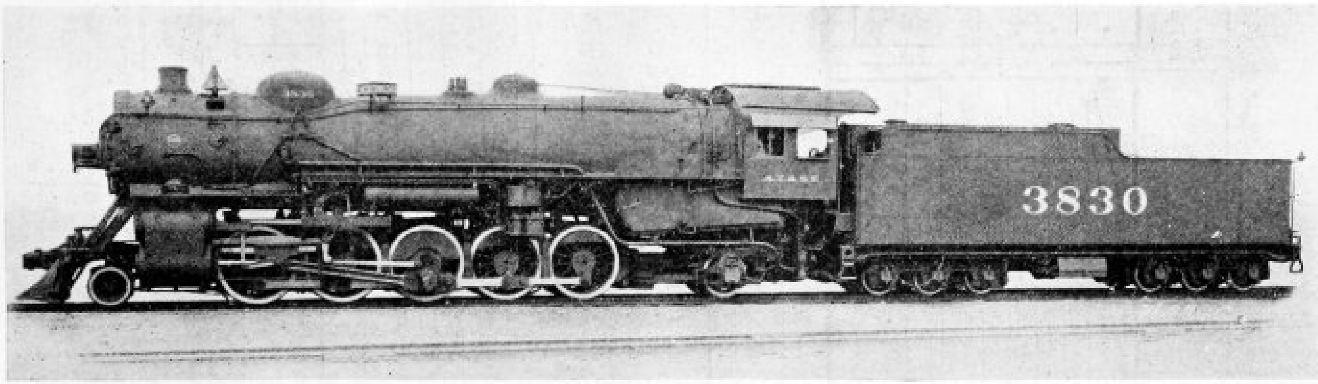


Fig. 1.—One of the New 2-10-2 Santa Fe Locomotives Having the Largest Fireboxes Ever Rolled from Single Plates

Details of New Santa Fe Locomotive Boilers

The 2-10-2 type Santa Fe locomotives, described in the following article, built for the Atchison, Topeka & Santa Fe railroad by the Baldwin Locomotive Works, are essentially the same in construction as other heavy freight locomotives of this type. The boilers of these engines, however, have the largest fireboxes ever formed from single plates. Structural features of these boilers are outlined and the development of the firebox sheets given.

A contract for ten Santa Fe 2-10-2 type freight locomotives has recently been completed at the Baldwin Locomotive Works, Philadelphia, for the Atchison, Topeka & Santa Fe railroad. These engines, which embody the latest developments in the design of this type locomotive, have the feature of being equipped with the largest locomotive fireboxes rolled from single plates. This construction, of course, eliminates the troublesome joints which occur when fireboxes are made up in the usual way from three plates. The boiler is of conical design, built for a working pressure of 195 pounds. The outside diameter of the first course is 88 inches, while the diameter of the rear course is 100 inches. The firebox is 132 inches long and 96 inches wide. There are 275 small flues of 2¼ inches diameter and 50 tubes of 5½ inches diameter. The distance between the tube sheets is 21 feet.

Firebox Plates

The ten firebox plates rolled by the Lukens Steel Company, Coatesville, Pa., were each 250 inches by 195½ inches by ⅜ inch. These plates were rolled from basic locomotive firebox steel furnished according to A. T. & S. F. specifications. These plates form the crown and sides of the firebox and also the combustion chambers in the boilers.

Plate for the boilers is of homogeneous steel intended for a pressure of 225 pounds with a factor of safety of 4 at this pressure. No allowance is made for welded seams.

Construction of Main and Auxiliary Domes

By a special cupping process developed at the Baldwin Works the main dome of the locomotives is pressed out of a single sheet of open hearth steel. The walls are drawn down in the process to ¾ inch while the flange is left somewhat heavier than this where riveted to the boiler. The dome cap is pressed from 1¼-inch material with flanges 1⅛ inch thick and with about 1½-inch dish to provide stiffness. Taper studs securing the dome cap to the dome ring extend all the way through the ring.

The auxiliary dome is located ahead of the main dome on the left side of the boiler and is pressed to shape from 1⅛-inch material. This particular position for the auxiliary dome was determined by the location of the dry pipe in order that the pipe would not interfere with anyone entering the boiler for inspection. A 17-inch clear opening is provided and the dome is double riveted all around. Three Crane 3-inch safety valves and one blow off valve are carried in the flat cover of the auxiliary dome. The casting is arranged so that a wrench may be applied readily when the removal of the valves is necessary.

The sides and crown of the firebox and of the combustion chamber are formed from a single sheet rolled for this purpose. The throat sheets and the firebox tube sheet and back head are all flanged in special dies in a single heat. The center line seam of the combustion chamber is welded. Firebox connections, throat sheets, seams, rivet holes, and in fact the details of the entire back ends of the ten locomotives have been made to a single standard so that, if necessary, they may be transferred from one boiler to another. Corner braces to the side sheet and back head have been eliminated because of the large radius at this point. At the top center line the back head flange has an inside radius of 2½ inches, which is increased to 7¼ inches at the horizontal center line and maintained at this amount to the bottom of the firebox.

The firebox has a sloping mud ring. In order to eliminate welding in filling plates on the back head flanges these were made sufficiently wide to allow a direct riveted connection to the mud ring. The mud ring is of cast steel 3¾ inches thick except at the corners, where one inch pads are fitted on the under side. The length is 133 3/16 inch and width 96¾ inch. The seams at the outside and inside of the mud ring corners are welded. The water leg at the sides of the firebox

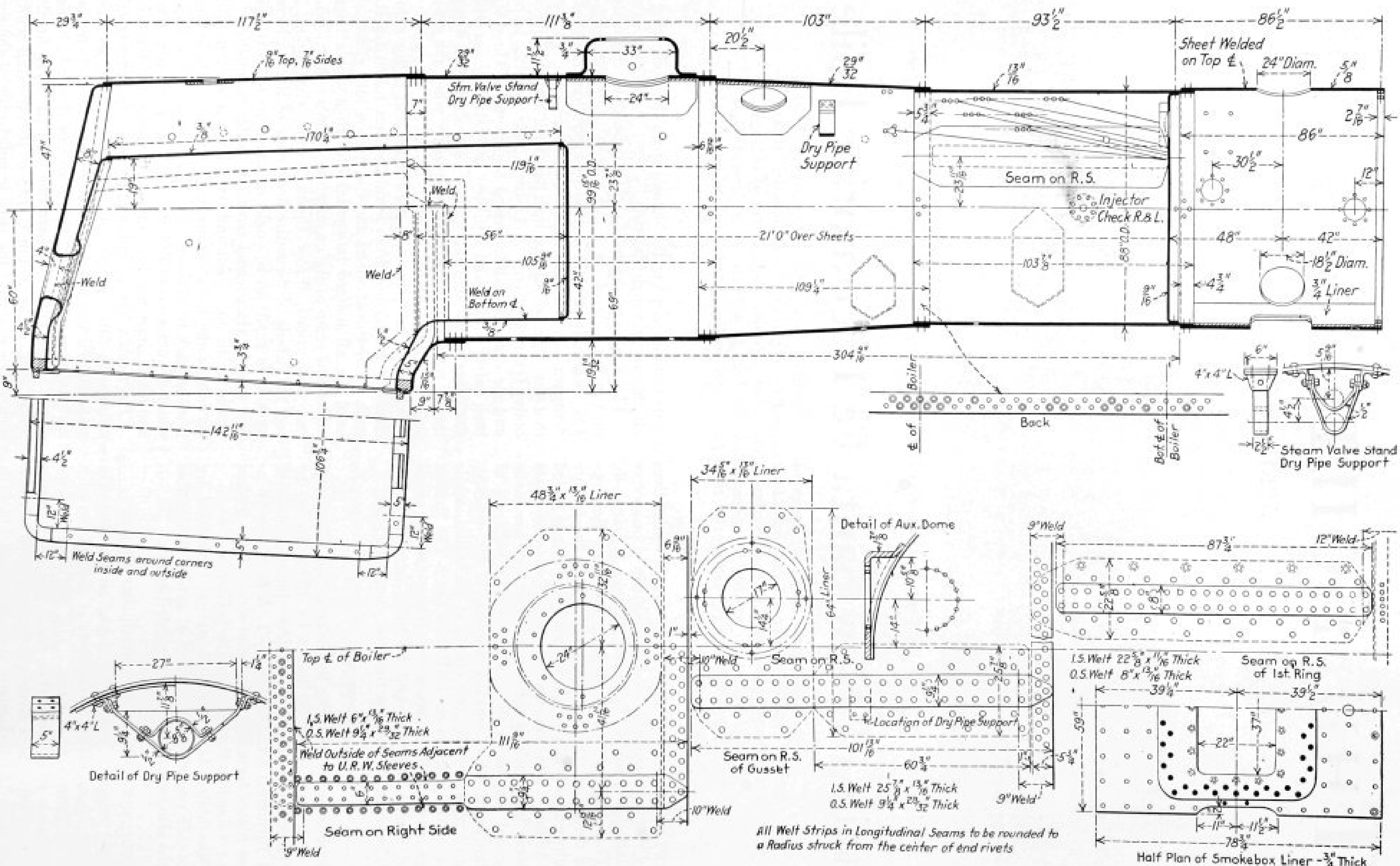


Fig. 2.—Details of Santa Fe Locomotive Boiler with the Arrangement of the Longitudinal Riveted Seams

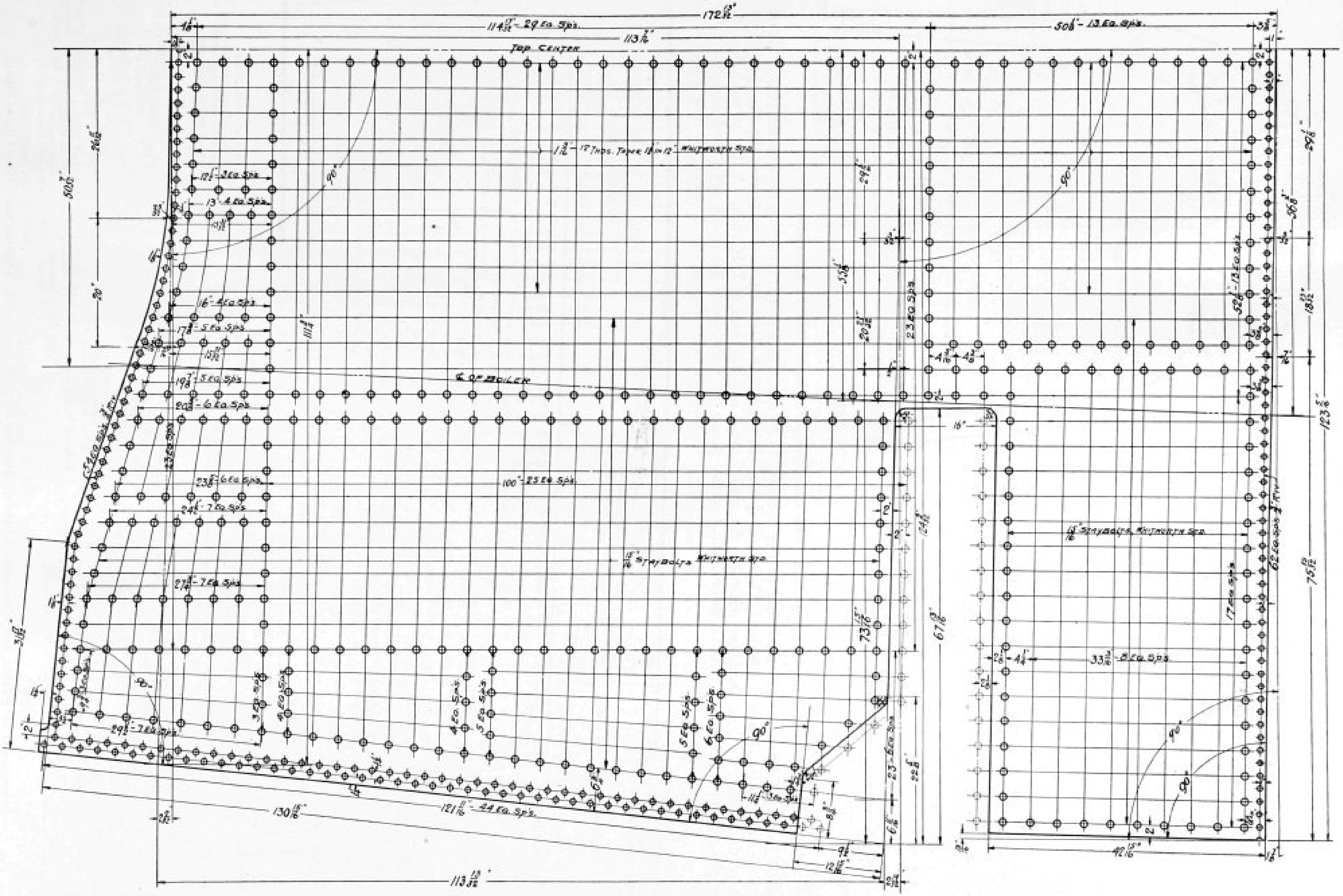


Fig. 3.—Development of the Firebox Sheet as Laid Out Ready for Rolling

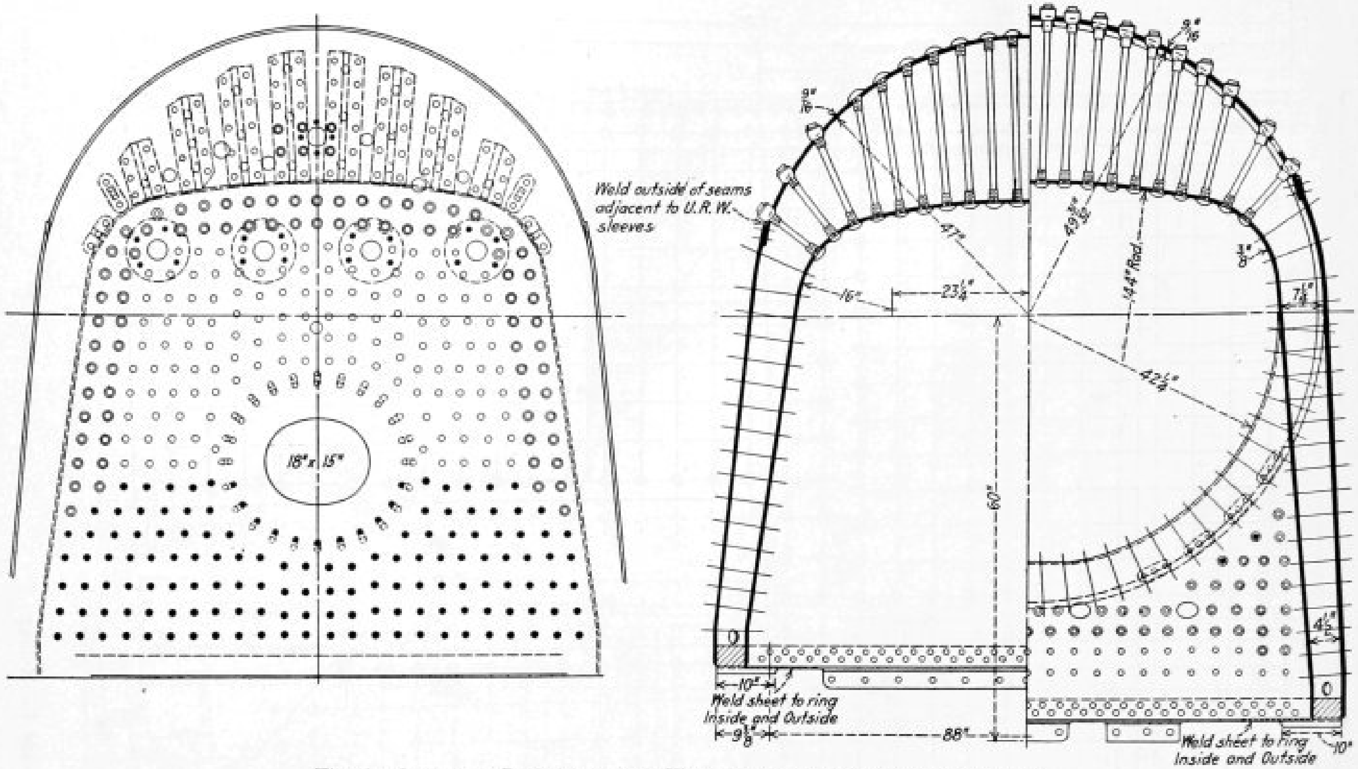


Fig. 4.—Sections at Back Head and Through Firebox of Santa Fe Locomotive

is tapered from 4½ inches at the mud ring to 7¼ inches at the horizontal center line of the boiler. The water space flanges of the outside wrapper sheet are welded to the mud ring at the corners for a distance of 12 inches both inside and out.

As noted in Table I, including data on the plates, the outside wrapper sheets are in three pieces; the top of 9/16-inch metal and the sides of 7/16 inch. A line of weld is carried along the seam where the plates are joined adjacent to the welded staybolt sleeves which come at this longitudinal

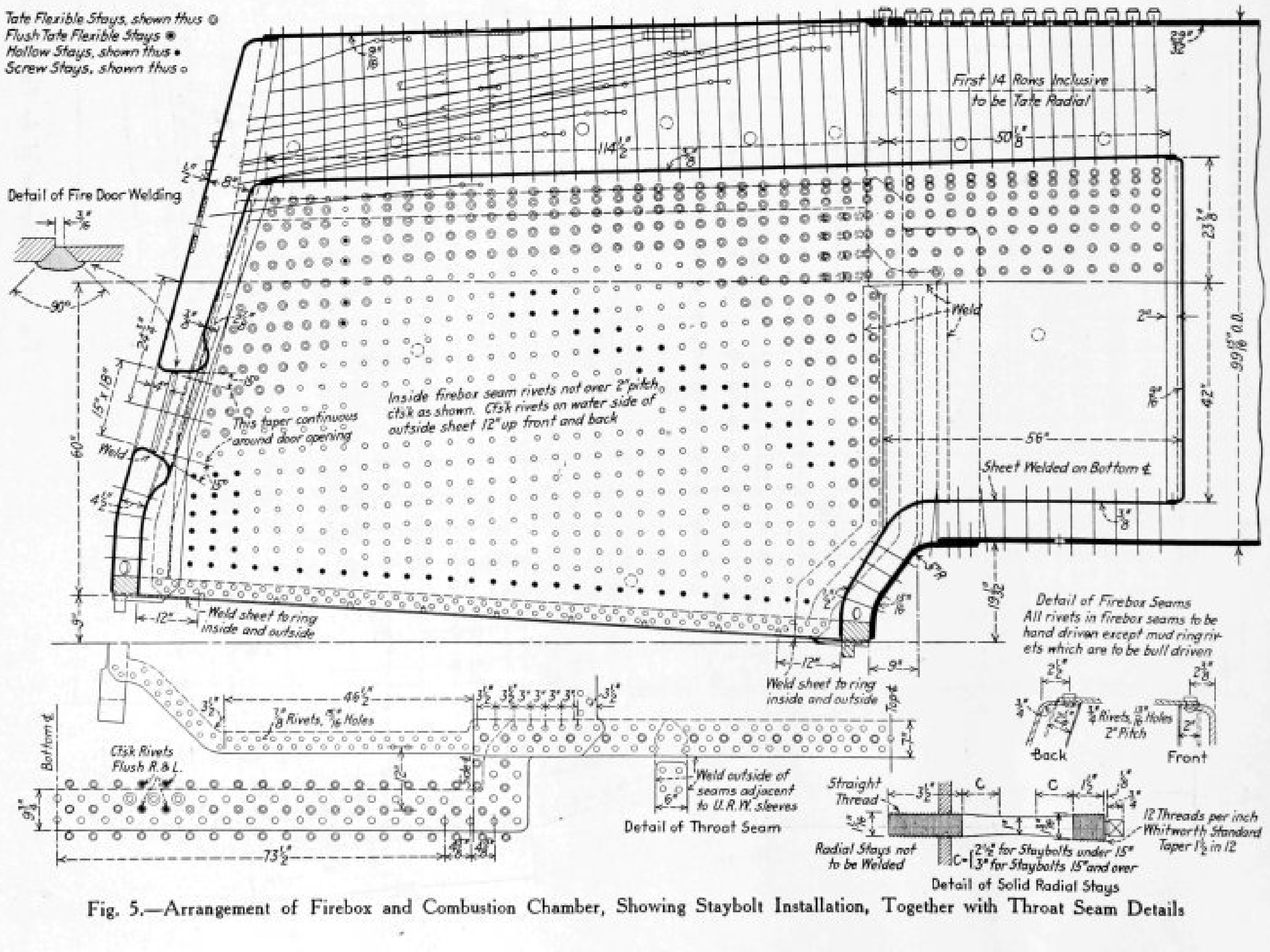


Fig. 5.—Arrangement of Firebox and Combustion Chamber, Showing Staybolt Installation, Together with Throat Seam Details

joint. Where the outside firebox side sheets meet the first course of the shell at the throat the seams are welded inside and outside.

Double riveting is used throughout the mud ring and the rivets are countersunk in the firebox sheet. Boiler stays are applied to extend all the way through the sheets.

The fire door opening is 15 inches by 18 inches of A. T. & S. F. standard form with O'Connor patent flange. This flange at the top of the opening is horizontal and slopes with the back head throughout the circumference of the door. Sheets at the fire door seam are butted together and electric welded. Plugs have been omitted from the seam. The welded seam is at a distance of 4 inches from the back head. From the firing deck to the center of the door is 22¾ inches and from the bottom of the mud ring 36 inches. Franklin type fire doors are fitted having the pedals arranged so as not to interfere with the use of the grate shaker lever.

Flues and Arch Tubes

The firebox is provided with a 56-inch combustion chamber in order that the flue length might be kept within 21 feet. This extension is thoroughly braced.

Flue holes in front and back flue sheets are drilled. Two hundred and seventy-five tubes are installed having a diameter of 2¼ inches and 50 tubes of 5½ inches. The front ends of all 5½-inch tubes are beaded as well as the 2¼-inch tubes among and adjacent to the 5½-inch tubes. All remaining small tubes are not beaded in the front sheet. All flues are electrically welded in the back flue sheet. Tubes throughout their entire length have in no case been brought closer to the boiler shell rivet heads than 1¼ inches, the latter being countersunk when necessary to provide this clearance.

Flue ferrules are of 35-pound copper. Beads on the tubes are ⅛-inch high. The tools for beading were supplied by the railway company and tested with gages made to the company standard. Expanding was done with tools conforming to the contour of the flue ends so that the metal might not be distorted when flues are worked during repairs. Sectional expanders were used on both flues and superheater tubes. Superheater and arch tubes were beaded with standard tools of the railroad company.

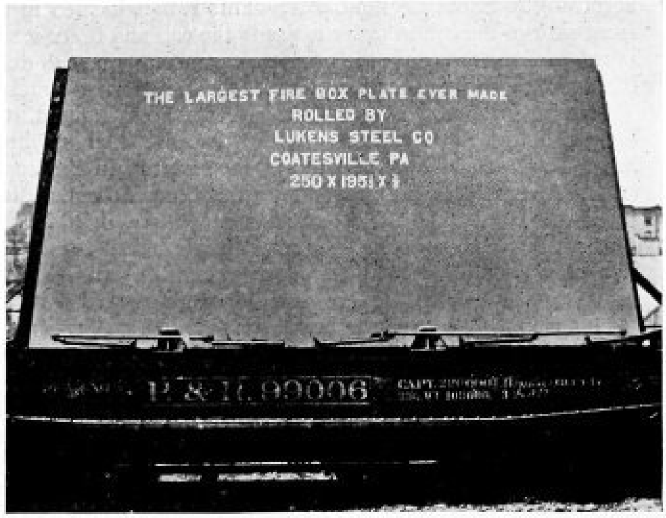


Fig. 7.—One of the Ten Plates Supplied by the Lukens Steel Company Ready for Shipment to the Baldwin Locomotive Works

Arch tubes are spaced on 18¼-inch centers. The firebrick arch was supplied by the A. T. & S. F. and the tubes bent to suit the arch contour. Plugs in arch tubes were supplied by the Prime Manufacturing Company.

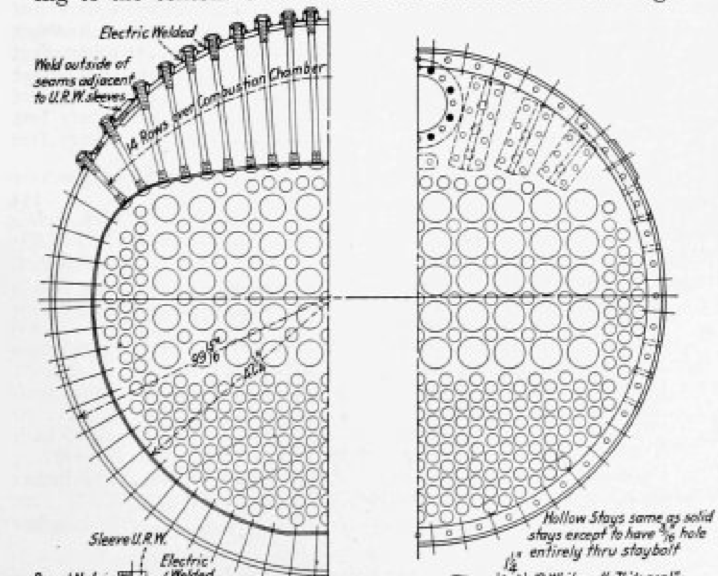


Fig. 6.—Sections of Boiler Through the Combustion Chamber and at the Front Tube Sheet, with Details of Stays Used for Bracing

Riveted Joints

Details of the principal riveted joints are given on the boiler drawings. In general, the longitudinal seams in the shell are butt jointed, sextuple riveted with straps both inside and outside. The joints have a required efficiency of 90 percent. The circumferential seams in the barrel are double riveted. Both the circumferential and connecting seams were worked on the bull riveter. In the dome course the longitudinal seam is located on one side of the top center line so that the seam does not pass through the dome opening. The corners of all butt straps are rounded to a radius struck from the center of the end rivets. Great care has been given to all the seam riveting.

When using bull riveting machines the rivets were held in the grips until they began to turn black so that full shrinkage had taken place before the rivets were released. Rivets in the boiler connecting seam and circumferential seams that come directly over the spring hanger stirrup are countersunk on the outside to clear the spring hangers.

In the firebox the procedure followed in driving rivets is to countersink the heads on the fire side.

Bosses are built up on the wrapper sheet by welding where Tate adjustable crown stays pass through the sheet. All holes in the boiler shell, in the steam dome, in the throat sheet, at the shell seams and in the firebox were drilled instead of being punched. Holes for three rows of staybolts on each side of the firebox at the crown sheet corner are centered but not drilled until the sheet has been rolled.

Staybolt and Stay Equipment

The boilers are equipped with Tate flexible staybolts in the breaking zone. In all there are 971 of these, 15/16 inch in diameter in the firebox and in the combustion chamber. Common staybolts are also used in the firebox while Tate adjustable crown stays are installed in the combustion chamber. The use of the flexible and adjustable staybolts eliminates common staybolts and common radial stays in the combustion chamber. Radial stays are entirely of the Tate adjustable crown type except one transverse row which is of the solid radial type. These solid radial type stays are made according to Santa Fe standards. This row is located in the front wall of the cab in order to apply the cab and brace it satisfactorily and to obtain the proper clearance for the cab door. Six solid radial stays are applied under the dynamo bracket.

Standard lengths of staybolts are used throughout, the longest being 12¾ inches over the threads. All staybolts have a 3/16-inch hole drilled 1¼ inches deep in the upper end. After the solid staybolts have been driven, teltale holes are countersunk 1/16-inch deep with a drill having the cutting edges at a 60-degree angle with the center line of the drill. The pitch of staybolts and radial stays center to center in the firebox sheet does not exceed 4 inches in any case. Common staybolts are screwed and riveted to the inside and outside sheets and Tate flexible stays and adjustable crown stays are screwed and riveted to the inside sheet according to the railroad company's practice. Radial stays and staybolts are snapped on the inside end as well as on the outside. Rigid and hollow water space staybolts and Tate flexible staybolts have diameters of 15/16 inch. Radial stays in the crown sheet have a tapered thread 1 3/16 inches in diameter at dimension *B* noted on the detail drawing of the stay. The last row of radial stays is located adjacent to the door sheet in order to thoroughly stay the back portion of the crown.

Staybolts behind the brick work have 3/16-inch holes throughout their full length. Such staybolts as would come behind the brick if the engines were later equipped for burning oil also have 3/16-inch holes drilled in them. Where any of the hollow staybolts installed would not take the gage prescribed by the Bureau of Locomotive Inspection, holes were reamed out sufficiently to meet the requirements.

The first row of staybolts around the fire door opening was not driven until the door seam had been welded. All water space stays, including Tate and hollow stays, have Whitworth threads, 12 per inch. Caps and sleeves for Tate water space and crown bolts have V threads and crown bolts have Whitworth threads at both ends, 12 per inch. Cab knees, brackets and other attachments located over staybolts have holes drilled opposite the stays to facilitate inspection and testing.

Ashpans

The ashpan is arranged to have the upper slope at as great an angle with the horizontal as possible. The slope at the lower portion has a minimum clearance at the frame of ½ inch. The ashpan of each locomotive has one hopper at the rear and two hoppers in front of the rear truck axle. The ashpan air space around the mud ring is 6 inches and the slope of the tube sheet commences at the inside edge of the spacer support. The flare of the pan extends at least 8½ inches beyond the edge of the mud ring in order to obtain a full air opening. The edge of the flare is turned up for a height of 2 inches. Hinged to this flare a netting covers the air opening at the sides. The pan is built wide enough so that when the netting is applied it does not limit the access of air into the pan. The air opening is about 15 percent of the grate area. The netting is of rectangular form to give the greatest area of opening.

Grates

The grate fingers, bars and the like are of Santa Fe standard design for bituminous coal but modified in this case to suit the size of the firebox. The top line of the grate is 4¾ inches above the bottom of the mud ring. The side and center grate bar supports are so designed and fastened as not to be moved by operation of the grate shaker. After installation the grates were operated in test to see that the supports were stationary and that the fingers on the bars did not interfere.

The grate rods are attached to the lug on the grate connecting bar. Auxiliary shafts are applied between the back of the ashpan and rear furnace bearer sheet to provide for the application of the shaker rods to the arms on the grate bars near the center of the engine. The dump grates are 17¼ inches wide and are specially reinforced. The grate shaker locks outside and inside are of cast steel designed according to Santa Fe standards instead of the type formerly used in locomotives of this type in order to provide an arrangement that will give satisfactory movement of the grates for road shaking by throwing out the inside locks only. The grate shaker arrangement was designed so that the grates could be operated by either hand or power. The shaker lever latch is above the firing deck in order that it may be operated by foot.

Table 1.—Principal Details of 2-10-2 Santa Fe Locomotive Boilers

Style	Conical
Working pressure	195 pounds
Diameter first shell, outside	88 inches
Diameter rear shell, outside	100 inches
Length firebox	132 5/16 inches
Width firebox	96 inches
Thickness firebox sheet	⅜ inch
Thickness first course of shell	13/16 inch
Thickness second course of shell	29/32 inch
Thickness third course of shell	15/16 inch
Wrapper sheet is in three pieces.	
Thickness wrapper sheet top	9/16 inch
Thickness wrapper sheet sides	7/16 inch
Thickness boiler back head	½ inch
Thickness firebox extension wrapper sheet	⅜ inch
Thickness firebox extension throat sheet	½ inch
Thickness outside throat sheet	15/16 inch
Thickness front flue sheet	9/16 inch
Thickness smokebox	⅝ inch
Thickness smokebox liner	¾ inch
Tubes, number	50
Tubes, diameter	5½ inches
Flues, number	275
Flues, diameter	2¼ inches
Arch tubes, number	4
Arch tubes, diameter	3½ inches
Tubes and flues, length	21 feet
Heating surface, tubes	3,388 square feet
Heating surface, flues	1,506 square feet
Heating surface, firebox	376 square feet
Heating surface, arch tubes	41 square feet
Heating surface, total	5,311 square feet
Heating surface, superheater	1,298 square feet
Equivalent heating surface*	7,258 square feet
Grate area	88.3 square feet

Table 2.—Staybolt Installation in 2-10-2 Santa Fe Locomotive

Number of crown stays	454
Diameter of crown stays	1 3/16 inches
Number of screw stays	883
Diameter of screw stays	15/16 inch
Number solid radial stays	414
Diameter of solid radial stays	1 3/16 inches
Number Rome hollow stays	306
Diameter Rome hollow stays	15/16 inch
Number Tate flexible stays	971
Diameter Tate flexible stays	15/16 inch
Number Tate flush stays	30
Diameter Tate flush stays	15/16 inch
Number Tate flexible stays	4
Diameter Tate flexible stays	1 ⅛ inches
Number screw stays	28
Diameter screw stays	1 ⅛ inches

The grate shaker arrangement is such that the cylinders are operated independently and located beneath the cab outside the wind sheets at the rear of the boiler back head. One cylinder is located on each side of the locomotive. The cylinder lever jaws, shaker rod jaws and all operating details have the jaws and arms welded instead of bolted together. The shaker cylinders are arranged so that one cylinder operates the right side grates both front and back and the other cylinder the left side grates.

* Equivalent heating surface = total heating surface + 1.5 times the superheating surface.

(*Continued on page* 124)

Financing Our Foreign Trade*

Provision for Long-Term Credits Necessary so That the World Can Do Business With Us

BY GEORGE ED. SMITH**

THE business men of the country have watched and waited for more than two years, while the time has arrived when it has been necessary to provide some means for preventing the complete disruption of our export trade. Since the armistice a $4,000,000,000 trade balance has piled up, and now a further balance finds difficulty in being financed. The National Chamber of Commerce, the National Foreign Trade Council, the National Association of Manufacturers, all agreed long ago that something should be done to solve this great problem. The opportunity came when Congress passed the "Edge Act," and when a committee of the American Bankers' Association formed the plans for the Foreign Trade Financing Corporation, which by its very size and its nationally representative character, is expected to make real headway in remedying the chief obstacle now in the path of American exporters.

Foreign buyers need American goods more than ever; American manufacturers, business men and farmers need more than ever to supply what the foreigner wants. They have the demand. We have the goods. By supplying that demand we could get rid of that great surplus, could keep busy six days a week instead of four, and could pave the way toward a new position for the United States in the international commerce of the world.

> The solution of American labor's greatest problem—unemployment—is the exporting of American time sheets to bring back American payrolls. The products of American workmanship under our present credit system can only go part of the way in reaching the foreign buyer. To reach the foreign buyer, to keep American goods flowing, American industries running, and to bring back work for the four million pairs of American idle hands, there must be provided at once adequate machinery for granting long-term credits in our export trade. Until these long-term credits are available, American cargoes will be halted in mid-ocean, caravans loaded with American goods will be stopped in the middle of their journeys, and a great barrier will remain in place in all parts of the world, checking the flow of American time sheets for the solution of filling American payrolls.

Why can't this be done now?

Because the commercial banks of the United States cannot go on extending long-term loans, and further, because the American dollar is at such a high premium in foreign countries that foreign buyers cannot afford to do business with us on the short-term basis, customary in this country. In granting short-term credits the limit has about been reached. It is only by giving the foreign buyer more time in which to pay for his goods that we can compete successfully with the rest of the world and sell our surplus products abroad.

Now, what is the reason for this four-billion dollar trade balance, and why is it threatening to put us out of business with the rest of the world?

Foreign buyers since the armistice piled up this four-billion dollar trade balance as a result of purchases, which would ordinarily have been stretched out over a period of years. Normally they would have purchased what they needed, and the balance of trade kept practically level, although it was turning in our favor, but instead of taking a sufficient amount of time so that demand would balance demand, or so that we would absorb direct securities from the other side, as England and France did in the past, this balance piled up through an immense one-sided purchasing on the part of foreign buyers in a short time.

Such a thing would not have happened, if this balance of trade had gradually grown in our favor rather than to be dumped upon us. We would have had a gradual balance of trade to even up, and as it was gradual, we would have absorbed securities as the natural way to balance up that trade. It was not possible to educate the people of this country as to the advantage of absorbing foreign securities direct, since they had been a debtor people so long that they do not know what to do as a creditor.

Therefore, there had to be a medium through which to absorb these securities, first investigating their worth, and then pooling them and issuing debentures based on them to the people. It has been felt that the big jump in the balance of trade with its consequent disruption of exchange would, undoubtedly, not have come if securities had been absorbed to correct it. Therefore, let us consider a proposition which will absorb these securities in sufficient volume to have some effect on the balance of trade. This is the reason for the immense size of the Foreign Trade Financing Corporation.

Let us see whether we want securities or not. In the first place, if we do not get securities in payment for the goods we have sent abroad, we are going to get other goods. Do we want a tremendous amount of imported goods dumped in on us? We want raw materials that we do not produce. We want many things, such as coffee, rubber, sugar, etc., cheaper, so that we will get more of the good things of the world that we do not produce for less of our individual effort. We want imports of certain goods, but we do not want four billion dollars' worth of manufactured goods dumped into the country, when we are now able to produce more of manufactured goods than we can consume. Wouldn't it be better to absorb good securities and have foreign people pay us interest? In the last analysis, we must import goods, gold or securities to settle our trade balance. We do not want the goods—we have taken all the gold foreign people can spare—and now we stand up against a wall because we cannot absorb securities. For the present we have taken more than enough from Europe that is movable. We do not want any more. We must become, as we would have become under normal conditions, a rich investing nation, as every rich exporting nation in the past has always become.

The question then is, whether this country will back up its export trade. It is not a question of whether the Foreign Trade Financing Corporation itself will succeed or not. The question is, whether we can get behind the proposition and by group thinking and concerted action, solve one of the biggest problems that has ever confronted our country. Put it another way, the question is, whether we have to depend upon a crisis to show the country that it ought to have done what the brains of the country are now telling us we ought to know.

---

* From an address delivered at Editorial Conference luncheon, Associated Business Papers, Inc., New York, February 18, 1921.

** President, Royal Typewriter Company, and member, Organization Committee, Foreign Trade Financing Corporation.

The problem is one which it will take an immense institution to handle. We will say now that we want to solve one particular problem, and I will lay it in front of you concretely.

There is in Australia to-day a market for American automobiles. We are not shipping them. Why? Because there is not a dollar market in Australia at this moment, and for that reason many of our men in Detroit are not working, and we are not producing the automobiles. We must create a dollar market in Australia in order to sell our goods there and keep our men working. How are we going to do it? By long-term credits. Is it right that we should have unemployed workmen in the country when we can by right action revive our market abroad? This is not being done out of charity of our hearts to help people who cannot help themselves. It is not an effort to make the League of Nations work. It is to develop the market for American products outside the United States. Why not take our dollars—put them to work—go on paying our workmen and keep up the prosperity of the country?

We manufacture a tremendous amount of goods in America beyond the amount that is needed for home consumption. Naturally we cannot sell them in America. We need outside markets to dispose of them. When we cannot do this, there is unemployment for the men who manufactured these goods. When all is said and done when we export, we export labor. Labor is the biggest part of all goods we export. Take the automobile. The manufacturer of this article does not make ten percent profit on his turnover. If he did, he would be many times a millionaire. No, he makes nearer 5 percent. Fifteen percent of his cost goes to buying raw materials. The remainder goes into labor. In the end, more than 75 percent of his cost goes to the workman. What, therefore, we are trying to do is to take the time sheets out of the factories of America, export them, and bring back payrolls for our American workmen.

When you finance foreign trade, you only finance the time of our American workmen a bit further to its ultimate consumer.

Some time ago, we, as manufacturers, sat back and said to the parties in the other countries, "Come to our factory and get the automobiles, and pay us cash." The farmer said, "Come and get my corn from the farm or the local elevator, and pay cash." When our exports began to decline, our producers relented a bit, and financed their goods to the port of shipment, letting the buyer take and pay for them there. Now our exports have shrunken so far, and our available financial machinery has become clogged so much, that we cannot carry the goods any further along to the ultimate consumer. It is impossible for the foreign buyer to take goods on the terms made available by our commercial banks, and therefore we cannot sell the goods.

This is not the bankers' problem alone. It is the people's problem. It requires *group* thinking, *group* action.

I think that having a hundred million people, all wearing the same hats, the same clothes, the same ties, the same shoes, all eating the same things, is a tremendous advantage for any nation. It gives a standardized market for the products of the country. That gives us a great advantage in going out and selling these standardized goods in the world's markets. But this great body of one hundred million people is unorganized, and you know that an unorganized majority in many cases will not do what an organized minority could.

The answer is this: We must educate the people. We must bring about group thinking, making the people realize that what we are doing is putting machinery in operation, which will back their payroll. We must make them understand that it is their problem. If all of us sit aside and wait for somebody else to act, the task will never be done.

I am thoroughly convinced that what we need in this country is to think together, work together, act together, in a real spirit, and then the financing of our foreign trade will go over and be one of the greatest propositions of the world.

Notes on General Shop Practice at Du Bois

By George W. Armstrong

Many interesting and effective methods have been developed at the Du Bois shops of the Buffalo, Rochester & Pittsburgh, each one a real factor in increasing the efficiency of shop operation. Careful attention to details, elimination of much lost motion and the equipment of machines with timesaving jigs and fixtures all help to increase shop output and reduce the unit costs of repair work.

Washout plugs are quickly and accurately turned and threaded in an engine lathe, Fig. 1. Several sizes of castings are carried so as to reduce the amount of metal to be removed to an economical minimum, about 1/8 inch range being cared for by each casting. The small end of the plug is cored out to a bell shape to reduce the weight and permit quick center punching for the tail stock center.

The threading tool is a hobbed chaser (as shown on top of the tool post) held in a block fitted to take the place of the

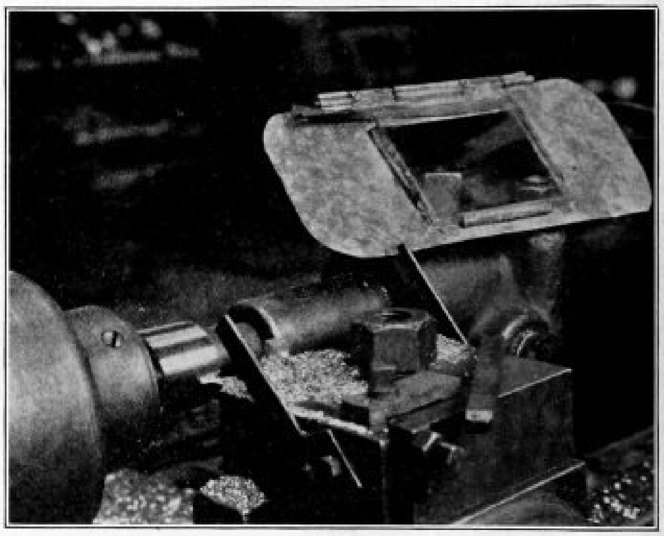


Fig. 1.—Method of Machining Washout Plugs

regular tool post. Grinding this tool at an angle furnishes a turning edge to precede the threading chaser. By means of an adjustable stop, the carriage travel can be regulated, permitting the taking of several cuts and yet maintaining the size where a number are made of the same size. The taper is obtained by setting over the tail stock, as this method has been found to give the best results. The strips, shown at an angle on the side of the tool block, have been provided to

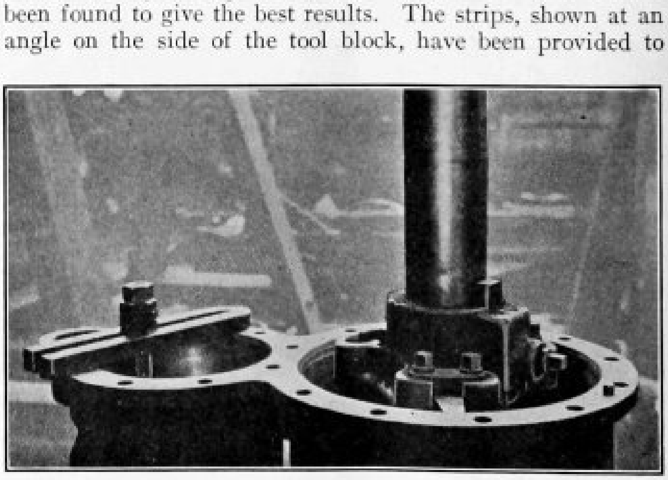


Fig. 2.—Adjustable Head Used in Boring Air Compressor Cylinders

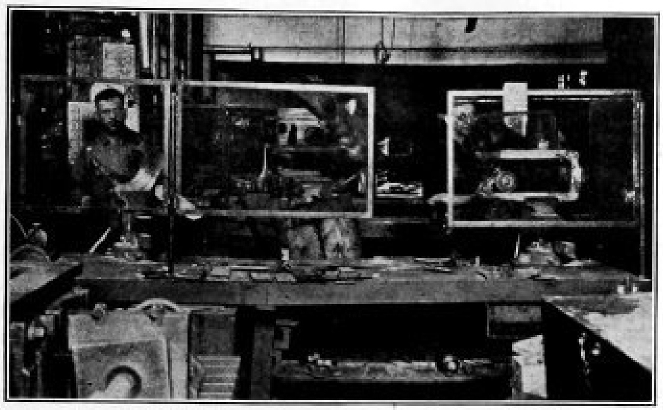


Fig. 3.—Folding Screens Are a Convenient and Effective Safety Device

hold the hinged guard, protecting the workman from flying brass chips. The average production, working on a quantity shop order, is 100 plugs in eight hours.

Air-compressor cylinders are accurately and quickly bored on a radial-drill press, Fig. 2, the steam cylinder of an 8½ inch cross compound compressor being shown. A regular boring tool through the bar is used for the small bore cylinders, the adjustable boring head being used for the 14½-inch cylinders. The boring bar is maintained rigid by a pilot bracket bolted to the side of the drill-press table. As illustrated, a clamping bolt and cross iron through one cylinder allows the other cylinder to be swung over the side of the drill-press table and the boring bar extends through the cylinder to the pilot bracket. A roughing feed of .009 inch and finishing feed of .006 inch are used.

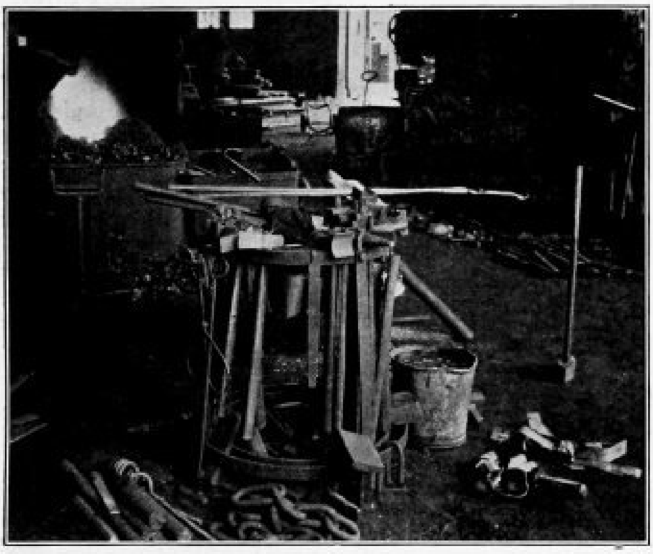


Fig. 4.—Handy Tool Rack With Sheet Iron Drawer

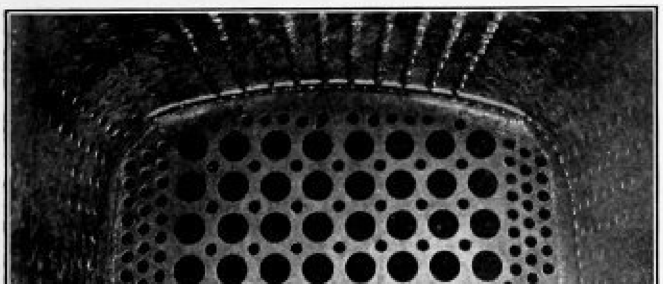


Fig. 5.—Application of New Flue Hole Portion to Back Flue Sheet

Safeguards are everywhere in evidence in the Du Bois shops, indicative of the vigilance of the men on the safety committee, who make a general inspection of the shop every other Saturday afternoon. One very simple and valuable safety device is the screen, Fig. 3, used around vises where much chipping and filing is done, especially in the rod department. These screens when not in use can readily be folded back out of the way.

A good blacksmith shop tool rack has been devised, Fig. 4, which keeps the tools readily available and near the anvil where wanted. It consists of two concentric circles of 1½-inch by ¼-inch iron separated as shown, one pair forming the top and the other the bottom of the tool rack. A sheet-iron drawer is provided in the center for keeping orders, time books, etc. It is difficult to say just how many steps and how much time are saved each day by having tools and working implements right at hand ready for use.

Fig. 6.—Fixture Used in Rolling Boilers

Rolling boilers is quickly and easily accomplished by the fixture illustrated in Fig. 6. The boiler is slung from the main-hoist hook with the steel-shackle bar under the belly of the boiler. Turning to any desired position is accomplished by the cable attached to the auxiliary-hoist hook.

The practice of electric welding has come into general use at Du Bois and shows excellent results, especially on boiler work. A large number of fireboxes have been applied with complete electric-welded seams, except at the top of the back tube sheet, where it has been found more satisfactory to rivet to the crown sheet. Back heads are welded in completely, including the door holes. Where flue sheets require replacing solely because of cracked bridges or where a change is made from saturated to superheated steam, the flue hole portion is cut out by the torch and a new section welded in place, Fig. 5, thus requiring no renewal of staybolts or driving of mud-ring rivets. Side sheets requiring renewal because of enlarged staybolt holes, or other causes except defective seams, are renewed by electrically welding a new section in place.

Composition and Properties of Boiler Tubes*

Study of Causes Underlying Defective Tubes and the Effect of Grain Growth on the Physical Properties

BY ALBERT E. WHITE.†

During the winters of 1913-1914 and 1914-1915 considerable difficulty was experienced by the Park Place heating plant of the Detroit Edison Company in maintaining continuity of boiler operation. This difficulty arose because of the frequent shutdowns necessitated when boiler tubes bore evidence of being or becoming defective, requiring in consequence the temporary closing down of the boiler or boilers until the tubes in question could be replaced. Tubes in the front bank of the boilers were particularly prone to develop defects, and since this condition was experienced in its most aggravating form at a time when the boilers were most needed, namely, during the various cold snaps of the winter, investigations were started so that suitable steps might be taken to combat the trouble.

The necessity for obtaining relief was emphasized in June, 1915, when No. 7 tube in the third row of No. 7 boiler at the Park Place heating plant let go. The appearance of this tube after the accident is given in Fig. 1. This tube failure made necessary the rebuilding of most of the boiler, and especially the replacement of nearly all of the tubes in the boiler. Fortunately no injuries were sustained by any of the men in the plant.

The accident, however, indicated the need for prompt relief and investigations were started along three lines: (*a*) water softening, (*b*) rearrangement of baffling, and (*c*) considerations relating to the composition and constitution of boiler tubes.

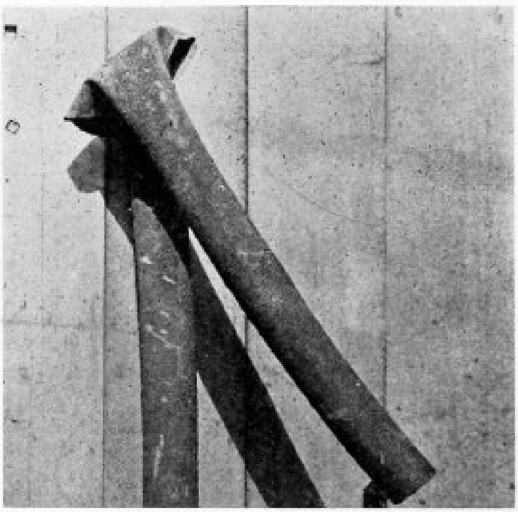


Fig. 1.—Burst Tube From the Heating Plant, Detroit Edison Company

With reference to water softening, it was noted that practically all of the tubes which were replaced showed a thin but tough scale on the water side. This scale was calcium sulphate and was thin simply because the quantity of this salt in the boiler feed water was relatively small and in plants operating under normal load conditions would have warranted no considerations. In these boilers, however, which were of the Stirling watertube type of 750 horsepower, the long periods of cold often necessitated a load averaging 80 percent above the nominal rating for periods extending at times into as many as six days. These load conditions, while not apparently unusually exacting, were in reality very severe when cognizance is taken of the fact that 98 percent of the boiler feed water was raw water drawn from the city mains.

Effect of Scale on Tubes

There was no question but that the thin scale seriously affected heat transmission and was one of the contributing factors leading to tube failure. Much research work was done on this phase of the problem and it resulted in a decision to treat all of the water in the plant with soda ash. Since this treatment has been in use practically all of the insolubles are caught in the live steam purifier. There is no scale in any of the tubes, although there are flocculent particles of insoluble sodium carbonate circulating with the water in the boilers. This product, together with the other minor insoluble ones that may be present and the soluble salts, especially sodium sulphate, are kept down to harmless percentages by frequent boiler blow-offs. The Dionic tester is used as a guide, experience indicating that when it reads under 1,800 no fear need be had of trouble resulting from foaming and priming.

Changes in Baffling

Steps were also instituted with reference to a study of the baffling. At the time when the trouble was most pronounced, the front baffles were between the first and second rows of tubes. This arrangement had been adopted since it was believed that it would produce higher temperatures with consequent fuel economy and abatement of the smoke nuisance.

The investigations showed that most of the tube replacements were from the front row. For the purpose therefore of distributing the radiant heat among a greater number of tubes, hoping in this way to increase tube life without, however, carrying the same to such an extent as to decrease the fuel economy or run into the smoke troubles coming from incomplete combustion, the front baffling was changed so as to lie between the second and third rows rather than between the first and second rows. This arrangement has been most beneficial. There has been no decrease in fuel economy nor increase in smoke nuisance and tube replacements have been materially lowered.

Constitution of Tubes

Under the third line of investigation listed above—the composition and constitution of boiler tubes—the first step was a study of the constitution of the metal in the tubes. This was undertaken for the purpose of ascertaining the effect of service conditions upon the types of tubes now employed. The metal in a very considerable number of tubes was examined metallographically, the etching mediums being the common nitric acid and the so-called Rosenhain reagent. This latter deposits copper over the surface of the metal, giving an even coating when the distribution of the metalloids is uniform; but when such is not the case, disclosing minutest segregations and imperfections most clearly by variations in the depth of the plating.

Two photomicrographs showing the structure of a piece of boiler tube metal which was selected as typical of the average of the majority of the sections examined are shown in Figs. 2 and 3. The photomicrograph in Fig. 2 was taken after a sample had been etched in nitric acid, and in Fig. 3 treated with the Rosenhain reagent. It will be noted that the etching is uniformly distributed, indicating that the constituents are evenly dispersed throughout the metal. A clearly defined ghost line is brought out, resulting from phosphorus segrega-

* Abstract of paper presented at the annual meeting, New York, December, 1920, of The American Society of Mechanical Engineers.

† Consulting Metallurgical Engineer, Professor of Chemical Engineering, University of Michigan.

tion, although more apparent in one resulting from the Rosenhain etching. There are also strikingly evident cavities or segregations which the writer has detected in many of the samples which he has examined. He considers this condition most serious and will further discuss it below.

CAUSES OF TUBE FAILURE

On the completion of this preliminary survey attention was directed to the causes of tube failure. Excluding that due to imperfect heat transmission resulting from scale, the writer believes that the principal causes can be listed under the following heads:

(*a*) Failure due to tube brittleness resulting from absorption by the metal of hydrogen and usually attributable to faulty boiler feed water treatment.

(*b*) Failure due to blowholes or other imperfections in the metal.

(*c*) Failure due to recrystallization of the metal.

Tube Brittleness Resulting from Hydrogen Absorption. The first of these causes, namely, that due to tube brittleness resulting from the absorption by the metal of hydrogen, will not be developed in this paper. The facts are outsanding that contained hydrogen in metal makes it extremely brittle. The facts are further outstanding that certain types of water improperly treated, or all water excessively treated with certain types of boiler compounds, will cause the tubes to absorb hydrogen and become brittle. With intelligent treatment, however, there need be no cause for concern over tube failure from this source.

Failure from Blowholes. Failure from blowholes and other imperfections, the writer believes, should receive greater consideration in the future than has been accorded it in the past. The matter of course goes back to the steel mill and calls for greater emphasis on quality and less on tonnage.

A photomicrograph of a sample of metal containing blowholes is shown in Fig. 4. The ghost line is evident, and even a casual scrutiny reveals radiating lines issuing from the center of the cavity. This condition is manifest in all of the photomicrographs taken of specimens with blowholes and indicates a lack of continuity of the metal. Should service conditions cause the tube to bag and should a cavity of the pipe shown in Fig. 2 be at the nipple of the bag, there is every reason to anticipate a bursting of the tube, with all of the attending dangers and expense.

Failure from Recrystallization. This matter merits much consideration. Recrystallization is accompanied by a marked decrease in the elastic limit and fatigue-resisting properties of the metal manifesting this phenomenon. It will occur if steel with a low carbon content which has previously been mechanically deformed at a temperature below the critical is

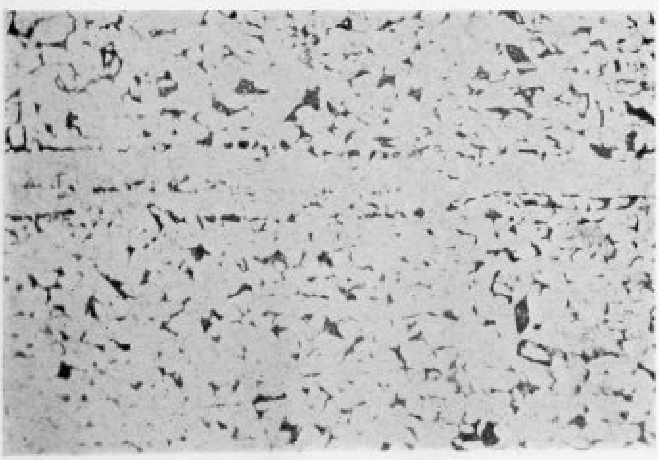


Fig. 2.—Average Boiler Tube Structure Etched With Nitric Acid, With a Magnification of 100

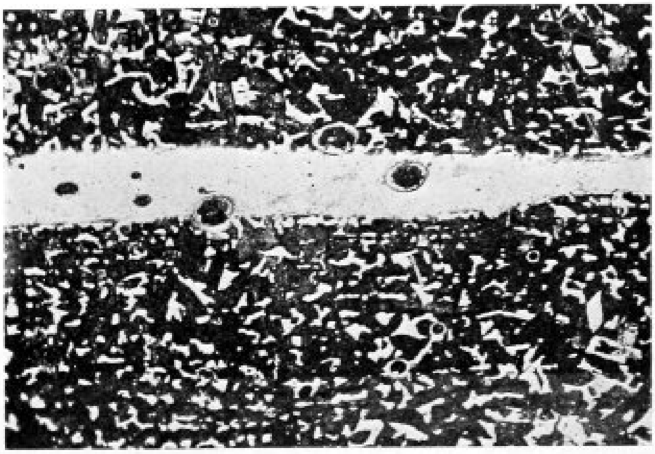


Fig. 3.—Rosenhain Etched Boiler Tube Structure, Magnification 100

later heated for a sufficient time to any temperature below that at the critical. The common composition for boiler tubes is such that this class of metal is especially susceptible to this phenomenon. Mechanical deformation to some degree is unfortunately assured by present-day methods of handling tubes, for at the mill tubes are straightened and in many cases actually brought to final size when below the critical temperature. Tubes are often bent during fabrication and erection and are universally rolled into the tube sheet when cold, and the methods of cleaning tubes in service often employ forms of apparatus which produce local deformation by repeated hammer blows. Finally, the time and temperature conditions required for recrystalization are present.

TIME--TEMPERATURE CRITERION FOR CRYSTAL GROWTH

Heating of deformed metal to temperatures approaching the critical causes crystal growth in very short time periods. Corresponding growth occurs more slowly at lower temperatures, the time periods required for the same increasing very rapidly as the temperature to which the material is heated decreases. Values experimentally determined for temperatures from 550 degrees C. (1,022 degrees F.) to 675 degrees C. (1,247 degrees F.) for one set of conditions are given by the following equations:

T (minutes) $= 8$ for 675 degrees C. (1,247 degrees F.)
T (minutes) $= 8 \times 3$ for 650 degrees C. (1,202 degrees F.)
T (minutes) $= 8 \times 3^2$ for 625 degrees C. (1,157 degrees F.)
T (minutes) $= 8 \times 3^3$ for 600 degrees C. (1,112 degrees F.)*

or, in general, for temperatures below 675 degrees C. (1,247 degrees F.):

$$T = 8 \times 3^n,$$

where:

$T =$ time in minutes.
$t =$ temperature in degrees C.
$n = (675 - t)/25.$

That the normal method of handling boiler tubes results in mechanical deformation and that this metal as a result, under the proper conditions of time and temperature, will develop large crystals, is shown in Figs. 5 and 6. Fig. 5 is from a photomicrograph of a specimen of a tube which has been so deformed, and Fig. 6 from a specimen after receiving heat treatment at a temperature below the critical which quickly developed grain growth. A comparison of the grain sizes of the two samples indicates that the tube has been sufficiently deformed to respond to the laws of grain growth when the proper conditions for this development are present.

PHYSICAL TESTS

Both tension tests and fatigue tests were made to determine the effect of coarse grains on the physical properties of the

* Recrystallization as a Factor in the Failure of Boiler Tubes, White and Wood. Proc. American Society for Testing Materials, vol. xvi, pp. 82-116.

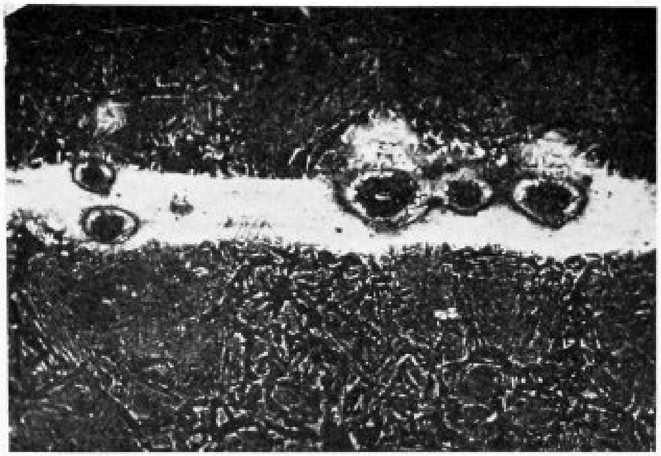


Fig. 4.—Example of a Blow Hole Occurring in Section of Boiler Tube, Rosenhain Etched

tubes. In each of the tension tests three samples per set were employed: The first on metal as received, the second on metal annealed for 10 minutes at 950 degrees C., or 1,742 degrees F., and then cooled in the furnace, and the third on coarse grained metal produced by stressing all of the test specimens the same amount and in all cases past the elastic limit and followed by an annealing for three hours at a temperature of 800 degrees C., or 1,472 degrees F. In the fatigue tests ten samples per set were used because of the greater difficulties in a test of this kind in securing check results.

The physical properties of the "as received" samples showed satisfactory metal. The average tensile strength and elastic limit values of the "coarse grain" samples were 27.2 and 58.9 percent lower than they were for the "as received" samples, and indicate therefore a decidedly inferior grade of metal. In the fatigue tests, also, the "coarse grain" metal was 16.2 percent poorer than the "as received" and 48.70 percent poorer than the "annealed" metal.

Composition of Tubes

In view of all of the conditions above pointed out, there arose a question as to whether or not the present composition of boiler tubes, from the consumer's standpoint, was the most acceptable. Would there be a composition as easy to make from the producer's viewpoint, as easy to install, as resistant to the absorption of hydrogen, more strong, as, free, if not freer, from blowholes, and above all less subject to recrystallization?

This is a formidable set of conditions, and yet do not tubes with a carbon content between 0.30 to 0.35 percent more perfectly meet all of the above conditions than tubes with a carbon content ranging between 0.08 to 0.18 percent?

Tubes with this higher carbon range will not be appreciably more difficult to manufacture or to install and there is nothing to indicate that they will absorb hydrogen more readily. It should be possible to make them as free of blowholes; there is no question but that they are at least 40 percent stronger as measured by tensile strength and elastic limit tests throughout all working temperatures with no detrimental decrease in elongation or reduction; and, finally, and most important of all, tubes with the higher carbon range are not subject to recrystallization.

On this last point the literature is suggestive, although there have been no pieces of work as yet published as far as the writer knows which give direct proof.

In view of this condition, therefore, the following test was carried out to ascertain roughly the carbon range in which grain growth on deformed iron* when heated at temperatures below the critical range occurred. Five irons were used with carbon varying from 0.006 to 0.315 percent. Each of the samples was annealed so as to secure freedom from strains and obtain minimum grain size. This treatment was then followed by impressing a 5-millimeter ball on each specimen under a load of 3,000 kilograms. Each sample was then heated for four hours at 675 degrees C., or 1,247 degrees F., a temperature considerably below the critical for all of the carbon ranges present. The specimens were then examined and the average grain size in the section undeformed and in that portion of the deformed area showing maximum grain size compared.

The results given in Table 1 indicate that iron in carbon ranges from 0.006 to 0.251 percent, inclusive, undergoes a perceptible grain growth when treated as just described, and that iron with a carbon content of 0.315 percent is not thus visibly subject to grain growth. Not only was there evident a marked growth in the ferrite grains for the irons ranging in carbon content from 0.006 to 0.251 percent, inclusive, but in the irons in this range where there was a visible quantity of carbon existing as pearlite, very apparent agglomeration or balling up of this constituent was in evidence.

TABLE 1.—EFFECT OF CARBON CONTENT ON GRAIN GROWTH IN DEFORMED IRON WHEN HEATED BELOW THE CRITICAL TEMPERATURE

Carbon Content,	Number of Ferrite Grains per Square Inch	
Percent	Undeformed	Deformed
0.006	3.9	1.9
0.103	25.4	13.4
0.203	63.4	23.0
0.251	26.3	16.0
0.315	(a)	(a)

(a) Grains too small to count. Photomicrographs from both the undeformed and deformed areas show no appreciable difference in grain size.

Service Comparison Between Medium-High and Low Carbon Boiler Tubes

Not only do all theoretical considerations point to the procurement of an increased life for boiler tubes through a raising of the carbon content, but the results of some actual tests on which data are now available seem to indicate and confirm this claim.

This test was started in 1916-1917 by placing in the front row of four of the 750-horsepower Stirling boilers at the Park Place heating plant of the Detroit Edison Company tubes of a medium-high carbon content averaging around 0.30 percent carbon, and in four other boilers at the same plant operating under the same loads at about the same time tubes with a carbon content between 0.08 and 0.18 percent.

The results given in the "Service Test" (Table 2) speak for themselves, for of the medium-high carbon tubes only

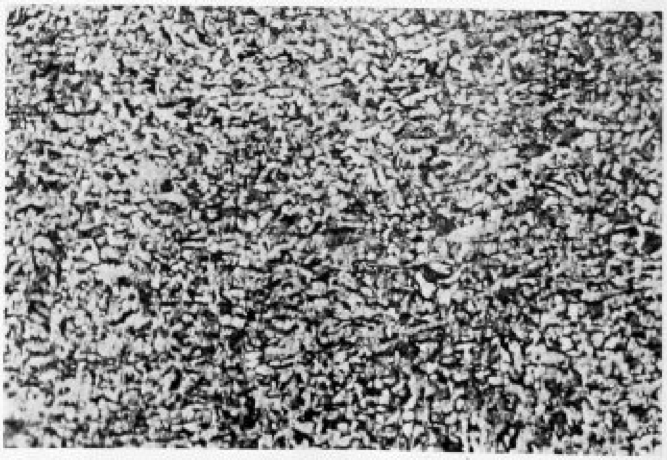


Fig. 5.—Section of Boiler Tube Adjacent to Tube Sheet, Before Heat Treatment

* The word "iron" is used in its generic sense and is intended to include steel and what is commonly called ingot iron.

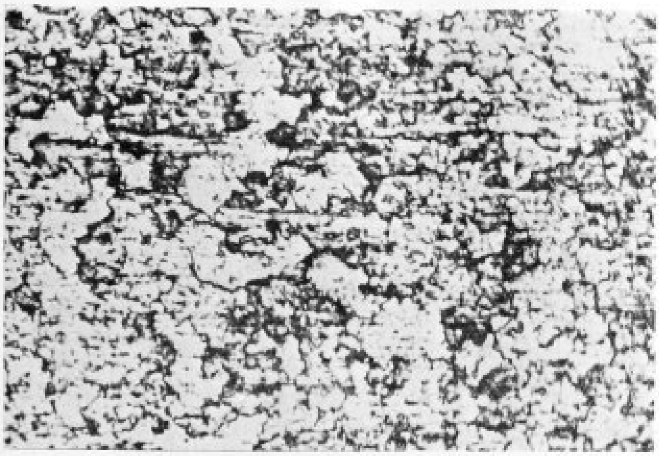


Fig. 6.—Effect on Grain Growth of Heating Boiler Tube at 650 Degrees C. for 15 Hours

TABLE 2.—SERVICE TEST ON MEDIUM-HIGH AND LOW CARBON BOILER TUBES AT PARK PLACE HEATING PLANT, DETROIT, MICH.

Boiler Number	Installation Number	Installation Date	Replacement Number	Replacement Date
High Carbon Tubes in Front Row				
3	29	June 19, 1916	27	July 27, 1918
			15	Summer, 1920
6	29	May 9, 1916	13	Sept. 11, 1917
			5	July 15, 1919
			1	Summer, 1920
7	29	June 19, 1917		
8	29	June 9, 1917		
Totals	116		61	
Low Carbon Tubes in Front Row				
1	29	Sept. 23, 1916	27	July 12, 1918
			5	Summer, 1920
2	29	Sept, 18, 1916	10	Sept. 28, 1917
			27	July 11, 1920
			7	Summer, 1920
4	29	June 14, 1916	18	Jan. 6, 1917
			5	July 27, 1918
			13	June 17, 1919
			5	Summer, 1920
5	10	June 5, 1916		
	19	Aug. 3, 1917	10	August 3, 1917
Totals	116		127	

about one-half have been replaced, and of the low carbon tubes more than a 100 percent replacement has been necessary

This paper has been prepared not for the purpose of suggesting radical changes in boiler tube composition nor for the purpose of criticizing present boiler tube manufacturing practices, for, all things considered, it is on a very high plane with respect to quality. It has been prepared, however, to present certain facts, especially those relating to grain growth, to which tubes of the commonly accepted composition are so subject; and in view of these facts to question whether tubes with a carbon content varying between 0.30 and 0.35 percent would not insure longer tube life and safer boiler operation than tubes with a carbon range between 0.08 to 0.18 percent.

Spring Meeting of American Society of Mechanical Engineers

May 23 has been set as the date of the spring meeting of The American Society of Mechanical Engineers. It will be held in Chicago at the Congress Hotel.

Sessions are planned by the professional sections on aeronautics, fuels, management, material handling, machine shop, power, forest products and railroads.

J. F. Lary, who was for eight years superintendent of the Watson-Stillman Company's plant, has accepted a position as assistant works manager with the Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Constitution and By-Laws of National Board of Boiler Inspectors

The report of the February convention of the National Board of Boiler and Pressure Vessel Inspectors, which appeared in the February and March issues of THE BOILER MAKER, did not contain the constitution adopted by the Board at this meeting. This constitution, outling as it does the policies and scope of the Association, has as its principal object the promotion of uniformity in the construction and inspection of boilers in the United States.

Preamble

The National Board of Boiler and Pressure Vessel Inspectors is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances, and to secure interchangeability between political subdivisions of the United States.

Constitution

Article 1

Section 1. *Name:* This organization shall be known as The National Board of Boiler and Pressure Vessel Inspectors.

Article 2

Section 1. *Objects:* To promote uniform boiler laws and rules throughout the jurisdiction of its members;

To secure uniform approvals of specific designs of boilers and other pressure vessels as well as appurtenances and devices used in connection with their safe operation;

To promote one uniform code of rules and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for inspectors who are to enforce the requirements of said code; and

To compile official statistics and other data.

Article 3

Section 1. *Membership:* The membership of this Board shall be restricted to the Chief Inspector, or the official charged with the enforcement of inspection regulations by any political subdivision of the United States that has adopted any of the codes of the American Society of Mechanical Engineers.

Section 2. Such membership shall terminate when such Chief Inspector or other official ceases to be employed by such political subdivision, or when such political subdivision shall no longer accept any of the codes of the American Society of Mechanical Engineers.

Section 3. *Honorary Members:* Any person who renders distinguished service in the promotion of public safety by the procurement of uniform regulations and laws may be elected to honorary membership by the unanimous vote of the Board at a regular meeting.

Section 4. *Associate Members:* Any person who is concerned with or interested in uniform regulations of steam boilers and pressure vessels may be elected an associate member by the Executive Committee, but no such associate member shall be entitled to vote or hold office. Any member who retires from active membership in the Board shall, at the option of such member, be placed on the roll as an associate member. Annual dues for associate members shall be five dollars.

Section 5. *Certificates of Membership:* The Executive Committee of the Board shall provide suitable certificates for the various grades of membership in the National Board of Boiler and Pressure Vessel Inspectors.

Article 4

Section 1. *Officers:* The officers of this Board shall be a Chairman, a Vice-Chairman, a Secretary-Treasurer and a Statistician.

Section 2. *Election of Officers:* Such officers shall be elected at a regular meeting by a majority ballot, and shall hold office for the period of two years, or until their successors are elected and qualified.

Section 3. Officers shall be elected from the membership of this Board, except that the Secretary-Treasurer and Statistician shall be a present or past member.

Article 5

Section 1. *Duties of Officers:* Chairman—It shall be the duty of the Chairman to preside at all meetings; preserve order during its deliberations; to appoint all committees; and to sign all records and other documents used in connection with the work of this Board.

Section 2. Vice-Chairman—The Vice-Chairman shall perform all the duties of the Chairman in the case of his absence or disability, and in case of the resignation or death of the Chairman shall perform all the duties of that office until such vacancy is filled by an election as herein provided.

Section 3. Secretary-Treasurer—The Secretary-Treasurer shall have full charge of all books, papers, records and other documents of this Board; he shall receive and have charge of all fees and other moneys, and shall pay all bills; he shall keep the minutes of all meetings; and shall keep a full and complete record of all receipts and disbursements; he shall conduct all correspondence pertaining to his office; he shall compile statistics and other data as may be required for the use of the members; and shall perform such other duties as this Board may from time to time designate. In the event of the office of the Secretary-Treasurer becoming vacant before the expiration of the term for which he was elected, the Executive Committee shall appoint a successor for the unexpired term.

Section 4. Statistician—The Statistician shall procure and keep record of such statistics as may be required by or useful to the Executive Committee.

Article 6

Section 1. *Committees:* There shall be an Executive Committee, consisting of the Chairman, Vice-Chairman, Secretary-Treasurer and Statistician, which shall, between regular meetings, carry into effect any and all matters pertaining to the welfare of the Board.

Section 2. There shall also be the following standing committees:

1st. On specific designs of boilers and other pressure vessels and appurtenances and devices used in connection with their safe operation;

2d. On qualification and examination of Inspectors.

Section 3. Such other committees shall be appointed from time to time as may be required.

Article 7

Section 1. *Removal of Officers:* Any officer or member of any committee may, for just cause, be removed by a majority vote of the membership of this Board at any regular meeting or special meeting called to consider any grievance or charges, which must be filed in writing, against such offending officer or member of a committee after 30 days' notice.

Article 8

Section 1. *Meetings:* At least one meeting shall be held annually, and special meetings may be held, upon 30 days' notice, at such time and place as may be deemed expedient by the Executive Committee, provided, however, that if such meeting is called for the purpose of considering any specific design, appurtenance or device, the expense of such meeting shall be paid by the person or persons making the application.

Section 2. *Quorum:* Seven members shall constitute a quorum for the transaction of business, except that the approval of any specific design, appurtenance or device shall require the 90 percent affirmative vote of the membership of this Board.

Article 9

Section 1. *Order of Business:* The order of business at all meetings of this Board shall be as follows:

1. Roll call;
2. Reading of minutes of previous meeting;
3. Reports of standing committees;
4. Reports of special committees;
5. Communications from officers and members;
6. Unfinished business;
7. New business.

Article 10

Section 1. *Amendments:* This Constitution may be amended by a three-fourths vote of the entire voting membership. Such action must be taken at a regular meeting. A vote by mail can be recorded, provided it is received before or at such meeting.

By-Laws

Article 1

Section 1. *Approval:* Whenever it is desired to have the approval of this Board on a specific design of steam boiler or other pressure vessel, or of any appurtenance or device used in connection with same, the applicant for such approval shall furnish the Secretary-Treasurer six copies of blueprints, specifications or other data.

Section 2. The Secretary-Treasurer shall then refer the matter to the standing committee appointed for such purpose. Upon a report of this committee the applicant will furnish the Secretary-Treasurer a sufficient number of copies of blueprints, specifications or other data as may be necessary to supply each member of this Board with a copy.

Section 3. The approval of such specific design, appurtenance or device shall require the 90 percent affirmative vote of the membership of this Board.

Section 4. The Secretary-Treasurer shall keep a complete record to include reasons upon which any application was rejected.

Section 5. Upon receipt of approval by the Board, the manufacturer of such specific design, appurtenance or device shall distinctly stamp same with a four-leaf clover design bearing the initials N. B. B. I.

Section 6. The applicant for the approval of such specific design, appurtenance or device shall pay a fee of one hundred dollars to the Secretary-Treasurer at the time of filing application.

Article 2

Section 1. *Stamp:* Unless otherwise exempted, any steam boiler or other pressure vessel built after July 1, 1921, may be used within the jurisdiction of any member of this Board which has been distinctly stamped with the A. S. M. E. symbol, and the fac simile approved by the National Board of Boiler and Pressure Vessel Inspectors.

Section 2. *Code:* No steam boiler or other pressure vessel may be stamped as specified in Section 1 unless it conforms with the rules formulated by the Boiler Code Committee of the American Society of Mechanical Engineers and has been thoroughly inspected during construction and upon completion by an inspector who has qualified in accordance with the requirements of Art. 3 of these By-Laws.

Section 3. *Data Reports:* The manufacturer of each steam boiler stamped as herein provided shall file with this Board a detailed data report in duplicate, on forms furnished by the Secretary-Treasurer, accompanied by a filing fee of two dollars.

Article 3

Section 1. *Shop Inspection:* No person shall inspect any steam boiler, or other pressure vessel, during construction and upon completion, and witness the stamping of it with the fac simile approved by the Board, unless he has a certificate of competency as well as a commission authorizing him to do so as hereinafter provided.

Section 2. *Certificates of Competency:* A certificate of competency shall be issued by the political subdivision conducting the examination to any person passing a written examination in accordance with the rules formulated by the National Board of Boiler and Pressure Vessel Inspectors.

Section 3. *Commission:* The holder of a certificate of competency issued as herein provided who desires to make inspections in accordance with the requirements of these By-Laws shall make application to the National Board for a commission authorizing him to do so.

Standardization of Flue Safe Ending

BY C. E. LESTER

In many shops the number of safe ends used or the maximum weight at which a flue might be scrapped has been in a great measure left to the judgement of the flue fire operator and to the man on the flue cutting machine, whose total

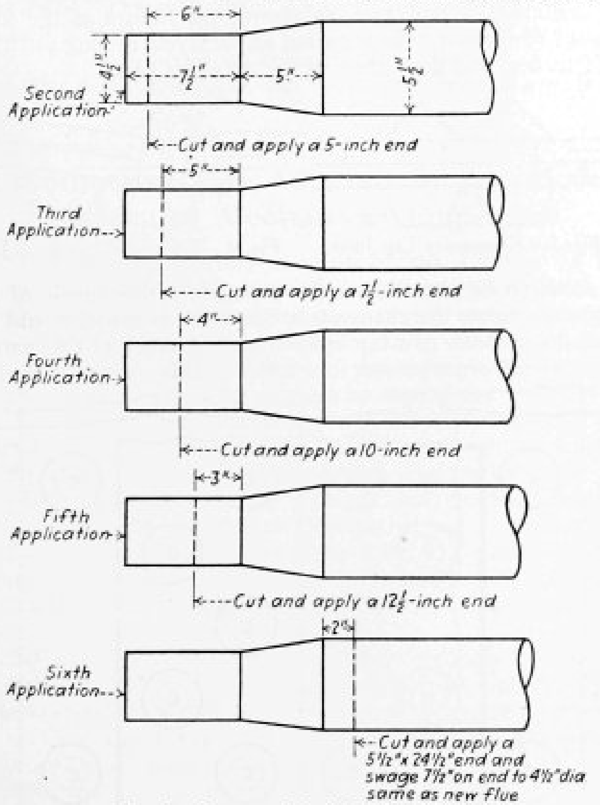


Fig. 1.—System of Safe Ending Flues

knowledge of flues is generally that a short piece is cut off the end to make a place for another new piece.

To eliminate the losses in material caused by scrapping good material and to avoid the delays and failures caused by using unsuitable material and running too many safe ends, a system of weights and measures for safe ends and body flues was on one railroad adopted and is submitted for the approval of the readers of The Boiler Maker.

Superheater Flues

Superheater flues shall be swaged to 7½ inches on the straight and shall be prepared as indicated on the accompanying tables and sketches.

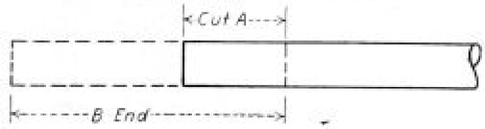
Superheater flues shall not contain more than two welds.

First application, new flue; second application as shown above, and so on.

Flues (other than superheater) shall not contain more than three welds, with a total length of not over 21 inches.

Flues (other than superheater) having more than 21 inches of welds shall have all old welds cut off and a piece of new second hand flue of sufficient size to bring to required length be welded on; to this shall be added a new 5-inch piece at the firebox end. Thereafter the following rules shall govern:

Rules Governing the Safe Ending of Flues at Succeeding Applications



	A Inches	B Inches	Remarks
First application	...	..	New flue
Second application	1½	5	One weld
Third application	5½	8	One weld
Fourth application	8½	11	One weld
Fifth application	11½	14	One weld
Sixth application	1½	5	Two welds
Seventh application	5½	8	Two welds
Eighth application	8½	11	Two welds
Ninth application	27½	30	One weld
Tenth application	1½	5	Two welds
Eleventh application	5½	8	Two welds
Twelfth application	8½	11	Two welds

Flues having worn thin after being cleaned and having reached the following weights shall not be used for steam boiler purposes:

Diameter, Feet	Weight
2	1¾ pounds or less per foot
2¼	2 pounds or less per foot
2½	2¼ pounds or less per foot
3	2¾ pounds or less per foot
3½	4 pounds or less per foot
4	4½ pounds or less per foot
4½	4¾ pounds or less per foot
5½	7 pounds or less per foot

In some few cases flues under the minimum weight for safe steam purposes are made use of in pilot slats, drainage slats, etc., but usually they are good for nothing but scrap.

Changing Old Lap Seam Boilers to Butt Seam Construction*

Not long after the steam boiler came into general use in America considerable discussion was aroused with respect to the question of limiting the life of a boiler. Numerous instances of serious accident, which it seemed impossible to account for, had impressed many with the idea that a boiler, like any other piece of apparatus, was subject to deterioration

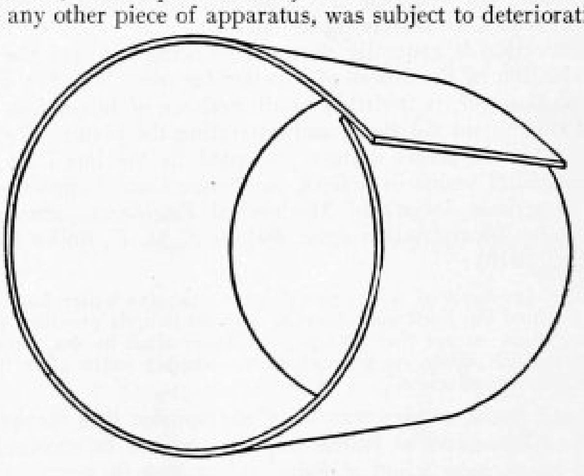


Fig. 1.—When Plates Are Rolled to a Cylindrical Form There is a Tendency for Plate Edges to Remain Flat as in This Case

from constant use and that therefore it would be best to take a boiler out of service after a certain period. Infact, a number of concerns followed this practice. The majority of boiler users and engineers, however, felt then, as they do now, that

* From *The Locomotive*, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

rigid inspection would safeguard their boiler plants and would furthermore be of greater service in the interest of economy, for it was admitted that many boilers had served for twice the life that, by some, had been allowed for safety.

The plan of relying on inspection for a forewarning was adopted and served well, but there were a number of unaccountable explosions in boilers of relatively short life. At the time, the majority of boilers in use were constructed with a longitudinal lap joint. A series of investigations was conducted to study the stress conditions in this type of joint, and it was found that the construction, both from its fundamental shape and the conditions of manufacture, presented a most dangerous condition.

In *The Locomotive* for April, 1905, there appeared an account of the disastrous boiler explosion at Brockton, Mass., on March 20, 1905, and also an article on the "Lap-joint Crack," to which type of defect the explosion was said to be due. For the sake of clearness we shall present here some of the more important points which were brought out in the last-named article.

When a boiler plate is rolled to a cylindrical form the edges of the plate, in passing through the rolls, are not gripped as effectively as is the middle of the plate, so that the ends are left somewhat flat. The condition produced is illustrated in Fig. 1. This necessitates the plates being forced together at the edges, and this produces an added stress that persists unless relieved by annealing. In addition to this, the plates, if bent after punching, will bend along a line of rivet holes as shown in Fig. 2 in somewhat exaggerated form.

The elementary lap joint is illustrated in Fig. 3. If tension is applied as indicated in Fig. 4, the plates, in an attempt to aline themselves with the load, will bend along a line running under the outer edge of the rivet heads.

The combined effect of all these conditions, together with the constant bending of these joints by changes of pressure when in use, is to impose excessive stresses in the surface of the boiler plate along the line just mentioned. This has produced, in many boilers, a crack which starts always from the inside or covered surface of the inside or the outside plate of the joint as indicated at *A* and *B* in Fig. 4. This crack may eventually work its way through the plate until it shows itself by leakage. But in many cases it may develop for some distance along the joint and yet remain absolutely invisible. Eventually the weakness may develop to the point of complete failure and a disastrous explosion.

Inspection is generally accepted as being safe for the determination of the fitness of a boiler for use. The lap seam crack, however, is invisible to all methods of inspection, except cutting out the rivets and separating the plates. Recognizing the insidious danger presented in the lap joint for longitudinal seams in boilers, the Boiler Code Committee of the American Society of Mechanical Engineers formulated the following regulation (par. 380, A. S. M. E. Boiler Code, edition 1918):

"The age limit of a horizontal return tubular boiler having a longitudinal lap joint and carrying over 50 pounds pressure shall be 20 years, except that no lap joint boiler shall be discontinued from service solely on account of age until 5 years after these rules become effective."

Some boiler owners may be of the opinion that the longitudinal lap seams of boilers of this type can be changed to butt strap construction and the boilers kept in service after the time limit. This change of design and construction is not approved, however, by those thoroughly familiar with steam boilers, for, although butt straps and more rivets may be added, the material along the line of the joint, which was abused and tortured by the forming of the lap joint and fatigued by the years of service which subjected it to the expansion and contraction brought about by the many changes of temperature and pressure, would be further abused on the portion of the original construction left after cutting off one side of the lap joint and forcing the edges of the plate into line to form a butt joint.

Assuming that a double riveted lap joint has been changed to a triple riveted butt construction, the joint, after placing the butt straps and riveting, would appear as shown in Fig. 5 with the rivet holes of the original lap joint at *B* and the new

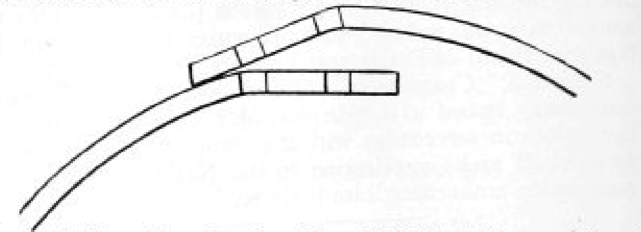


Fig. 2.—If Bent After Punching, Plates Will Bend Along a Line of Rivet Holes

holes at *C*. If a defect existed in the plate as shown at *A* the joint would be very faulty. Assuming the original joint as having the rivet holes spaced 3¼ inches and the additional holes spaced 6½ inches, if the plate material were defective or contained a lap crack as shown, the failure of the joint would require only the shearing of the rivets in long pitch, or 6½ inches, and the failure of the defective plate.

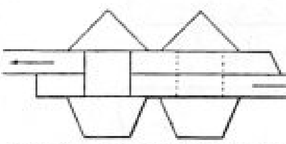


Fig. 3.—Elementary Lap Joint

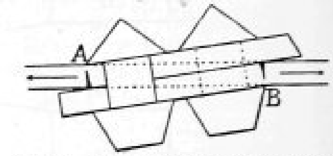


Fig. 4.—Effect of Tension on Joint

It might be argued that the exposure of the inside of the lap seam, when the change to a butt seam is made, would reveal the presence of a lap seam crack. A crack of this nature is, however, often present in a boiler of this construction after

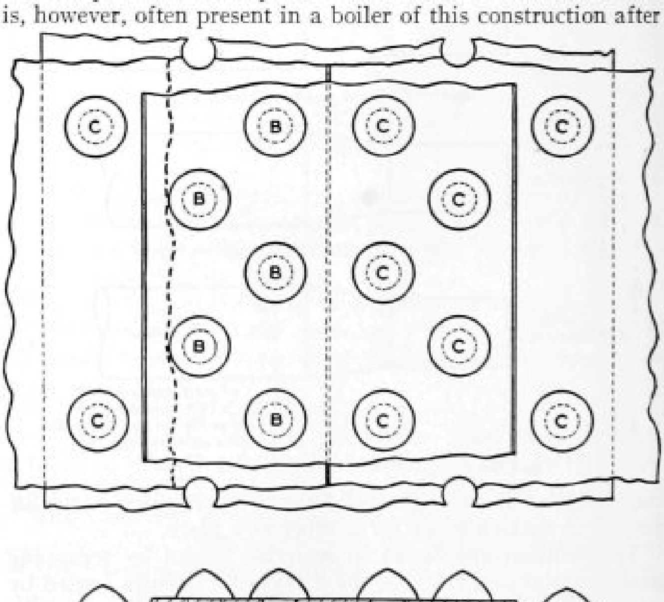


Fig. 5.—Double Riveted Lap Joint Changed to Triple Riveted Butt Strap Type

years of service, although it may not be visible to the naked eye. But even though no crack exists it must be remembered that boiler plate, like any other material, becomes fatigued after long years of service, and for this reason, after it has been under stress for many years, it should not be subjected to a change of shape and torture of the material in an endeavor to keep the boiler in service, especially when there is evidence that the altered structure is defective.

The age limit of twenty years is none too exacting, as will be evidenced by an explosion resulting from a lap seam crack of a boiler at the Tallahoma Lumber Company at Mossville, Miss., on October 21, 1920. This boiler was less than five years old. The explosion completely wrecked the plant, killed three men and injured four others. There was no negligence on the part of the operators and there was ample proof that the accident did not result from low water or overheating. On the other hand, the lap seam cracks could be clearly seen in the boiler plates after the disaster.

Regulations such as we have quoted are not intended to be arbitrary. Railroad companies determine the safe load capacity for each of their freight cars, and if they discover an overloaded car they refuse to transport it. This is done not only to avoid the possibility of straining and breaking the overloaded car, but also to prevent a possible wreck which might result in loss of life, property damage and delay. In a like manner the Boiler Code Committee requests that steam boilers and pressure vessels be designed and constructed for a safe working pressure and that they be not subjected to overloads. The rule quoted above is sane and economic because it is intended for the protection of life, limb and property. So also should be regarded the action of the boiler inspector condemning any construction regarded as unsafe.

Locomotive Code Adopted by American Society of Mechanical Engineers

At the recent monthly meeting of the Council of the American Society of Mechanical Engineers held in Boston, a special committee, which has been working on the formulation of a Locomotive Boiler Code for nearly three and a half years presented a finished draft of this code for the approval of the Council. With its passage by vote of the members of the Council this code becomes part of the Boiler Code of the Society and will form the basis for the future standardization of American locomotive boiler design and construction.

The code deals with the physical and chemical properties of materials entering into locomotive boiler construction and gives all necessary data for the work. It is expected that the code in addition to producing a standard locomotive boiler will accomplish considerable saving in the ultimate cost of construction and also maintenance.

The Locomotive Code was intended originally for boilers that did not come under the jurisdiction of the Interstate Commerce Commission, but the code has proven to be so wide in its scope that government officials in the Commission have expressed their desire to incorporate the rules bodily in their construction requirements.

The Locomotive Code is the first of a series of codes which, when completed will cover substantially every pressure sure vessel used in the United State, fired or unfired. Several foreign countries are already using these safety standards and its is believed that others will follow.

The complete Locomotive Boiler Code will be published in a future issue of The Boiler Maker.

When a section of a steel plate is heated with the oxy-acetylene torch, expansion of the heated metal is restrained by the surrounding cold metal. When the metal cools it shrinks. Advantage of this is taken to remove buckles from plates. The buckle should be located closely and circled with chalk. Three or four spots should be marked. Heating the spots results in the complete disappearance of the buckle, due to the upsetting and subsequent contraction of the metal. It might be explained that a buckle in a plate is simply a result of excess metal at that place. When the metal is shrunk the buckle lies flat.—*Autogenous Welding.*

Stool for Supporting Front End of Boiler

By E. A. Miller

When a new saddle is to be applied to a locomotive, it is bolted between the front ends of the frames, and the boiler is

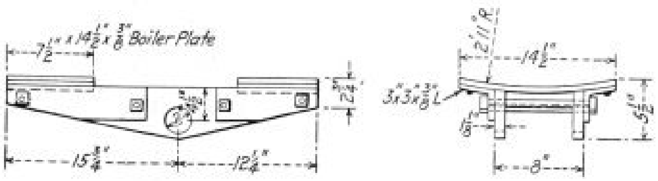


Fig. 1.—Fulcrum Plate

put in place. The top flange of the saddle is chalked or painted all around and a line scribed along the sides, front and back of the saddle ¼ inch or any convenient depth below

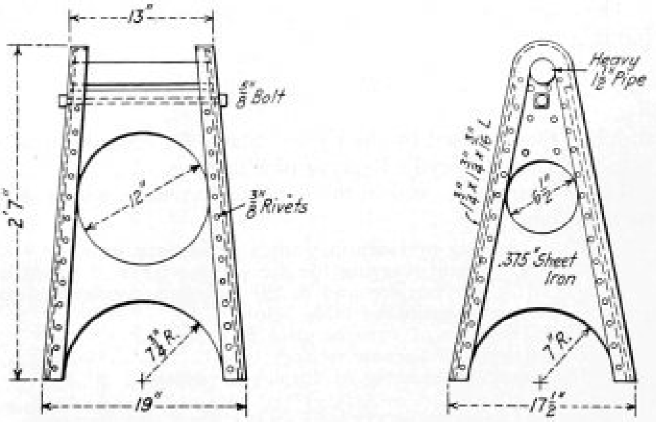


Fig. 2.—Details of Stool Construction

the boiler, to follow as a guide in chipping the saddle to the proper contour. After being so marked the front end of the boiler is lifted up and the stool set in place as illustrated.

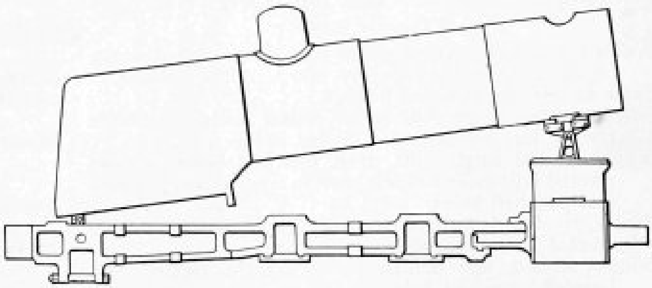


Fig. 3.—Sketch Showing Application of Stool

The frame of the stool is made of 1¾-inch by 1¾-inch by 3/16-inch angle iron bent at the top around heavy 1½-inch wrought iron pipe, which extends from one side to the other. The frame is stiffened by ⅜-inch sheet iron riveted to the angle irons as shown. A 6½-inch hole is cut in the sides and 12-inch holes in the front and back. The bottoms are cut out as shown.

The fulcrum plate consists of two 1⅛-inch by 28-inch wrought iron plates, cut to the shape shown and provided with 2-inch holes. The fulcrum plate rocks on a heavy 2-inch wrought iron pipe. Four pieces of 3-inch by ⅜-inch angle are bolted to the plates, and curved plates extend from side to side. These curved plates are made of ⅜-inch boiler plate and are riveted to the angle irons, the rivets being countersunk on top.

Working Pressures on Furnaces

Construction and Use of Chart Arranged for Obtaining the Thicknesses of Metal in Boiler Furnaces

BY JOHN S. WATTS

The accompanying chart will simplify the work required to calculate the thickness of the furnaces for boilers built to pass the regulations of the various authorities.

The formula on which it is based is:

$$WP = \frac{C \times T^2}{(L + 1) \times D},$$

which is that used by the following:

British Board of Trade;
Dominion of Canada for marine boilers;
Provincial Governments of Canada for land boilers.

The chart has also been notated to conform to the following formula:

$$WP = \frac{C \times T^2}{L \times D},$$

which is the one used by the United States Steamboat Inspection Service and Lloyd's Register of Shipping.

In both formulae, and in the limiting formulae, which will come up later:

WP = working pressure in pounds per square inch.
C = a constant, varying for the various types of joints in the furnace and in the different regulations, as given in the table below.
T = thickness of furnace plate in inches.
L = length of furnace in feet.
D = outside diameter of furnace in inches.

PROVINCIAL GOVERNMENTS OF CANADA FOR LAND BOILERS

Type of Joint	Constant
Double riveted single butt strap or single riveted double butt strap	112,500
Single riveted single butt strap	100,000
Double riveted lap	96,000
Single riveted lap	87,500

BRITISH BOARD OF TRADE AND DOMINION OF CANADA

Type of Joint	Constant
Welded or double riveted single butt strap, drilled holes, or single riveted double butt strap, drilled holes	99,000
Same as last, but punched holes	93,500
Single riveted single butt strap, drilled holes, or double riveted lap, beveled, and drilled holes	88,000
Single riveted single butt strap, punched holes; double riveted lap, drilled holes; double riveted lap, beveled, and punched holes	82,500
Single riveted lap, beveled, and drilled holes; double riveted lap, punched holes	77,000
Single riveted lap, drilled holes; single riveted lap, beveled, punched holes	71,500
Single riveted lap, punched holes	66,000

U. S. A. AND LLOYD'S

Type of Joint	Constant
No specification	89,600

To prevent making from the above formulae a furnace that would give way by the crushing of the material, all authorities give a limiting formula, which is:

$$WP = \frac{C' \times T}{D},$$

where C' = a constant fixed by the various authorities as below:

Canadian Dominion and Provincial Governments	C' = 10,000
British Board of Trade	C' = 9,900
Lloyd's for 9/16-inch plates and under	C' = 8,000
Lloyd's for plates over 9/16-inch	C' = 8,800

All authorities except Lloyd's use for corrugated furnaces the formula:

$$WP = \frac{14{,}000 \times T}{D},$$

which is the one used in the chart.

The chart is made to take plates up to 5/8 inch thick as the maximum, and this thickness should not be exceeded, as there is a strong tendency to burn down to that thickness if the plates are made thicker.

The rules of the British Board of Trade and of the Dominion of Canada reduce the working pressure on furnaces in vertical boilers by 10 percent below that allowed for horizontal furnaces and demand that vertical furnaces be tapered one inch in diameter per foot of height.

Therefore, when using the chart for vertical furnaces for either of these authorities, take $\frac{WP}{0.9}$ instead of the actual WP to determine the thickness; or, if determining the WP, deduct 10 percent from the answer given by the chart.

FINDING THICKNESS OF METAL FOR TYPICAL FURNACE

To illustrate the use of the chart we will take an example, to find the thickness of plate required for a furnace 36 inches outside diameter, 6 feet long, for 160 pounds working pressure to the Board of Trade regulations.

First, on the scale of working pressures trace up the vertical line for 125 pounds pressure to its intersection with the diagonal line for 36 inches diameter. From this point draw a horizontal line to the vertical line for 6 feet length. Through this new point draw a line from the right-hand corner of the chart to the vertical line, as shown, and from this last point draw a horizontal line. Now, from the intersection of this horizontal line with the vertical line for the constant 99,000 (the highest allowed by the British Board of Trade) we find the thickness required is 37/64 inch; or, if we choose, we can take a thicker plate and a lower constant, the chart giving us the choice at a glance of any of the following Board of Trade constants with the respective thicknesses given below:

Constant	Thickness, Inches
99,000	37/64
93,500	19/32
88,000	39/64
82,500	5/8

The thickness required being taken from the diagonal line next above the intersection of the horizontal line, with the vertical line representing the constant. The chart also shows that we could use a corrugated furnace 11/32 inch thick.

At the right-hand side of the chart horizontal full lines have been drawn, indicating the diameters and pressures for the minimum thickness allowed by the limiting formula:

$$WP = \frac{C' \times T}{D},$$

taking C' = 10,000.

The British Board of Trade constant is 99,000 and gives a working pressure only 1 percent less, so the chart is practically correct for them, too.

In the example the minimum thickness according to the

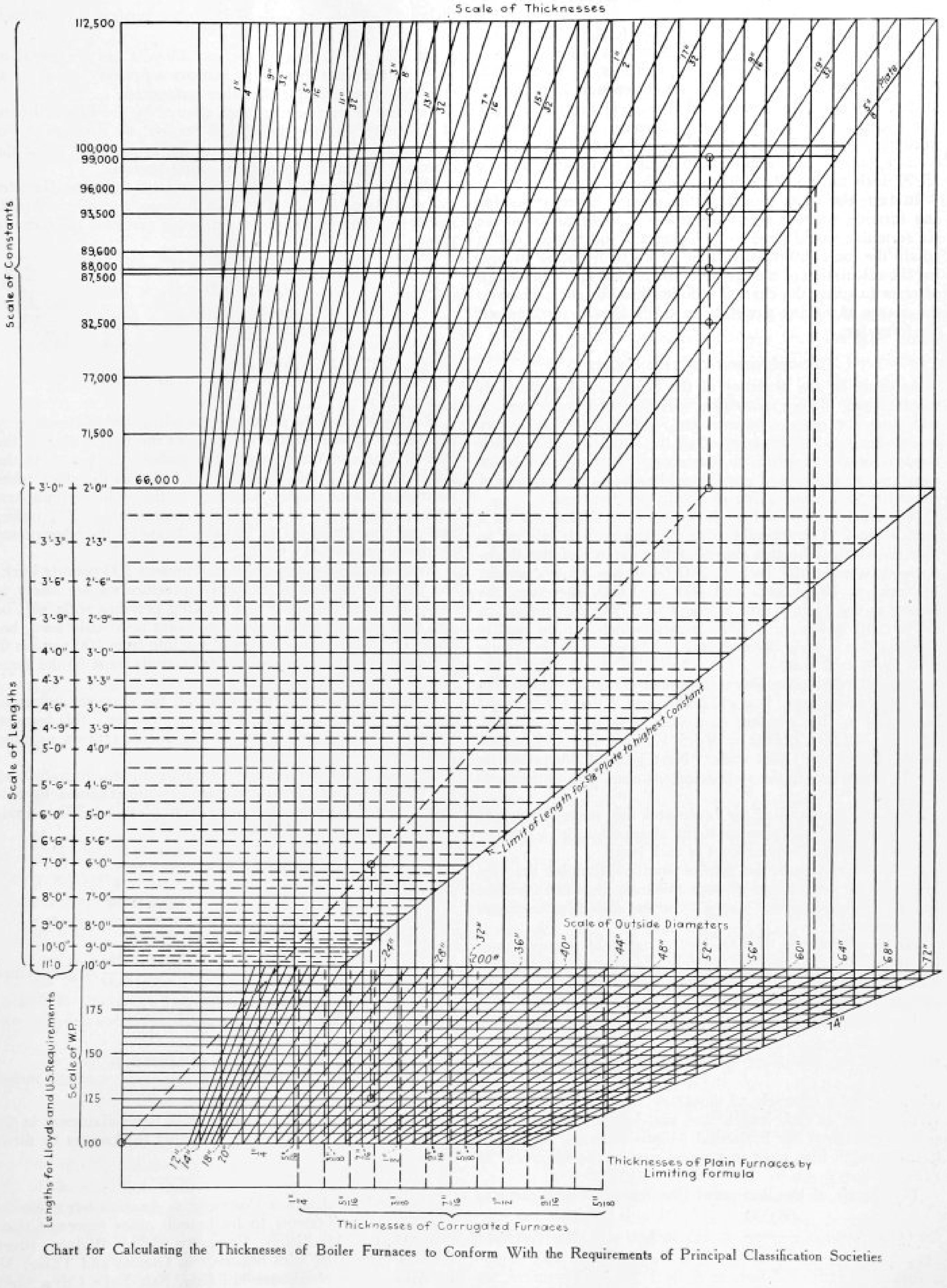


Chart for Calculating the Thicknesses of Boiler Furnaces to Conform With the Requirements of Principal Classification Societies chart is 29/64 inch, so we are well over the limit with any of the thicknesses given above.

In order to make the chart fully complete, dotted horizontal lines have been drawn to indicate the thickness for all diameters and pressures on corrugated furnaces, so that if the furnace desired cannot be made strong enough if plain the thickness required in a corrugated furnace is seen at a glance. For example, a 40-inch diameter furnace for 160 pounds working pressure is above the ⅝-inch thickness for a plain furnace, but we read from the chart that a corrugated furnace 15/32 inch thick will fulfill the requirements.

In fact, the chart shows all the possible alternatives for any furnace, whereas otherwise in the example quoted above six formulae would have to be looked up and worked out to obtain the same information, four of which formulae involving the calculation of the square of the thickness. The chance of error in using the chart is infinitestimal in comparison to the chance of making a mistake in calculation in working out the formulae.

Construction of the Chart

As proof of the accuracy of the chart I will explain its construction. This explanation will also enable the user to add lines for other constants, etc., although as far as my knowledge goes the constants of all the authorities using inch measurements are given in the chart. It may also be of assistance to students of graphic arithmetic as an example of its utility as a time-saving device in practical use.

We commence by laying off the scale of thicknesses on a vertical line. The formula using T^2, this scale is laid off so that the vertical heights represent the squares of the thicknesses to a scale of 1 inch = 240/64 inches. For example, ⅝ inch = 40/64 inch and $40^2 = 1{,}600$; therefore, the height to the ⅝-inch line is equal to 1,600/240 inches = 6 160/240 inches = 6 8/16 inches, which can be readily measured on a scale divided into 1/12 inch, such as a scale of 1 inch = 1 foot.

Now take this same line to represent $C \times T^2$, where C is the highest constant, i. e., 112,500, and draw a horizontal line equal to this constant to a scale of 1 inch = 12,000. That is, 112,500/12,000 = 9 4.5/12, or 9 feet 4½ inches, on the 1-inch = 1-foot scale. Next join all the points on the thickness line to the right-hand, or zero, end of the horizontal line.

From the zero end of the horizontal line scale off lengths equal to the various constants to the aforesaid scale, 1 inch = 12,000, and erect vertical lines at each point.

It is obvious from the law of similar triangles that the height to the intersection of each thickness line and constant line is proportional to $C \times T^2$ for the respective thickness and constant.

We now take the 66,000 line to represent the minimum length we are likely to want, namely, 2 feet, and for clearness will retain the end of the horizontal line already fixed as the zero point for the scale of constants.

The total height of the line taken for length = 2 feet is now taken as equal to $\dfrac{C \times T^2}{L+1} = \dfrac{C \times T^2}{3}$, and, as this quantity varies inversely as the $(L+1)$, it follows that the vertical lines at each length line, and hence (by the law of similar triangles) the horizontal lengths from the zero point to each length line, must be proportional to the reciprocal of $(L+1)$.

The length of the horizontal line from the zero point to the 66,000 line is $\dfrac{66{,}000}{12{,}000} = 5\tfrac{1}{2}$ inches, and this represents a furnace length of 2 feet, or $L + 1 = 3$. Therefore, we scale off the other lengths from the zero point equal to 5½ inches $\times \dfrac{3}{L+1} = \dfrac{16.5}{L+1}$ and raise vertical lines at each point. As the United States and Lloyd's use L instead of $L + 1$, the length lines are marked separately for them at one foot more than for the other authorities.

Ten feet being the maximum allowed by the British Board of Trade (8 feet for the United States), we stop at 10 feet and extend this line vertically upwards and use it for the diameter line at 200 pounds working pressure.

On this last vertical line we fix a point for some diameter by calculation, as, say, a ⅝-inch furnace, with $C = 96{,}000$ and 2 feet long at 200 pounds working pressure, the formula being:

$$WP = \frac{C \times T^2}{(L+1) \times D}.$$

$$200 = \frac{96{,}000 \times (\tfrac{5}{8})^2}{3 \times D}.$$

$$D = \frac{96{,}000 \times (\tfrac{5}{8})^2}{200 \times 3} = 62\tfrac{1}{2} \text{ inches.}$$

Having marked the point corresponding to this diameter by drawing a horizontal line across from the intersection of the 96,000 line and the ⅝-inch line (where the length is the minimum, i. e., 2 feet, the line is straight, as the chart takes no cognizance of shorter furnaces) to the scale of diameters, we have the length of vertical line representing 62½ inches and can now divide up the line to indicate all the other points by direct proportion.

Next we take the zero point to represent 100 pounds working pressure, as this is the lowest pressure we are likely to use. The zero point for the working pressure scale will be 1½ inches to the right of the zero point previously used, because 1½ inches is the length of the line from 100 pounds to 200 pounds, and from zero to 100 pounds must be the same length.

Now draw diagonal lines from all the diameter points to this last zero point (not shown on the drawing), this because the thickness required varies as the diameter times working pressure.

The points for the limiting formula for plain furnaces and for thicknesses of corrugated furnaces are obtained by calculating the diameter for a ⅝-inch plate at 200 pounds working pressure as follows:

$$\text{For plain furnaces } WP = \frac{10{,}000 \times T}{D}.$$

$$\text{Therefore } 200 = \frac{10{,}000 \times \tfrac{5}{8}}{D},$$

$$D = \frac{10{,}000 \times \tfrac{5}{8}}{200} = 31\tfrac{1}{4} \text{ inches.}$$

$$\text{And for corrugated furnaces } WP = \frac{14{,}000 \times T}{D}.$$

$$\text{Therefore } D = \frac{14{,}000 \times \tfrac{5}{8}}{200} = 43\tfrac{3}{4} \text{ inches.}$$

and drawing horizontal lines through these diameters at the 200-pound line and obtaining the other thicknesses by direct division.

The Underfeed Stoker Company of America has made the following appointments to its branch office representation: The Merkle Machinery Company, 1733 Walnut street, Kansas City, Mo., with branches in Omaha and Tulsa; M. L. Alison, 616 Newhouse building, Salt Lake City; Smith and Whitney, Southwestern Life building, Dallas, Tex.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

Edward A. Simmons, *President* Roy V. Wright, *Secretary*
Henry Lee, *Vice-Pres. and Treas.*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 341 The Arcade
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,500 copies were printed; that of these 4,500 copies, 3,833 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 92 were mailed to advertisers; 66 were mailed to employees and correspondents, and 493 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 20,200, an average of 5,050 copies a month.

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

GENERAL:
Details of New Sante Fe Locomotive Boilers 95
Financing Our Foreign Trade 101
Notes on General Shop Practice at DuBois 102
Composition and Properties of Boiler Tubes 104
Spring Meeting of American Society of Mechanical Engineers 107
Constitution and By Laws of National Board of Boiler Inspectors 107
Standardization of Flue Safe Ending 109
Changing Old Lap Seam Boilers to Butt Seam Construction 109
Locomotive Code Adopted by American Society of Mechanical Engineers 111
Stool for Supporting Front End of Boilers 111
Working Pressures on Furnaces 112
Stoker Fired Locomotive Makes Continuous Run Over Three Divisions 124

EDITORIAL COMMENT 115
ENGINEERING SPECIALTIES FOR BOILER MAKING 116
PERSONALS 117

QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Double Angle Pipe Layout 118
Development of Y Breeching 118
Layout of an Oblique Pipe Joint 118
Boiler and Engine Ratings 119
Rule for Finding Length of Arc When Radius and Degree of Arc are Known 119
Cone Intersection and Development 120
Cylinder and Cone Intersection 120
Tube Welding 121

BOOK REVIEWS 121

LETTERS FROM PRACTICAL BOILER MAKERS:
Lap Seam Crack Causes Boler Failure 122
What is the Formula for Inefficiency? 123
Finding a Solution to the Apprentice Problem 123

ASSOCIATIONS 125
TRADE PUBLICATIONS 125
SELECTED PATENTS FOR BOILER MAKERS 126

An announcement has just been received from the secretary's office of the Master Boiler Makers' Association that the 1921 convention, which was to have taken place in St. Louis, May 23-26 will not be held this year.

The adoption of the Locomotive Boiler Code by the Council of the American Society of Mechanical Engineers marks a step forward in the work of standardizing boiler requirements in this country. The committee which prepared the code is made up of prominent railway engineers, locomotive manufacturers and the chief mechanical engineer of the Interstate Commerce Commission. Every branch of the locomotive industry—production, inspection and operating—has thus been represented, with the result that the locomotive requirements adopted will tend towards the most economical as well as the safest methods of construction and maintenance.

In spite of the fact that the code was originally intended for locomotive boilers not subject to government control and inspection, its provisions are so inclusive, practically forming a detailed specification of construction, that members of the Interstate Commerce Commission have expressed the desire to incorporate the rules in the code of that department.

The extension of American credit in foreign markets is essential to the complete development of our export trade. The demand for American products abroad exists as it never has before, but the sale of commodities is blocked by the trade balance in our favor resulting from the war. Many individual producers have extended credit in the period of high production of the past two years, but these and other forms of independent financing have not been able to provide for exports in any appreciable volume.

In every country which holds possibilities as a market for American goods, natural resources exist which form excellent security for long-term credits. For the purpose of turning these resources into credit the Foreign Trade Financing Corporation was organized by the American Bankers Association. This and similar financing corporations were made possible by the Edge amendment to the Federal Reserve Act, authorizing such companies to finance their long-term loans by issuing debenture bonds to the value of ten times the original capital.

The Foreign Trade Financing Corporation having a working capital of $100,000,000, is thus alone able to use $1,100,000,000, for the purpose of supporting the credit facilities of our foreign trade and by so doing, provide work for the unemployed in this and other countries.

Results of the investigation by Albert E. White on the composition and properties of boiler tubes given elsewhere in this issue, indicate certain causes which are mainly responsible for the deterioration of tubes in service. The absortion of hydrogen by the metal in the tubes, due to faulty feed water treatment, is a cause for brittleness. As the report states, intelligent water treatment eliminates any trouble from this source and so need not be a cause for concern.

Blow holes and other imperfections in the steel as a cause of tube failures can be prevented by the control of the quality at the steel mill. The one cause of trouble mainly dealt with in this investigation was that due to re-crystallization of the metal in the tubes. Mechanical deformation of tubes and the subsequent heating to any temperature below the critical, especially when the steel has a low carbon content, causes the phenomenon of re-cystallization with a resulting decrease in the elastic limit of the steel and in its fatigue resisting properties.

The line of thought brought out by this paper is important to tube manufacturers, boiler constructors and operators, for by finding a steel of a composition which might be cold worked without a corresponding grain growth, while at the same time retaining the desirable qualities of resistance to the absorption of hydrogen and freedom from blow holes fewer tube replacements might be found necessary.

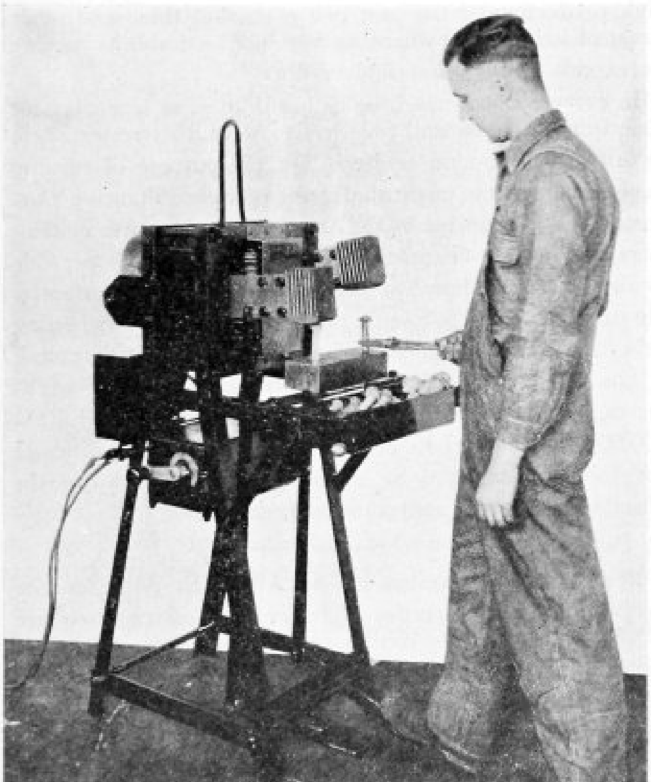
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

New Type Electric Rivet Heater

A new type of rivet heater, suitable for work in boiler shops, on structural steel work, etc., has recently been developed by the General Electric Company, Schenectady, N. Y. The heater is designed with safety features and is adaptable for both intermittent and steady operation.

The heater consists of an air cooled transformer, with a single turn, short circuited secondary, in which the rivets to be heated form a part of the secondary circuit. The primary



New General Electric Rivet Heater

winding is designed for operation on 220, 440 or 550 volt single phase circuits of 40, 50 or 60 cycles. Taps are brought out from the primary winding to a drum controller, so that six different voltages can be obtained on the secondary. This makes adjustment for various sizes of rivets, or rates of heating, simply a matter of setting the handle on the drum controller.

The secondary coil is divided into two electrodes moved by pedals, and a cold rolled copper electrode block directly under them. The two rivets to be heated are placed on the lower block, and the movable electrodes lowered on them, thus completing the circuit. Since the resistance of the rivets varies from six to fifty times that of the copper, according to temperature, most of the electrical energy in the secondary is dissipated in the form of heat in the rivets.

It often happens that the demand for rivets is intermittent, for various reasons. In order to take care of such a condition, this heater is provided with a switch which operates to disconnect one side of the primary from the line. The switch is opened by means of a lever convenient to the left hand of the operator.

The heater is rated 15 kilowatts 90 percent power factor continuously. The input can be increased to 17.5 kilowatts for two hours or 20 kilowatts for one hour without exceeding the rated temperature rise of 550 degrees C. It weighs about 600 pounds and is provided with a bail for lifting, or if desired, wheels so that it can be rolled from place to place.

Automatic Fire Alarm

A new departure in fire alarms has been placed on the market under the name "Fireklock," which is designed to offer a solution for a number of fire alarm problems. The device is automatic in its operation and consists of a bell with a self-contained system of clock-work, controlled by a fusible link.

The principle of its operation is that of a clanging of the bell, once the mechanism is released by the melting of the fusible link at a temperature of 160 degrees F., the idea being to have the device spread the alarm while the fire is in its incipiency and before it has progressed beyond control by hand extinguishers. Once the alarm starts it rings incessantly for five minutes, after which it may be made ready for use again by inserting a new fusible link and winding up the mechanism.

These alarms occupy a space five inches in diameter and are intended to be placed in locations where a fire is liable to occur, as in freight rooms, warehouses, paint and oil rooms, etc. This alarm is manufactured by the Pyrene Manufacturing Company, Chicago.

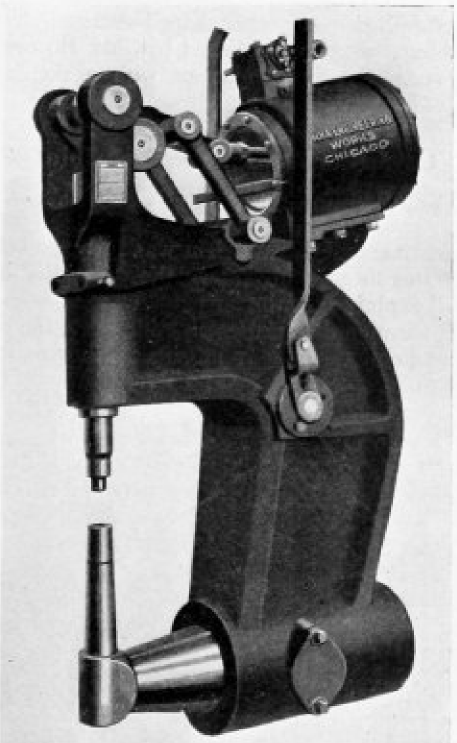
A New Rivet Set

The Chicago Pneumatic-Tool Company, New York, has recently introduced a new rivet set for pneumatic hammers. This set, the Boyer by name, is said to be a successful culmination of efforts directed for some time by the company to the manufacture of a tool capable of affording a more uniform and greater resistance to the stress of riveting service than had been obtained in its earlier types. Those recognizing the influence which the rivet set has upon the character and quantity of work and even on the lasting qualities of the hammer and familiar with the trouble which often attends the use of sets will be interested in the new device, particularly for the possibilities it presents of withstanding service conditions. In this connection it is said that in a series of recent tests, different sets were found to permit the driving of from 12,000 to 20,000 rivets before requiring renewal, all of them displaying great uniformity in performance. Aside from using raw materials subject to rigid specifications, the secret of the success in the manufacture of these tools appears to lie in an accurate control of the forging and subsequent heat-treating processes.

Pneumatic Boiler Head Riveter

A boiler head riveter, having a forged alloy steel, heat-treated stake designed to reach through the handhole in the center of the last head of a double convex head boiler and buck up rivets in the flange as the boiler is revolved on the stake, has been produced by the Hanna Engineering Works, Chicago, Ill. This riveter has a reach of 14 inches and 18 inches and a gap of 35 inches and operates under 80 tons pressure.

The action of this riveter resolves itself into two mechanical operations—a toggle motion during the first part of the piston stroke and a lever action during the latter half of the stroke. The dies of the riveter may be adjusted so that a rivet will receive the rated pressure and be finished at any place between the sixth and twelfth inch of piston travel, thus eliminating the necessity of striking the rivet more than once. The gap between the die and the end of the rivet is closed and the rivet partially upset by the toggling action. In the last half of the stroke or the lever action, the plates are drawn together and the rivet heads formed. In order to determine when the dies are adjusted properly an indicator is attached to the cylinder. So long as the end of the piston stops within the limits shown on this gage the rivet will have received the rated pressure.



Pneumatic Riveter for Boiler Work

The frames of the riveter are of cast steel, while the working joints are bronze bushed, and the lower toggle is fitted at each end with a removable socket made of special bronze. The valve stem and piston trunk are provided with flanged lever packings and the piston is arranged with two sets of spring steel rings, with composition packings, which prevent any escape of air. All working bearings have drilled and threaded holes leading to them and are provided with screw plugs for forcing the grease into the bearings. The operating valve is a plain slide valve, actuated by a continuous valve stem, allowing operation from either side of the machine.

In addition to its use in heading up rivets in double convex head boilers, it is claimed that this riveter, because of its special stake, is adaptable to the use of long lower dies and so can be employed in various kinds of tank work and the like wherever a long die is necessary.

Pneumatic Riveters utilizing the same principles of operation but designed for other operations in boiler and tank fabrication are produced by this company.

PERSONALS

E. W. Young

E. W. Young, 3rd vice-president of the Master Boiler Makers' Association, was born and educated in Dubuque, Iowa. He served a full apprenticeship in the Iowa Iron Works at Dubuque and later worked as journeyman and assistant foreman in general contract and marine work at this plant. Following this period Mr. Young was employed as journeyman by the Des Moines Manufacturing Company, Des Moines, Iowa, in stationary and contract boiler work. In the same capacity of journeyman he served with the Glenn Bros. Boiler Works, Minneapolis, Minn., the Northwestern Manufacturing Company, Stillwater, Minn., and finally in the Chicago, Burlington and Quincy Railway shops at Burlington, Iowa. After completing his connection here he became journeyman at the Chicago, Milwaukee & St. Paul Railway shops at Minneapolis and later traveling boiler inspector for the system, which position he still holds in addition to duties as a federal inspector of the Interstate Commerce Commission. Mr. Young has conducted numerous accident investigations for the Interstate Commerce Commission and railroad companies, and has written many papers dealing with various phases of boiler construction, which have been read at the conventions of the Master Boiler Makers' Association. He has been a member of the executive board of this association for a number of years and has held the offices of 3rd, 4th and 5th vice-president.

Keith J. Evans, advertising manager Joseph T. Ryerson & Son, was elected president of the Engineering Advertisers' Association at the recent annual meeting at Chicago.

Benjamin F. Thomas, previously mechanical engineer of the United Railways of St. Louis, has taken a position as assistant superintendent of power for the Scullin Steel Company of St. Louis.

H. A. Lacerda has accepted the position of general boiler foreman of the Cuba Railroad with headquarters at Camaguey, Cuba, and will leave this country in a short time to take up his new duties.

L. A. De Marais, formerly with the New York sales offices of the Ohio Locomotive Crane Company and the Bedford Foundry & Machine Company, is now on the New York sales force of the Champion Engineering Company, 149 Broadway, New York.

F. E. Whitcomb, special representative of the Federal Signal Company, Albany, N. Y., has left that company to become vice-president and sales manager of the Consolidated Equipment Company, Ltd. This firm handles railway, marine and signal supplies, with headquarters at Montreal.

The Blaw-Knox Company will establish a sales office in the southwest, with headquarters in Kansas City, Mo. R. B. Randall of the Chicago office will be in charge of the new territory and offices will be located in the Interstate Building at Kansas City.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Double-Angle Pipe Layout

Q.—I have had a great deal of difficulty with the development of the double-angle pipe shown in Fig. 1 and would like to see it worked out in THE BOILER MAKER. A. A.

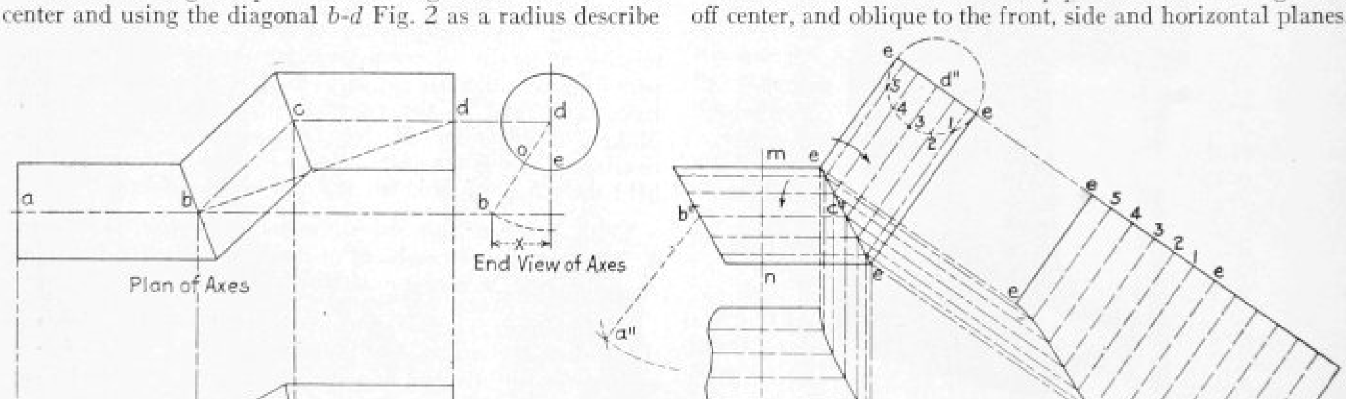
A.—The enclosed drawing shows the method of projecting a full view of the oblique pipe and its pattern.

In Fig. 1 the pipe's axes are laid off in a plan, side and end elevation, from which the true length of the diagonal *b-d* and oblique pipe axis *b-c* are found as in Fig. 2. In this view a horizontal line is drawn of indefinite length and a perpendicular equal to distance *x* of the elevation is laid off from it. On the horizontal base line lay off the lengths *b-d* and *b-c* of the plan and draw the true diagonal lines.

With these true lengths draw Fig. 3 as follows:

Make *b″-c″* Fig. 3 equal to *b-c* of Fig. 2 and with *b″* as a center and using the diagonal *b-d* Fig. 2 as a radius describe an arc. Using *c″* as a center, and *c′-d′* of the elevation as a radius draw an arc; intersecting the arc draw from *b″*, thus establishing point *d″*. The angles between axes *a″-b,″ b″-c″* and *c″-d″* Fig. 3 are all equal and shown in their true size in Fig. 3.

Patterns for the pipes are laid off in Fig. 3 at right angles to the pipe sections, which was done so as to show how the development lines are used. The patterns for the horizontal pipes are alike. Fig. 3 shows the pipe sections lying in the same plane, but if the joints are made as indicated the patterns will work out correctly. The lower horizontal pipe can be placed in position and the unit revolved through an arc length *d-c* bringing the pipe connection into its required place.



Elevations and Pattern of Double Angle Pipe

Development of Y-Breeching

Q.—Will you kindly inform me where I can get a work showing the development of a Y-breeching, where the openings of the boilers are rectangular and the stack round. Has it ever been shown in THE BOILER MAKER, and if so, when? E. C. L.

A.—There have been given in THE BOILER MAKER layouts for Y-breechings where the upper connection is round and the Y-legs of a wash boiler shape. The same method of development can be applied to any other shaped sections. You should have our volume recently published by THE BOILER MAKER on laying out. Kindly furnish us with a sketch of your problem.

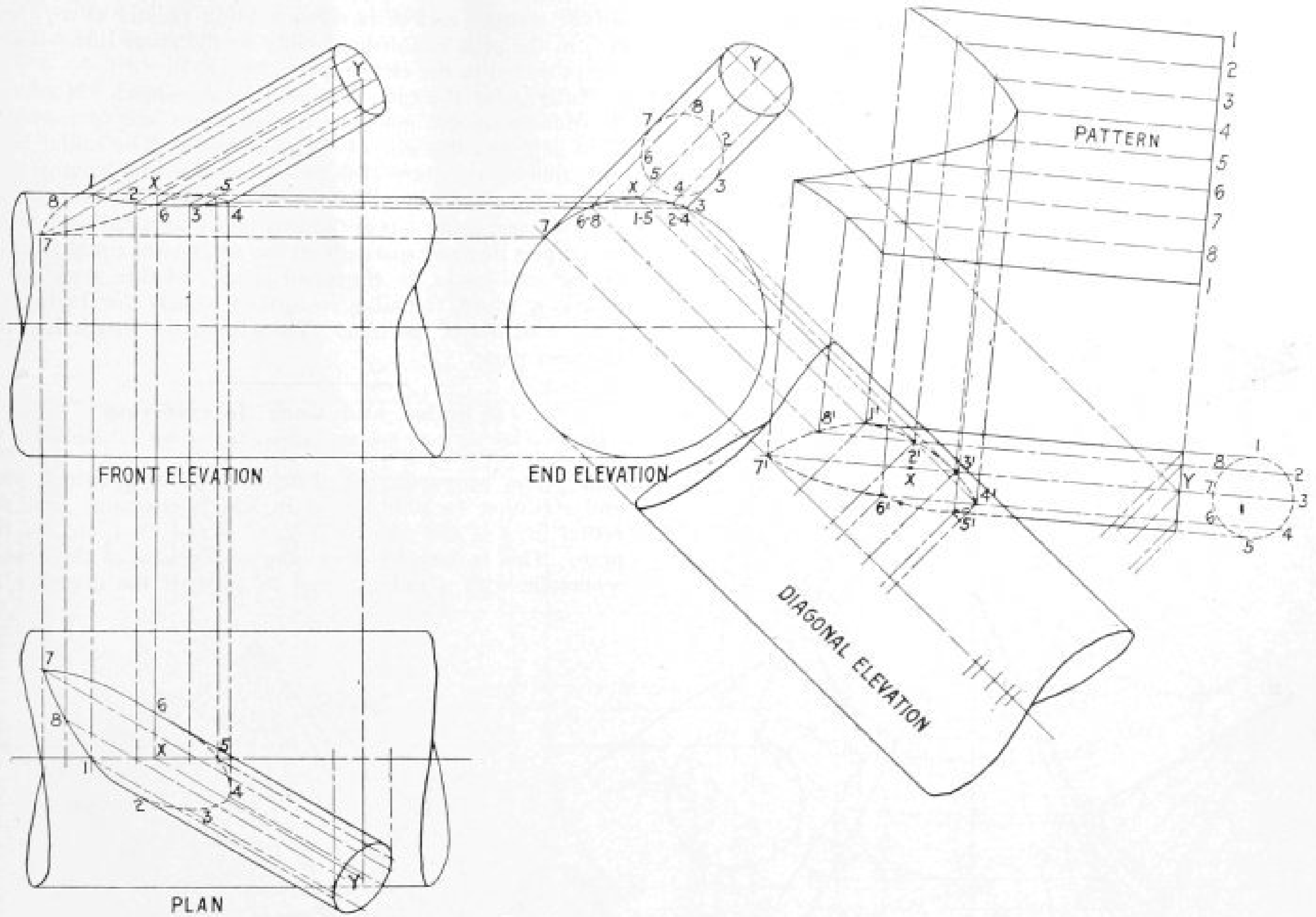
Layout of An Oblique Pipe Joint

Q.—Kindly illustrate and explain the layout of a pipe connection where a small pipe joins a large one at an oblique angle both horizontally and vertically. APPRENTICE.

A.—Some time ago this problem was fully explained; but as it illustrates to good advantage the principles of projection, we will explain it again.

In the illustration the smaller pipe intersects the larger one off center, and oblique to the front, side and horizontal planes. To obtain a full view of the connection, which will show the true angle the inclined pipe makes with the other, a diagonal elevation is laid off at right angles to the axis *x-y* of the end elevation. The distance between *x-y* of the diagonal view as measured at right angles to the axis of the large pipe is equal to the vertical distance between these points of the front elevation. Draw a profile of the small pipe in the diagonal view, do the same in the end view, numbering the points as indicated.

The front elevation and plan are shown completed and as they would appear in looking at the connection from the top and front views. The pattern in this example is laid



Development of Oblique Pipe Joint

off at right angles to *x-y* of the diagonal view. The circumference of the small pipe is laid off on line 1-1, and this length is divided into the same number of parts as contained in the circle or profile of the small pipe. Layouts of this kind are as simple to develop as intersections lying in the same plane, the only difference being the requirement of showing an additional view which brings the two pipes into the same vertical plane.

Boiler and Engine Ratings

Q.—Please give a rough outline of method used in determining the size of a Scotch marine boiler for a certain size engine. J. C. N.

A.—The rating of power boilers is according to horsepower. This is based on the following: "The unit of boiler horsepower is the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. into steam at the same temperature."

The size of boiler required will vary according to the specifications, the type of engine and its size. Simple engines as used in hoisting work use as high as 40 pounds of steam per horsepower per hour. Condensing engines use about 20 pounds of steam per horsepower per hour. Compound condensing engines around 15 pounds, and triple expansion condensing engines around 10 pounds of steam per horsepower per hour.

Knowing the size of engine in horsepower and the amount of steam required per horsepower per hour, the size of boiler can be determined approximately. For example, the rated horsepower of a condensing engine is 150 horsepower and 20 pounds of steam is required per horsepower per hour.

$150 \times 20 = 3{,}000$ pounds of steam per hour.

To determine the size or horsepower of the boiler, divide the amount of steam required per hour by the number of pounds of water evaporated into steam by one boiler horsepower per hour. Tables are given in engineers' handbooks that give the amount of water evaporated per hour by 1 boiler horsepower into steam at various gage pressures and feed water temperatures.

Consider a boiler to be operated at 160 pounds pressure, temperature of feed water 60 degrees F. The pounds of water evaporated per hour per horsepower equals approximately $28\frac{1}{2}$ pounds.

Then $3{,}000 \div 28\frac{1}{2} = 105.3$ boiler horsepower.

Rule for Finding Length of Arc When Radius and Degree of Arc Are Known

Q.—I would like to learn of the rule for finding the length of an arc when the radius is known and the degrees in the arc. *Example:* The radius to which an arc is drawn equals 38 inches, and the arc angle is 72 degrees. What is the length of the arc? K. C.

A.—Length of arc = number of degrees in the arc $\times$ 0.017453 $\times$ radius.

Example: $72 \times 0.017453 \times 38 = 47\frac{3}{4}$ inches, length of arc.

The number 0.017453 is the length of an arc of 1 degree, whose radius equals 1 inch. The circumference of a circle of a 1-inch radius equals $1 \times 6.2832 = 6.2832$ inches. In a circle there are 360 degrees.

$6.2832 \div 360 = .017453$ inch, length of an arc of 1 degree.

Length of an arc of 1 degree = radius $\times$ 0.017453.
Length of an arc of 1 minute = radius $\times$ 0.0002909.
Length of an arc of 1 second = radius $\times$ 0.0000048.

In cases where the arc reads degrees and minutes reduce the degrees to minutes and multiply by 0.0002909 to find the length of arc.

When the degree of arc reads degrees, minutes and seconds, reduce the angle to read seconds and multiply by 0.0000048.

Cone Intersection and Development

Q.—Will you please supply me with the general layout of one cone intersecting another. Any size angle of intersection will do if the full instructions for the layout are supplied. G. C.

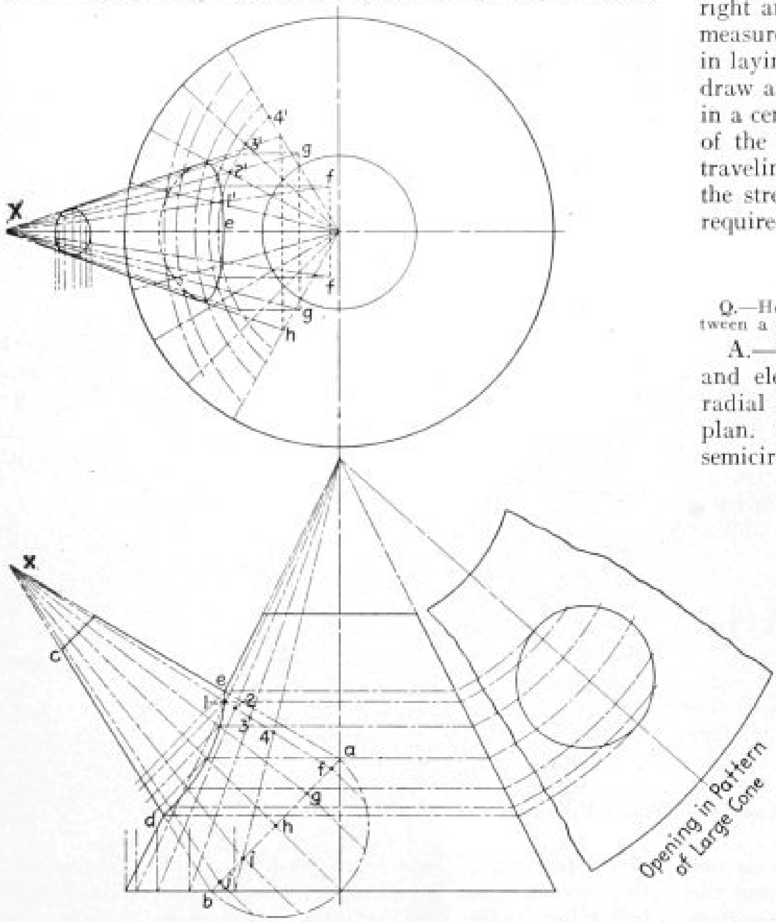
A.—The accompanying drawing illustrates the several steps in the development of an intersection between two cones. curved sections and their corresponding radials as *x-f*, *x-h*, etc., in the plan establishes points on the miter line. These are projected to the elevation.

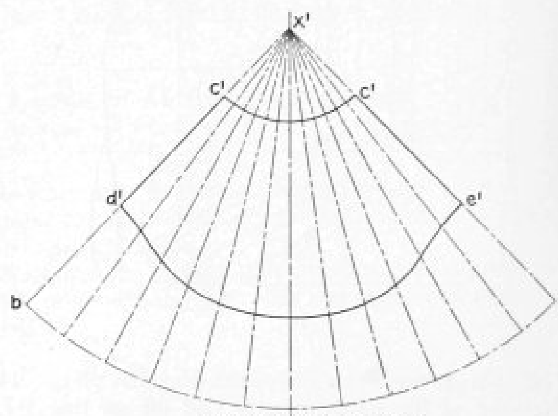
Patterns for the cones can now be developed. Note that the points on the miter in the elevation are projected at right angles to the axis of the small cone. The radial lines measured on the outer element *x-d* are the true lengths used in laying out the pattern for the small cone. For this pattern draw an arc, using *x-b* of the small cone as a radius. Draw in a center line and space off on the arc, spaces equal to those of the semi-circle for the small cone. In this work use a traveling wheel (circular measuring wheel) for laying off the stretch out of the cone. Then space the length into the required parts.

Cylinder and Cone Intersection

Q.—How are the miter line and patterns laid off for an intersection between a cylinder and cone? C. B.

A.—The accompanying sketch shows the required plan and elevation for this layout in which determine first the radial lines of the cone as *O'-2*, *O'-3* and *O'-4*, etc., of the plan. This is done by describing on the base of the cone a semicircle with a radius equal to one-half the diameter of





Pattern of Small Cone

Layout of Intersecting Cones

Draw the outlines of the cone in a plan and elevation. Divide the semi-circle which represents one-half of the base of the small cone into a number of equal parts. From these points and at right angles to *a-b* draw lines to intersect it and from these points draw radial lines to point *x*, the apex of the small cone. In the plan view locate the sections of the small cone as *x-f-f*, *x-g-g*, and *x-h-h*, which is done by drawing vertical projectors from the points *f-g-h-i* and *j* of the elevation. The horizontal distance between points *f-f*, *g-g*, etc., is obtained by measuring the distance between the radials at the points where they intersect the base *a-b* of the elevation. For example, *f-f* of the plan equals *i-g* of the elevation and *g-g* of the plan equals *j-f* of the elevation and *h-h* equals *a-b*. Imagine these triangular sections as *x-f-f* and *x-h-h*, etc., to be planes passed through the small cone and also the larger cone. Where these cut the large cone, sections of the large cone are found and they are either elliptical, parabolic or hyperbolic in form, depending on the inclination of the cutting planes. The shapes of these sections are shown partially by the dotted curved lines as they appear in the plan view. The development of one section in this case will be given.

Divide one-half of the circle plan view into twice as many parts as in the semi-circle of the small cone and draw the radial lines from the points on the circle to its center. Locate the radials in the elevation. Where the radial line *x-f* of the small cone intersects the radial lines of the large cone establishes points 1-2-3 and 4. Project these to the plan as at 1'-2'-3'-4'. Continue in this way until all of the required curves in the plan are found. The intersection between these

the base of the cone. From the points on the semi-circle project lines to the base of the cone and connect these points with *O'*, the apex of the cone. In the elevation establish the radial lines or elements of the cone and draw them of indefinite length. Where the radials in the plan view cross the circle of the cylinder fixes points as shown at 3-2-4-5, etc. These lie on the miter and are shown projected to the elevation to intersect corresponding radial lines.

Before developing the pattern of the cone, project the points 5-6-7 and 8 of the elevation of the cone at right angles to its axis *o-T* and to intersect the outer element of the cone. The lengths of these radials measured on the outer element are the true lengths to be used in the pattern development.

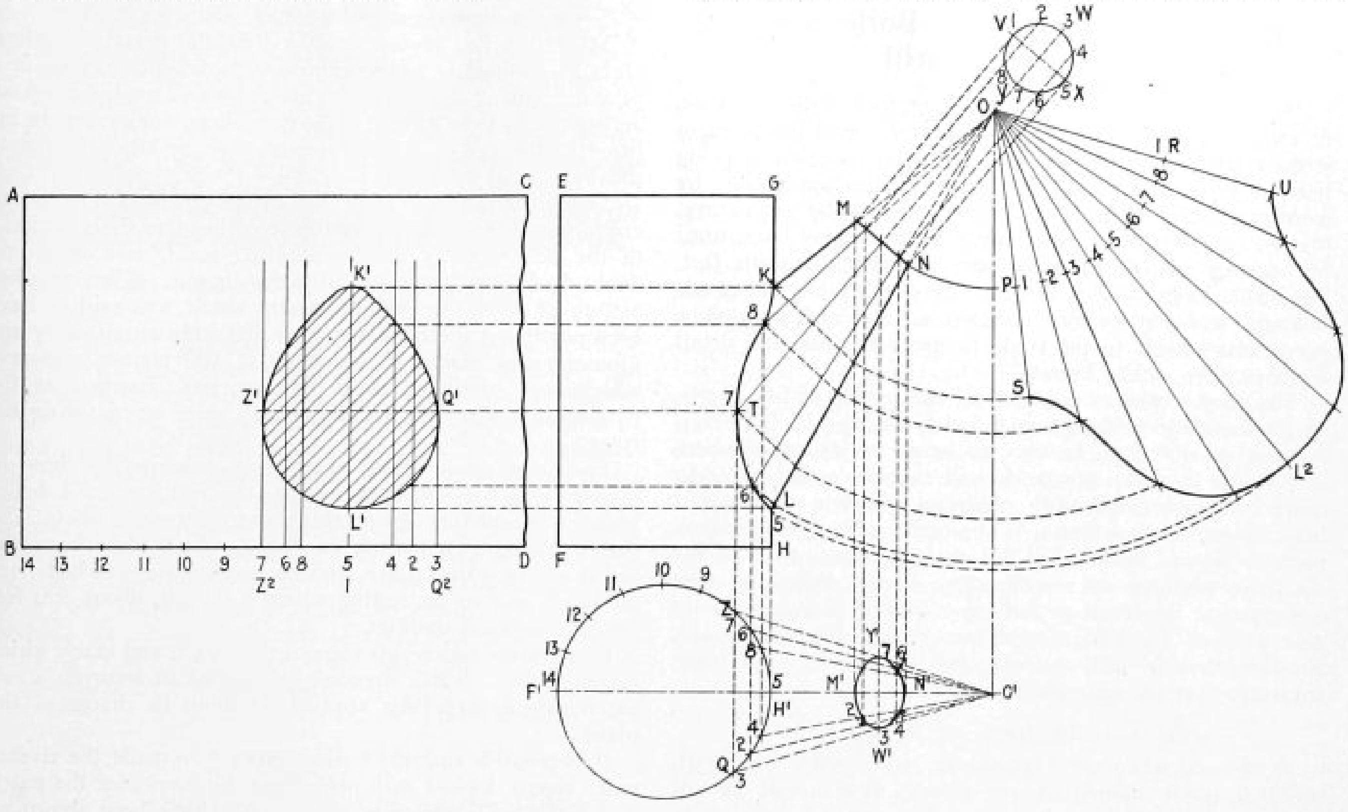
Pattern of Cone

Using *O* as a center and *O-N* as a radius, draw an arc. Divide this arc into the same number of equal parts as contained in the circle representing the small end of the cone. Connect point *O* with 1-2-3-4-5-6-7 and 8, making these radial lines of a convenient length. With *O* as a center, lay off on the radials in the pattern the true developers of the cone as taken on its outer element. These are shown projected by arcs from the cone to its pattern.

Opening in Pattern of Cylinder

This development is made by laying off first the arc lengths between the points 5-4, 5-2, 5-3, 5-8, 5-6 and 5-7 of the plan on a stretchout line in the pattern of the cylinder.

Draw lines in the pattern from points 3-2-4, etc., at right angles to the stretchout line, in this case *B-D*. From the elevation draw projectors from points 5-6-7-8, etc., to intersect lines numbered to correspond, thus establishing points lying on the opening. The projection work is shown carried out step by step and points are indicated on the patterns to correspond with those in the plan and elevation so no trouble should arise in following the work.



Cone Intersecting a Cylinder

BOOK REVIEWS

MODERN WELDING METHODS. By Victor W. Page, M. S. A. E. Size, 6 by 9 inches. Pages, 292. Illustrations, 200. New York, 1920. Norman W. Henley Publishing Company.

This is a book of instruction on methods of joining metals by welding for the mechanic and the factory executive. It is not intended as an engineering work, but rather a more practical treatise on welding, soldering and brazing processes. It describes in detail oxy-acetylene, thermit, electric arc and resistance welding, together with a description of the apparatus needed and instructions as to its use. Cost data results are included so that it is possible to determine the most economical method of welding a given piece of work. The book also includes instructions for the heat treatment of steel, and tables on tempering tools, melting points of metals, temperature determinations and the like.

THE WELDING ENCYCLOPEDIA. Compiled and edited by L. B. McKenzie and H. S. Card. Size, 6 by 9 inches. Pages, 326. Illustrations, 375. Published by the Welding Engineer Publishing Company, Chicago, Ill., 1921.

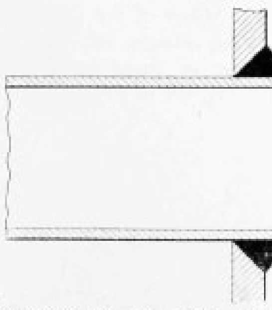
This is a reference and instruction book on the subject of autogenous welding by various methods. The first part of the book contains an illustrated dictionary section, giving definitions of words, terms and trade names used in the welding trade. The oxy-acetylene, electric arc, electric resistance and thermit processes are treated in separate chapters, which give instructions for welding metals by each of these processes. Rules and regulations of the various states, the Department of Commerce, the Interstate Commerce Commission, the American Society of Mechanical Engineers' Boiler Code Committee, the Underwriters' Laboratories, Lloyd's Register of Shipping and other regulatory bodies in connection with the application of welding processes are reviewed. A special chapter is devoted to boiler welding and another to the heat treatment of steels. Charts and tables show graphically the right and wrong methods of preparing welds and the like.

Tube Welding

Q.—In electric welding tube ends on boiler heads we would like to know which is more practical to weld the tube ends with water in the boiler or with the boiler empty?

The work we have in mind is welding the upper end of the tubes in waste heat boilers. These tubes are 4 inches diameter and will be rolled and beaded over in the regular way and then welded over the top of the bead so as to make the bead stronger to resist the contraction and expansion which is caused by throwing the blast on and off. In waste heat boilers this usually gives trouble with the tube ends. E. K.

A.—Water above the tube line will assist in controlling the stresses, due to expansion and contraction during welding, as the water will take up some of the heat radiated from the metal, thereby tending to localize the heat from the arc. Welding over-beaded tubes can be done, but not so satisfactorily as when the tube and tube sheet are arranged as shown in the accompanying figure. Welding the bead to the flat surface of the tube sheet will require careful handling of the electrode, so as not to burn the tubes. When welding circular connections in a vertical position, start at the bottom and work to the top, completing first one-half of the joint, then the other half.



Arrangement of Tube and Tube Sheet for Welding

The George T. Ladd Company, makers of watertube boilers, has announced the appointment of J. B. Crane to the sales and engineering department. Mr. Crane has had extensive experience in the construction and operation of power houses.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Lap Seam Crack Causes Boiler Failure in Planing Mill

Many of the details of boiler making, and in that term we, of course, include boiler repairing, have found no place in written language but may be said to be traditional, being handed down from the journeyman to the apprentice, by word of mouth. Other details may be said to be proprietary, that is, some workman experiments with new processes, until he becomes acquainted with some formerly unknown fact, applicable to the trade, of which he immediately takes advantage, with satisfactory personal results, and with some permanent benefit to the trade in general, when the detail becomes more widely known.

The good workman is proud of the results of his efforts, and when trade-pride ceases to exist, whether he be manufacturer or workman, he may no longer be depended upon, and sooner or later his work will become outclassed. In order to obtain satisfactory results, a complete understanding of the trade is essential. The boiler maker doing repair work is thrown more upon his own resources than is the workman engaged in routine shop work. When on new construction, the foreman and other journeymen are usually near at hand for advice when necessary. It may be said, however, that friendly counsel and conferences of a trade nature are far too uncommon.

Experience Required in Repair Work

At any rate, when a call for outside repair work is received, one of the most capable and experienced men in that class of work, is, or should be, sent to the job, for it is impossible to determine the far reaching effects of a lapse in judgment, when outlining the repairs to be made, and the manner of making them. The owner of a boiler is anxious to obtain the greatest possible term of service, consistent with safety, and is often willing to spend more for patches, new tubes, or resetting, than the value of the boiler warrants. Of course, if permanent, safe and satisfactory repairs are possible, no one should object to a patch of proper dimensions, properly applied, but the boiler maker should have sufficient judgment to determine, and sufficient confidence to refuse, if repairs should not be made, for otherwise lives and property are placed in danger.

Lap Seam Crack in Boiler Causes Explosion

At 7:30 a. m., September 20, 1920, the town of Antlers, Okla., was shocked by the explosion of a boiler located in a planing mill at that place. The plant was totally wrecked, and two men were killed, while two others were seriously injured. The head of one of the men who were killed was completely severed from the body.

The immediate cause of the explosion was a lap seam crack, which extended from the front head to the rear head of the boiler, along the longitudinal seam, and which no doubt had been years in fully developing. The complete history of the boiler was unknown, but it was said to have been purchased second hand, provided with usual safety appliances, and placed in operation at 100 pounds pressure, which was continued until leakage was observed at the longitudinal seam on the right hand side, when facing the front.

The home made brand of calking, provided by those in charge, was not sufficient to stop the leakage, so a boiler maker was sent for, and patching was determined upon. The patch can be seen plainly in Fig 2, which also shows the extent of the seam failure, and the shell plate detached from the heads and tubes, resting where it landed, about 300 feet from its original position.

Fig. 3 gives a close-up view of the patch, and crack which extended through the threaded holes, used in securing a soft patch, which had been applied by those in charge of the plant.

It is possible that the boiler maker who made the riveted patch repair, looked with pride upon his work, for the patch was tight, and while its shape could have been improved upon, its workmanship was above the average. It is further probable he had never heard of a lap seam crack. This is a defect thousands of men are seeking daily, in order to prevent just what took place at Antlers, and if this mechanic had been thoroughly posted upon the developments which have taken place in his trade in recent years, the designs which have proven faulty, and the many failures of lap joints, due to the lap joint cracking, he could have prevented the disaster, by refusing to make repairs.

Many of the states have adopted laws regulating the material, design, construction and operation of steam boilers, but few of them have dealt extensively with rules controlling

Fig. 1.—Result of Boiler Explosion in Planing Mill, Antlers, Okla.

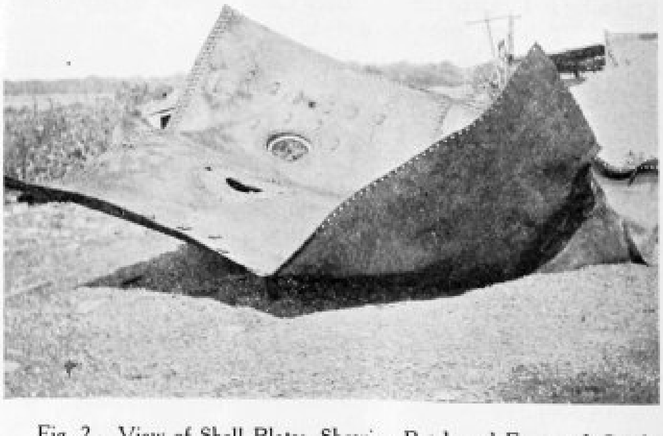


Fig. 2.—View of Shell Plates, Showing Patch and Extent of Crack

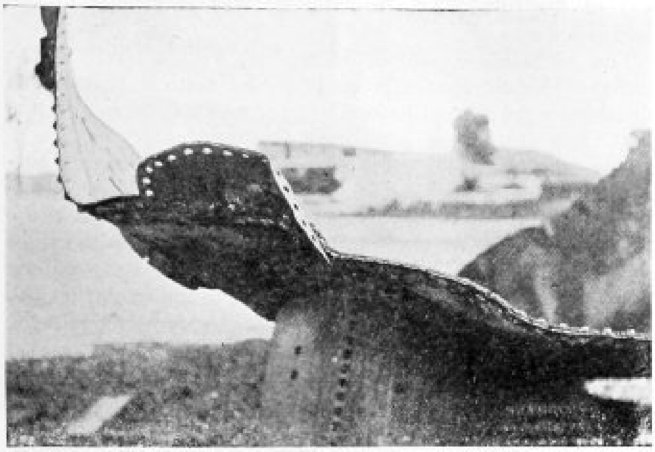


Fig. 3.—Close-Up View of Patch and Crack

boiler repairs. However, there is one requirement which has been almost universally adopted, which prohibits the repairing of a sheet in which a lap seam crack has developed.

The A. S. M. E. Boiler Code limits the pressure on lap-seam boilers to 50 pounds after 20 years of service, and likewise prohibits repairing the sheet of a boiler in which a lap seam crack has been discovered. The loss of life and damage to property at the Antlers' Planing Mill alone, to say nothing of the great number of similar explosions which have occurred elsewhere, clearly justifies the Code requirements, and every boiler maker called upon to tighten by calking, or repair by patching the longitudinal seam of a lap-seam boiler, should refuse to make repairs until it is clearly demonstrated that a lap seam crack does not exist.

J. P. Morrison.

What is the Formula for Inefficiency?

I read a statement worded something like this the other day: "80 percent efficient means 25 percent inefficient." Is that correct?

We are generally in the habit of thinking that 80 percent efficient means 20 percent inefficient. We simply subtract 80 from 100. The writer of the above statement evidently desires to show us that we are wrong, and that wastage is greater than we suppose. His formula seems to be

$$\text{Inefficiency} = \frac{100 - \text{efficiency}}{\text{Efficiency}}$$

But let us see. Let us substitute an efficiency of 50 percent in his formula. We then get

$$\frac{100 - 50}{50} = 100 \text{ percent inefficiency.}$$

Now, 100 percent inefficient, I should say, means that "all is lost," and that the efficiency is zero instead of 50 percent. It is true that where boiler efficiency is 50 percent, for example, just as much heat is lost as is utilized. The amount of fuel burned is twice as great as it would be with 100 percent efficiency. Or, if 100 percent efficiency were possible the fuel bill would be cut in half.

I conclude, therefore, that the writer of the above statement was a wee bit too eager to point out the seriousness of losses. He tried to make them look as big as possible via the mathematical route. In an extreme case, where the efficiency is 1 percent, his method would give

$$\frac{100 - 1}{1} = 9{,}900 \text{ percent inefficiency.}$$

To my mind the logical formula for inefficiency (if inefficiency can be stated as a percentage) is:

$$100 - \text{efficiency} = \text{percent inefficiency.}$$

Brooklyn, N. Y. W. F. Schaphorst.

Finding a Solution to the Apprentice Problem

The question of the apprentice as set forth by the writer in the January issue of The Boiler Maker is timely, as beyond a doubt the recent industrial condition has to a great extent worked havoc with the regular apprentices in the various boiler shops throughout the country. Unless some general move is made to overcome this condition, the prestige and importance of boiler making will be lost on account of the laxness of those most vitally interested.

One of the great obstacles to be overcome in regard to the improvement of the apprentice system, is the present flat rate of wages paid mechanics, which, under various wage agreements is in vogue in most of the shops throughout the country. Until this system is modified in some manner so as to give a differential rate of wages, or until the officials of the various shops recognize the importance of assisting in the improvement of the system, it is doubtful if any general raising of the standard of apprentice training is obtainable.

Under the existing conditions, the apprentice sees that he will receive the standard rate of wages, as soon as he completes his apprenticeship, so why should he spend time and money in studying when there is no special inducement offered him to do so?

The great incentive in stirring up ambition in the young man is either the looking forward to holding responsible or executive positions, or the fact that special consideration in the line of increased wages is waiting for the one who masters the technical details of the trade he is learning. These taken singly or together go far towards starting the normal young man on the path of progress and to success. Eliminate one or both and the apprentice becomes a mere cog in the industrial machine, wherein some one other than he does the necessary thinking.

In my opinion there are two methods whereby the apprentice can be assisted in mastering the technical details of the trade he is learning, namely, by the establishment of vocational classes in the different shops or works, or by encouragement of home study. While either of these methods is practical and good, from my own experience and observation that of vocational classes in the works must receive the first consideration primarily because, being compulsory for the apprentice to attend, it is an easy matter to keep check of the progress made by the boy both as to his work in the class room and also in the shop.

Then, too, being under the supervision of competent and practical instructors he has the advantage of being able to get the proper attention and assistance when necessary.

Finally he receives the benefit of class room discussion, which tends to bring out the ideas and thoughts which usually lie dormant unless developed in this manner.

Under the vocational system the apprentice is required to attend class a certain specified number of hours per month, being allowed the time from his work to do so. This might be taken to mean that the company would be placed at a disadvantage in having the man attend during working hours, but by careful selection of the class, this can be brought to a minimum and it soon creates a much more capable mechanic, and has the tendency to interest the apprentice in his work so that he thinks of its value rather than with the wish that his apprenticeship were completed.

I have had the opportunity of seeing the results of the vocational training systems in vogue on the Pennsylvania lines, Canadian Pacific Railway, Canadian National railways and in the industrial plant of the Goodyear Tire & Rubber Company, and, while they differ in detail, all are pretty much the same in their general principles. In all these, the apprentices are under the supervision of practical instructors and take up a systematic course of instruction that will enable them to obtain a thorough understanding of the various phases of the trade. Besides those mentioned there are other companies which have training systems along more or less similar lines. Some such system as outlined above is without a doubt the most beneficial both to the apprentices and to the company, but it can only be established economically when there is a considerable number of apprentices such as would be found in general construction and repair shops.

In establishments where the number of apprentices is limited the method of home study is practical and beneficial and the results are well worthy of consideration. In such cases, however, it would be of great benefit to the young men if the foreman or officials of the shop were to interest themselves in the progress of the apprentice and give such assistance as they are able to offer.

Where either of these methods is in operation it would be a great inducement and encouragement to the individual apprentice if the different foremen and officials were to contribute something towards prizes to be competed for by the apprentices. This plan has the tendency to create a spirit of competition among the different apprentices and at the same time shows them that those in authority recognize the benefits to be obtained by a systematic course of study.

The idea of the foremen showing interest in the advancement of the apprentices under them is especially worthy of note, as in most cases the apprentices are of such an age that good advice when properly given is most readily taken and considered. It might be added that the foreman is the one person to whom the beginner looks for assistance and encouragement, so that he has the opportunity of acting in a capacity which is of great importance to both company and apprentice.

When the importance of the boiler making trade is taken into consideration and the necessity of mechanics being thoroughly familiar with the numerous laws and requirements pertaining to the construction and up-keep of boilers and pressure vessels, the writer is of the opinion that the sooner some move is made to inaugurate a general educational system whereby the apprentices can obtain the required training, the sooner will the standard of the young mechanic be what it should, namely, 100 percent efficient.

"Progress."

New Santa Fe Locomotive Boilers

(Continued from page 100)

The stokers are of the locomotive Stoker Company's duplex type except for some modifications of the conveyor to suit the size of the tender. The stoker housing and hopper casting feet are secured by 1⅜-inch diameter fitted bolts in reamed holes. The foundation bolts which secure the stoker to the brackets or to the rear deck of the locomotive are fitted in reamed holes and secured by double nuts.

Superheater

The superheater was supplied by the Superheater Company, New York. The superheater tube units are 50 in number of seamless steel 1½ inches in diameter No. 9 B. W. G., manufactured by the Globe Seamless Steel Tube Company. The return bends of the superheater tubes are of forged construction. Superheater unit clamp bolts were manufactured by Joseph T. Ryerson & Son according to the railroad company's instructions. The superheater is a Type A Double Loop having 50 units. The superheater header is of the modified through-bolt type cast by the Superheater Company. The channels leading to the steam pipe have an area equal to the area of the pipe. The superheater was fabricated at the Baldwin works.

The superheater damper is applied with a shaft at the center. The damper cylinder is of the vertical type. The superheater damper pipe is of copper ⅝-inch outside diameter. The drain pipe is ½-inch diameter.

The smokebox is of the extended type 89¼ inches outside diameter with pressed steel front and door. Three cleaning holes with caps are provided in the smokebox, one at the front end on the left side and the two remaining on the right and left sides near the flue sheet for inspecting supheaters. Frames for the cleaning holes are riveted to the smokebox. A standard Santa Fe cinder hopper is located beneath the smokebox.

Steam Pipes

Saturated steam is delivered from the dome located on the rear course of the boiler through the inside of the dry pipe to the superheater. Steam from the superheater is delivered to the cylinders through pipes located partially within the smokebox. Steam pipes pass through the sides of the smoke box and join the valve chamber midway between the ends. The connections are carefully made where the pipes pass through the smokebox to provide against air leakage.

Boiler Tests

The boilers were tested with a steam pressure of 245 pounds, which is the pressure for which the boilers are built plus 20 pounds. They were also tested with hot water to a pressure of 300 pounds, which is 33 1/3 percent in excess of the designed pressure. This hot water test of the boiler was made after the fastenings for the dynamo bracket, belly brace, tee irons, bell, sand box, steam turret, hand rail columns, reservoir brackets, running board brackets and the like, which tap into the boiler, have been applied. After being tested, the boilers and tubes were thoroughly dried to prevent accumulation of rust and pitting of the tubes.

Stoker Fired Locomotive Makes Continuous Run Over Three Divisions

To demonstrate that a trip for a locomotive need not necessarily be limited to one division of approximately 100 miles, as has been generally the fixed practice on railroads for many years past, the Erie Railroad recently planned a test run by which one of its through New York-Chicago passenger trains would be hauled over three divisions, by one engine alone instead of using three engines as at present.

This test was based on the belief that the superior firing service of the modern mechanical stoker on heavy locomotives and long runs would render fire cleaning unnecessary at the end of each division. Continuous operation over the three divisions would be advantageous as it would eliminate the costs of terminal handling, time consumed, etc.

Accordingly on February 24, heavy Pacific type engine No. 2926 equipped with a duplex stoker attached to Erie train No. 3, consisting of one mail car, one express car, two coaches, two Pullman cars and one dining car left Jersey City at 12:18 p. m. for a continuous trip over the New York, Delaware and Susquehanna divisions, a total distance of 332.3 miles.

On the return trip, February 25, the same engine left Hornell at 10:57 a. m., one hour and one minute late, with train No. 4, consisting of one mail car, one express car, two coaches, two Pullman cars and one dinning car, arriving at Jersey City at 7:00 p. m. on time. There was no hand firing done nor was the rake used during the round trip of 664.6 miles.

The fire was clean on arrival at Jersey City terminal, the ash pan being reasonably free from ash and not in any way clogged; and insofar as the condition of the engine was concerned, it could have been placed on another train and returned to Susquehanna over two divisions.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; A. G. Pratt, Babcock and Wilcox Company, Bayonne, N. J.; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio.; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

PNEUMATIC TOOLS—An illustrated folder giving specifications and short descriptions of the principal types of riveting hammers, chipping hammers, drills, staybolt riveters and the like, manufactured by the Keller Pneumatic Tool Company, Grand Haven, Mich., has recently been sent out.

PORTABLE ELECTRIC DRILLS—The Standard Electric Tool Company, Cincinnati, O., has sent out a loose-leaf folder containing details of high power universal portable electric drills, reamers and grinders for operation on alternating and direct current. Applications of these tools to various kinds of work are illustrated and the general specifications given.

BOILER TUBE CLEANERS—Catalogue Z of the Liberty Manufacturing Company, Pittsburgh, Pa., contains details of the construction and operation of water driven and air driven boiler tube cleaners both for firetube and watertube boilers. For firetube or return tubular boilers special knocker heads for use with standard water and air motors are described.

NATIONAL SELLING AIDS—For the purpose of promoting co-operation between the National Tube Company, Pittsburgh, Pa., and the companies which distribute and sell "National" pipe, this booklet has been issued to suggest advertising material for catalogues, booklets, stock lists and the like. A review of the bulletins issued from time to time by the National Tube Company is also given.

RE-GENERATIVE COMPRESSOR—In Bulletin No. 350 the Griscom-Russell Company, New York, outlines the need for an evaporator aboardship that will operate efficiently at capacities less than rating. It goes on to describe the G. R. re-generative compressor, which, it is claimed, accomplishes this efficiency by compressing and delivering to the evaporator coils a portion of the vapor taken from the evaporator. This vapor, with a certain amount of boiler steam, makes up the total steam required for evaporator operation, otherwise the total steam would have to be supplied by the boiler.

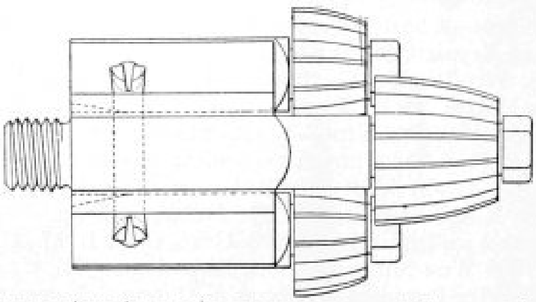
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,363,232. CUTTER HEAD FOR BOILER TUBE CLEANERS. PHILIP J. DARLINGTON, OF HARTFORD, CONNECTICUT, ASSIGNOR TO THE ROTO COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF CONNECTICUT.

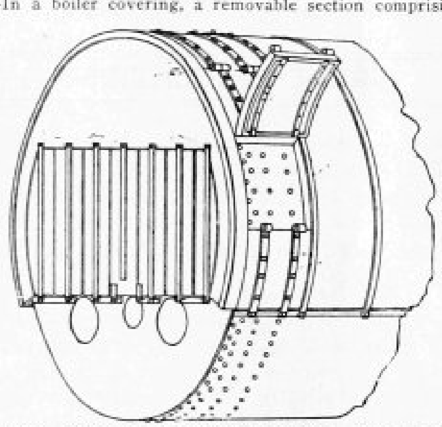
Claim 1.—A cutter for a tube cleaner having a body with longitudinally extending outwardly opening grooves in its sides, long arms held at one end



by transverse pivots in opposite grooves, cutters rotarily mounted on the free ends of said long arms, short arms held at one end by transverse pivots in opposite grooves, cutters rotarily mounted on the free ends of said short arms, the cutters on the short arms, when the arms are closed, lying close back of the cutters on the long arms, with the cutting teeth of the cutters on the short arms curved longitudinally on arcs of shorter radii than the cutting teeth of the cutters on the long arms. Four claims.

1,363,173. REMOVABLE COVERING FOR BOILERS. JAMES C. WORKMAN, OF LAKEWOOD, OHIO, ASSIGNOR TO THE AMERICAN SHIP BUILDING COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF NEW JERSEY.

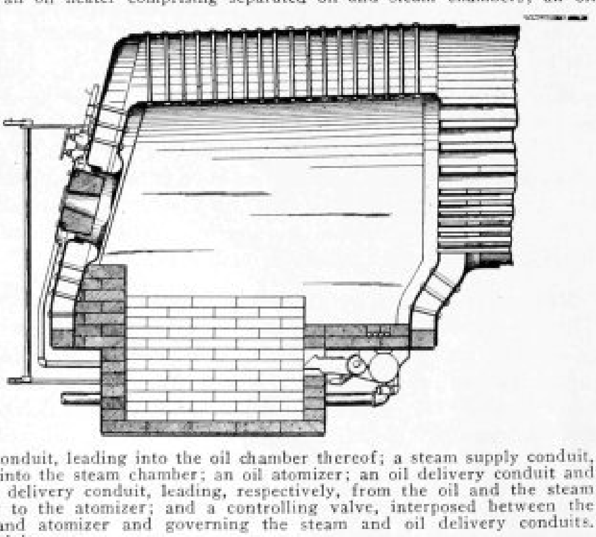
Claim 1.—In a boiler covering, a removable section comprising a shallow



open frame work, refractory material laid therein, and a wire lacing extending across the open face of such frame work, said lacing being adapted to maintain such material in position.

1,360,641. OIL-BURNING APPLIANCE FOR FURNACES. ALFRED HUTTON AND JOHN M. MAHONEY, OF SCHENECTADY, NEW YORK.

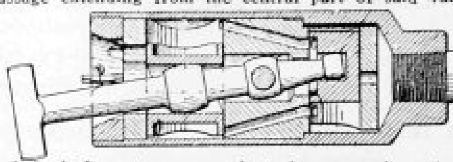
Claim 1.—In a hydrocarbon burning apparatus for furnaces, the combination of an oil heater comprising separated oil and steam chambers; an oil



supply conduit, leading into the oil chamber thereof; a steam supply conduit, leading into the steam chamber; an oil atomizer; an oil delivery conduit and a steam delivery conduit, leading, respectively, from the oil and the steam chamber to the atomizer; and a controlling valve, interposed between the heater and atomizer and governing the steam and oil delivery conduits. Eleven claims.

1,363,301. BOILER TUBE CLEANER. JOHN ZILLIOX, OF ORCHARD PARK, NEW YORK.

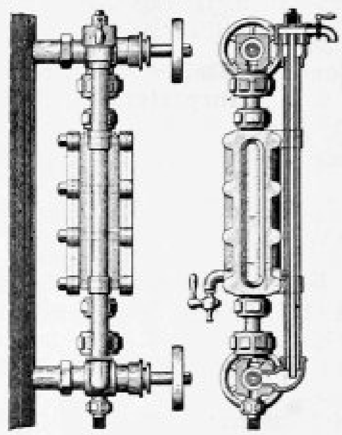
Claim.—A boilertube cleaner comprising a body having an inlet at its rear end for a pressure medium, a transverse slide valve seat in its rear part, a transverse motor cylinder in its front part, supply passages connecting opposite ends of the valve seat with opposite ends of the cylinder, and an exhaust passage extending from the central part of said valve seat to the



front end of the body, a transverse pivot pin arranged on the body between said cylinder and valve seat, a piston arranged in said cylinder and provided with a diametrical opening, a slide valve movable on said seat and having a cavity on its rear side and adapted to connect said inlet and exhaust passage alternately with said supply passages and provided in the bottom of said cavity with a recess, and a hammer having a lever which is arranged in said exhaust passage and mounted on said pin and provided with a rear arm having a spherical rear end which engages with said recess, and a front arm provided intermediate of its ends with a spherical enlargement which engages with said opening in the piston and provided at its front end with a hammer head, said lever and its head and spherical enlargements being constructed of a single piece, the spherical enlargement on the rear arm of the hammer lever being smaller than the spherical enlargment on the front arm of the same. Four claims.

1,306,167. BOILER PROTECTING DEVICE. LAMBERT J. BORDO, OF ROSLYN, PENNSYLVANIA.

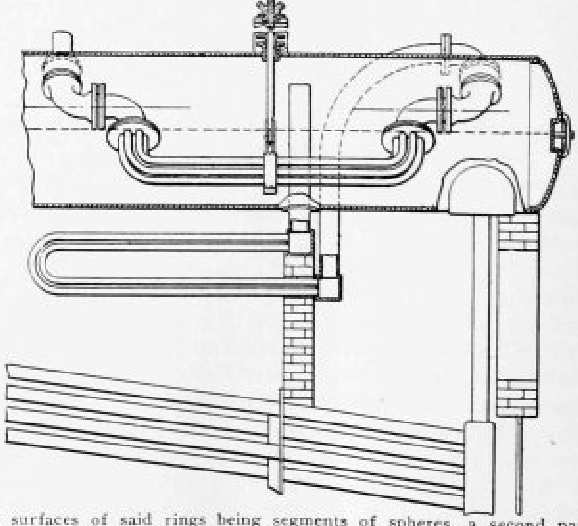
Claim 1.—A low water indicating device for boilers comprising a chambered casing adapted to be connected at its lower end to the water space of the boiler, and provided at its upper end with a wall portion formed



of material melting at a temperature lower than the normal steam temperature of the boiler, said casing being formed with two passages leading from the top of said casing to different levels adjacent the bottom thereof and uniting to form a siphon discharge from said chamber for the water contained in the upper portion thereof when a fall in boiler water level permits steam to enter the lower end of said chamber. Two claims.

1,351,465. APPARATUS FOR REGULATING THE TEMPERATURE OF SUPERHEATED STEAM. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—In apparatus of the class described, the combination of two elbows each with one end flared, a ring secured in each of said flaring ends, the



inner surfaces of said rings being segments of spheres, a second pair of elbows, a ring secured on the outside of each adjacent to one end, the outer surfaces of said rings being complementary to and engaging respectively with the inner surfaces of the first named rings, means to keep the two second named rings in engagement with the two first named rings, a plate secured to each of the second pair of elbows, tubes connecting said plates, the two flexible joints thus formed being in alinement so that the two pairs of rings lie parallel to each other. Four claims.

THE BOILER MAKER

MAY, 1921

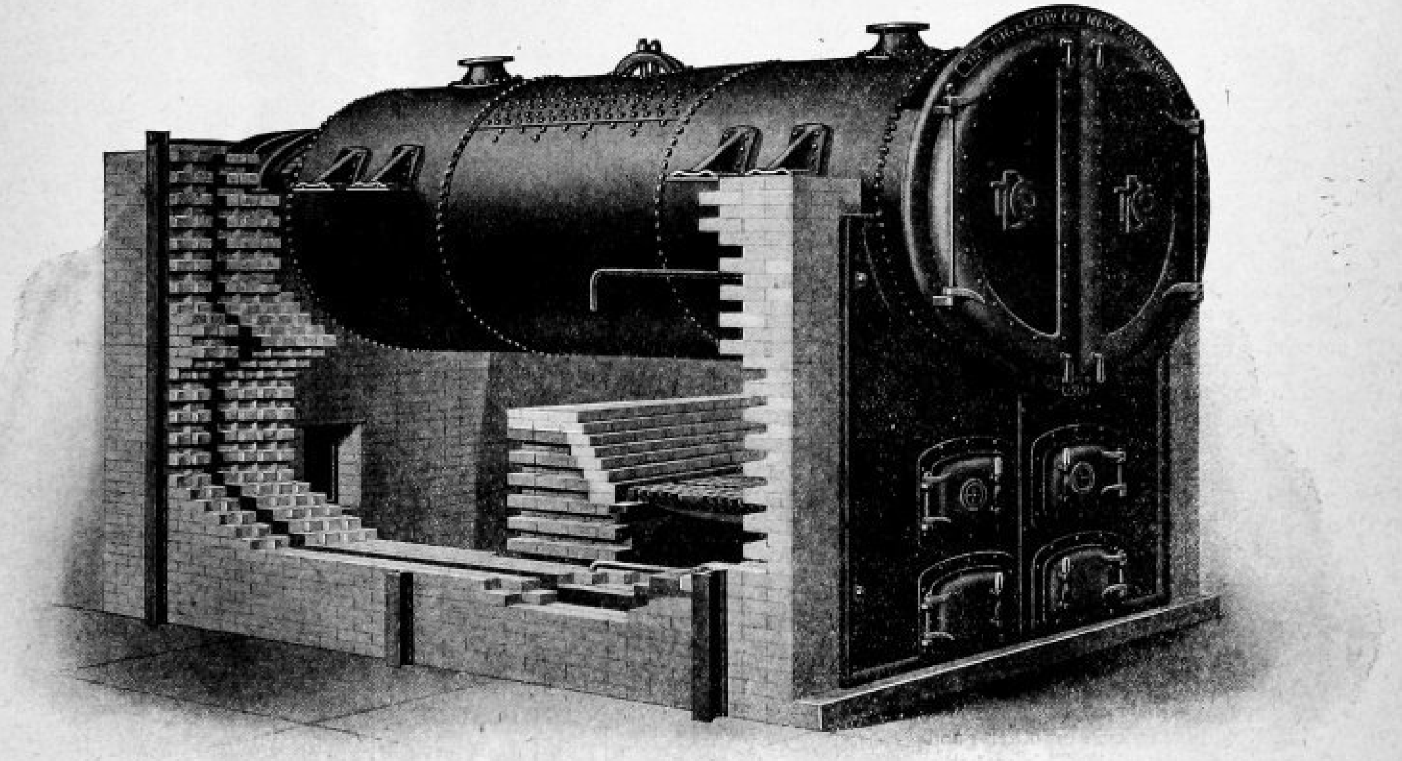


Fig. 1.—Sectional View of Horizontal Return Tubular Boiler Setting Designed by The Bigelow Comp any, New Haven, Conn.

Constructing Horizontal Boiler Settings

Typical Setting Designs Adopted as Standard by the Hartford Steam Boiler Inspection and Insurance Company

By H. E. Dart*

THE engineering department of the Hartford Steam Boiler Inspection and Insurance Company recently completed new drawings of setting plans for horizontal tubular boilers. In past years there has been a big demand for such setting plans and some of the tracings for the more common sizes of boilers are literally worn out. In making the new drawings, advantage is taken of the opportunity to show certain features in greater detail than was formerly the case, and the scope of the plans has also been extended so as to include typical methods of piping and the proper manner for installing the usual fittings and attachments. Figures are also given to show the quantities of bricks required for setting the boilers in accordance with the plans. For each of the common sizes of boilers it is the intention to make four drawings, two with overhanging fronts and two with flush fronts, one of each style showing boilers suspended independently of the setting walls and the other showing boilers supported by means of brackets resting on the walls as shown in Fig. 1.

The most important features in connection with the new setting plans are described below. While many of the features mentioned will apply equally well to the design of settings for any other type of boiler, it should be remembered that this description is concerned primarily with hand-fired, horizontal tubular boilers using coal for fuel, and is written from that viewpoint.

Wall Construction

On the old setting plans of the Hartford Company the outside walls are shown as indicated by Type I, Fig. 2, but on the new plans we are showing all of the four types of construction described in Fig 2, leaving it to the boiler owner to make his choice between these designs. Complete dimensions are given on the drawings for each type of construction.

The design shown by Type I involves the construction of two separate brick walls, bonded solidly together for a distance of about sixteen inches at the top and at the

* Superintendent of engineering department, Hartford Steam Boiler Inspection and Insurance Company.

bottom, but separated by an air space two inches wide for the remainder of the height. It is thought by many people that this air space acts as a heat insulator, but such is not the case; experiments by the Bureau of Mines have shown that a wall of this type will transmit just as much heat under given conditions as a solid wall of the same total thickness. As regards air leakage into the furnace, however, the double wall with an air space has a distinct advantage over the solid wall shown by Type II, because the cracks will occur principally in the inner wall, leaving the outer wall intact. With a solid wall, the cracks will extend clear through the brickwork, thus greatly increasing the probability of air leaks and thereby decreasing the efficiency on account of excess air.

Type III in Fig. 2 makes use of insulating bricks to reduce the amount of heat that is transmitted through the wall and thereby lost. These insulating bricks are made of different materials by different manufacturers and they are cut to the proper size to lay up evenly with ordinary bricks and firebricks. They have little mechanical strength in themselves, so that it is best to use metal ties, as shown in the cut, for bonding the inner firebrick section to the common brick on the outside. It is also advisable to use a uniform thickness of nine inches for the firebrick lining in place of the 4½-inch lining with headers as shown for the other types. This type of construction makes a very good setting, costing somewhat more than either Type I or Type II.

Type IV is similar to Type I with a steel casing substituted for the outer wall and the air space filled with magnesia or other good insulating material. This makes a most excellent form of setting, the only drawback to its more general use being its greater cost as compared with other types. The insulating material reduces the heat radiation loss to a minimum and the steel casing prevents the even greater loss due to air leakage through the setting walls and also cuts maintenance cost.

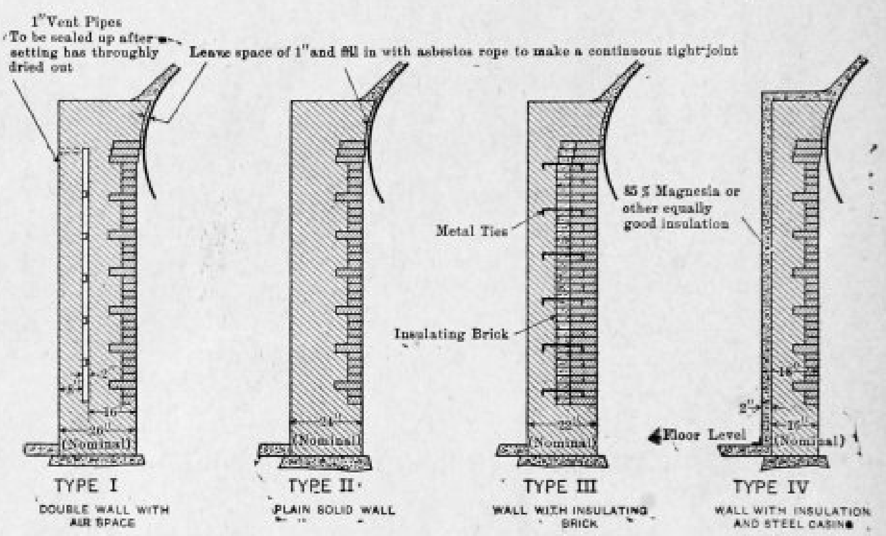


Fig. 2.—Different Types of Construction for Setting Walls

For the division walls between boilers set in battery, the style of construction shown in Fig. 3 is satisfactory, regardless of what type of construction is used for the outside walls. The vertical slot shown in the center of the wall does not indicate an air space like that in Type I, but is intended to show that the two walls should be built separately and not bonded together in the center. This is advisable to make allowance for expansion when there is a fire on only one side of the wall.

The sections in Fig. 2 apply to the side walls at the rear of the bridge wall. For the furnace section in front of the bridge wall we advise that the walls be battered from the grate level to the closing-in line near the middle of the boiler shell. Our drawings show a batter of six inches in this height, thus making the walls that much thicker at the bottom. A reference to Fig. 3 will make this point clear. The section at the left shows the battered wall, while that at the right shows the straight form which can be used back of the bridge wall.

In constructing side walls and division walls it is a good idea to build an arch in the firebrick lining at a height of about three feet above the grates, as illustrated in Fig. 4. When it is necessary to replace firebrick, this arch supports the brickwork above and prevents it from falling down.

For construction like that shown in Types I, II and IV, where the firebrick lining is only 4½ inches thick, headers should be used for every fifth course or even more frequently. In all firebrick work the joints between the bricks should be made just as thin as possible. For this reason a trowel should not be used, but the bricks should be dipped in thin fire clay and then rubbed down into place so as to make "brick-to-brick" joints.

Allowance for Expansion and Prevention of Air Leaks

Ample provision should be made throughout to allow the boiler and the setting to expand without cracking the brickwork or opening up places where air can leak into the setting. If the brickwork is built tight up to the boiler shell at the closing-in line, cracks are sure to develop when the boiler is heated up and there will also be an opportunity for air to leak in between the boiler and the brickwork. It is best, therefore, to leave the brickwork about an inch away from the boiler and fill this space with asbestos rope or some similar material, as illustrated in the different sections of Fig. 2. In a similar way, the brickwork and the ironwork of the boiler front should be kept about ¾ inch away from the boiler shell (and concentric therewith) and this space should be filled in with asbestos rope. To prevent cracking due to endwise expansion of the bridge wall, it should be built separately from the side walls, leaving a space of about one inch at each end. This space should be filled with asbestos rope to prevent the accumulation of ashes which would become solid and nullify the advantage to be gained by building the bridge wall independently of the side walls.

At the rear end of the boiler a space of about 1½ inches should be left between the boiler head and the brickwork; this space can best be sealed against air leakage by extending the insulating covering down over it as shown in Fig. 4.

Protection of Blow-Off Pipes

The proper protection of the blow-off pipe is an important feature in connection with any setting for a horizontal tubular boiler. There are many ways of providing such protection, and in making a choice between different methods one important principle to be kept in mind is that the pipe should be easily accessible for inspection. For this reason a simple pipe sleeve around the blow-off pipe is not satisfactory because such a sleeve cannot be removed without disconnecting the blow-off pipe. Split sleeves of cast-iron are better, but it is usually rather difficult to remove them after the connecting bolts have been exposed to the heat and flames.

Except under extraordinary conditions the method of installation shown in Fig. 4 provides ample protection for blow-off pipes. The principal features of this method are a V-shaped pier of firebrick which prevents the flames from impinging upon the vertical portion of the pipe, and the location of the elbow in a covered trench where it will be well protected. Blow-off pipes are more liable to fail at the elbow than at any other point, and the location of the elbow in this position is therefore highly desirable. The best arrangement is to build the bottom of the combustion chamber at a somewhat higher level than the boiler room floor, so that there will be space enough to install the blow-off valve or cock without cutting into the floor. It is advisable also to locate the cleaning door at one side of the center where there will be no interference with the blow-off valve when the door is opened. Plenty of space to permit freedom of movement, due to expansion or settlement, should be left around the pipe where it passes through the setting wall. For this purpose a pipe sleeve about four inches long should be built into the brickwork at the outer end, but a larger opening can be left around the pipe through the remainder of the wall thickness, without any sleeve. The sleeve should have a diameter two inches greater than that of the blow-off pipe and it should be filled with asbestos to prevent air leakage.

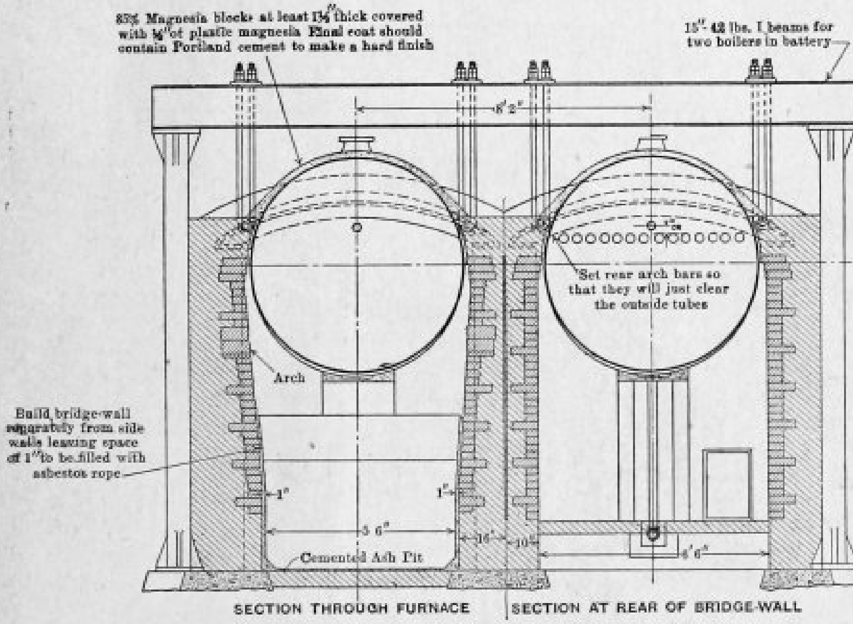


Fig. 3.—Transverse Section Through Setting for Battery of Two Boilers

ARCH BARS

The rear arch bars shown on our setting plans and in Fig. 4 are of the so-called "Hartford" type, designed by this company several years ago. Bars of this type extend transversely of the setting, spanning its width and bearing upon the side walls. Except for large boilers, only two of these arch bars are needed for a single setting, but a different pattern is required for each size of boiler. In some sections of the country the "quadrant" type of arch bar is more popular and it is just as acceptable; this style of arch bar is made in the form of a quadrant or ninety-degree arc of a circle. The bars rest on the rear wall, arching over to the rear head, and some means must be provided to support the upper ends, so as to permit the boiler to expand without developing air leaks. Several of these bars are needed for a single setting, the exact number depending upon the diameter of the boiler, but the same pattern can be used for all sizes of boilers where the distance from the rear head to the rear wall of the setting is the same. Both types of arch bar described above are so designed that the metal is protected by the firebrick and not exposed to the action of the flames and hot gases; this feature should be a requirement in the design of any arch bar.

Arch bars should be set so as to leave a full, free opening through all the tubes, with proper provisions for inspecting and removing the fusible plug; but, at the same time, care should be taken that no part of the head above the lowest permissible water level is exposed to the heat. We recently heard of a case where a head was burned, due either to poorly designed arch bars or to placing the arch bars so high as to expose the upper part of the head to extreme heat.

GRATES

We believe that there is a general tendency to use larger grates than necessary with hand-fired boilers of the horizontal tubular type, and this belief is borne out by our experience in several cases where we have found that coal was being burned at a rate of ten to twelve pounds per square foot of grate area per hour, whereas better results would be obtained with a rate of fifteen to twenty pounds of coal per square foot per hour. In some cases we have advised blanking off the rear part of the grates by covering them with firebrick and a gain in economy of coal consumption has been secured in such cases. Furthermore, it has been common practice to use the same size of grates for a given diameter of boiler regardless of the tube length, though it is obvious that if a certain area is proper for a boiler eighteen feet long it would not be correct for a sixteen-foot boiler in which the heating surface would be about 11 percent less. Assuming an evaporation of about nine pounds of water per pound of coal, the ratio of heating surface to grate area should be about 40 to 1 in order to develop the full rated capacity of a boiler when burning coal at the rate of fifteen pounds per square foot of grate per hour.

With battered furnace walls, as described in the foregoing, the width of grates will be six inches less than the boiler diameter, while with straight walls, as frequently used, the grates have a width equal to the diameter of the boiler.

HEIGHT ABOVE GRATES

Remarkable savings in fuel consumption have been claimed in many cases as a result of setting horizontal tubular boilers at extreme heights above the grates, but, as a general rule, these claims do not seem to be fully substantiated because all of the credit for any increased efficiency is laid to the greater height of furnace, whereas there are usually other factors which should also receive consideration. In a typical case of this kind a new boiler is installed in a plant where there are one or more older boilers and perhaps the new boiler is set at a height of 5 feet above the grates, while the corresponding height of the old boilers is only 28 inches. More or less careful tests are made and it is found that the new boiler is more economical in coal consumption than the old ones. It is

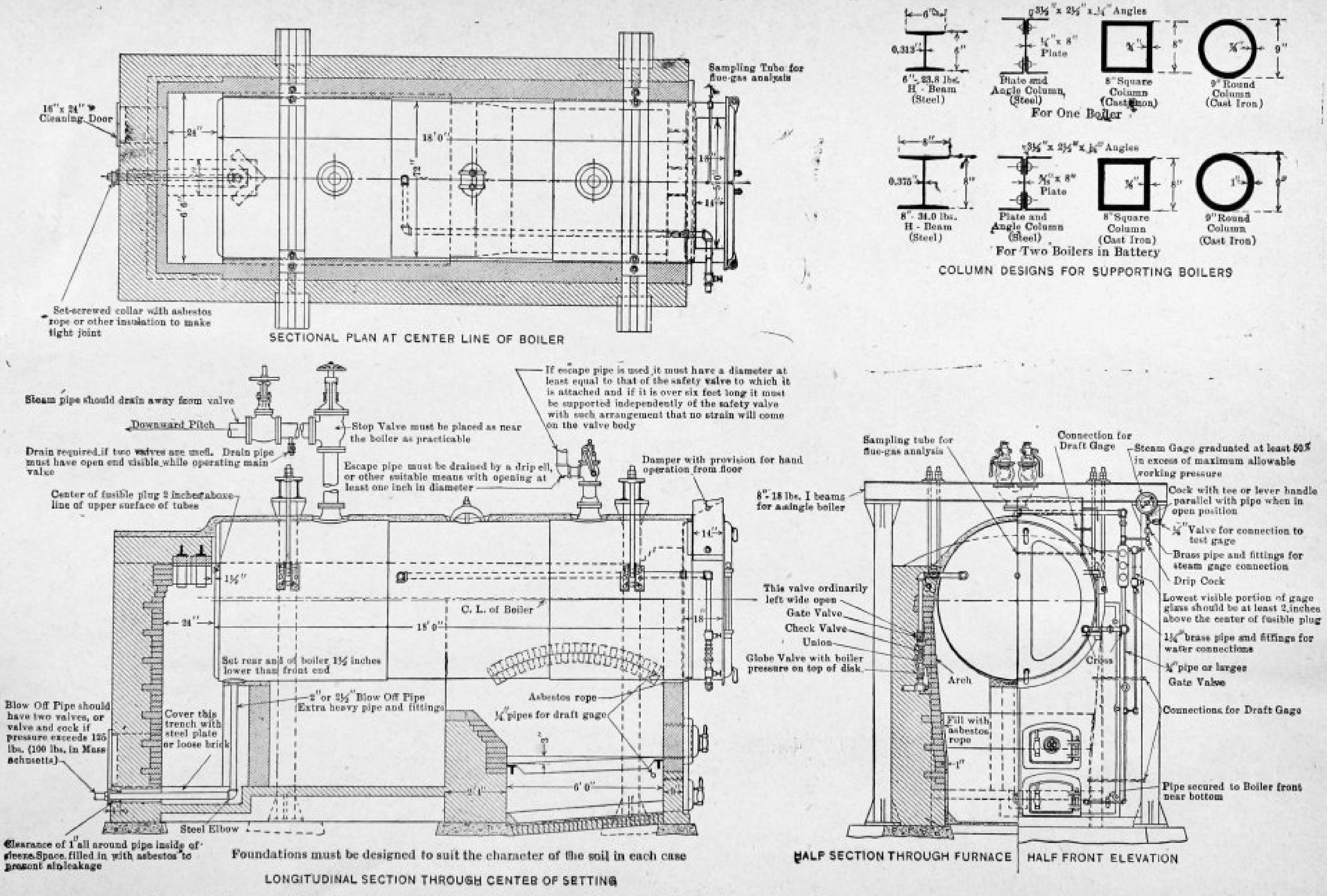


Fig. 4.—Setting and Piping Plan for 72-inch by 18-foot Horizontal Tubular Boiler and Supporting Column for Single Boilers or Two Boilers in Battery

then almost invariably assumed that the gain in economy is entirely due to setting the boiler at a greater height above the grates; although the old settings may be twelve or fifteen years old and full of cracks and openings which permit the entrance of a large percentage of excess air while the new setting is tight, this fact is completely disregarded. Furthermore, it seems to be generally assumed that the height chosen in any such case is the proper height to give the best results, although there is usually no information available to prove that just as good results would not have been obtained with a height of 3½ feet, for instance, instead of 5 feet. In attributing a gain in economy to higher settings there are other factors also which may be ignored, such as a change in the fuel used, an improvement in the proportions or design of the new boiler as compared with the older ones, better firing methods, improved draft conditions and method of draft control, a better type of grates, etc.

For a 72-inch boiler with tubes 18 feet long, for instance, the heights which we advise would be as follows:

For anthracite coal and semi-bituminous coals containing less than 18 percent of volatile matter (Pocohantas, Georges Creek, etc.)—36 inches.

For bituminous coals containing from 18 percent to 35 percent of volatile matter (Pittsburgh)—40 inches.

For bituminous coals containing more than 35 percent of volatile matter (Illinois, etc.)—44 inches.

For other sizes of boilers the figures are varied so as to maintain approximately the same ratio of combustion volume to grate area.

Method of Support

When boilers are suspended in battery it is best to place the supporting columns entirely outside of the setting walls, using only four columns with beams of sufficient strength to support the boilers in a single span. With standard I-beams it is possible to support in this manner three boilers of any diameter not exceeding 78 inches or two boilers of larger diameter. If the installation involves more boilers it is best to set them in separate batteries of two or three boilers each, rather than to use columns in the division walls between boilers; if it is absolutely necessary to use such intermediate columns, an air space should be left all around each one with a suitable ventilating duct to admit air at the bottom.

Our setting plans show the proper sizes of I-beams to use for suspending boilers, together with alternate designs for both round and square cast-iron columns, structural steel H-beams and built-up columns made of plates and angles. In general, it will be found that these designs are heavier than those usually employed by boiler manufacturers, but we think that these sizes are needed in order for the columns to have a strength equal to that of all other parts of the installation where it is customary to use a factor of safety of 5. Boiler columns are loaded entirely at one side and the stresses are therefore greater than when the loading is symmetrical as assumed in the tables published in structural steel handbooks. Furthermore, proper consideration should always be given to the "ratio of slenderness," a heavier section being needed for a long column than for a shorter one carrying the same load. I-beams are frequently used for columns, but they are not well adapted for the purpose, as the distribution of metal in the I-beam section does not make a good column design.

Boilers having a diameter of 78 inches or less can be supported by brackets which rest upon bearing plates built into the setting walls, but the suspension method is better, particularly for the larger sizes. Four brackets (two on each side) are sufficient for boiler diameters of 54 inches or less, but eight brackets should be used for boilers larger than this size; the brackets should be located in pairs with a single bearing plate for each pair. Brackets at the front end should rest directly upon the plates, but rollers should be used under the brackets at the rear end to permit free expansion of the boiler.

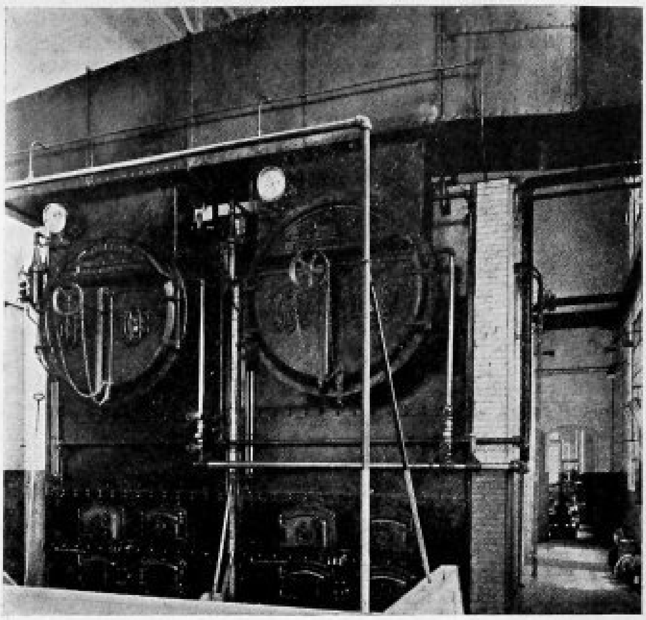


Fig. 5.—Battery of Two Boilers Built by the D. M. Dillon Steam Boiler Company, Fitchburg, Mass.

Installation of Boiler Piping, Valves, Fittings

Fig. 4 shows a typical longitudinal section through a suspended boiler with overhanging front. Several self-explanatory notes will be found on this drawing relative to the proper installation of piping, valves and other details. In addition to the items mentioned the following details should receive attention in any well-planned installation.

The steam gage should be graduated at least 50 percent in excess of the maximum allowable working pressure and it should be piped up with a siphon, union cock, drip cock and connection with stop valve for test gage, brass pipe and fittings being used throughout.

A water glass and three gage cocks should be used. The lowest visible part of the water glass should be at least two inches above the center of the fusible plug and the gage cocks should be located within the range of the visible length of the glass. Brass pipe and fittings, 1¼-inch size, should be used for the water connection to the water column, except for small boilers where the minimum size may be 1 inch.

A blow-down pipe should be provided for the water column with a gate valve or cock. This pipe should have a diameter of at least ¾ inch and should be connected to the ash pit or some other safe and convenient point of waste. It should be secured to the boiler front near the bottom by a pipe clip or other suitable means.

All valves and fittings should be of extra heavy pattern if the pressure exceeds 125 pounds per square inch. In Massachusetts a state law fixes this limit at 100 pounds.

A sampling pipe for flue gas analysis and three ¼-inch pipes for draft gage connections should be placed in position when the setting is being built.

The foregoing description is intended to cover the more important features connected with the construction of brick settings for horizontal tubular boilers and the installation of such boilers in accordance with good practice, but without any unnecessary frills.

Calculating Stresses in Pressure Vessels

BY WILLIAM C. STROTT*

The following article on the determination of stresses in pressure vessels is intended to serve as an introduction to a series of articles on the design of riveted joints, which will commence in an early issue of THE BOILER MAKER. *A theoretical discussion of the subject matter has been avoided wherever it has been possible to demonstrate the principles involved by the use of practical problems.*

Instead of plunging at once into a mass of "dry" theory, as is often done in text-books on engineering subjects, we shall present in its complete practical form the formula for determining the maximum safe working pressure on a cylindrical vessel when under internal pressure:

$$P = \frac{S \times t \times E}{R \times f}. \quad (1)$$

The notations employed in the above formula are as follows:

P = maximum allowable safe working pressure in pounds per square inch, gage.
t = thickness of shell plate, in inches.
E = efficiency of the longitudinal joint, in percentage of the solid plate, as 0.75, 0.90, etc.
R = radius of the shell (half the internal diameter of the largest course), in inches.
S = the *ultimate* tensile strength, in pounds per square inch, allowed for the shell plate material.
f = a factor of safety, as 4, 5, etc.

A detailed explanation of the meaning of the above terms will now be given.

Gage Pressure

When a vessel is said to be under a pressure of, say, 100 pounds per square inch, it means that the contained fluid —be it steam, air, gas or liquid —is acting with a force equal to a weight of 100 pounds upon every square inch of the internal surface of the vessel. This force acts equal and opposite in every direction at right angles to the surface, as indicated by the radial arrows in the accompanying illustration, Fig. 1.

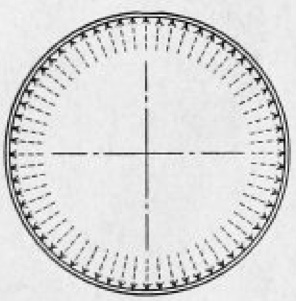


Fig. 1.—Action of Internal Pressure on Cylindrical Vessel

The term pressure to which we always refer in calculations of this kind is known as the "gage pressure" and is the actual *effective* pressure existing within the vessel as indicated by a pressure gage.

Absolute Pressure

If a vessel under a gage pressure of, say, 100 pounds per square inch were placed in a perfect vacuum, the actual effective pressure within the vessel would be increased to (100 + 14.7) = 114.7 pounds per square inch, because the balancing effect of the atmosphere to the extent of 14.7 pounds per square inch would be absent. The actual force tending to rupture the vessel will then, as stated above, have been increased to 114.7 pounds per square inch.

When pressures are calculated from zero vacuum they are termed absolute pressures and are simply determined by adding the atmospheric pressure to the gage pressure.†

The Meaning of "Ultimate Tensile Strength"

When a cylindrical shell is under internal pressure the material composing it is in tension, or is said to be subjected to a tensile stress. The effect of a tensile stress is to separate the fibers of the material resulting in a "stretch" or elongation.

The amount of elongation is directly proportional to the force applied, which means that if a pull of 10,000 pounds will stretch a bar of steel 1/16 of an inch, a force of 20,000 pounds will stretch it ⅛ of an inch, or twice the former amount. This is known as "Hooke's Law," relating to the elasticity of materials. All materials have this property—some more so than others, while steel is probably the most elastic of all the metals.

The elasticity of steel ceases, however, when the metal has been stretched to a certain limit, when it will no longer spring back to its original proportions on being relieved of stress. This limit is known as the "elastic limit" of the material. If we still continue to apply stress after the "elastic limit" has been reached, the material takes on a permanent "set" and is then said to be "distorted." From this point on, if the load still be applied, the original physical properties of the material will be destroyed, elongation rapidly increases, while the cross-sectional area of metal at the center of the bar is reduced until rupture finally occurs.

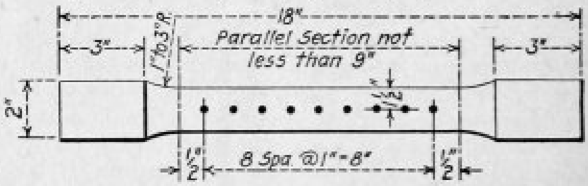


Fig. 2.—Standard Specimen for Tensile Test of Plate Material

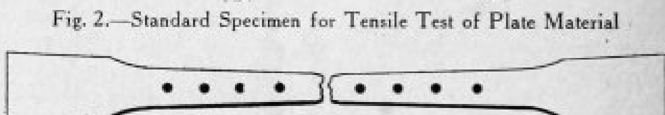


Fig. 3.—Condition of Specimen After Being Tested

By means of a testing machine it is possible to determine the exact physical properties which any material may have. Fig. 2 represents the standard test specimen as required for all tension tests of steel plate.

The black dots shown on the center line are not holes, but sharp marks made with a "prick-punch"; their purpose will be explained.

After the specimen has been placed in the machine and tested to destruction, these punch marks will be found to be farther and farther apart towards the center. From them the deformation which the bar underwent may then be accurately determined.

Fig. 3 shows the approximate condition of a test specimen after it has been tested to destruction.

Let us suppose, as an example, that we are going to test a sample cut from one of the plates which are to compose the shell of a boiler. Its thickness we shall assume as 17/32, or 0.53125 inch. Its cross-sectional area we find to be (1.5 inches × 0.53125 inch), or 0.796875 square inch. We now clamp the ends of the test specimen between the two heads of the machine and throw on the power. Slowly the heads separate, stressing the specimen. When the elastic limit is reached, and on the instant when the plate takes a permanent set, the beam on the machine drops and the pull in pounds can

* Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

† 14.7 pounds per square inch is the atmospheric pressure at sea level. At higher altitudes the atmospheric pressure decreases.

be read directly therefrom. Beyond this stage the specimen undergoes distortion and finally snaps, having by this time taken the form similar to Fig. 3. The machine then automatically stops, and the total force that has been applied to rupture the specimen is also indicated. Let us assume that the specimen broke at 44,000 pounds. This value is what is termed its ultimate tensile strength. Resolving this to a unit per one square inch, we get:

$$\frac{44{,}000}{.796875},$$

or approximately 55,250 pounds per square inch as the ultimate tensile strength of this plate.

Suppose further that the distance between the extreme punch marks on the specimen measured 10¼ inches. This, then, would indicate an elongation of (10¼ — 8), or 2¼ inches, which would be expressed as:

$$\frac{2.25}{18.25}, \text{ or 27.3 percent in 8 inches.}$$

The minimum percentage of elongation in 8 inches required by the A. S. M. E. Boiler Code is based on the following ratio:

$$\frac{1{,}500{,}000}{\text{Unit tensile strength as tested}}.$$

For our assumed test specimen the percentage of elongation required would be:

$$\frac{1{,}500{,}000}{55{,}250}, \text{ or 27.1 (expressed as percent),}$$

which would demand a minimum elongation of (0.271×8),

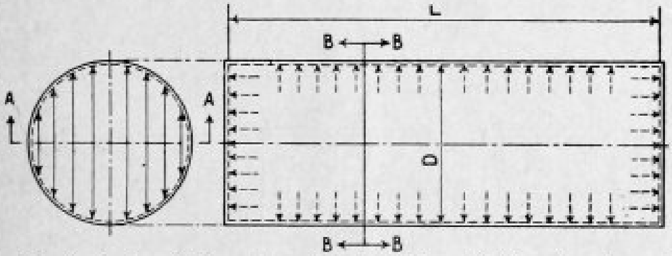


Fig. 4.—Action of Forces in a Cylindrical Vessel Subjected to Internal Pressure

or 2.168 inches in 8 inches. The result of this imaginary test proves the plate to be satisfactory in this respect.

Certain tolerances are provided by the Code with regard to plates ¼ inch thick and over 11/16 inch thick, but they need not be considered here.

In addition to the physical requirements of boiler material, certain compositions must be conformed to, such as the percentage of the carbon, manganese, phosphorus and sulphur content of the steel. These items, however, are "worries" for the chemical laboratory at the steel mill. It is suggested that the reader secure a copy of the A. S. M. E. Boiler Code and familiarize himself with the specifications covering boiler material.

Minimum Tensile Strength Allowed

The minimum tensile strength allowed for boiler plate steel is 55,000 pounds per square inch, but it may have a maximum range not to exceed 65,000 pounds per square inch, providing, of course, that all other requirements are fulfilled. Regardless of how high a tensile strength the plates may actually have shown in a test, the Code demands that all plates be stamped 55,000 pounds at the mill. The reason for this is two-fold:

First, steel having a high tensile strength is necessarily high in carbon, and a high percentage of carbon results in a material that is very brittle.

Second, the various plates, for a certain boiler, when they come from the mill, might all have the same tensile strength; then, again, in another set of plates some might have a tensile strength of 55,000 pounds and others as high as 65,000 pounds per square inch. Obviously, the strength of the 55,000-pound plates would govern for the reason that no chain is stronger than its weakest link.

Establishing a minimum tensile strength is also of great value to the purchaser of a steam boiler, in that it fixes a minimum plate thickness for a given diameter and working pressure. Therefore, knowing the minimum value allowed, the designing engineer may at once determine the plate thickness required, which results in more uniformity of design among competitive builders.

From the foregoing elementary discussion of strength of materials it should now be apparent that long before a pressure vessel "lets go," a permanent set or distortion of the plates will have occurred. For this reason such a design must be avoided that while the boiler is under pressure the material will be stressed to its elastic limit. We must, in fact, when making calculations, assume values that are considerably well below that limit.

Concerning the factor of safety, this is simply a more polite way of saying a "factor of ignorance," and whatever value we give the symbol "*f*," be it 2, 3, 4, 5, etc., means that we are designing the boiler just that many times as strong as would be theoretically required to rupture it when under pressure.

A factor of safety of less than 5 is not allowed, but we may use a higher one at will, although practice has deemed it unnecessary. When inspecting old boilers where the plates have worn thin and the quality of the material that went into the boiler is not known, it is customary for boiler insurance companies to increase the factor of safety at their discretion. For new boilers, however, the usual factor of safety employed is 5.

This safety factor allows for possible errors in calculations, gradual weakening of the boiler through years of operation, and the ever-attendant dangers met with while the boiler is in service, due either to carelessness or sheer ignorance of those in charge.

But the chief reason for employing so high a factor of safety is for the purpose of bringing the actual working stresses well below the yield point of the material, so that when the material is stressed while under load it will return to its original proportions when the stress is relieved, without injuring the metal.

The minimum yield point required by the A. S. M. E. Code specifications is 0.5 of the minimum unit tensile strength of the material and equals $(0.5 \times 55{,}000$ pounds), or 27,500 pounds per square inch. We can easily see now where at least 2.5 of our factor of safety of 5 has gone. So in the final reckoning we do not have any too much margin of safety to provide for the "factors of ignorance" cited previously—probably not more than five-tenths.

Efficiency of the Longitudinal Joint

After the shell plate, or plates, have been rolled to a cylindrical form, the abutting edges are joined together; this is termed the longitudinal joint. Joints may be either riveted or welded, but since up to the present time welding the joints of pressure vessels—particularly of steam boilers—has not reached a stage of general acceptance, riveting is resorted to entirely.

In a riveted joint it is necessary to punch holes in the plate to receive the rivets. This very evidently reduces the original cross-sectional area, and consequently the strength of the solid plate. It should therefore be quite plain that no matter what its form or how heavily it may be constructed, a riveted seam cannot possibly be made to equal the strength of the solid plate.

If it were possible to form a seamless cylindrical shell, thereby having no longitudinal joint, the bursting pressure of such a vessel would be governed only by its diameter, and the thickness and tensile strength of the material. It should also be quite plain that the efficiency of the "imaginary" joint would be 100 percent or unity, whence E in formula (1) would have the value of 1 and could be eliminated from the formula altogether.

Since any riveted joint will necessarily have an efficiency, with relation to the solid plate, equal to less than 1, it follows that in a practical application E in formula (1) would be designated as a certain percentage, as 0.50, 0.60, 0.75, 0.90, etc., of the solid plate, depending on the design and construction of the joint.

Practical Application of Formula (1)

Having learned the meaning of the terms entering into formula (1), a practical application will now be given.

Problem.—Determine the maximum safe working pressure that would be allowed on the shell or drum of a pressure vessel 60 inches inside diameter, thickness of shell plate ⅜ inch, ultimate tensile strength of plate 55,000 pounds per square inch, factor of safety 5, and efficiency of longitudinal seam 85 percent.

Substituting values for letters in formula (1), we will have:

$$P = \frac{55{,}000 \times 0.375 \times 0.85}{30 \times 5},$$

whence:

$$P \times 30 \times 5 = 55{,}000 \times 0.375 \times 0.85,$$

or:

$$150 \times P = 17{,}531.$$

Therefore:

$$P = (17{,}531 \div 150), \text{ or } 117 \text{ pounds per square inch.}$$

Determining Any Unknown Value in Formula (1)

It is very frequently desirable to find the value of any other term in formula (1) when the working pressure is known. We then transpose the formula so that the unknown value will be on the left and the known terms on the right side of the equation, as follows:

To find the required thickness of plate:

$$(1a) \qquad t = \frac{P \times R \times f}{S \times E}.$$

To find the unit stress in the plate:

$$(1b) \qquad S = \frac{P \times R \times f}{t \times E}.$$

To find the factor of safety:

$$(1c) \qquad f = \frac{S \times t \times E}{P \times R}.$$

To find the required efficiency of the longitudinal joint:

$$(1d) \qquad E = \frac{P \times R \times F}{S \times t}.$$

Derivation of Formula (1)

When a cylindrical vessel is subjected to internal pressure the tendency is to increase its diameter, thereby resulting in a stress in the shell plate. This is known as the "hoop stress" and its action is identical with the "stretch" in a toy balloon when inflated.

Let us consider the cylindrical vessel illustrated in Fig. 4.

The majority of those taking up this subject for the first time cannot understand why the total pressure acting upon the internal surface of the vessel is not considered, instead of on only the projected area of a plane through its diameter. The argument is advanced that, since the actual area of the circumferential surface of plate is greater than an area taken through its diameter, the resulting force tending to rupture the shell would therefore be greater, and should be the force to consider.

Although the pressure within a cylinder does act at right angles to every infinitesimal surface of the circumference of the shell, as was previously illustrated by means of Fig. 1, it can be proved by higher mathematics that the sum of the vertical components of all such radial forces is equal to the *resultant force* on a plane through the diameter of the cylinder. Referring to Fig. 4, this resultant is evidently equal to the total pressure acting on a plane such as *A-A*, through the diameter of the cylinder.

By representing the internal pressure, in pounds per square inch, by P, the length of the cylinder by L, and its diameter by D, we have the following equation:

$$(a) \qquad F = L \times D \times P,$$

where F represents the total force tending to rupture the shell through any plane of its diameter, as *A-A* in Fig. 4.

Let us also consider the semicircular vessel shown in Fig. 5.

Assuming that the flat plate will not bend when the vessel is under pressure, it must be true that the force tending to rupture the shell plate at *t-t* is equal to the total pressure on the flat plate. If this were not true, then we would have two unequal forces acting against each other, which is absolutely contrary to the natural law, that: "For every action there must be an opposite reaction of equal magnitude." For instance, if the actual pressure on the semicircular surface of plate were 4,700 pounds, and that on the flat plate only 3,000 pounds, it should stand to reason that the shell plate could not possibly receive a greater load than that capable of being carried by the flat plate. This fact can actually be proved by means of the well-known steam engine cylinder and piston. See Fig. 6 (a), (b) and (c).

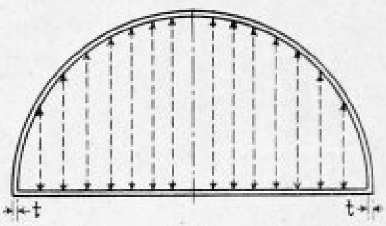


Fig. 5.—Internal Pressure in Vessel having Semicircular Section

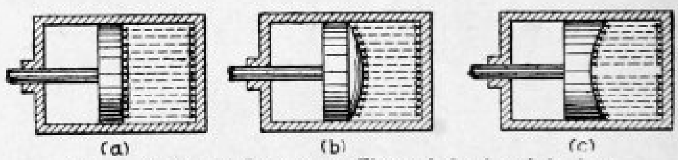


Fig. 6.—Action of Pressure on Flat and Cambered Surfaces

Regardless of the shape of the piston head, it has been demonstrated that the total force acting on the piston is always equal to its projected area multiplied by the steam pressure, or ($D^2 \times 0.7854 \times P$), even though the piston head be so designed as to give many times the actual cross-sectional area of the cylinder.

Having proved our point, we may now return to the previous discussion in connection with formula (a). It should by this time be quite plain that force F is transmitted to the shell plate whose cross-sectional area is equal to the length of the cylinder multiplied by twice the plate thickness, for the reason that the shell plate must be torn at two points in order to divide the cylinder into two semicircles. By next multiplying the cross-sectional area of the metal by its tensile strength in pounds per square inch, we get the total resistance which the shell offers the internal pressure. Expressing this as an equation, we have:

$$(b) \qquad F = L \times 2t \times S,$$

where F is the total resistance offered by the shell plate.

In order that the vessel shall be in equilibrium, it should be plain that the value of F in formula (b) be at least equal to the value of F in formula (a). In other words, the resistance of the shell plate against rupture must be at least equal to the total internal force tending to cause rupture. Therefore we equate the internal force with the external resistance, whence:

$$\text{(c)} \quad L \times D \times P = L \times 2t \times S.$$

Transposing for P, we get:

$$\text{(d)} \quad P = \frac{L \times 2t \times S}{L \times D}.$$

By denoting the diameter D in terms of the radius, or by $2R$, we have:

$$\text{(e)} \quad P = \frac{L \times 2t \times S}{L \times 2R}.$$

Notice that the letters L and the figure 2 appear in both numerator and denominator of the above fraction, whence they may be cancelled out of the terms, and the equation finally resolves itself into the following simplified form:

$$\text{(f)} \quad P = \frac{t \times S}{R},$$

which represents the fundamental formula for the *bursting pressure* of a cylindrical shell or drum. It should be seen that the length of the vessel L having disappeared from the equation, this value has nothing whatever to do with its strength, only the three values, viz., plate thickness, plate strength and diameter of the shell being the governing values.

Formula (f) as it stands cannot, however, be employed in practice, for the reason that no account has been taken of the weakening effect of a longitudinal seam, nor of a factor of safety. So in order to render the formula of practical use, the value S must be divided by the factor of safety, while the thickness of plate or t must be multiplied by the efficiency of the longitudinal joint, whence equation (f) becomes:

$$\text{(g)} \quad P = \frac{t \times E \times \frac{S}{f}}{R}.$$

Resolving this equation by inverting the divisor and multiplying, we finally reduce the equation to the following form:

$$\text{(1)} \quad P = \frac{t \times E \times S}{f \times R},$$

which is nothing more nor less than formula (1) presented at the beginning of this chapter.

STRESSES IN A CYLINDRICAL VESSEL DUE TO PRESSURE ON THE HEADS

Referring again to Fig. 4, it should be seen that the pressure against the heads tends to tear the vessel into two parts across its diameter, as indicated by the section line and arrows *B-B*. This is known as the "end-thrust," and the manner in which the force acts is indicated by means of the small arrows drawn perpendicular to the heads. The magnitude of the end thrust is evidently equal to the area of one head in square inches, multiplied by the pressure in pounds per square inch. Expressing this as equation, we have:

$$\text{(h)} \quad F = D^2 \times 0.7854 \times P.$$

In order for the shell to be in equilibrium, the total strength of the circumference of plate must be at least equal to the end thrust on the heads, or:

$$\text{(2a)} \quad F = D \times 3.1416 \times t \times S.$$

Therefore the value of F in each of the above equations must be equal to each other, or equating the force to the resistance, we get:

$$\text{(j)} \quad D^2 \times 0.7854 \times P = D \times 3.1416 \times t \times S.$$

Solving for P, we get:

$$\text{(k)} \quad P = \frac{D \times 3.1416 \times t \times S}{D^2 \times 0.7854}, \text{ or } \frac{4 \times t \times S}{D}.$$

Denoting the diameter D in terms of the radius, or R, we write:

$$\text{(l)} \quad P = \frac{4 \times t \times S}{2 \times R}, \text{ or } \frac{2 \times t \times S}{R}.$$

The above equation finally represents the fundamental formula for the *bursting pressure* on a cylindrical shell due to the end thrust of the heads. In practice, however, there are circular seams to take into account, likewise factors of safety. Therefore we inject these items into equation (l), so that:

$$\text{(2)} \quad P = \frac{2 \times t \times S \times E}{R \times f}.$$

Let us now compare formula (1) with formula (2). Notice that item for item they are identically the same with the single exception that formula (2) contains the figure "2," whereas formula (1) does not. Dividing formula (2) by formula (1), we get:

$$\frac{2 \times t \times S \times E}{R \times f} \times \frac{R \times f}{t \times S \times E} = 2,$$

which simply means that a cylindrical vessel under internal pressure is exactly twice as strong with regards to end thrust as it is with regards to hoop tension. For this reason the circumferential joints of pressure vessels need be only one-half as strong as the longitudinal joints, and is why the former are never more than double riveted lap seams, whereas the longitudinal seams are invariably double butt strapped with from 2 to 5 or more rows of rivets, depending on the efficiency of joint required.

This matter concerning the relative stresses in the circumferential and longitudinal seams of pressure vessels appears to be a much abused subject. In attempting an explanation of this theory it is surprising what a large number of practical men will say that the ring seams of a boiler are twice as strong as the longitudinal seams. What is meant, of course, is that the ring seams are subjected to but *one-half* as much stress as the longitudinal, whence the ring seams require only one-half the efficiency necessary in the longitudinal seams.

In the previous practical application of formula (1) a longitudinal joint having an efficiency of 85 percent was assumed, and together with the various other conditions given the resulting working pressure was found to be 117 pounds per square inch. Then, according to what was just borne out in connection with our derivation of formula (2), this identical vessel would be good for the same pressure, with ring seams having an efficiency of only:

$$\frac{(185)}{2}, \text{ or } 42.5 \text{ percent.}$$

Proof.—Substituting values in formula (2), we have:

$$P = \frac{2 \times 0.375 \times 55{,}000 \times 0.425}{30 \times 5},$$

or:

$$150 \times P = 17{,}531,$$

whence:

$$P = (17{,}531 \div 150), \text{ or } 117 \text{ pounds per square inch.}$$

DETERMINING ANY UNKNOWN VALUE IN FORMULA (2)

It is also very frequently desirable to find the value of other terms in formula (2), when the working pressure is known. We then transpose the formula so that the unknown term desired will be on the left and the known term on the right side of the equation, as follows:

(*Continued on page* 138)

New Method of Applying Arch Tubes

Practical Suggestions for Eliminating Large Plugs in the Throat Sheet End of Arch Tubes

BY "MAPLE LEAF"

The ordinary method adopted to form a steam-tight joint for the application of arch tubes in locomotive fireboxes is to make use of tube rollers, flaring and beading tools to set them in the back tube sheet and door sheet holes. In applying these tools it is necessary to have slightly larger holes drilled directly opposite the inside firebox holes in the throat sheet and backhead of the outside firebox in order to make the ends of the tubes accessible for the operation, as well as provide means to introduce rotary cleaners to keep the tubes clean, and for inspection purposes.

There is considerable expense attached to drilling, tapping and fitting these external holes with brass plugs, as well as a high maintenance expense following the application. There is also a greater risk when applying larger plugs than the smaller ones in general use for washout purposes in the staybolt zone of locomotive boilers, particularly so when used without reinforcing the plate.

The reinforcing of the plate for plugs over 1½ inches diameter should be compulsory, not because of the lack of strength when new, but rather to forestall later deterioration and to prevent cross threading when applied. For this purpose the writer does not believe in drilling holes for the application of plugs in the throat sheet so long as a satisfactory joint can be effected for the arch tube in the back tube sheet without such means. The reason for this belief is that the arch tube is always rotary cleaned from the opposite end of the arch flue which is accessible through the plugs in the backhead of the boiler in the cabs of the engines, and those who are intent on keeping arch tubes safe know that the body of the rotary must be kept built up so that it will not pass through an arch tube without having removed all harmful foreign matter.

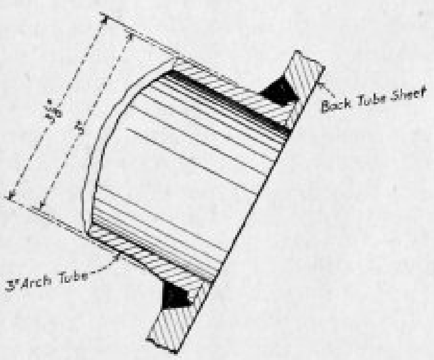


Fig. 1.—General Practice in Applying Arch Tubes

All workmen using rotary cleaners have no difficulty in determining whether the cleaner has passed through the entire length of the flue; therefore, when this has been done the cleaner actually becomes the inspector, as it cannot pass through without having cleaned the flue. Under such conditions when the rotary does pass through, experience tells us the tube must be clean, although as a matter of practice we inspect the arch tube internally with an electric searchlight from both ends of the arch tube to assure us of its cleanliness. Following out this practice we can only see a very short distance in the tube where it is secured to the back tube sheet, and as a searchlight can be introduced by way of the washout plugs in the throat sheet the omission of plugs in the throat sheet opposite the arch tubes will not interfere with the inspection and proper maintenance of the arch tubes.

There is always a galvanic action in proximity to the brass plugs, which are located as low in the water space as the arch tube plugs in the throat sheet, and we frequently find throat sheets, staybolts, back tube sheets and arch tubes severely corroded at this location; therefore, dispensing with them will be an advantage.

The necessity for brass plugs in the throat sheet opposite arch tubes will be unnecessary with the proposed method of connecting the arch tube described in this article to the back tube sheet, as it will make a permanent joint which will not become leaky between renewals. The strength of this joint to resist pulling away from the sheet is much in excess of the joint made with rollers, flaring and beading tools which are now in general use by the trade for arch tube application.

Fig. 1 illustrates the general practice of applying arch tubes, together with the arrangement of plugs opposite each end of the tubes. These are located in suitable numbers in the throat sheet and backhead of the boilers to correspond with the number of arch tubes in the firebox.

Fig. 2 shows the arch tube prepared for installation according to the method proposed in this article. Note that the one end of the arch tube is thickened so that it will be ¼ inch thick for 1 inch of its length. This is done by upsetting it in a die, following which it is flanged to suit the counterbored hole in the back tube sheet. The flanging is done under the same heat as the thickening process with suitable dies.

A view of the back tube sheet with an arch tube arranged

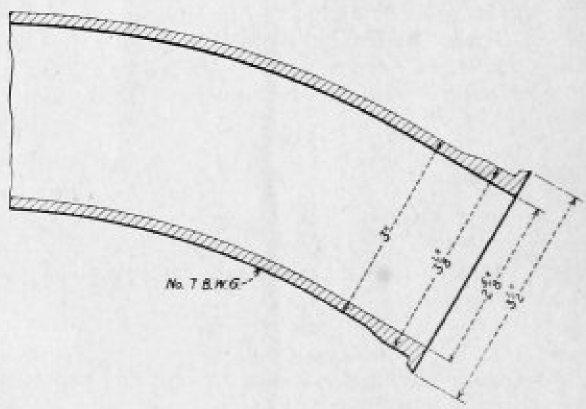


Fig. 2.—View Showing 3-inch Arch Tube Prepared for Setting; Proportional Sizes for Larger Tubes

according to the proposed method with throat sheet plugs omitted is shown in Fig. 3, as well as a view of a 3-inch arch tube in full size showing the joint more clearly. Proportionate dimensions to accommodate larger sized arch tubes are desirable. The hole in the back tube sheet is first drilled of a size to suit the inside diameter of the arch tube, after which it is counterbored with a specially manufactured drill, which not only enlarges the hole from the firebox side to within ⅛ inch of the water space side of the tube sheet, but countersinks the plate to about a 45-degree angle, thus providing a seat for the flanged end of the arch tube to rest against.

The flanging of the arch tube is not only a means whereby the space between the plate and tube is made equal round the girth of the tube, but it also affords greater strength for the arch tube to resist pulling out of its joint due to the peculiar position of the flange in relation to the fused material.

When the arch tube is cut to length and placed in position, the rolling and setting at the door sheet end must be deferred until the opposite end is completely welded in the back tube sheet. The possibility of a joint of this kind becoming leaky in service is very remote because of its good water contact.

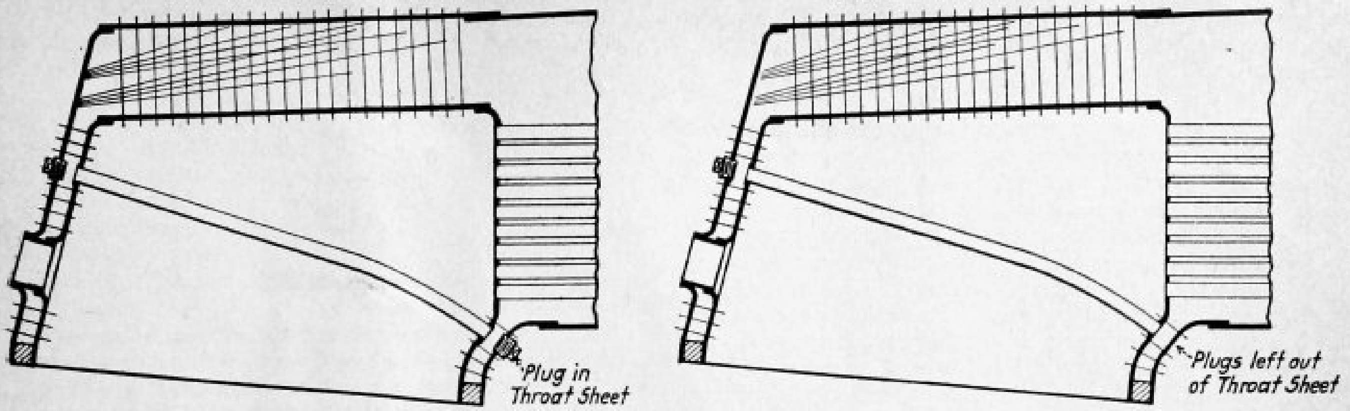


Fig. 3.—Arch Tubes Arranged in Locomotive Fireboxes Showing Throat Sheet Plug Installed in One and Omitted in the Other

The writer has considered that mechanical officers of the railways may claim that an arch tube with a welded joint connecting the back tube sheet will not permit the same freedom for the expansion of the tube as formerly obtained under the old method of setting. My experience is that there is no possible way known to the trade whereby a steam-tight expansion joint can be adapted to arch tubes where they connect with the door and tube sheet, although there are means whereby the differential of expansion between the arch tubes and inside firebox is kept under control by curving the flue.

An abnormal expansion of the arch flues cannot occur except when maintenance of the boiler and arch tubes are neglected, which results from the improper and insufficient washing of the boiler and from operating the engine without the brick arch in position. Operating a dirty boiler and arch tubes will cause the tubes to pocket and sag, thus setting up a condition which may result in a rupture of the tube, or an abnormal sag may even pull the tube out of its joint in the tube or door sheet. Operating without the brick in position should not be permitted, because the quantity of water contained in arch tubes when fully surrounded with the ignited gases and the engine operating to full capacity is liable to cause the failure of the arch tubes, whereas with the arch in place the tubes are only in contact with the impinging flame for a portion of their circumference. In other words, there is not the same opportunity to flash all the water in arch tubes into steam with the arch in as there is when it is left out; therefore, the arch should be maintained as a question of safety. There is no fool proof joint which could be expected to resist such neglects as above described.

Many mechanical officers may still like to have the low end of the arch tube inspectable from that end, and this may be accomplished by substituting small plugs opposite the arch tube. This type joint, however, permits the elimination of large plugs in the throat sheet end of the tubes, with a consequent increase in the economy of construction.

Rules Governing the Inspection of Railway Stationary Boilers in Canada

The Board of Railway Commissioners for Canada has ordered that the railway companies subject to its jurisdiction put in force not later than June 1, 1921, regulations promulgated by the board for the inspection of railway steam boilers other than locomotive boilers. The orders cover the design and construction of the boiler and appurtenances and provide for periodical inspection.

Code of Rules Adopted

These rules shall apply to all steam boilers, and their appurtenances, operated by railway companies within the board's jurisdiction, except boilers of locomotives, or boilers used solely for heating, which carry pressure not exceeding 15 pounds per square inch.

The chief mechanical officer of each railway company will be held responsible for the general design, construction, and inspection of all boilers covered by these rules. He must know that all inspections are made in accordance with the rules, and that the defects disclosed by any inspections are properly repaired before the boiler is returned to service.

Determine Safety Factor

The working pressure of each boiler shall be determined by the mechanical engineer, using the formula commonly used in determining safe working pressure, and after a thorough inspection and report by a competent inspector. The minimum factor of safety allowed shall be four. In determining safe working pressure, the maximum allowable stress shall be 7,500 pounds per square inch for staybolts, and 9,000 pounds per square inch for round or rectangular braces supporting flat surfaces.

Each boiler shall be given a serial number by the operating railway. A metal badge plate, showing this number and the safe working pressure, shall be attached to each boiler.

Specifications of each boiler shall be kept on file in the office of the chief mechanical officer of the railway company. Within one year after this rule becomes effective, each railway company will file a report with the chief mechanical officer of the railway company, and a copy with the board, for each boiler subject to these rules, giving all the data called for thereon.

Each boiler shall have at least one safety valve, of sufficient capacity to prevent an accumulation of pressure more than 5 percent above the working pressure, and shall be connected direct to the boiler. Safety valves shall be set at pressure not to exceed 6 pounds above the allowed working pressure. Working safety valves on boiler shall be tested each day boiler is in use. Failure of safety valve to open before an excess pressure of 10 pounds has been reached must immediately be reported to the proper authority and repairs made. Not less frequently than once each six months, all safety valves on boiler shall be tested, and adjustment made if necessary. At this test, as well as at all other tests where the safety valves are adjusted, two steam gages shall be used, one of which shall be in full view of the person adjusting the valves.

TESTS OF STEAM GAGE

Each boiler shall have a steam gage, graduated to at least 50 pounds above the working pressure, connected direct to steam space of boiler, equipped with a suitable siphon, and with no more than one cock or valve between boiler and gage. This cock to be located near steam gage. Steam gages shall be tested at least once each six months, or whenever any irregularity is shown, and shall also be tested before any adjustment is made of the safety valve. Each time gage is tested siphon pipe and cock must be cleaned and examined.

Each boiler shall have at least three gage cocks, and one waterglass, so located that the lowest reading shall be at least 3 inches above the lowest safe water line. Each waterglass shall be equipped with a valve at each end of glass, and with a blow-off or drain at bottom of glass. Gage cocks, waterglass and water column valves, cocks, and connections shall be maintained in an operative condition, free from leaks, and shall be cleaned of scale each time boiler is washed. Suitable lights shall be provided for waterglass and steam gage.

HYDROSTATIC TESTS

Before being placed in service, and not less than once each 12 months thereafter, each boiler shall be subjected to a hydrostatic pressure of 25 percent greater than the working pressure, and the boiler and appurtenances carefully examined while under pressure. After hydrostatic pressure has been applied, a thorough inspection shall be made of every accessible part of the boiler. Manholes shall be removed to permit of interior inspection. Boiler having lap joint longitudinal seams should be examined with special care, to detect grooving or cracks at edge of seams. Watertube boilers should be examined with special care, to detect blistering on the tubes, tubes bending, and leakage or corrosion where tubes are fastened to headers. Soot and cinders shall be cleaned from furnace and combustion chamber, and a thorough inspection made of the brick lining and setting, the fire wall, baffles, and grates. Threaded and flange joints on steam header, steam pipe, and blow-off line shall be examined carefully, for signs of corrosion or wasting. After repairs are completed, the boiler must be fired up, safety valves set, and boiler and appurtenances examined. All cocks, valves, seams, pipes, flanges, and joints must be tight under this pressure. All defects disclosed by any of the above inspections must be repaired before the boiler is returned to use. A certified report of the inspection and repairs shall be filed with the chief mechanical officer of the railway company, and a copy sent to the board.

STAYBOLT INSPECTION

Locomotive type boilers, working under a pressure of 125 pounds or more, should have the staybolts tested at least once each six months. Locomotive type boilers working under a pressure of less than 125 pounds, and vertical type boilers, to have staybolts tested annually. No boiler shall remain in service with five or more broken staybolts.

Boilers shall be thoroughly washed as often as water conditions require. Special care shall be given to watertube boilers, to prevent an accumulation of scale in the tubes, and the tubes must be scraped, if necessary. At washout periods, soot, ashes, and cinders shall be cleaned from furnace and combustion chamber, and brick lining, setting and firewall examined.

GENERAL INSPECTION EACH SIX MONTHS

Not less frequently than once each six months, an inspection of the boiler under steam shall be made by a competent inspector. He shall test the safety valves, gage cocks, and waterglass, blow-off valve, examine and test the feed pump or injectors, examine steam pipes for leaks, giving close attention to leaks around threaded joints, see that pipes are well braced, that all valves are operative, examine the setting of the boilers and the general condition of the boiler room, with special reference to fire risks. He shall report any defects found to the division officer in charge and to the local officer in charge, so that prompt repairs can be made. A certified report of the inspection and repairs shall be filed with the chief mechanical officer of the railway company, and a copy sent to the board.

Boilers in batteries, connected to same steam header, shall each have a suitable valve between boiler and header, which must be maintained in an operative condition.

Each steam outlet from boiler (except safety valve connections) shall be equipped with a suitable valve, which must be maintained in an operative condition.

Injectors and pumps must be kept in such condition that they will feed water into the boiler against the maximum pressure allowed on the boiler.

DEFECTS COVERING WITHDRAWAL OF BOILER FROM SERVICE

Boilers with any of the following defects shall be withdrawn from service until after proper repairs are made: Cracks in cylindrical boilers or headers; bags or bulges in shells of external fired boilers or unstayed surfaces of internal fired boilers; bulges in arch or water tubes; more than one gage cock inoperative; safety valve inoperative.

Boilers showing indications of having been low in water or of mud burning shall not be used until after inspection by a competent inspector.

Where necessary to plug flues, the plugs shall be tied together with a rod not less than ¾ inch in diameter, and a report of same made to the officer in charge, who will have proper repairs made.

When making internal inspection of one of a battery of boilers, another employe will be stationed outside of boiler, whose duty shall be to prevent steam valves from other boilers being opened into boiler being inspected.

An annual certificate of inspection shall be posted, under glass, in a conspicuous place in the boiler room. This certificate shall also show the number of the boiler, the allowed working pressure, the date of inspection, and the signature of inspector. Inspection certificates may be made in triplicate and copy filed with provincial inspector of boilers, if desired.

Calculating Stresses in Pressure Vessels

(*Continued from page* 135)

To find the required thickness of plate:

$$t = \frac{P \times R \times f}{2 \times S \times E}. \qquad (2a)$$

To find the unit stress in the plate:

$$S = \frac{P \times R \times f}{2 \times t \times E}. \qquad (2b)$$

To find the factor of safety:

$$f = \frac{S \times 2 \times t \times E}{P \times R}. \qquad (2c)$$

To find the required efficiency of the circumferential seams:

$$E = \frac{P \times R \times f}{2 \times S \times t}. \qquad (2d)$$

(*To be continued.*)

Foreign Trade Developments in Boiler Industry

By L. W. Alwyn-Schmidt*

The foreign demand for American boilers and boiler equipment that has been characteristic for the business of this industry during the last few years continued during the year 1920, showing in some instances even an increase over former figures. As it happened the export business came very handy during the second half of the year, when the demand from the domestic market began to decline, which shows again the advantage of having an export connection as an adjunct to an industry's domestic business.

Boilers are not exactly a very handy export article, but they have the advantage that they require little attention as to packing. They can be placed in the hold of a steamer without any special preparation, aside from giving them some protection against rust. With the loading and handling equipment available boilers may be moved about as readily as package goods could be handled in the past. The huge size of the boilers and the enormous empty space that has to be carried along with them, nevertheless, make boilers an expensive freight, especially in times when other and more compact cargoes can be had.

Luckily for our boiler exporters conditions in the ocean shipping business have been comparatively favorable to the carrying of bulky and heavy weights and so have been able to make good use of the situation by shipping a number of well-sized boiler orders. If we continue to export boilers at the present rate we shall, no doubt, learn to make still better use of the shipping market and arrange our business in such a manner as to always use the cheapest freight seasons for sending boilers abroad. Large boilers are rarely ordered on the spur of the moment. As a rule the order is preceded by considerable correspondence, exchange of specifications and similar preliminaries. In the course of these formalities it is often possible to bring an order to book by simply pointing out the advantage of a favorable freight rate, which can easily turn the scale in favor of the firm that is able to offer the most suitable shipping conditions.

> The American boiler and boiler equipment industry fortunately has given some special attention to the wants of foreign countries during the last few years. Interest was awakened first during the war when orders for foreign installations were coming to us as a matter of necessity for the purchaser who could not buy anywhere else. After the war the connection has been continued and in some instances has been scientifically developed by our own industry. The demand for American boilers and boiler equipment in this manner has been made less subject to chance and the very satisfactory export results of the last year reflect best the good work done in this respect by our American manufacturers.
>
> L. W. Alwyn-Schmidt.

American Boilers Stand Up Well Against Foreign Competition

The business during the last year has been secured under what amounted to practically normal conditions. English makers, which are our biggest competitors at the present time, had all facilities to quote as freely as ourselves and have, no doubt, gained a large share of the business for boiler equipment that has come into the market during the last twelve months. The German boiler makers have had little chance yet to compete and the comparatively lower prices that they could offer owing to the lower exchange rate of the mark as compared with the dollar and pound sterling seems to have been of little avail.

The fact is that the money exchange has little effect upon the transaction of big business like that of purchasing steam power equipment. The foreign purchaser of course takes into consideration the possibility of making a little deal in German marks and gaining in this manner a rise out of the German manufacturer. But the German manufacturers are not as independent in the supply of raw materials and labor as they used to be before the war. Sixty percent of their iron has gone and the remainder is not quite enough to cover the German domestic demand, assuming a normal rate of consumption. So part of the iron required for the manufacture of export goods has to come from abroad and has to be paid for at the present prevailing international prices plus the devaluation of the German mark. This is one of the cases where the imported article dictates the price of the domestic product and iron prices in Germany, therefore follow international quotations, as is the rule with practically all raw materials bought to-day in Germany. The German boiler makers thus pay more for their steel than their competitors in England and the United States, and the somewhat lower cost of labor is fully counterbalanced by the increased cost of transportation. Allowing, therefore, even for a lower price of the German equipment, there stands against a conclusion of the order the danger of a sudden move of the exchanges in favor of the German mark, by which the buyer might find himself a heavy loser, as has been the case already frequently during the last year.

Germany Out of the Running

So the German boiler makers are at the present time out of the running, with the exception possibly of the markets in the immediate neighborhood of Germany, which are those in which our manufacturers are not so much interested. The history of the international boiler markets has shown that the Atlantic route is not particularly favorable to the boiler business. England is sending boilers to this country, but there has been always a tendency to fight shy of shipping boilers over the Atlantic from and to the United States, pending the exceptional conditions of the war. The reason most likely is the special situation of the freight market in the north Atlantic shipping service, which is not very favorable to the transportation of heavy freights.

If price, therefore, is not the deciding element in the acquisition of a foreign contract for boilers, what must be regarded as the most essential factor? There is only one answer to this question. This is the convenience of the buyer. The industrial equipment situation of the world is by no means as desirable as it might be. In fact the world moves very slowly in improving its industrial power, discarding antiquated equipment rarely before compelled to by force of circumstances. This is not only the case in the less developed industrial countries, but even such highly progressed

* Consulting economist, New York Economic Service Bureau.

nations as our own are carrying along a mass of antiquated equipment that would appall the engineers if they knew the truth. For example, during the recent war machine tools were found in some plants that had been put into use during the Civil war and which were still doing their work. Boilers twenty years old and more are no rarity in this country and elsewhere, and one frequently finds boilers in South America which date back far into the last century, having done good work in Europe and having been sold second hand to their present owners. Such boilers naturally cannot be expected to work at full efficiency. But the significance of this for the American manufacturer of boiler equipment is not lack of effectiveness but its effect upon the rest of the equipment that is used in connection with the same boiler. It is of course entirely out of the question to fit such a boiler with the modern high pressure steam equipment necessary for most up-to-date power installations. Equipment of antiquated type, as compared with that used in connection with modern plants, has to be used, and the demand consequently runs in the direction of such equipment.

Industrial Effectiveness Influences Character of Boiler Demand

This of course influences the whole equipment business in a manner that can hardly be imagined and is one of the causes why there was so little foreign trade done by our manufacturers before the war. An exception is found in the case of American valves and supplementary equipment, which, as a rule, can be used with any type of boiler installation.

Since the war this condition has changed and the change has been in favor of the American industry. The value of the American boilers and boiler equipment in use now outside the United States is roughly speaking $100,000,000. At least half of that amount was shipped during the last few years. In addition to this equipment many plants have been constructed during the last few years in Asia, Australia and South America upon specifications made by American engineers. In these cases the machine equipment may have been supplied by American firms and part of the transmission and steam equipment possibly has come from American sources. The boilers, however, have either been imported from England or made in the countries themselves. China has a number of plants able to construct high-power boilers if necessary and the Japanese boiler works are doing quite satisfactory work even as regards the construction of very high-class boilers. As to effectiveness in use there is of course little to choose between a first-class American and an English boiler and the two can easily be interchanged. A process of industrial modernization has gone all over the world during the years of the war which will benefit our own boiler works and steam equipment makers because it widens the sales-field for American equipment.

It can be said that American boiler equipment can be fitted to sixty percent of all the existing steam power installations outside Europe and the United States, which is a great advantage. American engineers of course have always given preference to American steam equipment whenever they had to make specifications for new installations.

Properly speaking the American boiler maker did not care very much for his foreign business and it needed some event like the war to bring home to him the possibilities of his markets outside the United States. In consequence our foreign customers did not know very much about American boilers and steam equipment. They have now learned that in quality our boilers are equal to any foreign make and that in adaptability they are even superior. The last two years have shown that the impression gained during the war is likely to be a permanent one and it is now up to our own boiler makers to hold their present advantage.

If it is at all possible to make a prediction as to the future course of our foreign business it would probably be as follows: This business is bound to grow in volume during the next few years although the values may show a decline owing to the general decline of prices all over the world. The demand will be smaller during the first half of the present year but will increase more and more during the summer and should be normal again by the end of the year. From then business will increase both in volume and value.

Specifications for Welding Material Adopted by American Welding Society

The following are specifications for welding material compiled for the railroads by the American Welding Society. These specifications deal only with material for welding mild steel. Others to be brought out later will deal with high carbon steel and with non-ferrous metals.

Electrodes, Iron and Steel (Bare)

1. *General:* The following specifications prefixed by the letter E are recommended for the purchase of all bare iron and steel electrodes for use in arc welding:

2. *Scope:* The electrodes herein specified are recommended as covering the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies, such as the American Bureau of Shipping and the Interstate Commerce Commission, etc.

3. *Material:* Material made by the puddling process is not permitted.

4. *Physical Properties:* Electrodes shall be made of commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipes, seams, etc. Diameter shall not vary more than plus or minus 3 percent from diameter specified.

5. *Nomenclature:* The use of the prefix letter E is to indicate that the material is intended for electric welding.

6. *Chemical Composition* shall be within the following limits for mild steel.

MILD STEEL

No. E1A

Carbon	not over 0.06 of one percent
Manganese	not over 0.15 of one percent
Phosphorus	not over 0.04 of one percent
Sulphur	not over 0.04 of one percent
Silicon	not over 0.08 of one percent

No. E1B

Carbon	0.13—0.18 of one percent
Manganese	0.40—0.60 of one percent
Phosphorus	not over 0.04 of one percent
Sulphur	not over 0.04 of one percent
Silicon	not over 0.06 of one percent

7. *Recommended Sizes:* 3/32-, 1/8-, 5/32-, 3/16-inch diameters.

8. *Uses:* For welding mild steel, structural shapes, plate, bars or low carbon steel forgings and castings.

9. *Note:* Under the heading "Mild Steel" two analyses of material are specified, both of which are manufactured and acceptable.

10. *Surface Finish:* The surface shall be smooth and free from rust, oil or grease.

11. *Tests:* In the hands of an experienced welder electrodes shall demonstrate good weldability and shall pass through the arc in flat and overhead positions smoothly and evenly without detrimental phenomena.

12. *Packing:* Electrodes shall be delivered in coils or in straight 14-inch lengths, packed and wrapped as follows:

(a) *Bundles* of 50 pounds net weight, securely wired and wrapped in heavy weatherproof paper.
(b) *Bundles* of 50 pounds net weight, securely wrapped in heavy burlap.
(c) *Boxes* or kegs of 100, 200 or 300 pounds net weight and wrapped as per paragraph (a).
(d) *Boxes* or kegs of 100, 200 or 300 pounds net weight and wrapped as per paragraph (b).
(e) *Coils* of approximately 50 or 100 pounds net weight and wrapped as per paragraph (a) or (b).

13. *Markings:* All bundles, coils, boxes or kegs shall be provided with a metal tag wired or nailed on the outside bearing the following information:

Make ....
Specif. No. ....
Dia. ....
Nom. weight ....

14. *Ordering:* Material ordered under these specifications shall be known as:

"Electrodes, iron and steel bare American Welding Society Specifications No. 1, issued April 1, 1920."

All orders should be specified in pounds.

In addition, requisitions shall show the following:

Specif. No.
Size
Packing

As a guide in ordering, the following information is of use:

Size, inches...........	1/16	3/32	1/8	5/32	3/16	1/4
Pounds per 100 feet....	1.04	2.3	4.1	6.5	9.3	16.7
Feet per 100 pounds....	9,615	4,273	2,403	1,537	1,067	600
Mils	63	94	125	156	188	250

OXY-ACETYLENE WELDING RODS

1. *General:* The following specifications, prefixed by the letter G, are recommended for the purchase of all iron and steel welding rods for use in gas welding.

2. *Scope:* The welding rods herein specified are recommended as covering the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies, such as the American Bureau of Shipping and the Interstate Commerce Commission, etc.

3. *Material:* Material made by the puddling process is not permitted.

4. *Physical Properties:* Welding rods shall be made of dead soft annealed commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipes, seams, etc. Diameter shall not vary more than plus or minus 3 percent from diameter specified.

5. *Nomenclature:* The use of the prefix letter G is to indicate that the material is intended for gas welding.

6. *Chemical Composition* shall be within the following limits for mild steel:

MILD STEEL
No. G1A

Carbon	not over 0.06 of one percent
Manganese	not over 0.15 of one percent
Phosphorus	not over 0.04 of one percent
Sulphur	not over 0.04 of one percent
Silicon	not over 0.08 of one percent

7. *Recommended Sizes:* 1/16-, 3/32-, 1/8-, 5/32-, 3/16-, 1/4-, 5/16-, 3/8-inch diameters.

8. *Uses:* For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

9. *Surface Finish:* The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper-coated.

10. *Tests:* In the hands of an experienced welder welding rods shall demonstrate good weldability and shall flow smoothly and evenly without detrimental phenomena.

11. *Packing:* Welding rods shall be delivered in coils or in straight 36-inch lengths, packed and wrapped as follows:

(a) *Bundles* of 50 pounds net weight, securely wired and wrapped in heavy weatherproof paper.
(b) *Bundles* of 50 pounds net weight, securely wrapped in heavy burlap.
(c) *Boxes* or kegs of 100, 200 or 300 pounds net weight and wrapped as per paragraph (a).
(d) *Boxes* or kegs of 100, 200 or 300 pounds net weight and wrapped as per paragraph (b).
(e) *Coils* of approximately 50 or 100 pounds net weight and wrapped as per paragraph (a) or (b).

12. *Marking:* All bundles, coils, boxes or kegs shall be provided with a metal tag wired or nailed on the outside, bearing the following information:

Make ....
Specif. No. ....
Dia. ....
Nom. weight ....

13. *Ordering:* Material ordered under these specifications shall be known as:

"Oxy-acetylene welding rods, American Welding Society Specifications No. 1, issued April 1, 1920."

All orders should be specified in pounds. In addition, requisitions shall show the following:

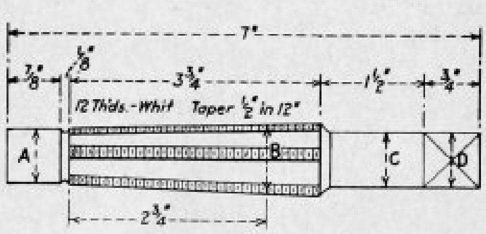
Specif. No.
Size
Packing

As a guide in ordering, the following information is of use:

Size, inches..........	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Pounds per 100 feet..	1.04	2.3	4.1	6.5	9.3	16.7	2.6	37.5
Feet per 100 pounds..	9,615	4,273	2,403	1,537	1,067	600	383	266
Mils	63	94	125	156	188	250	312	375

Tapping Radial Holes in Boiler Shells

The difficulty which inexperienced workmen find in tapping holes in boiler shells so that studs applied in these holes will be on radial lines is well known. For example, most air compressor brackets are supported on the barrel of the boiler by means of six studs. The brackets range from 2 to 3 feet long and the studs are about that distance apart. If tapped



D	C	B	A
1/2"	5/8"	5/8"	1/2"
9/16"	3/4"	3/4"	5/8"
5/8"	7/8"	7/8"	3/4"
11/16"	1"	1"	7/8"
3/4"	1 1/8"	1 1/8"	1"
3/4"	1 1/4"	1 1/4"	1 1/8"
13/16"	1 3/8"	1 3/8"	1 1/4"

Tap Developed for Tapping Radial Holes

into the boiler on radial lines the studs will not be parallel, but many times an attempt is made to have them parallel, and the result is undue strain on the stud, to say nothing of an unworkmanlike looking job.

In order to overcome this condition and facilitate the application of boiler studs along radial lines, the tap illustrated has been devised. The end of the tap is extended as shown at *A* in a cylindrical surface equal in diameter to the smallest diameter of the thread. With care in drilling the boiler shell on a radial line (the diameter of the hole being slightly larger than *A*), the tap will obviously start in the direction of the drilled hole, and as a result the hole will be tapped along a radial line. The proportions of *A*, *B*, *C* and *D* are shown in the table for seven different sizes of taps. The use of this tap will also aid in tapping a hole at right angles to a given plain surface, following the direction of the drilled hole as previously described.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval.

Case No. 324—Inquiry: In the formation of the header element of a watertube boiler to operate at 500 pounds pressure, with a tubular header of 2 inches outside diameter, is it necessary that the ligament between two openings, where 1⅛-inch cross-tubes are inserted on 1½-inch pitch, shall be designed under the requirements of paragraph 192?

Reply: It is the opinion of the committee that, while the strength of the construction may be calculated by the ordinary formula for cylinders, there are elements in the particular design which may result in the ability to carry higher pressures than would be allowed by the ordinary formula. The committee therefore recommends that a test be made as provided for in paragraph 247 of the Code. It further recommends that in making the test the pressure that will cause the material to be stressed to the yield point be determined.

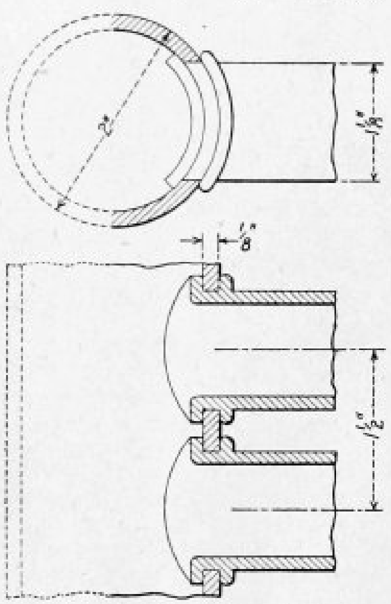


Fig. 1.—Case 324. Spherical Head Construction

Case No. 328—Inquiry: Is it necessary, in the manufacture of boiler and superheater headers of open-hearth steel pipe, that the tensile strength be calculated on the basis of 55,000 pounds, or is steel of lower tensile strength allowable in material of this form as permitted under paragraph 28c of the Boiler Plate Steel Specifications?

Reply: If the material in the header conforms to a steel specification other than steel plate specification and shows a lower tensile strength than 55,000 pounds per square inch, it is the opinion of the committee that it is permissible to calculate the header design on the basis of this lower value the same as is permitted for steel plate material as indicated in paragraph 28c. See also Case No. 218.

Case No. 329 (Reopened)—Inquiry: What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing?

Reply: It is the opinion of the committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in paragraph 88 of the Code. While the Code contains no specific statement as to the tensile strength of the material used in seamless tubing, it is the opinion of the committee that 50,000 pounds could be used as a basis for calculating the safe working pressure.

Case No. 331—Inquiry: Is it permissible, under paragraph 311a of the Boiler Code, to use in the blowoff connection a valve and a cock formed in a single body casting, instead of two separate valves or a valve and a cock as specified in that paragraph?

Reply: It is the opinion of the committee that the use of two valves, or a valve and a cock, combined in one body does not meet the requirements of paragraph 311a of the Boiler Code.

Case No. 332—Inquiry: Is it permissible under the requirements of the Boiler Code to attach a nozzle outlet to a pipe-header manifold by inserting the nozzle through a hole in the header and peening the edges over inside the header, as shown in Fig. 2, the nozzle being autogenously welded to the header on the outside for steam tightness?

Reply: It is the opinion of the committee that this construction will not meet the requirements of paragraph 186, as peening over of the inserted edges of the nozzle will not afford greater strength to withstand the steam pressure on the cross-sectional area of the nozzle than flaring as specified in Case No. 235.

Strength of Reinforcing Rings

Case No. 333—Inquiry: (a) Where a steam nozzle or safety valve nozzle is placed upon a boiler drum in which the shell is made thicker than that required for giving a factor of safety of 5, do the requirements of paragraphs 260 and 261 apply, which specify that the strength of the reinforcing rings shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and the rivet holes for the reinforcement, and that the strength of the rivets in shear on each side of the reinforcement shall equal the tensile strength of the maximum amount of the shell plate removed by the opening?

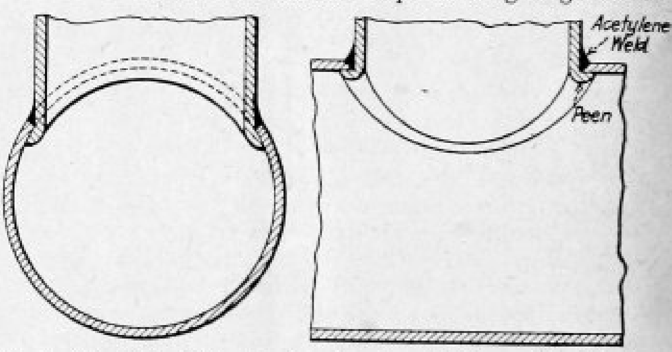


Fig. 2.—Case 332. Design for Attaching Nozzle Outlet to Pipe Headers —Not Approved

(b) Does paragraph 325 respecting allowable shearing and crushing stress on rivets used for attaching lugs or brackets apply to other than horizontal return tubular boilers for constructions where the weight is more evenly divided between the lugs than in the case of horizontal return tubular boilers?

Reply: (a) The requirements in paragraphs 260 and 261 are based on the use of a shell having a thickness corresponding to a factor of safety of 5 at the seams, or weakest part of the shell. Where the thickness of the shell is greater than necessary to give a factor of safety of 5, the openings through the shell, to meet the requirements of paragraphs 260 and 261, need not be reinforced to any greater amount than that required for such a shell.

Aside from the requirements in paragraphs 260 and 261, the flange of the nozzle should be made substantial enough to withstand cross-strains to which it may be subjected through expansive strains of the piping, etc.

(b) Paragraph 325 applies to all types of boilers irrespective of the number of lugs employed.

Case No. 334—Inquiry: Is it permissible, under the requirements of paragraph 332, to apply the A. S. M. E. Code boiler stamp to a boiler whose construction cannot be completed in the shop so as to subject the drum or any of its parts to hydrostatic test? Such a test would be practical only after the boiler has been erected in the field.

Reply: It is the opinion of the Committee that those boilers which cannot be completed and hydrostatically tested in the shop may have the stamping applied before shipment, final certification to be made after hydrostatic test is made in the field.

Case No. 336—Inquiry: An interpretation is requested of the term "or other opening" in paragraphs 260 and 261 of the Boiler Code. Does it apply to openings cut for steel nozzles and boiler flanges?

Reply: It is the opinion of the Committee that the term "or other opening" applies to openings cut for steel nozzles and boiler flanges over 3-inch pipe size.

Seams in Vertical Boiler Shells

Case No. 338—Inquiry: Is it necessary in the construction of a 54-inch drum of a vertical watertube boiler which is formed of 1 3/16-inch plate with 3 1/32-inch tube holes, giving a ligament efficiency of 47.3 percent, to use a butt strap ⅞-inch thick as indicated in Table I of the Boiler Code? It is evident that the shell above the ligaments is much stronger than necessary for the desired working pressure of 225 pounds per square inch, and that 23/32-inch thickness of shell is all that is necessary outside of the ligaments.

Reply: It is the opinion of the Committee that in the design of a joint for such a drum where the shell thickness is purposely made thicker than necessary for the working pressure in order to increase the ligament efficiency, the butt straps and riveting need not be proportioned for a greater strength than that necessary to carry the working pressure for which the drum is designed.

Case No. 339—Inquiry: Will an internal feed pipe formed of a main feed pipe with numerous small, short nipples tapped into one side and with elbows at either end bushed down to similar small nipples, as shown in Fig. 3, meet the requirement of paragraph 314 of the Boiler Code? This arrangement is made to force a certain amount of water to flow through the nipples instead of all through two nozzles.

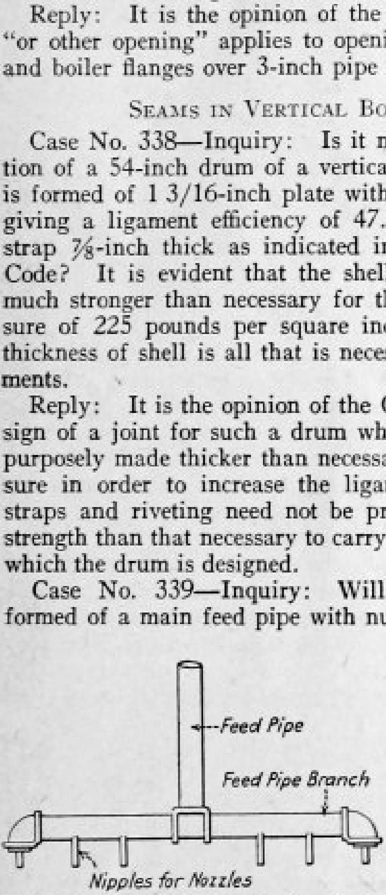


Fig. 3.—Case 339. Design for Feed Pipe Header—Not Approved

Reply: It is the opinion of the Committee that the construction proposed does not meet the intent of this requirement, which specifies open ends of the pipe in order that incrustation may not under any circumstances cause stoppage.

Case No. 340—Inquiry: Is it permissible, under the requirements of the A. S. M. E. Boiler Code, to construct a 66-inch horizontal return tubular boiler for hot water heating, to operate at pressures exceeding 50 pounds, in which (a) handholes only are provided for cleaning and inspection, or (b) with manhole below the tubes only and tubes filling the entire upper space of the shell, there being no steam space required?

Reply: In the opinion of the Committee this case is fully covered by paragraph 264, and the construction would be in accordance with the Code if sufficient provision were made for adequate inspection.

Case No. 341—Inquiry: What is necessary to determine the pitch of the braces to stay an annulus in the top head of a vertical submerged tube boiler shown in Fig. 4, in which the annular space is 5½ inches wide by 36 inches in inside diameter, and the boiler is to be operated at 100 pounds per square inch?

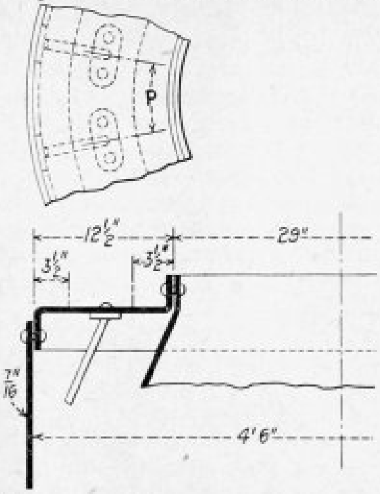


Fig. 4.—Case 341. Design for Top Head of Vertical Submerged Type Boiler

Reply: There is no specific rule in the Code applying to such construction. Paragraph 203a indicates the permissible coefficient C for the formula in paragraph 199, from which the maximum distance between centers of rivets should be determined. Table V gives the permissible stress for braces which, in conjunction with the total pressure on the annulus (making proper allowance for angularity of the braces), designates the total brace area necessary. See also Case No. 308.

Beveling Firebox Sheets to Provide for Contraction

When setting a patch in a firebox sheet and welding with the oxy-acetylene torch it is necessary to provide for expansion and contraction. It is customary in some railway shops to bump or corrugate the patch so as to provide a certain amount of elasticity within the sheet itself. Another method is to turn the sharp edges of the bevels back with a fuller tool. The practice is substantially as follows:

The defective portion of the side sheet is cut out and beveled to an angle of about 45 degrees. The corners of the openings are rounded to a radius of about one inch. The patch is cut to the same dimensions as the opening and beveled all around to an angle of 45 degrees. It is drilled and tapped for the staybolts, set in place and the staybolts screwed in. The edges of the plates are heated with the torch and a fuller tool from 3/16-inch to ¼-inch wide is driven into the vee to curl the sharp edges back. This is done all around before starting to weld. Welding is started at one corner, using a filler rod to bridge the opening, and the "tack" is carried clear around without stopping. Welding then is done in the usual manner, using the torch and the welding rod in approved fashion to puddle and make a ripple weld. No reinforcement is required, that is, it is not necessary to build the weld above the level of the sheet. The curled edges tack welded are put in tension, but they are supposed to yield by straightening out. When welding has been completed the projection of the curled edges on the far side of the plate should be reduced to a negligible amount.

Unfortunately, the practice just described to provide for expansion and contraction, is not preferable to bumping or corrugating the patch, because the elasticity of the curved edges is more apparent than real.—*Autogenous Welding.*

After May 1 the general offices of the Superheater Company will be moved from 30 Church street to 17 East 42d street, New York.

The American Arch Company, Inc., announces that its general offices are now located in the National City Building, 17 East 42d street, New York.

Standardization of Locomotive Boiler Staybolts

By C. E. Lester

The accompanying drawing shows a complete set of standard boiler bolts, that is, patch bolts, staybolts or water-space bolts, radial stays and crown bolts, covering all the rigid bolts that ordinarily are applied to locomotive boilers.

In the submission of the drawing it is the intent to criticise as well as to commend some of the details illustrated. The drawing represents the standard practice on a certain railroad and has, in the writer's opinion, certain excellent features as well as some objectionable ones.

The recessing of staybolts either by machining or by upsetting smaller sizes in the water space section gives more flexibility to the bolts where most needed, relieving in a degree, the stresses on the threaded sections in the sheet, with less liability of breakage from the cantilever action of the bolt, when the firebox sheets are under pressure and under expansive strains. There is also a considerable increase in the available water space, when a full installation of reduced section bolts is used. Flexibility also tends to lessen the accumulation of incrusting solids around the base of the bolts.

The standardization of bolts permits the purchase of bolts threaded. It is also possible to produce them in a central plant, if certain precautions are exercised. It is quite necessary that neither taps nor bolts have excessive tolerances. For example, if specifications permit the purchase of staybolt iron with a minus tolerance, it is, of course, necessary to procure taps without a plus tolerance. In other words, the shipping to a shop of finished bolts means departure from the old established method of fitting the bolts to the taps and requires the tap to suit the bolts. This is not as difficult as may at first be thought. With due regard for micrometric sizes in the manufacture of the bolts and a close check of taps in use successful results may be obtained if, in addition to the precautions named, a second or follow-up tap be used to clear out the ragged threads and make all holes the same size.

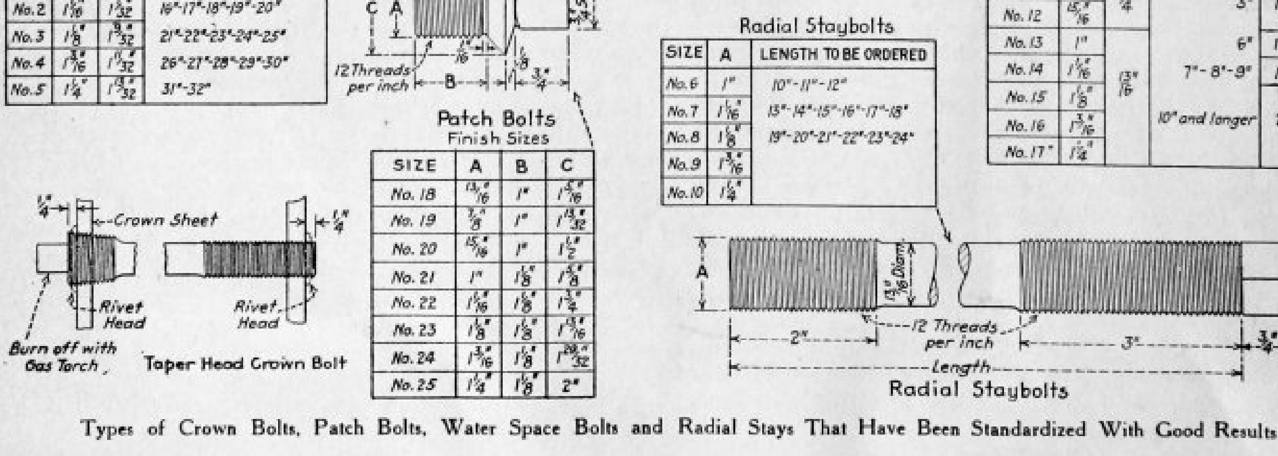
The minus tolerance permitted in the purchase of staybolt material frequently means that double cutting is necessary, that is, if specifications permit the acceptance of staybolt iron .004 inch under size it means that cutting down to the next size under will be necessary to insure full threads on the bolt.

Staybolts should not be applied: when (1) threads in sheet do not show a full perfect thread; (2) when threads on bolt do not show a full perfect thread; (3) when the bolt is loose enough to be turned by hand after it is entered in the second sheet.

Federal requirements are that all staybolts 8 inches or less in length must have inspection holes in them. It is presumed that this precaution was intended to apply to finished lengths and not simply to bolts that were 8 inches long before they were applied to the boiler. If such is the case and the bolts are cut, forged and drilled at this length there is a liability of not having an 8-inch driven length. A bolt originally 8¾ inches long usually means a bolt about 7½ inches long after it is driven. It is my opinion after 25 years in the boiler field that to limit detector holes to bolts 8 inches or shorter is a mistake; for, while not so many long bolts break as short ones, there is nevertheless a sufficient number of long bolts broken (even if they are not generally found on hammer test) to warrant a detector hole.

Explosions due to broken crown bolts or radial stays would seem to indicate that inspectors are not impressed with the importance of hammer testing long bolts. In many cases lack of suitable diagrams covering staybolt installations handicap inspectors. Boilers of the same class may have different types of stays applied and the inspector at some outside point having no diagram, sounds the bolts, thinks they are flexible and passes them up. Instead they may be broken rigid bolts and as there are no detector holes breaks cannot be found. The engine may get to the shop before trouble happens and it may not. All rigid bolts should have detector holes as a matter of safety and the opinion is ventured that it will be a lawful requirement before many years.

The diametric sizes listed under waterspace bolts running from ⅞ inch to 1¼ inches are generally in use on all railroads. Many roads reduce the center of all bolts, but some do not. In any event it is believed that a short staybolt above 1⅛ inches diameter is too large for usage. One company has a provision that where a rigid bolt exceeds 1¼ inches in diameter and new patches or inner sheets are ap-



Crown Bolts

SIZE	A	B	LENGTH TO BE ORDERED
No. 1	1"	1 5/32"	
No. 2	1 1/16"	1 7/32"	16"-17"-18"-19"-20"
No. 3	1⅛"	1 9/32"	21"-22"-23"-24"-25"
No. 4	1 3/16"	1 11/32"	26"-27"-28"-29"-30"
No. 5	1¼"	1 13/32"	31"-32"

Patch Bolts
Finish Sizes

SIZE	A	B	C
No. 18	13/16"	1"	1 5/16"
No. 19	⅞"	1"	1 13/32"
No. 20	15/16"	1"	1½"
No. 21	1"	1⅛"	1⅝"
No. 22	1 1/16"	1⅛"	1¾"
No. 23	1⅛"	1⅛"	1 13/16"
No. 24	1 3/16"	1⅛"	1 29/32"
No. 25	1¼"	1⅛"	2"

Radial Staybolts

SIZE	A	LENGTH TO BE ORDERED
No. 6	1"	10"-11"-12"
No. 7	1 1/16"	13"-14"-15"-16"-17"-18"
No. 8	1⅛"	19"-20"-21"-22"-23"-24"
No. 9	1 3/16"	
No. 10	1¼"	

Water Space Bolts

SIZE	A	D	LENGTHS TO BE ORDERED	B	C
No. 11	⅞"	¾"	5"	1½"	1½"
No. 12	15/16"				
No. 13	1"	13/16"	6"	1½"	1⅞"
No. 14	1 1/16"		7"-8"-9"	1½"	2½"
No. 15	1⅛"		10" and longer	2"	3"
No. 16	1 3/16"				
No. 17"	1¼"				

Types of Crown Bolts, Patch Bolts, Water Space Bolts and Radial Stays That Have Been Standardized With Good Results plied, that a flexible bolt of the Tate type shall be used and the hole in the firebox sheet be made the size originally cut when the boiler was built. Some roads when applying new inner sheets, apply thimbles to the outer sheet and reduce to standard the inner sheet; others reduce by welding the hole in the outside sheet and still others have practically no limit for the maximum size. A practice recently put into effect by the writer goes farther than any of these and prohibits the use of a staybolt at any time above 1⅛ inches in diameter whether in the back shop or engine house. Such facilities as are available should be used in keeping the sizes down to the maximum of 1⅛ inches. The plan has been to discontinue carrying staybolt stock above this size and to remove such staybolt taps from service. Aside from being good boiler practice, it eliminates two sizes of staybolt stock and a number of staybolt taps. Both these are items of considerable expense.

The elimination of all other type crown bolts in favor of the taper fit drive head bolt has been a move having nothing but good results. It is believed that this type of bolt, when properly applied, is without a peer where bad water is used. It is, however, a mistake to attempt to set the bolt for a proper length to drive as shown on the drawing. It has been found that in order to have uniform heads for driving that bolts should be set for length rather than for tightness. More recent instructions provide that bolts be made a shade larger and pulled tight regardless of the amount, sticking out to be burned off.

Many foremen differ regarding the proper manner in which to drive a hammered head crown bolt of this type; however, I believe that a light hammer with a bobbing tool that merely sets the edge of the bolt down to the plate is sufficient driving.

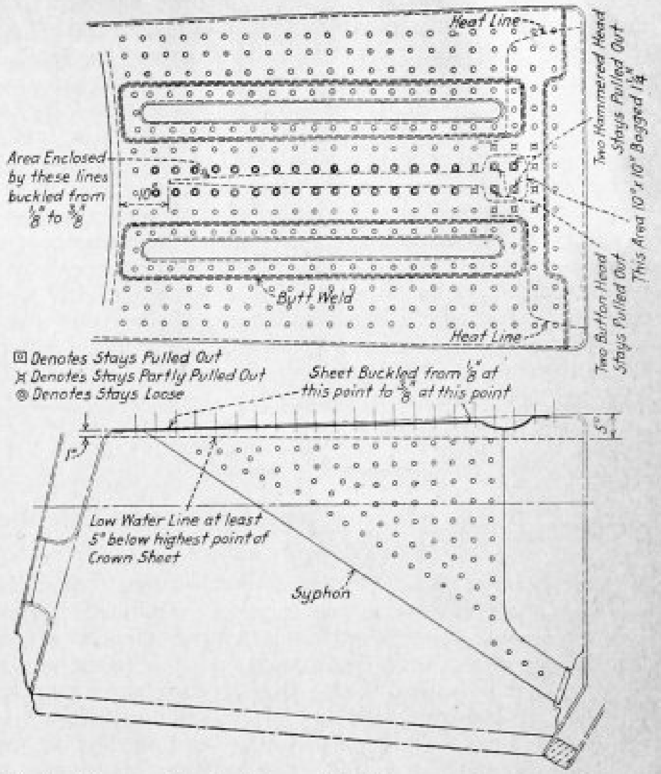


Fig. 2.—Diagram Showing Extent of the Damage to the Crown Sheet of the Engine

Crown Sheet Failure Without an Explosion

The serious consequences which generally follow the initial failure of an exposed locomotive crown sheet when the boiler is under working pressure make noteworthy any case in which such a failure, caused by low water, remains within sufficiently narrow local limits to result in no more than an engine failure.

Such a case, of special interest because of the fact that the firebox was equipped with the Nicholson Thermic Siphon, occurred January 19, 1921.

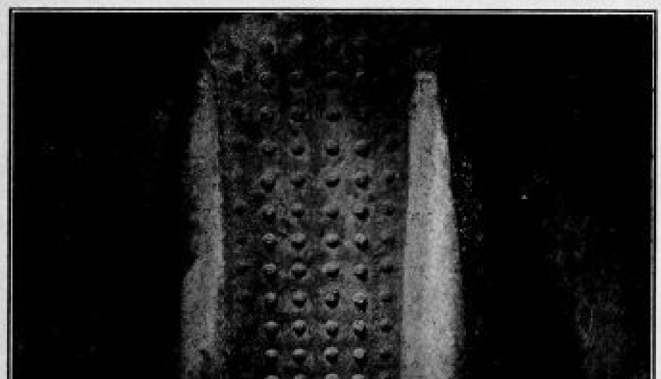


Fig. 1.—Interior View of the Firebox Showing the Most Affected Area of the Crown Sheet

At the time of the failure the locomotive, which is of the Consolidation type, was pulling a heavy freight train with a strong draft on the fire, to which the crown sheet was exposed with a water level afterwards determined to have been between five inches and eight inches below the highest point of the sheet. The location of the failure and the affected portion of the crown sheet are shown in Figs 1 and 2. It will be seen that an area about 10 inches square just back of the first two transverse rows of stays became sufficiently overheated to be pushed off of the heads of the two center stays in the next two transverse rows, and pocketed to a maximum depth of about 1¼ inches. The stays nearest adjoining this area in the second, third, fourth and fifth transverse rows from the front of the crown sheet all were partially pulled out of the sheet. With this condition existing the train was pulled into a siding before the locomotive failed completely, due to the blow-down through the crown stay holes in the pocketed portion of the sheet.

After shopping the engine, a careful examination of the firebox disclosed the following facts: (1) That the water level at the time of the accident was below the highest point of the crown sheet, a distance variously estimated at from five to eight inches; (2) that from the pocket in the sheet back to within 10 inches of the door sheet the crown sheet was buckled from ⅛ inch to ⅜ inch between the two center rows of radial stays; (3) that the two center rows of radial stays were loosened in the sheet; (4) that with these two exceptions there was no evidence of overheating the sheets between or outside of the siphons, and (5) that between the flue sheet and the front of the siphons evidences of overheating were clear on an area extending down about eight longitudinal rows of stays on either side of the center line.

In observing this case from the standpoint of the relation of the Nicholson Thermic Siphon to the extent to which the crown sheet was damaged, it should be pointed out that in other cases similar or even more extended areas of the crown sheets have pulled off the stays in boilers not equipped with the siphon without a complete failure of the sheets. Two of the principal factors determining the extent of the damage in such cases are the strength of the staying and the temperature and rate at which heat is being generated in the firebox at the time of the failure. In the case of the locomotive under consideration, one of these factors was favorable to the rapid extension of the affected crown sheet area, inasmuch as the temperature of the firebox and the rate of heat generation were high at the time of the initial failure. The reports of a number of boiler inspectors who examined the firebox after the accident agree in the opinion that water was delivered from the siphon over a considerable area of the crown sheet after it was exposed above the level of the water in the boiler. While the absence of this action might not have resulted in a complete failure of the crown sheet, its presence undoubtedly tended to limit the damaged area.

Increased Use of Oil-Fired Boilers in Europe

By T. Sington

There is an unmistakable tendency in industrial centers in practically all European countries to substitute oil-fired boilers for coal burners, wherever regular supplies of oil can be depended upon. The economy possible in the use of oil and the increasing difficulty of obtaining regular supplies of coal, make this change advisable. At present there is practically a coal famine throughout Europe, due to the reduction in output, resulting from the fewer man hours of production and the decreased production per man per hour. In France and still more in Italy coal prices have reached such a level as to place it entirely beyond the purchasing power of the average consumer.

Oil firing for boilers of the so-called Lancashire type, for example, does not require any very great complication of apparatus, and so the more generally favored European type can be readily described. A large overhead oil tank is placed either within or in close proximity to the boiler house, well above the level of the boilers, and is provided with a lamp, filter, level gage and drain cock. Where heavy oils only are obtainable, it is necessary to surround the tank with a steam coil to maintain the oil in a fluid condition. The coils are used also when the tank is in a very exposed position. As the oil stored in barrels or in a reservoir will probably be at a lower level than the overhead tank, either a power or a hand pump will be required to raise the oil to the higher level. Below the sump of the oil tank there is an oil strainer and a descending pipe with a branch to each flue or furnace, which conveys the oil to the burners near which are the air-inducing cones and regulators.

The connecting pipes, swivels and other small fittings are kept as simple as possible. Where oil is abundant and cheap, as in Mexico, southern Russia, Roumania and some other European areas, oil firing for both stationary and locomotive boilers has been in general use for many years.

Now the high price of coal, its scarcity and the frequency of strikes are forcing the substitution of oil firing into notice even where oil has to be imported, as in Great Britain. Here oil firing is being introduced even with coal seams directly below the boilers. Mill owners are studying the advantages of this convenient labor-saving system of firing. The great doubt is whether with the enormous world's consumption of oil the supply can be maintained. Many experts believe that within two decades it may show signs of exhaustion. For the sake of conservation, some types of burners are therefore preferable to others. In oil-burning installation, the fire bars should be covered with a layer of firebricks several inches in depth and the ordinary furnace doors should be replaced by special fittings so constructed that the air supply to the combustion chamber can be accurately regulated. This is an all-important feature to obtain really efficient combustion, that the proportions of oil and air should be such as to give the maximum heat.

An interesting modification of the oil-firing system is that adopted by many important companies with large works of *mixed* firing, that is a combination of coal and oil firing, the object being to help over occasional peak loads, instead of installing standby boilers. In such installation the burners are so arranged that they can be readily turned on during the heavy load periods without interfering with the coal firing when only a normal load has to be dealt with. This system is not suitable for general use and will probably always be limited to a small number of works.

Every pound of oil burned in an effective oil installation should give an average evaporation from and at 100 degrees C. (212 degrees F.) of 15 pounds of water. There is an obvious reduction of cartage, storage space and labor, increased cleanliness, and no possible increase from smoke and careless stoking. There can be little doubt, that if an ample and continuous supply of oil could be depended on oil firing would in a few years entirely supersede coal firing.

So important is the economy attending the burning of oil for generating steam that cargo and passenger vessels operating between ports where oil stores are available are almost invariably fitted with oil-fired boilers.

Plant Inspection Trips Scheduled for the Spring Meeting of the American Society of Mechanical Engineers

Many industrial plants in and around Chicago have extended invitations to members of the American Society of Mechanical Engineers to inspect them during the period of the spring meetings of the society, May 23—26. Visits to several plants are scheduled for each day and individuals may select such of the trips as will prove most interesting to them. The following schedule includes the name and the type of plants open to inspection on each of the four days of the meetings.

Tuesday: International Harvester Co., McCormick and Deering plants; Sears, Roebuck & Co., wall paper manufacture, handling and shipping merchandise; Mandel Brothers, package handling, coal and ash handling; Western Electric Co., manufacturer of telephone apparatus and cable.

Wednesday: Illinois Steel Co., South Works, South Chicago, plate mill, rail mill, Bessemer converters and general steel mill equipment; Commonwealth Edison Co., modern turbine central station at Fisk Street; Pennsylvania Lines terminal, freight handling plant, in connection with which there may be visited the neighboring warehouse of Marshall Field & Co., and the U. S. Terminal building; Crane Company, manufacture of valves and fittings in cast iron, malleable iron, steel and brass, the fabrication of pipe work.

Thursday: Chicago Mill & Lumber Co., 120-in. paper machine, manufacture of fibre, corrugated board and paper boxes; Clemetsen Company, manufacture of veneers and "Clemco" office desks; Pullman Company, Pullman cars, passenger coaches and freight cars; Underwriters' Laboratories, testing of appliances and devices for fire prevention; Yellow Cab Manufacturing Co., where the ubiquitous cabs come from.

Friday: Milwaukee Railway & Light Co.'s Lakeside plant, trip by rail to Milwaukee, boilers fired with powdered coal; Jos. T. Ryerson & Sons Co., warehouse of about a million square feet devoted to machinery and steel products.

The Mahr Mfg. Co. branch office at Pittsburgh has been changed from 498 Union Arcade to 223 Oliver Building, I. L. Edwards is in charge.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-Pres. and Treas.*

6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,800 copies were printed; that of these 4,800 copies, 4,000 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 89 were mailed to advertisers, 66 were mailed to employees and correspondents, and 629 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 25,000, an average of 5,000 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

GENERAL: PAGE
- Constructing Horizontal Boiler Settings 127
- Calculating Stresses in Pressure Vessels 132
- New Method of Applying Arch Tubes 136
- Rules Governing the Inspection of Railway Stationary Boilers in Canada 137
- Foreign Trade Developments in Boiler Industry 139
- Specifications for Welding Material Adopted by American Welding Society 140
- Tapping Radial Holes in Boiler Shells 141
- Work of the A. S. M. E. Boiler Code Committee 142
- Standardization of Locomotive Boiler Staybolts 144
- Crown Sheet Failure Without an Explosion 145
- Increased Use of Oil Fired Boilers in Europe 146
- Plant Inspection Trips Scheduled for Spring Meeting of the American Society of Mechanical Engineers 146

EDITORIAL COMMENT 147

ENGINEERING SPECIALTIES FOR BOILER MAKING 148

QUESTIONS AND ANSWERS FOR BOILER MAKERS:
- Transition Piece Intersecting a Cylinder 150
- Transverse and Longitudinal Stresses in Boiler Shells 150
- Rectangular Elbow Layout 151
- Uses of Firebrick Arches in Locomotive Boilers 151

LETTERS FROM PRACTICAL BOILER MAKERS:
- Items of Interest to Boiler Makers 152
- Acid Drum Explodes 152
- Simple Layout Problem 152
- Ideas Under a Bushel 153
- Causes of Bowing in Watertube Boiler Tubes 153

PERSONALS 154

ASSOCIATIONS 155

TRADE PUBLICATIONS 155

SELECTED PATENTS FOR BOILER MAKERS 156

Standardization of boiler settings has long been the aim of the engineering departments of boiler manufacturing companies. Some of the best work in this direction has been accomplished by the Hartford Steam Boiler Inspection and Insurance Company. The results of their investigations are published elsewhere in this issue of THE BOILER MAKER. The designs suggested are primarily intended for hand fired horizontal return tubular boilers, although they may be adapted to other types. Applications of the plans to boilers with flush and overhanging fronts as well as to both the supported and suspended types are explained.

The most important consideration in the design of boiler settings is the prevention of losses due to excessive air leakage. The use of insulating material for the boiler top applied in the form of asbestos blocks held in place by mesh wire provides one of the best means for eliminating the admission of air and, at the same time, facilitates inspections and repairs to the boiler. This form of covering should be finished with plastic magnesia or other insulating cement to fill up the cracks between the blocks. For a hard, smooth finish Portland cement may be mixed with the last coat of magnesia.

After a setting is constructed and found to be tight, it is essential that inspections and tests be carried out at not infrequent intervals to be sure that the asbestos remains in place and that all joints are properly sealed. At the rear end of the boiler especially, cracks are liable to form in the covering, due to the expansion and contraction of the boiler. To prevent trouble at this point, a piece of sheet iron may be fitted over the boiler shell, bent down over the head and extended under the insulating material out over the brickwork. In the maintenance of boilers care must also be taken to prevent leaks around the blow-off pipes, firing doors, clean out doors and the like.

From the early days of the generation of steam in boilers for use in the operation of engines, the question of determining an adequate measure of boiler capacity has been continually recurring. Originally a boiler was considered part of the engine unit to which it supplied steam and since these units were used to do work generally done by horses the term horsepower became the most convenient rating. Later, when boilers were built on contracts to furnish steam for given engine powers, the term horsepower was quite naturally applied as the boiler rating.

Since all engines required approximately the same amount of steam per horsepower at this time, the application of the term to boilers was logical. In order to establish the exact measure of the horsepower unit in pounds of steam, a committee of American engineers carried out a series of tests on boilers during the Centennial Exposition of 1876. This committee decided upon the horsepower unit as equivalent to the ability of a boiler to generate 30 pounds of steam per hour at a gage pressure of 70 pounds from feed water at 100 degrees C.

However, the generation of steam has now become a more complicated function than when the boiler horsepower unit was determined. Rather than a constant steam consumption of 30 pounds per engine horsepower per hour, a range of from 10 pounds to 60 pounds is now required to operate the various types of steam engines from high efficiency turbines to small engines operating under unfavorable conditions. Whether the steam is at high or low pressure, and whether it has a high moisture content or is superheated are features that must also be considered in arriving at a measure of the capacity of a boiler.

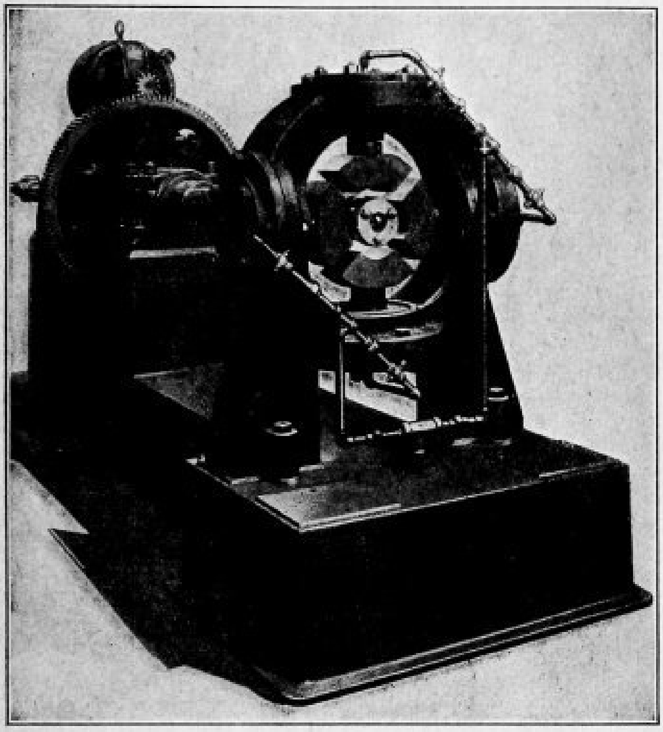
Proposals have been made to establish 1,000 British thermal units as a unit of evaporation in terms of which boiler capacities may be stated. The logic in establishing this arbitrary unit of evaporation seems open to question when the number of heat units put into the steam is the real measure of capacity. The customary rating for boilers is to consider 10 square feet of heating surface equivalent to one horsepower. The most sensible and desirable method of expressing capacity would seem to be the elimination of the term horsepower altogether and use the number of square feet of heating surface directly in designating the size of a boiler.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Universal Flue Welder

A new type of flue welder, built to meet the requirements of railroad shops, has lately been developed by the Southwark Foundry & Machine Company, Philadelphia, Pa., and is shown in the accompanying illustration. This machine



Improved Type of Flue Welder Built by the Southwark Foundry & Machine Company

embodies features essential to meet conditions that have arisen since the general adoption of the locomotive superheater. The principal feature of the machine is that it welds a flue on the inside, thus making the inside diameter of the flue at the weld the same as throughout the entire length. This method of welding is made possible by clamping the flue on the outside by four jaws or sections of a die and rolling it with an expanding and collapsible mandrel.

The clamping head of the machine is at the front and the driving mechanism at the rear. Four air cylinders are mounted in the clamping head in such a manner that the cylinder heads can be removed from the outside. The pistons are fitted with metal snap rings and the front end of each piston rod is equipped with a clamping jaw or die section. A welding mandrel which fits the inside of the flue runs through the center of the head longitudinally with the machine. The body of this mandrel is hollow and contains three tapered rollers which can be moved radially by inserting a tapered arbor that reaches through the middle of the spindle from the rear of the machine. This arbor is operated by an air cylinder controlled by means of a foot valve. A triple baffle of asbestos pressed board is furnished for deflecting the heat of the furnace from the welding head.

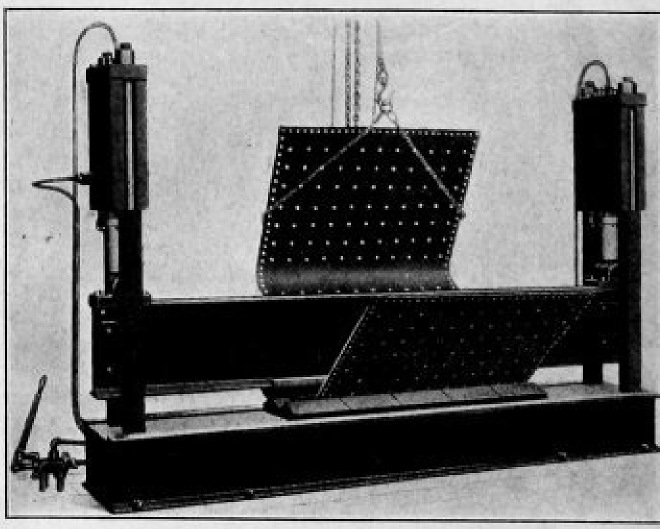
As the four clamping cylinders are connected to a single air line, they operate simultaneously with the opening of a single foot valve, which controls all operations. This valve is usually placed in front of the furnace and on the left-hand side of the machine. The timing of different operations is controlled by the piping to this foot valve, which is so arranged that the clamping head first comes in contact with the outside of the flues, then the clutch which rotates the mandrel is engaged and finally the expanding arbor is forced between the three rotating rolls in the mandrel, these rolls working the weld out against the clamping dies which also serve as an anvil. The time required for the actual rolling of a weld is from six to eight seconds. The total time for making a weld depends, of course, upon a number of factors, such as, for example, the size of the flue.

Plate Press with Sectional Dies

A plate press designed for use with sectional dies has been developed by the Houston, Stanwood & Gamble Company, Cincinnati, Ohio. The machine consists of a simple arrangement of cross-beam, connected to rams at each end by bearings, having swivel pins which give the beam flexibility and allows it to adjust itself to any unevenness of the work. The frame consists of heavy uprights, bolted through substantial cylinders at the top and bolted through a heavy reinforced base casting at the bottom. The upper sectional dies are placed on the beam of the machine in a simple manner. A bar extended through a hole in each die enables it to be lifted by two men and slipped on at the end of the beam. It is then moved along to any position which may be desired.

The lower sectional dies are placed on the bed of the machine and alined with the upper dies by means of the side channels which reinforce the bed. These side channels extend above the heavy base casting for that purpose. The operating lever for controlling both working and return stroke is conveniently located and is always within easy reach of the operator. The entire upper part of the machine is flexible to a necessary degree, which takes care of any uneven strains and stresses during the working stroke.

The operation of bending a wrapper sheet is shown in the



Sectional Dies Produce Accurate, Interchangeable Work illustration, and the press is particularly adapted for this class of work, the work possessing the added advantage of interchangeability. The machine is built in various sizes and capacities and is designed to operate by hydraulic or compressed air pressure.

New Telephone Equipment Increases Speed of Ryerson Steel Service

Joseph T. Ryerson & Son has installed new telephone equipment at the general offices in Chicago. This new equipment is known as a telephone order table and greatly improves telephone service where there is any number of calls to be received during the day.

The telephone order table consists of a long table with a signal board at one end. There are places at it for twelve steel service men, each equipped with standard telephone head set and set of keys.

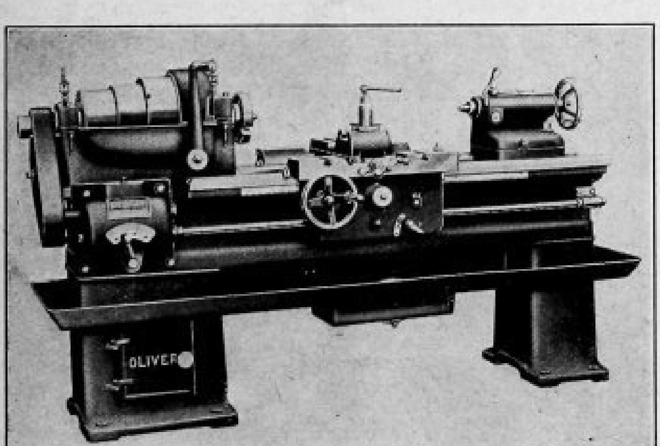
The Chicago office of the Ryerson Company has 52 trunk lines with 150 individual telephones. All calls are received through the Ryerson switchboard. The operators immediately refer all calls for the city sales desk to the telephone order table. A signal light on the pilot board flashes and buzzer sounds. The city salesmen respond by opening the listening key and are in instant communication with the caller.

Each man is provided with specification and price book and loose-leaf stock book, both of which are corrected to the minute, so that he may provide complete information regarding prices, specifications and sizes in stock without moving from his chair. If information is needed from the shipping department, a key is opened and the salesman secures the information regarding the delivery while the customer listens in on the conversation.

Simplicity Features New Oliver Lathe

After working on its design for several years, the Oliver Machinery Company, Grand Rapids, Mich., has developed a new 16-inch rapid production lathe, of which perhaps the most notable feature is its comparatively simple construction. By the elimination of more or less non-essential working parts and by strengthening the lathe at points subject to heavy working stress, a high production tool has been developed, which is now giving satisfactory service in several plants.

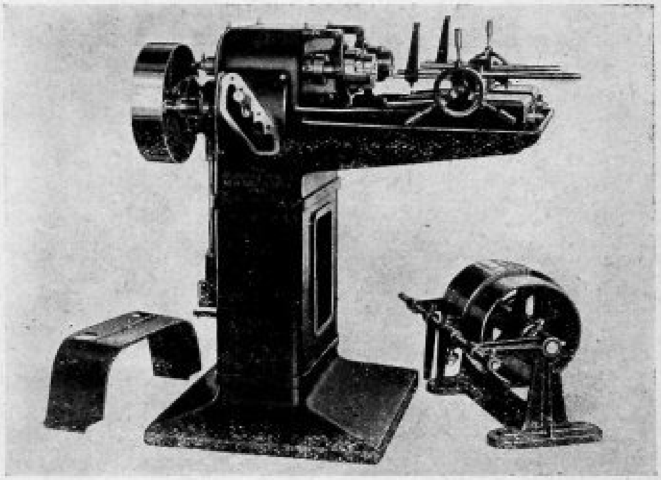
The simplest form of the lathe with a 3-step cone pulley headstock is shown in the illustration. The driving cone is large in diameter and each step of the cone is wide. This allows for a powerful drive at comparatively high speed. The large lever shown in the front of the headstock operates the starting and stopping clutch. The efficiency of this clutch and the ease of operating the lever are important elements in securing rapid production. The headstock may be furnished with double back gears or with single back gears, as desired. Four feeds are provided through the quick-change gear box. The tool post is mounted on a carriage of substantial construction, as shown. Provision is made for a continuous flow of cutting compound at the cutting point. All working parts are carefully guarded.



Oliver 16-inch Production Lathe

Double Spindle Threading Machine

A device known as the Geometric double spindle threading machine, designed primarily for threading work in which the time for both pieces is sufficient to allow the operator to chuck and start a second piece while the first is being completed, has been produced by the Geometric Tool Company, New Haven, Conn. A number of threading combinations are possible with this machine. Both spindles may be fitted with die heads for external threading only or with collapsing taps for internal threading or one spindle may carry a die head and the other a tap for handling work which requires both an external and internal thread.



Geometric Double Spindle Threading Machine

The bed of the machine consists of a substantial casting carrying two spindles which are mounted in bronze bearings. These spindles are driven by a single pulley located at the rear of the machine but can be driven independently by means of change gear levers at either side of the machine. Each carriage is fitted with a two-jawed chuck operated by a handwheel. An adjustable swinging gage on the side of the carriage provides an accurate means of setting the work for a predetermined length of thread. An adjustable stop on the triprod ahead of the carriage governs the opening of the die head and the length of the thread to be cut. Oil is forced from a reservoir through the spindles and die heads against the work by means of a single, gear pump driven from the main shaft through bevel gears. Change gear levers on the side of the machine control the spindle speeds.

The double spindle threading machine is regularly equipped with ¾ inch geometric die heads giving a cutting range ¼ inch, ⅜ inch, ½ inch, ⅝ inch, ¾ inch diameter and ⅛ inch to ½ inch standard pipe. The greatest length that can be cut at one setting of the work is 8½ inches; with re-setting a length of 14 inches may be cut.

The International Pulverized Fuel Corporation has moved its general offices to the National City Building, 17 East 42d street, New York.

The New York offices of the Franklin Railway Supply Company, Inc., are now located in the National City Building, 17 East 42d street, New York.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Transition Piece Intersecting a Cylinder

Q.—Please give me the solution for laying off the pattern of a transition piece which intersects a cylinder. B. M.

A.—The end and side view in the accompanying drawing gives a general idea of this problem. Triangulation is employed in developing the pattern, and all of the necessary

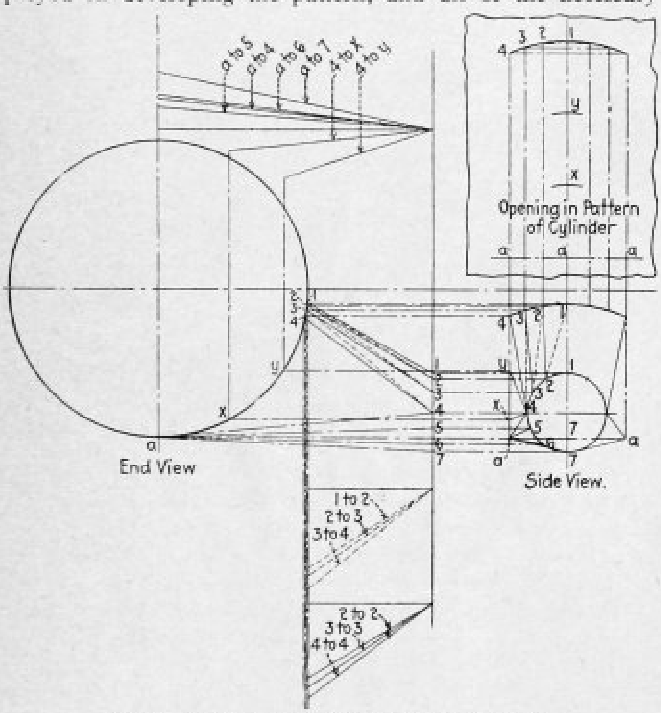


Fig. 1.—Construction Views of Transition Piece

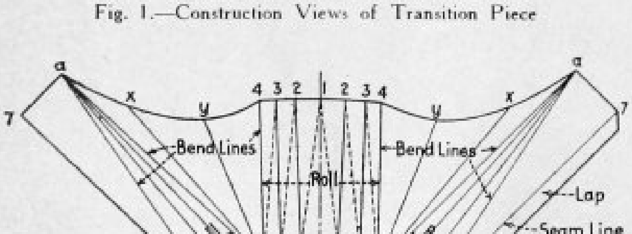


Fig. 2.—Pattern of Transition Piece

construction lines are indicated. The side view must be developed by projection so as to show the miter between the two parts. From the point 4 to *a* it is shown straight in the side view; however, this part of the joint is a curve of the cylinder from 4 to *a* end view. The outline of the miter at the top from 1 to 4 is curved and at the bottom it is straight extending from *a* to *a* side view and tangent at the point *a* of the end view. The opening into the transition piece is a circle, which is divided into a number of equal parts. The points on the base are connected with those on the circle with dotted and solid lines. Corresponding triangulation lines are laid off in the end view and from these data construct the right angled triangles. The heights for these triangles are shown projected from the end view and the bases are transferred from the side view. The hypotenuses 1-2, 2-2, 2-3, 3-3 etc., are the true lengths used in the pattern construction. As all lines of construction are identified by the same reference letter or number in the two views and pattern an explanation of the pattern development does not seem necessary.

Transverse and Longitudinal Stresses in Boiler Shells

Q.—Why is the longitudinal seam of a boiler only one-half the strength of the circumferential seam of the same kind? R. H. L.

A.—A cylindrical shell as represented in Fig. 1 (a) and (b) subjected to an internal pressure must resist two forces tending to rupture it. The force at (a) acts perpendicularly to the axis and tends to break the plate along the longitudinal plane *a-b-c-d*. The force acting in the direction of the arrows at (b) tends to rupture the shell in a transverse plane at right angles to the axis of the shell, or, in other words, in the plane of the circumferential seam.

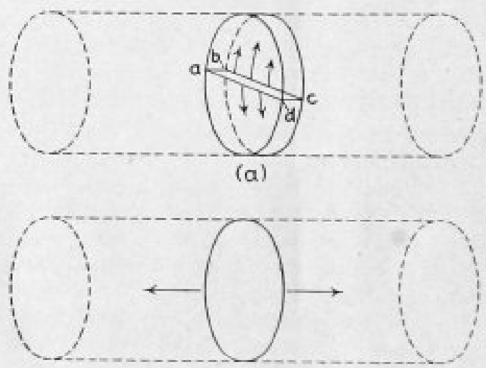


Fig. 1.—Demonstration of Stresses in Cylindrical Vessels

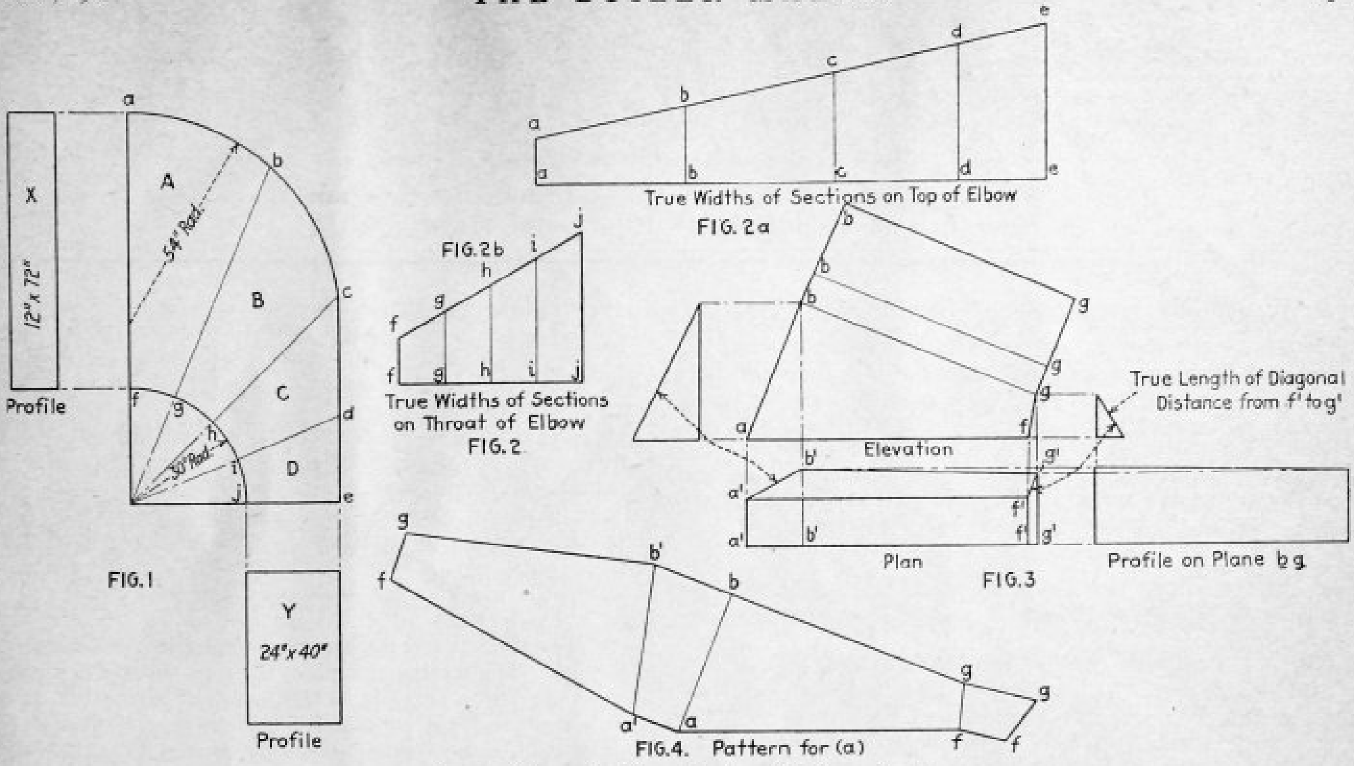
To ascertain the magnitude of the force acting as in Fig. 1 (a), consider a plate section as *a-b* and *c-d* each 1 inch wide; plate thickness equals ½ inch and diameter of shell (inside) equals 60 inches; steam pressure, 150 pounds per square inch.

Using the following formula:

$$S = \frac{Dp}{2t},$$

in which:

S = stress metal, pounds per square inch.
D = inside diameter, inches.
p = pressure, pounds per square inch.
t = thickness of metal, inches.



Layout of Irregular Elbow Having a 90-Degree Bend

Substituting values given, we have:

$$\frac{60 \times 150}{2 \times \frac{1}{2}} = 9{,}000 \text{ pounds per square inch.}$$

The magnitude of the force tending to rupture the shell transversely as shown at (b) may be ascertained by the formula:

$$S = \frac{Dp}{4t}.$$

Substituting values in the formula:

$$\frac{60 \times 150}{4 \times \frac{1}{2}} = 4{,}500 \text{ pounds per square inch.}$$

This may be better understood by figuring the stress in this way: Multiply the area of the boiler end in square inches by the pressure in pounds per square inch. This force is resisted by the tenacity of the plate whose sectional area is equal to the shell circumference multiplied by its thickness.

The magnitude of the force acting on the longitudinal plane may be ascertained by multiplying the cross-sectional area *a-b-c-d*, Fig. 1 (c), by the pressure in pounds per square inch. This force is resisted by the strength of two thicknesses of metal and its length.

Rectangular Elbow Layout

Q.—How would you lay out an irregular elbow, forming a 90-degree bend, the profile at one end being 12 inches by 72 inches and the other 24 inches by 40 inches, both being rectangular in shape? A. O.

A.—Fig. 1 being a reproduction of your problem shows the elbow in elevation and its profile. To find the widths of the elbow at the miters, *b-g*, *c-h*, *d-i*, the Fig. 2 is drawn. The line *a-e* is equal to length of the elbow at the top and is spaced as shown to correspond with the Fig. 1. From the points *a-b-c-d* and *e* erect perpendiculars to line *A-e*. At *a* set off the width of the profile *X*, which is 12 inches and from *e* make the length equal to 24 inches, the width of the profile *Y*. Connect *a-e* with a straight line, the lengths *b-b*, *c-c*, *d-d*, etc., are the widths for the top. For the throat lay off another view making *f-j* of Fig 2 equal to the length *f-j* of Fig. 1, and *f-f* equal 12 inches and *j-j* equal 40 inches.

The plan and elevation for each of the elbow sections can now be laid off. In Fig. 3 we have the two views for the section *A*. There are, as will be noted from the Fig. 3, two lines *a'-b'* and *f'-g'* shown foreshortened. Their true lengths are established by laying off two right angled triangles as shown opposite the elevation of Fig. 3. The pattern development is shown in Fig. 4, and from the arrangement of the reference letters its construction should be understood. Allowances must be made for seams.

Uses of Firebrick Arches in Locomotive Boilers

Q.—Why are firebrick arches used in locomotives? F. S.

A.—For combustion of coal gases to take place in the firebox of a locomotive boiler or in any other type, the lowest temperature required is about 1,800 degrees. In brick set boilers—that is, boilers surrounded by a brick furnace—the furnace temperature may be 2,500 to 3,000 degrees, but in locomotive types, where the furnace is inside the boiler and surrounded by water, the furnace temperature rarely rises above 2,000 degrees. The water temperature being so much less than the furnace temperature, it is evident that the gases that come in contact with the boiler heating surfaces will be cooled before the ignition point. Therefore, unless they are subsequently heated they will pass out through the chimney unconsumed. To assist in the combustion of the gases, brick arches are used where bituminous (soft) coal is burned. The arch extends from the tube plate toward the door and causes the gases to travel further, first toward the door and then over the brick arch. The arch becomes highly heated and prevents the gases from cooling before entering the tubes. Such an arch maintains heat for a long period, thereby aiding in keeping an even temperature.

The Chicago branch of the Keller Pneumatic Tool Company has been moved to larger and more up-to-date salesrooms and service station and will be located on the main floor in the Transportation Building, No. 624 South Dearborn street, Chicago, where a complete stock of tools and parts will be maintained.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Items of Interest to Boiler Makers

For locomotives operating on levels and grades up to 1½ percent inclusive, and for those coming within the following tabulated dimensions, set the lowest gage cock on the back head, as follows. (Engine must be level.)

Height of Lowest Gage Cock Above Highest Point of Crown Sheet. Inches	*Diameter of Boiler Largest Course Inches*
3	up to 53
3½	54 to 65
4	66 to 77
4½	78 and over

RADIAL STAYS

Radial stays with enlarged ends 1 inch, 1⅛ inches and 1¼ inches diameter over threads, and with bodies 13/16 inch, 15/16 inch and 1 1/16 inches are considered well proportioned for application to all classes of boilers. In other words, all radial stays with body diameters of 3/16 inch should be made less than the diameter of the upset ends. All stays over 8 inches long (outside of sheets) are to be classified as radial stays.

Rivet over the lower ends of all buttonhead stays under the crown. Except for coal burning engines use stays with buttonheads under the crown for at least six longitudinal rows. For all crown stays in Belpaire boilers, where the use of flexible expansion stays is not provided for, use stays with buttonheads.

Radial stays with buttonheads should have the threads under the heads increased in diameter by making the ends taper ½ inch in 12 inches. Holes should first be tapped through both sheets with parallel taps. The hole in the crown should be retapped with a tap, having a collar, to gage the exact diameter of the thread at the head 1/32 inch larger than the standard. Do not use buttonhead stays in oil burning boilers, but for at least six central longitudinal rows in these boilers use stays having the lower ends tapered 2 inches in 12 inches. The holes are to be tapped in the boiler in the same way as that mentioned for buttonhead stays.

Do not cut off squares on the lower end of the buttonhead stays after they are applied to the boiler. Fill the boiler with water above the highest point of the crown sheet and burn the squares off, if you wish to get rid of them. Cutting squares off has a tendency to loosen the bolts in the holes. Use flexible expansion stays riveted under the crown for the front transverse rows of all boilers with the first ring under 60 inches in diameter. They may also be used for the three front transverse rows of boilers with the first ring over 60 inches inside diameter.

The distance from the center line of the rivets in the firebox, tube and door sheets to the center of the first, and last rows of radial or crown stays should not be less than 3 inches. Crown stay spacing should be in accordance with the following table:

RADIAL STAYS

Diameter, Inches		Area Body	Limiting Load at Stress of
Body	Ends	Square Inches	4,500 Lbs.
13/16	1	.5185	2,333
15/16	1⅛	.6903	3,107
1/1-16	1¼	.8866	3,990

Allowable Pressure in Pounds on Area of				
22 Sq. Ins.	20 Sq. Ins.	18 Sq. Ins.	16 Sq. Ins.	14 Sq. Ins.
109	120	133	151	173
146	161	179	203	233
189	209	233	264	304

The following permissible stresses should be considered in the interest of safety: Shell and external firebox require a factor of safety of 4½, assuming the minimum tensile strength or stress of 5,500 pounds, taking the area at the minimum efficiency of the seams; staybolts have a tensile strength or stress of 5,500 pounds taking the area at the smallest section, which is the root of the thread; crown stays have a tensile stress of 4,500 pounds, taking the area at the smallest section and figuring the support at the lower end of the bolt. The tensile strength of the rods and rivets securing the angle iron brace is 8,000 pounds, figuring the supported area, and not considering the stiffness of the plate. Pins in double shear give 6,000 pounds and those bearing pressure 12,000 pounds. The feet for the braces to the back head and front tube sheet should be distributed so as not to concentrate the stress on any one section. Usually the diagonal should be at an angle of 10 or 12 degrees. The increased stress due to the diagonal brace need not be considered when the angle does not exceed 15 degrees.

Pittsburgh, Pa. GEORGE L. PRICE.

Acid Drum Explodes

While repairing acid drums at the Mount Lyell Chemical Works, Melbourne, Australia, recently, a boiler maker was killed instantly through one of the drums exploding. A number of mild steel drums, each 2 feet 4 inches by 1 foot 10 inches are used as containers of acids made at the works. Several had been returned to the factory as empty to be put in condition for future use.

The boiler maker doing the work had repaired six employing the oxy-acetylene welding process. While he was engaged with the seventh an explosion occurred. The top of the drum was blown off as the boiler maker was bending over the vessel. The end was driven out with such force that as it struck the unfortunate man it carried away half of his head. The obvious explanation is that a quantity of acid must have been left in the drum, which was supposed to have been empty, and all outlets being closed the heat of the oxy-acetylene flame raised the acid gas to a pressure exceeding the elastic limit of the vessel.

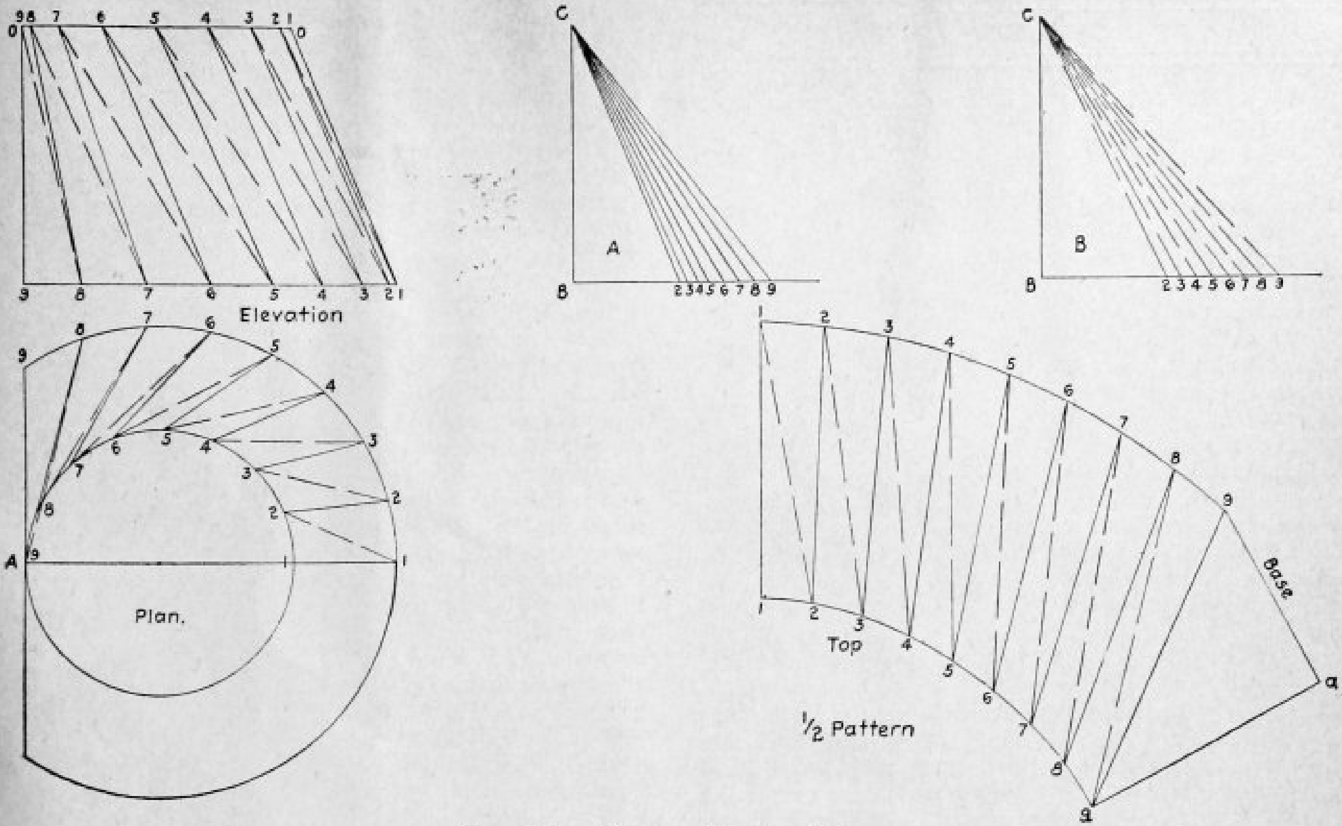
Melbourne, Australia. F. T. T.

Simple Layout Problem

Set up the plan and elevation of the accompanying transition piece. Divide the plan (top) into eight equal spaces, also between the points 1 to 9 of the base, and project to the elevation.

Now set off two right angles *A* and *B* and locate the points *B* and *C*, making them equal to the heights 9-9. From the points *B* set off the points 2-3-4-5-6-7-8-9, taking them from the plan as 1-1, 2-2, etc., to obtain the solid lines, and 1-2, 2-3 to obtain the dotted lines.

Having now obtained the true lengths of the elements, we will proceed to develop the pattern. Set off the line 1-1 from



General Layout for Transition Piece Problem

the elevation, as this line shows in its true length, and with the dividers set with a radius equal to the arcs of the top and base describe the arcs 2. Now with the true length of the dotted line 1-2 and from the point 1 as a center describe the arc intersecting the arc already described, and at the point draw dotted line 1-2. Now with the true length of line 2-2 and with point 2 as a center describe an arc intersecting the arc already described and connect with a solid line.

Proceed in this manner until the points 9-9 are reached, then describe an arc with a radius 9-*A* of the plan, and from point 9 of the top and a radius 9-9 of the elevation describe an arc intersecting the arc already described and connect lines, thus obtaining one-half of the pattern.

Olean, N. Y. CHARLES W. CARTER, JR.

Ideas Under a Bushel

For some reason or other the natural tendency seems to be "keep mum about trade kinks." When a worker, foreman or anyone else discovers an easier way to do something he hastily looks around to see whether or not anybody saw him do it in the newer or better way. He thinks to himself, "This idea is too valuable to reveal to others. I'll keep it to myself, and it may help me some time." He therefore does keep it to himself and continues to do the work the "old" way because the "new" way is his secret, and he fears somebody will steal his idea from him. The longer he keeps it the more valuable it seems to him. He never lets go of it, and perhaps lives to see someone else discover the same trick. The "other fellow" tells about it in the technical or trade papers and forges rapidly to the front.

Ideas are valuable, true enough, but they are of no value whatsoever if they are not used. If an idea is good and is patentable, and seems to be worth patenting, the thing to do is to take out a patent.

A friend of mine explained it to me in this way not long ago. He said, "Let us trade dimes. You give me a dime for one of my dimes." We traded. Then he said, "We haven't progressed a bit. You are no richer than you were before." I agreed with him. "Now," he said, "let's trade ideas. You tell me how to rearrange my belting system to save power and I'll tell you how money can be saved on lubricants." I agreed, and we traded ideas. The progressive man isn't afraid to tell what he knows or ask questions about what he doesn't know. He doesn't keep his candle under a bushel.

Brooklyn, N. Y. W. F. SCHAPHORST.

Causes of Bowing in Watertube Boiler Tubes

What explanation can be given for the tubes of watertube boilers bowing sometimes upward and sometimes downwards? I have given this some thought and am under the impression that the trouble is caused from overheating due to incrustation over a considerable length of the tube. The underside of the tube is then somewhat lengthened due to expansion, which causes the scale to crack and the water to come in contact with the metal, when contraction takes place due to the cooling effect of the water. The unequal expansion and contraction of the under and upper surfaces of the tube then cause the tube to bow upwards. When an oily or muddy accumulation or a combination of foreign matters is deposited in the tube, it will possibly bow downwards, as this accumulation can be elastic and will not crack in places to allow a cooling effect on tube by the water reaching the metal. I would like to have readers of THE BOILER MAKER discuss this question.

Omaha, Neb. WILLIAM SVATOS.

John Hyland, formerly in the railway supply business at Chicago, is now located at Atlanta, Ga., representing the Edgewater Steel Company, Pittsburgh, Pa., the Joliet Railway Supply Company, Burry Railway Supply Company, De-Remer-Blatchford Company, G. S. Wood Company and the Economy Torch Company, all of Chicago.

PERSONALS

W. J. Murphy, division boiler maker foreman of the Pennsylvania System, Pittsburgh, Pa., was born at Cresson Springs, January, 1878, and received his education in the public schools of Altoona. He also studied in the Scranton Mechanical School. He began his practical experience in the Altoona Shops of the Pennsylvania Railroad, where he served as an apprentice and as a journeyman boiler maker. He was later appointed instructor and traveling boiler inspector. Later he held the position of boiler foreman in charge of outside work for the James Morrison Boiler Works, Pittsburgh, and after leaving here became general foreman for the Pressed Steel Car Works, Pittsburgh. In 1903, he returned to the Pennsylvania Railroad, Lines West, as assistant boiler maker foreman at the North Side Pittsburgh Shops, and in 1911 was appointed division boiler maker foreman with the same company. Mr. Murphy has served on various special committees investigating boiler explosions and has written a number of papers on boiler practice. At present he is a member of the executive board of the Master Boiler Makers' Association and also of various associations in Pittsburgh, and an officer in the Railway Club of that city.

W. J. Murphy

George Austin, general boiler inspector, Atchison, Topeka & Santa Fe Railway, was born in England, June 26, 1855, and came to this country two years later and settled in Paterson, N. J., where he received his early education. His first practical experience was in the Rogers Locomotive Works in 1871, and shortly after in the Baldwin Locomotive Works. In 1875 he moved to Logansport, Ind., and worked in the boiler shop of the Pittsburgh, Cincinnati & St. Louis Railroad. For the next three years he served as a fireman on the road, but returned to the shops to complete his training in boiler work, in which he has been engaged ever since. In 1889 he moved to Brainard, Minn., and worked for the Great Northern Railroad until 1903, when he was transferred to Manden, North Dakota, as boiler foreman. At this place he commenced the study of the prevention of locomotive boiler repairs by properly maintaining engines in bad water districts and carried through many investigations for the railroad in this connection. He has written a great many articles on the maintenance of locomotive boilers for various publications, especially on blowing out and washing out systems. In 1902 he accepted the position of division foreman with the Santa Fe system, Oklahoma Division, and early in 1903 was given the work of standardizing the maintenance of boilers on this road. About 1906 he was appointed general boiler inspector of the Santa Fe system, and has continued in that position ever since. Mr. Austin took an active part in the enactment of the Federal Boiler Inspection Law in 1911. He is a member of the present Executive Board of the Master Boiler Makers' Association.

George Austin

Thomas F. Powers, system general boiler foreman of the Canadian and Northwest Railway, with headquarters at Chicago, was born October 20, 1882, at Winona, Minn. He was educated in the public schools of that city and commenced work in the Canadian and Northwest Railway boiler shops in 1899 as an apprentice. He worked in this capacity and as a journeyman for the same company at Winona and Tracy, Minn., and Huron, South Dakota. From June, 1907 to April, 1908, he was with the Duluth, South Shore and Atlantic Railroad as a journeyman at Marquette, Mich., but returned to the former company in May, 1908. The following year he was promoted to the position of foreman boiler maker at Chadron, Neb., and held this position until 1911, when he was promoted to his present position in charge of all boiler work on the Northwest system. Mr. Powers has been a member of the Master Boiler Makers' Association since 1910, and in 1914 was elected to membership on the Executive Board and served on this Board until 1920, being its chairman from 1917 to 1920. At the convention of 1920, held in Minneapolis, he was elected fifth vice-president. He has been chairman of various investigating committees in this association, at present holding this position on a special committee carrying out a complete survey of the autogenous welding practice of the large railroad systems of the country.

Thomas J. Powers

Frank N. Satter has resigned from the Youngstown Sheet & Tube Co., Youngstown, Ohio, to become chief inspector for the Newton Steel Co., Newton Falls, Ohio.

F. J. McCarty has resigned as general foreman of the socket shop, Youngstown Sheet & Tube Co., Youngstown, Ohio, to become president of the Federal Iron Works of Youngstown. He was with the sheet and tube company for 19 years.

Frank C. Whitney has resigned as Advertising Manager for Davis-Bournonville Company, Jersey City, after eleven years' service with that company in the oxy-acetylene apparatus field. He was also sales manager during the years 1914-1920.

H. G. Barbee, formerly in charge of Eastern railroad sales of the Chicago Pneumatic Tool Co., has been appointed manager of railroad sales, with headquarters in the Chicago Pneumatic Building, 6 East Forty-fourth Street, New York, as in the past.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; A. G. Pratt, Babcock and Wilcox Company, Bayonne, N. J.; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio.; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

ELLISON HARDENED BODY CHUCK.—A folder giving a complete description of Ellison hardened body drill chucks has been sent out by the E. Horton & Son Company, Windsor Locks, Conn.

WAGER BRIDGE WALL.—The description and application of furnace bridge walls manufactured by the Wager Furnace Bridge Wall Company, Inc., New York, has just been issued. Typical installations of the bridge wall are shown in Scotch marine boilers and marine watertube boilers.

C-H IRON CLAD SOLENOIDS.—Complete specifications and uses of iron clad solenoids produced by the Cutler-Hammer Manufacturing Co., Milwaukee, Wis., are outlined in this pamphlet. These solenoids are adapted for operating brakes used in connection with crane, elevator and hoist motors.

SUPERHEATERS.—Bulletin T-7, outlining the advantages of superheated steam in power plants, is being distributed by the Superheater Company, New York. The executives of companies generating power from fuel will find the information contained on the applications of superheaters to all manner of plants particularly useful.

FORCED DRAUGHT.—In Bulletin A-2, the James Howden & Company of America, Inc., Wellsville, N. Y., emphasizes the importance of the correct arrangement of forced draught systems and the necessity of care in the selection of equipment. General specifications for the complete Howden system are given.

ELECTRIC ARC WELDING ACCESSORIES.—Welding helmets and goggles, welding sand blast equipment, electrode holders and various other devices for use in the electric welding industry, are described and illustrated in a pamphlet issued by the Transportation Engineering Corporation, New York. A special section of the pamphlet is devoted to the application of coated electrodes in welding work.

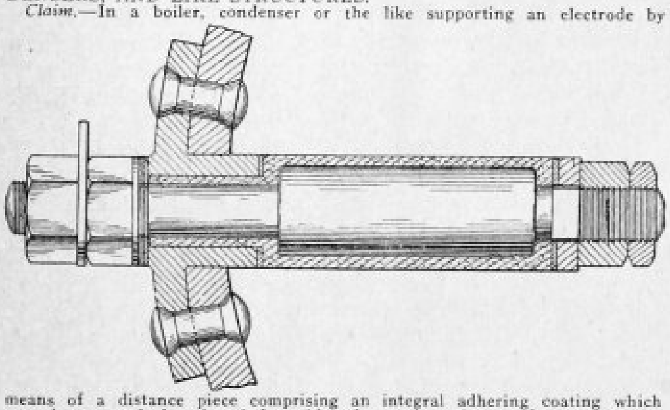
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D .C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,366,257. MEANS FOR MOUNTING ELECTRODES EMPLOYED IN THE PREVENTION OF CORROSION IN STEAM BOILERS, CONDENSERS, AND LIKE STRUCTURES.

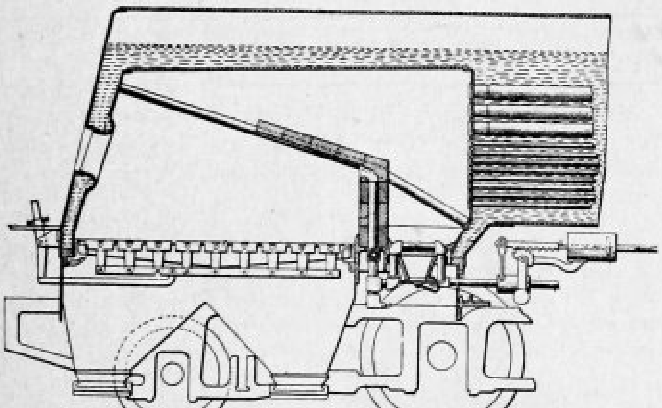
Claim.—In a boiler, condenser or the like supporting an electrode by



means of a distance piece comprising an integral adhering coating which contains one of the phenol formaldehyde condensation products as an ingredient substantially as and for the purposes described. Five claims.

1,369,105. LOCOMOTIVE-FIREBOX. RALEIGH J. HIMMELRIGHT, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

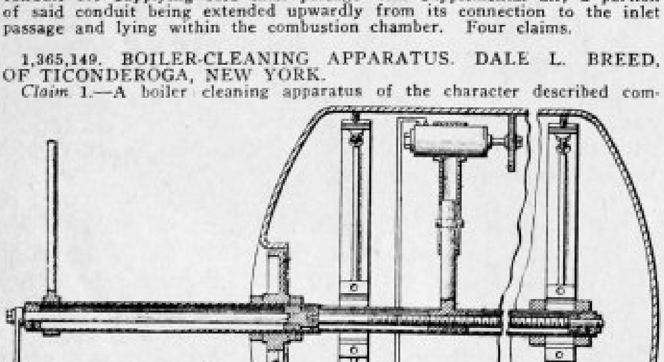
Claim 1.—The combination with a locomotive firebox having a trans-



verse bridge wall or baffle to the rear of the flue sheet dividing the fire box into a combustion chamber and a fire chamber, of an air inlet passage extending upwardly from the atmosphere through the bridge wall, and a conduit for supplying said inlet passage with supplemental air, a portion of said conduit being extended upwardly from its connection to the inlet passage and lying within the combustion chamber. Four claims.

1,365,149. BOILER-CLEANING APPARATUS. DALE L. BREED, OF TICONDEROGA, NEW YORK.

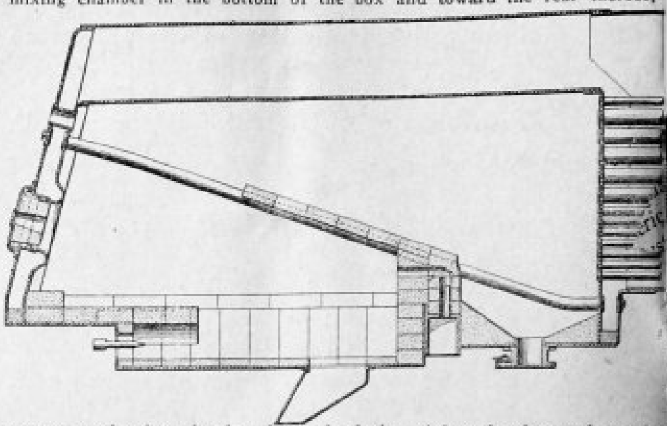
Claim 1.—A boiler cleaning apparatus of the character described com-



prising a rotatable shaft, an abrading member carried by said shaft and mounted to travel in an orbit around the latter, means for causing the abrading member to travel in a line parallel with said shaft, and means for imparting rotations to said abrading member independently of the rotations of said shaft. Eleven claims.

1,369,077. OIL-BURNING-LOCOMOTIVE FIREBOX. GUY M. BEAN, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO AMERICAN ARCH COMPANY, A CORPORATION OF DELAWARE.

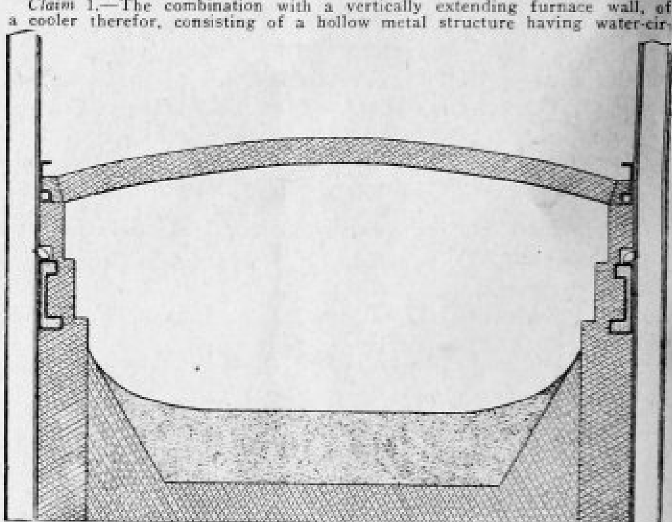
Claim 1.—In an oil oil burning locomotive firebox, the combination of mixing chamber in the bottom of the box and toward the rear thereof,



narrow combustion chamber forward of the mixing chamber and opening therefrom, and a wide combustion chamber located above and in open communication with the narrow combustion chamber and having its upper side formed of refractory arch bricks, and circulation tubes for supporting the arch. Eight claims.

1,371,906. WATER-COOLER FOR FURNACES. LUTHER L. KNOX, OF BELLEVUE, PENNSYLVANIA, ASSIGNOR TO BLAW-KNOX COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

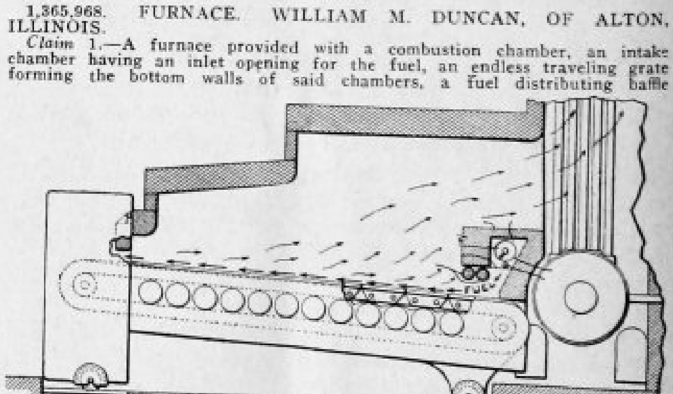
Claim 1.—The combination with a vertically extending furnace wall, of a cooler therefor, consisting of a hollow metal structure having water-cir-



culating connections, and set into the outer portion of the said wall, said structure having a substantially flat outer surface, but having a plurality of hollow horizontally extending ribs projecting from its inner surface into the body of the wall, and receiving portions of the wall between them, substantially as described. Three claims.

1,365,968. FURNACE. WILLIAM M. DUNCAN, OF ALTON, ILLINOIS.

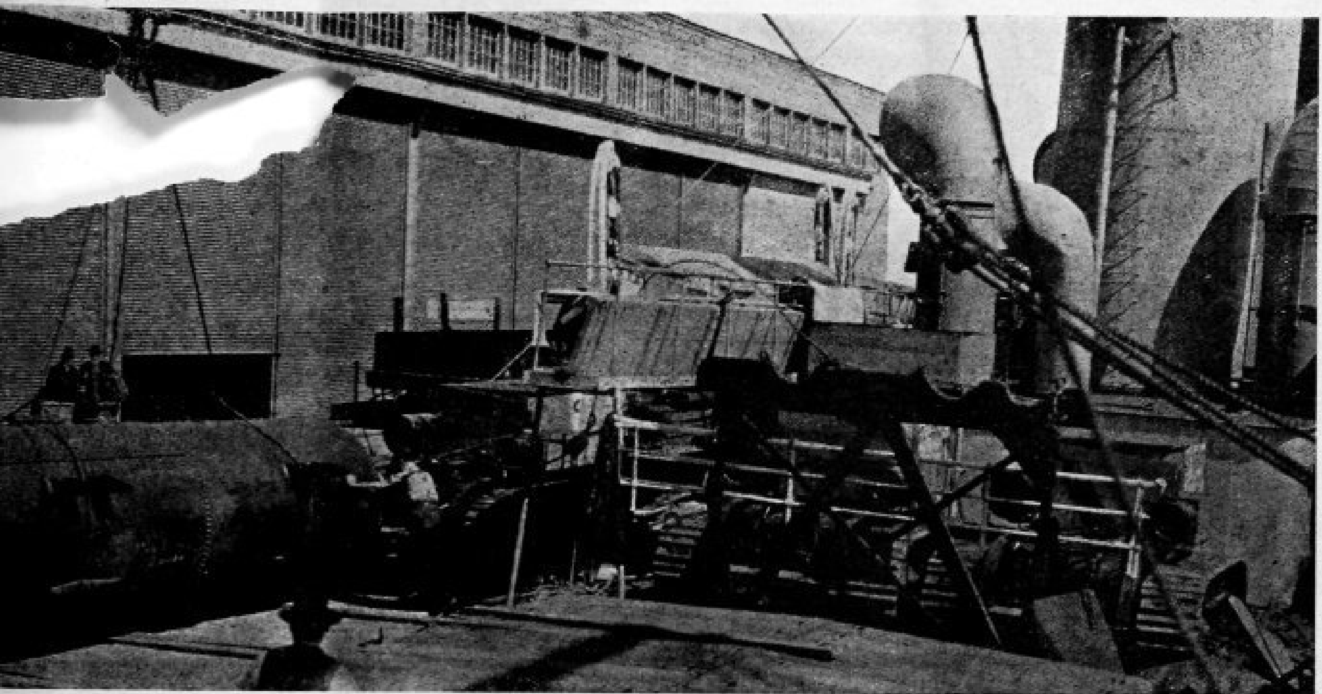
Claim 1.—A furnace provided with a combustion chamber, an intake chamber having an inlet opening for the fuel, an endless traveling grate forming the bottom walls of said chambers, a fuel distributing baffle



arranged transversely of said traveling grate and located above the grate in a line between said chambers so as to lie above and distribute the fuel passing from said intake chamber to said combustion chamber, means for delivering fuel to said inlet opening, and fuel projecting means comprising a blast device located below the discharge end of said delivery means whereby the incoming fuel is projected across the traveling grate in said intake chamber. Four claims.

THE BOILER MAKER

JUNE, 1921



Stowing Boilers on Deck of a Vessel in San Francisco for shipment to the Hawaiian Islands

·xpanding American Boiler Trade in the Orient

BY CHARLES W. GEIGER

The demand for power equipment and machinery in South American countries and in Africa is a more or less definitely known quantity, but the opportunities for building up the manufacturing industries in the islands of the Pacific and in the Oriental countries bordering the Pacific are not so well understood. Capital is being interested in the extensive construction of oil refineries, canning factories, paper mills and the like—all of which require boilers for power, cooking or other processes. The following article indicates a few of the industrial organizations in these regions that will have to be supplied with boilers and power machinery in increasing quantities to keep pace with their development during the next few years.

)IL producing countries, fruit growing regions and mining districts in the islands of the Pacific and in Aus-lia have begun the extensive development of manufacturing l refining facilities for these products, with a consequent owth in the demand for power generating equipment, es-cially boilers. The advantages of converting raw materials o finished products before shipment became apparent to producers of the Oriental and island countries when it s impossible for them to obtain sufficient tonnage to handle but the most needed supplies during the war period.

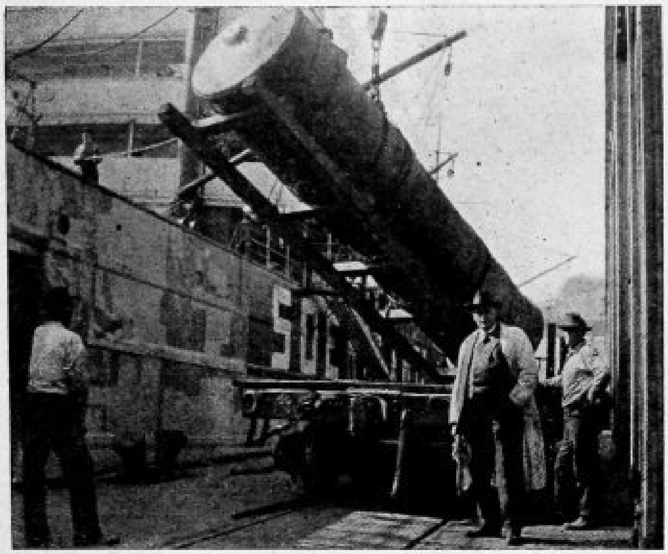
Plans were gradually developed by the more progressive ns to export their products in the finished state as soon as nufacturing equipment could be obtained. As a result airly steady stream of oil refining and sugar refining ma-nery, canning machinery and the like has been handled ough the port of San Francisco during the past two years. hough natural water power is available in certain coun-s, especially in the Philippine Islands, the greatest part of machinery requires steam for motive power, and boilers e formed a good part of our equipment exports.

In the Hawaiian Islands, for example, the Pauwela Pineapple Company was one of the first fruit growing concerns to realize the necessity of utilizing modern canning machinery for converting products before shipment, and to this end equipped an up-to-date factory at Honolulu. This plant, although more or less of an experiment, has an installation of three 150-horsepower horizontal return tubular boilers to supply steam for power and for cooking. These boilers are 72 inches diameter and 18 feet long, designed for a working pressure of 150 pounds and built to A. S. M. E. code standards.

Facilities for Handling and Shipping Boilers in San Francisco

These boilers, as, in fact, most of the machine equipment for the Hawaiian Islands, were carried by the Matson Navigation Company of San Francisco. The procedure followed in preparing boilers for shipment is to shunt the flat cars on which they are brought from the fabricating plant to sidings at the head of the dock, where they remain until the ship intended to carry them has discharged her cargo and practically completed the storage of her outbound load. Then the boilers or any other heavy machinery to be shipped are swung directly from the cars to the deck by means of the ship's tackle. Brace bars and cradles arranged on the deck serve to hold the equipment solidly through any weather that the ship might encounter on her voyage. The Matson Company maintains frequent service with the islands and provides a rapid and safe means of delivery for boilers. Other ports and steamship lines, however, on the Pacific coast are equipped for this service as well.

About 6,000,000 cases of pineapples are canned yearly in the Hawaiian Islands, and still the demand for this fruit is greater than the supply, so that many additional canneries are now being built. Practically all of the imports to these



Boiler Lashed to Shipping Cradle Being Swung Aboard a Freighter of the Matson Navigation Company

islands are from America, so the expansion of this industry will mean that the necessary machinery and boilers will be bought in the United States. Business men in the Hawaiian Islands are most favorable to American firms, and many companies maintain branch offices in San Francisco through which all their business in this country is carried on, both the selling of their products and the purchasing of equipment.

Hawaiian pineapple canners have so perfected their method of packing that their standard practice is being adopted by other canners throughout the countries of the Orient. In the Philippines quantities of pineapples are raised (although they are smaller in size than the Hawaiian fruit), and capital has been interested in erecting numerous canning plants in this country.

There is every reason why American concerns should go after this business in the Philippines, for the market is practically a domestic one; there is no barrier of language to hamper; the question of exchange rates is negligible; the market is open, friendly and altogether agreeable to American concerns. Recent activities, both in governmental and private commercial circles, indicate the intention of both to foster a close trade relationship between the countries. Mention may be made of the proposed port improvements and freight zone for the city of Manila, in which the outstanding end in view is to attract to the islands the bulk of American exports. During the year 1920 approximately $11,000,000 worth of machinery was imported to the islands, and this figure will be surpassed during the coming year. It is a fact that with the restoration to normal conditions generally, and particularly the economic awakening throughout this part of the world, the Philippine Islands offer an excellent field of expansion for American goods, especially machinery and boilers.

Government Canning Plants in Australia

Pineapples are raised in quantities in the state of Queensland, Australia. One pineapple cannery was built and equipped by the Commonwealth government about two years ago, the machinery being supplied by a San Francisco firm. This plant was so successful that five more canneries have been built in this region and others are contemplated. All of them were supplied with equipment by Am[illegible] A great deal of the mining machinery used in Au[illegible] imported from the United States.

In the Federated Malay States canning plan[illegible] operated by native help for many years, but the proc[illegible] not compare favorably with Hawaiian and Philippine methods of packing. In view of this fact, several large importing firms in Singapore have secured capital for erecting modern plants.

Field for New Boilers in Java

Throughout the oil regions of the Dutch East Indies American equipment is used in the refineries. The Java Pacific Line maintains frequent sailings from San Francisco to the ports of the Dutch East Indies, and so most of the machinery and boilers for the oil fields are shipped through this port.

Boilers for generating steam for the cocoanut oil mills are shipped to the various copra producing countries in the Orient. Formerly the raw copra was shipped to the United States and Europe, where it was made into cocoanut oil. Recently the advantages of shipping finished oil became apparent and firms interested in the industry commenced the establishment of mills in the Philippines and Dutch East Indies. Oil is now shipped to the United States in tank steamers, in barrels and in small size cans. The latter are used where bulk cargo carriers only are available. The cocoanut oil mill machinery in the Philippines is practically all driven by motors, so that boilers in this industry have been required both for power and heating and for reducing processes in connection with the manufacture of the oil. Internally fired boilers have been used largely in this work.

Storage Tanks Used at Mills

Numerous storage tanks are also needed for the oil mills, and at the present time there are forty-six of these mills operating, each one of which has storage space enough to hold its output until the complete cargo for an ordinary-sized tank ship has been produced. Plates for these tanks are cut and drilled at the mill and shipped through San Francisco for fabrication at their destination. On arrival at the islands the plates are set up and riveted. Water storage tanks in numbers are also shipped through San Francisco to Oriental countries.

The cocoanut oil industry in Java has also created a demand for storage tanks in this country. It is the usual practice in Java to build the cocoanut oil mills in the interior and then to transport the oil to the seaports, where it is pumped into double bottoms and ballast tanks of steamers sailing for San Francisco. For the purpose of handling the oil at the seaports until the arrival of a steamer, steel storage tanks of large size are constructed on the docks.

Government Examinations for Boiler Inspectors

The United States Civil Service Commission, Washington, D. C., announces open competitive examinations for the position of local and assistant inspector of boilers on July 6 and 7, 1921, in all the principal cities of the country. All citizens of the United States who meet the requirements may enter these examinations. Information may be obtained of the requirements from the local postoffices or customs offices.

Saving Fuel With Exhaust Steam Injectors

BY CLARENCE ROBERTS

The exhaust steam injector is used for boiler feeding on a great many locomotives in England and the British Colonies, and to some extent in France. In these countries it is claimed that a fuel saving of ten percent has been effected by the use of this device. A description of the injector and details of its operation are given in the following article.

THE exhaust steam injector has not been extensively adopted in this country for boiler feeding, although the 4,000 locomotives equipped with the device in England and her colonies have averaged a fuel saving of 10 percent since they have been in use.

The writer has ridden on English and French locomotives running on railroads in France equipped with exhaust steam injectors, and has observed that they were operated with the same facility as the live steam injector, evidently giving no more trouble than the latter. The engine crews seemed to like and take interest in them, operating them on all occasions practicable in preference to live steam injectors. Operating officials spoke favorably of this type of injector and said that its operation was quite as simple as the live steam injector and maintenance costs were little or no greater. A motive power official of the Northern Railway (France) said his road a few years ago built some very heavy 4-6-4 type suburban locomotives which were over-cylindered and consequently bad steamers. They were afterward equipped with exhaust steam injectors which so improved their steaming performances that they made too much steam even after enlarging the exhaust nozzle openings.

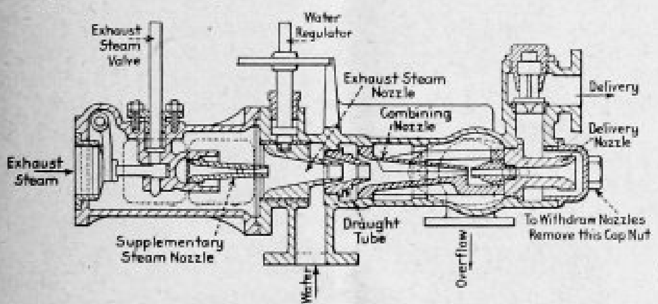


Fig. 1.—Exhaust Injector and Valve

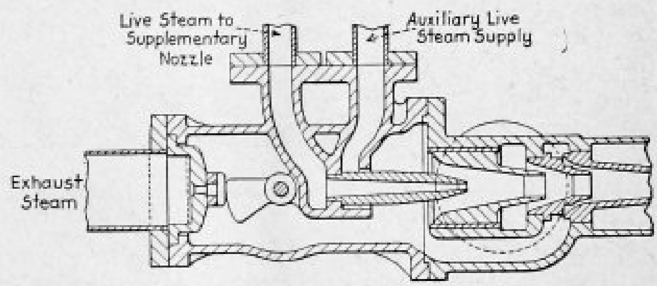


Fig. 2.—Automatic Exhaust Valve

The exhaust steam injector was invented in England about the year 1876, and the early types when working with steam at atmospheric pressure were capable of feeding against boiler pressures up to 70 pounds per square inch. Since its invention it has been improved so that now it is as reliable as the modern live steam injector for locomotive boiler feeding. The latest types present several new and important features and represent a very great advance over all previous types. They restart automatically, and when working with exhaust steam at atmospheric pressure are capable of delivering against a pressure of 120 pounds per square inch. With the addition of a small supplementary live steam jet the exhaust injector can feed against pressures up to 300 pounds per square inch. An auxiliary steam nozzle is provided for use when the locomotive is not using steam.

Principle of Operation

Few persons in this country have ever heard of the exhaust steam injector. To those who have read of it, it seems more or less of a mystery and contrary to all accepted principles that exhaust steam at atmospheric pressure should be able to force about ten times its own weight of water into a boiler under pressure. This seeming paradox, however, is easily explained when the action of the exhaust steam on the water is considered, for the same principles are involved as with the live steam injector, that is, a jet of steam moving at high velocity is condensed by a body of water moving at a low velocity, the momentum of the steam jet being transferred to the water, producing a combined jet moving with a resultant velocity sufficient to overcome the boiler pressure. While exhaust steam at atmospheric pressure has no velocity relative to the atmosphere, yet if it is allowed to issue into a vacuum it has a very high velocity; the velocity of exhaust steam at atmospheric pressure flowing into a perfect vacuum is more than 2,000 feet per second.

It is well known that when steam is condensed a vacuum is created, the degree of which is dependent upon the temperature of the water of condensation. In the exhaust steam injector a very high degree of vacuum is obtained by the condensation of the exhaust steam by the feed water in the combining nozzle of the injector. The highest vacuum is at the point of the steam nozzle where the steam and water meet. A vacuum of 24 to 26 inches of mercury is obtained, so that the exhaust steam flows in at an exceedingly high velocity. It there meets the feed water, and, being condensed by it, gives up its momentum to the combined jet, which then flows along the combining nozzle, where complete condensation takes place. The jet leaves the end of the combining nozzle at a velocity which is sufficiently high to carry it forward through the delivery nozzle and into the boiler. It will thus be seen the working of the injector is not dependent on steam being supplied under pressure, as is so often supposed, the sole determining factor being the steam velocity.

A sectional view of the double jet type injector is shown in Fig. 1. This comprises a casing containing the various nozzles and also branches for the delivery, overflow and water pipes. The nozzles consist of the exhaust steam nozzle, draft tube, combining or flap nozzle and delivery nozzle, while in the exhaust valve casing is fixed the supplementary steam nozzle which projects into the exhaust steam nozzle. The exhaust steam entering the injector passes into the main central exhaust steam nozzle, at the mouth of which it meets the feed water. Condensation immediately takes place, a very high degree of vacuum being formed, and the combined jet flows forward at a high velocity through the draft tube into the combining nozzle. The region of high vacuum extends to the entrance of the combining nozzle, and at this point a second supply of exhaust steam is admitted, which, flowing in at a very high velocity, impinges on and is condensed by the combined jet, imparting to it a further supply of energy, so increasing its velocity. After passing through the combining nozzle, the jet enters the delivery nozzle, where its velocity is reduced, the kinetic energy being changed into pressure energy, and leaving the injector the water passes into the boiler. This type differs from the live steam injector in having a steam inlet nozzle of a much larger cross-sectional area than that of a live steam injector of similar capacity, this being necessary to provide for the large volume of exhaust steam which must be passed.

An enlarged sectional view of the automatic exhaust valve is shown in Fig. 2. This governs the supply of exhaust steam to the injector, acts as a check valve when operating the injector with auxiliary steam when the engine is standing or running with steam shut off, and enables it to start automatically if the jet is in any way broken. As before stated, the exhaust steam alone develops a pressure of 120 pounds, and for higher pressures a small jet of live steam is introduced through the supplementary nozzle. The steam supply for this nozzle is obtained through the passage of the exhaust valve casing shown in Fig. 2, from a pipe connected to a supplementary steam valve on the boiler. The small jet of steam introduced through this nozzle gives the additional pressure required to feed the boiler. Water regulation is effected by varying the area for the entrance of water into the nozzles, by moving the exhaust steam nozzle to and fro, so that the surrounding area between the end of the exhaust nozzle and the draft tube is varied, and consequently the quantity of water entering is regulated according to the amount required. When necessary to work the injector as a live steam injector (when the locomotive is not using steam), a supply of live steam is introduced into the automatic exhaust valve casing through the auxiliary steam branch, entering the injector at the annular nozzle surrounding the supplementary nozzle. This supply flows into the exhaust steam nozzles, replacing the exhaust steam, and the injector works exactly as when exhaust steam is used, being as reliable and simple an instrument as any live steam injector, and equally prompt in starting and certain in action.

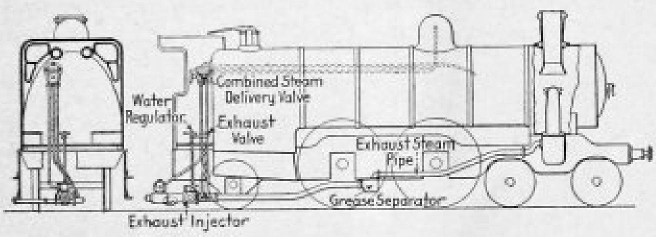


Fig. 3.—Arrangement of the Exhaust Injector on the Locomotive

The exhaust steam injector is capable of delivering against pressures as shown on the following table:

EXHAUST STEAM PRESSURE Pounds per Square Inch	DELIVERY PRESSURE Pounds per Square Inch
1	120
5	150
10	180
15	210
Atmospheric pressure augmented by small jet of live steam from supplementary nozzle	300

In Fig. 3 is shown the method of applying this apparatus on a British type of locomotive. This is diagrammatic only and can be modified to meet the requirements of design of any type of locomotive. A grease trap is necessary in the exhaust pipe. The size of injector known as No. 13, having a 4½-inch exhaust pipe and 2¼-inch delivery pipe, has a capacity of 3,800 gallons of water per hour using exhaust steam in connection with the supplementary jet.

In their efforts to increase the operating capacity and efficiency of the steam locomotive in America, railroad men seem to have overlooked or not realized the importance of the exhaust steam injector as a heat-saving appliance, for it should not only prove decidedly more efficient than the live steam injector, but everything considered should be comparable with the feed water heater in point of economy.

EFFICIENCY OF INJECTOR

For boiler feeding the injector has practically one hundred percent thermal efficiency and its first cost and cost of maintenance is less than a boiler feed pump, though the live steam injector is not the most economical means for feeding a boiler if waste or exhaust steam is available and can be utilized for heating the feed water, but we must not lose sight of the fact that in feed water heating economy comes only from utilizing heat that is now going to waste, for it cannot be considered a saving to utilize the exhaust steam from an appliance that replaces the injector for boiler feeding.

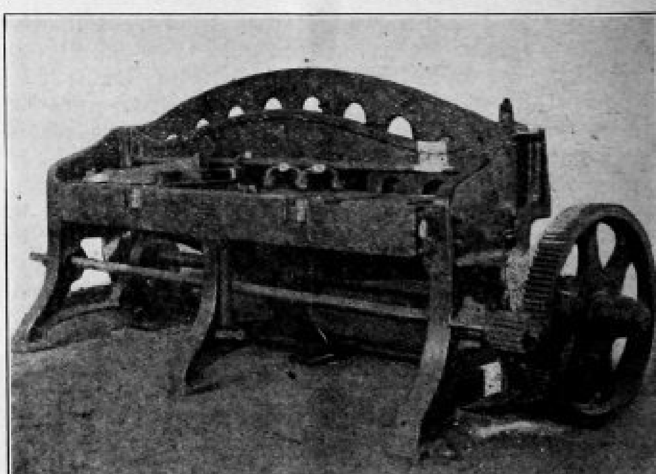
The advantages that should be derived from the use of the exhaust steam injector may be briefly stated as follows:

(a) Low first cost and low maintenance costs.
(b) Low rate of depreciation.
(c) Simplicity of design and ease of operation.
(d) The utilizing of exhaust steam for feed water heating, which results in saving both water and steam and consequently fuel.
(e) Reduction in back pressure in the locomotive cylinders.

There should be a field for the exhaust steam injector in America. In England an average fuel saving of 10 percent is claimed for the exhaust steam injector, and with our relatively higher back pressures we should obtain even a greater saving, so that the net saving in money probably would be as great or possibly greater than with feed water heaters, for which a 15 percent saving is claimed.

Wrecked Shear Reclaimed by Oxy-Acetylene Welding

The $3,000 metal shear shown in the illustration was broken in thirteen different places. In common parlance it was a "total wreck," and not many years ago would have been worthless except for a nominal value as scrap. In this day of modern welding, however, broken machinery of all kinds can be repaired so cheaply and satisfactorily that the first thought is always for reclamation. In this instance the big shear was repaired by welding by the Oxweld Acetylene Company, Newark, N. J. No unusual features were encountered, and the job is cited only as being typical of what has now become everyday welding practice.



Heavy Shear Repaired by Welding

Testing Covered Electrode Process Welds*

In producing the Scotch marine boiler described in the January issue of The Boiler Maker, *the covered electrode process of arc welding, known as the Kjellberg system, was used for all the welding work. The work was carried out by the Anglo-Swedish Electric Welding Company of London, and although until the construction of the boiler in question, the process has been used mainly in repair work, it is expected that advantage will be taken of it whenever possible in new construction.*

Autogenous welding in this country has not received the official approval that has been accorded it in England, yet the activities of the boiler manufacturing and welding societies in developing suitable tests of the process have accomplished a great deal in this direction. The results of tests on the welds made by the covered electrode welding process used on the Hawthorn-Wyber boiler described in the January issue of this magazine indicate what has recently been done in Europe in the development of welding.

For the benefit of those who have not had the opportunity of studying the description of the Hawthorn boiler, the following details are given:

The boiler is of the usual marine type, having three furnaces, and it was specially designed for welded joints. It is 15 feet 6 inches diameter and carries a working pressure of 180 pounds per square inch. The joints between the shell and the end plates are welded, as are also the joints of the combustion chambers, there being a total length of welding of about 500 feet. The boiler was found to be absolutely tight from the first hydraulic test at 360 pounds per square inch without any touching up being required. The steam trials were equally satisfactory, and the boiler has now been under steam for some months. This boiler, which is known as the Hawthorn-Wyber boiler, has obtained the approval of Lloyd's Register, the British Corporation and Bureau Veritas.

Tests on Welding Process

A brief description and a summary of the results which were obtained in the various tests carried out on joints welded by the Kjellberg system may be of interest. The test pieces were welded under the supervision and in the presence of Lloyd's surveyors, and by permission of Prof. J. B. Henderson, D.Sc., the tests were carried out by Prof. B. P. Haigh, D.Sc., M.B.E., A.M.Inst.C.E., in the engineering laboratory of the Royal Naval College, Greenwich, in the presence of representatives of Lloyd's Register of Shipping.

Test-pieces with welded butt joints in plates of different thicknesses, viz., ¼-inch, ½-inch, ¾-inch, and 1-inch, were tested in tension. For each thickness two welded pieces were tested and also two unwelded. Each test-piece was 24 inches in length by 3 inches breadth, cut down to a breadth of 2 inches for a distance of 6 inches on each side of the center.

In every instance the welded test-piece broke through a section of the plate remote from the weld. For this reason it is impossible to state a ratio between the strength of the weld and that of the plate, although it is clear that the ratio is greater than 100 percent.

The strength of the welded plates varied from 27.5 to 29.9 tons per square inch, with a mean value of 28.8. In the unwelded test-pieces the strengths varied from 28.1 to 30.1 tons per square inch, with a mean value of 29.1. The mean strength of the whole series of 16 pieces may be taken as 29 tons per square inch.

Table 2.—Results of Tests under Rotary Bending of Specimens Prepared from Two Welded Steel Plates. Specimens ¾-inch diam. Speed of Rotation 1,000 Revolutions per Minute. Subjected to Constant Bending Moment in Region of Weld.

Description.	Calculated Stress at Periphery.	Number of Rotations.	Remarks.
Steel plates 36 inch x 9 inch x ¾ inch thick, weld full width, 9 inch from one end—	Tons per square inch.		
Specimen No. 1......	6.6	5,000,000	Unbroken.
" No. 2......	6.6	5,000,000	Unbroken.
" No. 3......	8.6	5,000,000	Unbroken.
" No. 4......	9.5	3,040,000	Broke through weld material.
No. 5......	10.4	5,000,000	Unbroken.
" No. 6......	10.7	1,930,000	Broke through weld material.
" No. 7......	11.7	5,000,000	Unbroken.
" No. 8......	12.7	2,777,000	Broke through weld material.

Elongations were measured on lengths of 8 inches. In the unwelded plates the elongations ranged from 22.4 to 31.5 percent, indicating a satisfactory degree of ductility. In the welded pieces the elongations ranged from 16.3 to 21.3 percent. As the welds proved stronger than the plates, the reduction may be attributed to the resistance of the deposited metal.

Determinations were made on two test-pieces of rectangular section, 1 inch wide by ½ inch thick, composed wholly of deposited metal. The elongations were measured by means of a sensitive Ewing extensometer, on an 8-inch gage length. Precautions were taken to ensure that the determinations were

* Abstract of test report published in the "Shipbuilding and Shipping Record."

Table 1.—Results of Tests to ascertain the Tensile Properties of Two Steel Plates Welded Mid-length in accordance with the Kjellberg Electric Welding System, received from the Anglo-Swedish Electri (Welding Company, Limited.

Description.	Original.		Ultimate Strength.			Yield Point per square inch.	Ratio Yield to Ultimate.	Final Extension.		Remarks.	Ratio of Weld to Solid.
	Size.	Area.	Total.	Per square inch of Original Area.				In 4 inches including weld.	In 20 inches including fracture.		
	Inches.	Square Inches	Pounds	Pounds	Tons.	Tons.	Percent.	Percent.	Percent.		Percent.
Steel plate, welded mid-length ½-inch thick.....	20.0 x .53	10.6	665,200 tons. 296.9	62,800	28.0	17.9	64	14.0	25.2	Broke in solid, 6 inches from weld	
Steel plate, welded mid-length ½-inch thick.....	20.0 x .53	10.6	pounds. 645,300 tons. 288.1	60,900	27.2	17.6	65	10.0	13.4	Broke through weld	97.0

TABLE 3.—ADDITIONAL ROTARY TESTS.

Specimen No.	Calculated Stress at Periphery.	Number of Rotations.	Remarks.
	Tons per square inch		
1	10.4	5,000,000	Unbroken.
2	10.8	5,000,000	Unbroken.
3	12.9	5,000,000	Unbroken.
			Above pieces had previously run 5,000,000 revolutions. See previous table.
9	14.0	495,000	Broke at junction of weld to plate partly through weld material and partly through plate.

TABLE 4.—RESULTS OF TESTS UNDER IMPACT UPON TWO WELDED STEEL PLATES, BLOWS APPLIED TO WELD ACROSS WHOLE WIDTH OF PLATE, BOTH BLOWS ON THE SAME SIDE.

Description.	Span.	Weight of Tup.	Height of Fall.	Remarks.
		hundred-weight.	feet.	
Plate ¼-inch thick, 5 feet x 2 feet 6 inch, weld mid-length	1st blow 4 feet 6 inch	2	9	Uncracked.
	2nd blow 4 feet.....	2	9	Ditto
Plate ½-inch thick, 5 feet x 2 feet 6 inch, weld mid-length	1st blow 4 feet 6 inch	4	12	Ditto
	2nd blow 4 feet.....	4	12	Ditto

TABLE 5.—RESULTS OF THE MODULUS OF ELASTICITY TESTS

Testpiece No.	1	2
Thickness, Inches	0.498	0.495
Width, Inches	0.990	0.987
Max. stress applied Tons per square inch	15.2	13.3
Value of "E", Tons per square inch	13,000	13,200

not vitiated by the presence of bending stresses. After the first cycle of loading the test-pieces were found to behave elastically in subsequent cycles, giving reliable and consistent values for the modulus.

The mean value of the modulus of elasticity, 13,100 tons per square inch, equivalent to 29.4 million pounds per square inch, is regarded as satisfactory; being nearly the same as that of ordinary steel plate in good condition.

CHEMICAL ANALYSES

Chemical analyses were made for three samples as follows: No. 1, ends of the electrodes used in preparing the test-pieces for tensile tests, cleaned to remove any particles of the adherent coating; No. 2, drillings from the deposited metal of a weld in ½-inch plate; and No. 3, similar drillings from a 1-inch weld. It was found that the manganese of the electrode was largely retained in the deposited metal, as also was another constituent. The latter, although unusual, is not regarded as deleterious, and may have contributed to the tensile strength. Moreover, the carbon, determined by the color test, has been largely retained in the deposited metal.

MICROSTRUCTURE

Two of the tensile test-pieces were examined microscopically. The polished surfaces, when etched, exhibited to the naked eye the location and characteristics of the weld. The deposited metal was unusually uniform in grain; and the effect of heat had penetrated the adjacent metal of the plate to a depth of from ⅛ inch to 3/16 inch.

The microstructure clearly revealed at 100 magnifications that the action of heat on the metal of the plate was in no wise injurious; and the junction between the deposited and original metal was well merged, without any sharp line of demarcation.

In concluding his report, Dr. Haigh remarks that he did not, in any of the tests of experiments, observe anything tending to throw doubt on the satisfactory nature of the work. The system appears to be capable of giving exceedingly good results; and he was particularly impressed with the uniformity of the microstructure.

A further series of tests was carried out by David Kirkaldy & Son to ascertain, in addition to the tensile properties, the effect of impact and of repetition of bending stresses.

On account of the great importance of these rotary bending tests as showing to what extent the welds can be relied upon when exposed to alternating stresses under working conditions, some additional tests were carried out by Messrs. Kirkaldy with the results noted in the tables.

TABLE 6.—RESULTS OF TENSILE TESTS ON ¼-, ½-, ¾-, AND 1-INCH BUTT WELDED PLATES IN TENSION. TEST PIECES WERE 24 INCHES LONG BY 3 INCHES WIDE. FOR EACH THICKNESS TWO WELDED AND TWO UNWELDED PIECES WERE TESTED.

Piece.	Mark.	Thickness. inches.	Width. inches.	Yield Tons per square inch.	Break Tons per square inch.	Elongation Percent.	Remarks.
Unwelded	1	.292	1.95	20.4	29.5	27.5 on 8 inch.	
"	2	.294	1.95	20.6	29.7	22.4 on 9 inch.	
Welded	3	.292	2.01	19.8	29.9	16.3 on 8 inch.	Broke outside weld.
"	4	.292	2.01	20.1	29.9	21.9 on 8 inch.	Broke outside weld.
Unwelded	5	.528	1.99	17.7	28.3	29.5 on 8 inch.	
"	6	.523	2.01	18.2	28.1	28.0 on 8 inch.	
Welded	7	.523	2.00	17.25	27.5	20.6 on 8 inch.	Broke outside weld.
"	8	.520	2.02	16.9	27.5	20.0 on 8 inch.	Broke outside weld.
Unwelded	9	.740	2.00	17.8	30.1	25.0 on 8 inch.	
"	10	.742	2.01	15.2	29.1	31.5 on 8 inch.	
Welded	11	.740	2.00	16.5	28.7	20.0 on 8 inch.	Broke outside weld.
"	12	.738	2.00	15.9	28.8	19.4 on 8 inch.	Broke outside weld.
Unwelded	13	.968	1.99	13.9	29.2	27.8 on 9 inch.	
"	14	.970	1.99	13.9	28.5	31.1 on 9 inch.	
Welded	15	.966	1.99	14.3	29.0	21.3 on 8 inch.	Broke outside weld.
"	16	.965	2.00	14.3	28.9	18.7 on 8 inch.	Broke outside weld.

Welded Staybolts Installed in Santa Fe Boilers

In the description of the boilers of the new Santa Fe locomotives, beginning on page 95 of the April issue of THE BOILER MAKER, an outline of the staybolt installation is included. Reference was made in this outline to the fact that "Tate" flexible staybolts were installed throughout the boilers, but as will be noticed in the detail drawings of the staybolts accompanying the article, F. B. C. welded flexible staybolts were used in the combustion chamber and crown stays.

William Anglin resigned recently as superintendent of the bar mills of the Pittsburgh Crucible Steel Company, Midland, Pa.

Calculating Stresses in Pressure Vessels*

Strength of Materials Used in Cylindrical Tank Construction and Allowable External Pressures on Vacuum Tanks

BY WILLIAM C. STROTT†

THE heads of cylindrical pressure vessels should, when possible, be "dished" or "bumped" to the form illustrated in Fig. 7 (a) and (b). Heads so formed are self-sustaining, for the reason that they are in reality segments of spheres. The pressure tending to burst a spherical shell is evidently:

$$D^2 \times 0.7854 \times P. \tag{m}$$

The resistance to rupture is, of course:

$$D \times 3.1416 \times t \times S. \tag{n}$$

Whence, equating the internal force with the external resistance, we have:

$$D \times 3.1416 \times t \times S = D^2 \times 0.7854 \times P. \tag{o}$$

Resolving equation (o) for the bursting pressure, or P, we have:

$$P = \frac{D \times 3.1416 \times t \times S}{D^2 \times 0.7854}, \text{ or } \frac{4 \times t \times S}{D}. \tag{p}$$

By representing the diameter in terms of the radius, or $2R$, equation (p) reduces to the simplified form:

$$P = \frac{4 \times t \times S}{2 \times R}, \text{ or } \frac{2 \times t \times S}{R}. \tag{q}$$

By comparing equation (q) with equation (l) we find them to be identical, and from which we may correctly deduce that a dished head may be of the same thickness as the shell plate, provided the head be formed to the segment of a sphere whose radius is equal to the diameter of the shell to which the head is attached.

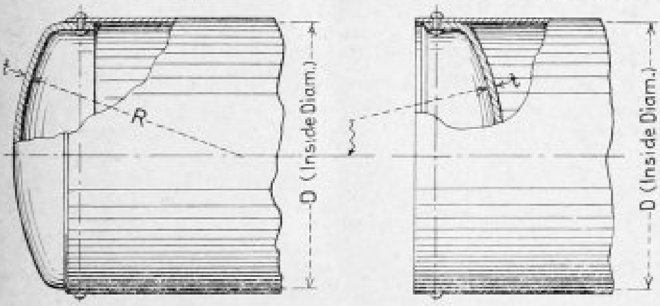


Fig. 7.—(a) Convex Head (Pressure on Concave Side) (b) Concave Head (Pressure on Convex Side)

FACTOR OF SAFETY EMBODIED IN DISHED HEAD DESIGN

In practice, however, dished heads are designed with a higher factor of safety than cylindrical shells, due to weaknesses that develop in the forming of such heads. Fig. 7 clearly shows that for the purpose of providing a means for riveting the head to the shell a vertical flange is turned on the head. The necessarily sharp corner radii of this flange represents an inherent weakness in its construction. There is little flexibility at this point, whereas the dished portion of the head is continually rising and falling, due to expansion and contraction, and also to fluctuations in pressure. Such a movement of the head is termed "breathing action" and its effect is to create cracks at the corner of the flange. Dished heads have been known to fail from this cause, by the head being blown completely from the boiler.

The A. S. M. E. boiler code gives the following practical formula for the thickness required in an unstayed dished head with the pressure acting on the concave side, as in Fig. 7 (a):

$$t = \frac{2.75 \times P \times R}{S} + 0.125, \tag{3}$$

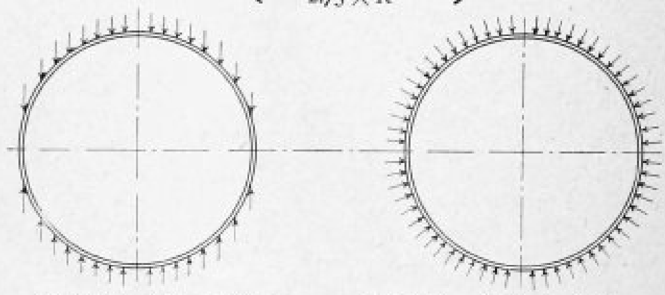
where:

t = thickness of plate, in inches.
P = maximum allowable working pressure, in pounds per square inch.
S = ultimate tensile strength of the material, in pounds per square inch.
R = radius to which the head is dished, in inches.

"Where two radii are used in forming the head, the longer shall be taken as the value of R in the formula." When the radius is less than 80 percent of the diameter of the shell or drum to which the head is attached, the value of R in the formula shall be made equal to 80 percent of the diameter.

It is frequently desirable to know the maximum allowable safe working pressure on a convex head for a given set of conditions. Formula (3) then takes the form:

$$P = \left(\frac{t \times S - 1.25 \times S}{2.75 \times R} \right) \tag{3a}$$



(a) Direct Action of Forces (b) Action of Resultant Forces

Fig. 8.—Illustration of the Action of Forces in a Vessel Subjected to External Pressure

PROBLEMS TO BE MET IN DESIGNING CONCAVE HEADS

It is very frequently necessary to attach dished heads to shells or drums so that the pressure acts upon the convex surface of the head, as illustrated in Fig. 7 (b).

This is also termed "backing in" the head. Theoretically, the forces tending to rupture a concave head are identical with those existing in a convex head. In fact, a concave head ought to be the stronger, for the reason that the plate is truly in compression rather than in tension.

Any dished head is bound to vary more or less from a true spherical form, and any resulting flat surface on a head used as in Fig. 7 (a) will be corrected by the pressure acting upon it. But with a head used as in Fig. 7 (b), such flat surfaces will be acted upon in the opposite direction, and it should be quite plain that the tendency of the pressure is to literally turn the head "inside out." Although this would be practically impossible, for the reason that the head would fail before such a condition could occur, it should be apparent that the stresses in a concave head are inherently greater than in a convex head of equal proportions. The A. S. M. E. boiler code requires that dished heads with the pressure acting on

* Second installment of article which commenced in the May issue of THE BOILER MAKER.

† Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

the convex side, as in Fig. 7 (b), shall have a maximum allowable working pressure equal to only 60 percent of that found by means of formula (3).

In accordance with the above rule, we may then arrange a new formula applying to concave heads, as follows:

$$(4) \qquad P = 0.60 \left(\frac{t \times S - 1.25 \times S}{2.75 \times R} \right)$$

where P is the maximum safe working pressure allowed on a dished head having the pressure acting on the convex side, as in Fig. 7 (b). (Note that the above formula is identical with formula (3_a), except that the right-hand term is multiplied by 60 percent, or 0.6, same being in accordance with the A. S. M. E. rule for such cases.)

Desiring to know what plate thickness to use when all other values are given, we transpose formula (4), as follows:

$$(4_a) \qquad t = \frac{2.75\, P \times R + 0.75 \times S}{0.60 \times S}.$$

The rule with regard to the radius of the "bump" as given in connection with formula (3) also applies to concave heads. When a dished head of either the concave or convex type has a flanged manhole opening, the thickness of the plate shall be increased by 1/8 inch over that given by formula (3) or (4_a).

CYLINDRICAL VESSELS SUBJECTED TO EXTERNAL PRESSURE

Theoretical formulae for the stresses in cylinders subjected to external pressure are of little value, since such cylinders will collapse before the compressive strength of the material is developed. Especially is this true of thin cylinders which are very long as compared with their diameter. Practical examples of cylindrical shells subjected to external pressure are the internal furnaces and tubes of boilers. Vacuum tanks also come under this classification, although they cannot possibly be subjected to an external pressure in excess of 14.7 pounds per square inch, for the reason that even that figure represents the absolute zero of pressure or a perfect vacuum. Up to the present time the nearest approach to a perfect vacuum which has as yet been attained is about 29 inches of mercury, equivalent to an external pressure of (29 × 0.495), or about 14.5 pounds per square inch.

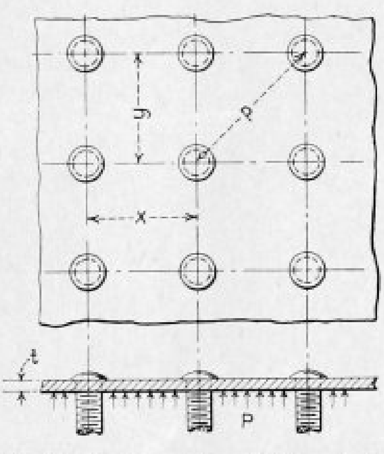


Fig. 9.—Continuous Plate, Uniform Load Supported at a System of Points

Fig. 8 (a) and (b) illustrates how external pressure acts upon a cylindrical vessel.

After comparing the above illustrations with Figs. 1, 4 and 5, and what was said in connection therewith, it should be quite plain that the forces tending to collapse a vessel under external pressure are identical with those tending to rupture it under internal pressure. But a cylindrical shell under internal pressure is subjected to *tensile* stress, whereas when subjected to external pressure the material is in *compression*, as the force arrows of Fig. 8 (b) clearly indicate. The stress equation for cylindrical vessels subjected to external pressure is derived in exactly the same manner as for internal pressure, and is the same as equation (f), which, for convenience, is again presented:

$$(f) \qquad P = \frac{t \times S}{R},$$

where the terms have the following significance:

P = *collapsing* pressure in pounds per square inch.
t = thickness of shell plate in inches.
R = *external* radius of the shell in inches.
S = ultimate *compressive strength* of the plate in pounds per square inch.

Since steel has a far greater strength in compression than in tension, it would seem that any cylindrical vessel could be subjected to a much higher external than internal pressure.

Stresses in *internal pressure* vessels, as has been shown, may be readily calculated, and with considerable assurance, but when the same cylinder is subjected to external pressure, although similar theoretical formulae apply, such calculations for compressive failure become valueless. The reason for this is, that any deviation from the true cylindrical form, no matter how slight, is rapidly increased by the external pressure and failure occurs by collapsing of the vessel. Even though vessels subjected to *internal pressure* may be greatly "out of round," it should be readily understood that such pressure tends to overcome rather than magnify the eccentricity, in the same manner that an oval-shaped rubber toy balloon tends to become perfectly round when sufficiently inflated.

In the case of vessels subjected to external pressure, it has therefore been necessary to resort to actual tests for the purpose of devising formulae for the collapsing pressure of cylindrical vessels. Extensive tests on cylindrical shells whose lengths did not exceed six diameters have led to the following generally accepted formula:

$$(5) \qquad P = C \left(\frac{t^{2.25}}{L \times D} \right).$$

where:

P = the *collapsing* pressure of a cylindrical shell in pounds per square inch.
t = thickness of the shell plate in inches.
D = *outside* diameter of the shell in inches.
L = length of the cylinder in inches.
C = a constant determined from the experiments and given as 11,600,000.

The reason for basing this formula on shells whose lengths did not exceed six diameters is because the tests proved that the collapsing pressure is unaffected when the lengths of shells are increased beyond the ratio. When using formula (5), where L is greater than six diameters, the value of L may be taken at (6 × d).

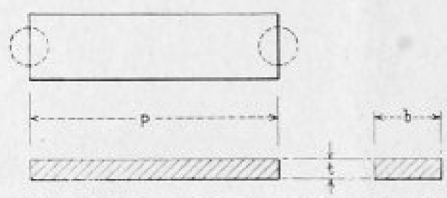


Fig. 10.—Assumed Section of Plate Through Maximum Pitch of Stays

It might be advisable to state here that dimension L in the above formula refers to the length of a *plain* section of the shell, hich may be either the center-to-center distance between circumferential seams or else the distance between reinforcing bands, whichever the case may be. From this we infer that any cylindrical vessel subjected to external pressure may actually be greater in length overall than six diameters, provided that the shell be built up in sections or reinforced at intervals by means of angle or tee bands riveted to its circumference.

PRACTICAL APPLICATION OF FORMULA (5)

Problem.—Given, a cylindrical shell 48 inches outside diameter by 12 feet (144 inches) long; the thickness of the shell plate is 7/16 (0.4375) of an inch. Determine the maximum external pressure that would be allowed on this vessel, on a factor of safety of five.

Solution.—For the required factor of safety, the constant C in formula (5) reduces to:

$$\frac{11{,}600{,}000}{5} = 2{,}320{,}000.$$

TABLE 1.—VALUES TO BE USED IN SOLVING PROBLEMS BY MEANS OF FORMULA (5)

Thickness of Shell Plate, Inches: Fraction	Decimal Equivalent	Corresponding Value of $t^{2.25}$
1/4	.25	.7853
9/32	.28125	.1024
5/16	.3125	.1292
11/32	.34375	.1604
3/8	.375	.1950
13/32	.40625	.2345
7/16	.4375	.2755
15/32	.46875	.3236
1/2	.5	.3716
17/32	.53125	.4266
9/16	.5625	.4842
19/32	.59375	.5496
5/8	.625	.6166
21/32	.65625	.6870
11/16	.6875	.7585
23/32	.71875	.8414
3/4	.75	.9247

Fractional powers of numbers, like the expression $t^{2.25}$, are most conveniently found by means of logarithms. For the convenience of those who are not sufficiently far advanced in mathematics as to be capable of solving such expressions, Table I has been prepared, which gives the value of $(t^{2.25})$ for plate thicknesses from 1/4 to 3/4 of an inch, varying by 1/32 of an inch.

For 7/16-inch shell plate, we find from the above table that the corresponding value of $(t^{2.25})$ is 0.2755. We may now substitute values in formula (5):

$$P = 2{,}320{,}000 \left(\frac{0.2755}{144 \times 48}\right).$$

Solving gives: $P = 92.5$ pounds per square inch, allowable external pressure.

INTERNAL FURNACES OF STEAM BOILERS

For corrugated internal furnaces of Scotch marine type boilers the A. S. M. E. boiler code presents the following formula:

$$(6) \qquad P = C \left(\frac{t}{D}\right)$$

where:

P = maximum allowable working pressure in pounds per square inch.
t = thickness of furnace in inches.
D = the mean diameter of the furnace in inches.
C = a constant varying from 10,000 to 17,300, depending on the type of furnace.

Formula (6) is evidently very similar to the experimental formula given previously, and was of course derived therefrom. By assuming the lowest value for C allowed by the code, and applying formula (6) to the conditions given in our previous problem, we get:

$$P = 10{,}000 \left(\frac{0.4375}{48}\right),$$ or approximately 91 pounds per square inch.

As the latter value is almost exactly equal to that found by the experimental formula, where a plain shell section was considered, then formula (5) evidently gives results that are far below actual requirements for plain shells. For plain internal furnaces, reinforced by flanging the ends of the sections and riveting them together* the code gives the formula:

$$(7) \qquad P = \frac{57.6}{D} [(18.75 \times T) - (1.03 \times L)],$$

where the values of P, D and L are the same as in the two preceding formulae, and T is the thickness of the shell in *sixteenths* of an inch (i. e., if the plate is 3/8 inch, then the value of T would be 6, because 3/8 equals six-*sixteenths*).

Substituting the values of our problem in formula (7), we have:

$$P = \frac{57.6}{48} [(18.75 \times 7) - (1.03 \times 144)].$$

Notice that (1.03×144) is greater than (18.75×7), which would result in the negative value "*minus* 17.07." A positive value being obviously impossible in this case, it must follow that the furnace section is either too long or else the plate is too thin. Even though we were to employ values for T and L, such that the expression $(18.75 \times T) - (1.03 \times L)$ in formula (7) will equal 1, then the allowable pressure would evidently be:

$$P = \frac{57.6}{48} \times 1,$$ or only 1.2 pounds per square inch.

In concluding this chapter it will be stated that for best practice the lengths of sections in compression vessels should not exceed one diameter. Even for ratios as high as 3:1 a factor of safety of at least 15 is necessary in the experimental formula (5), in order to render it applicable to plain cylindrical vessels subjected to internal pressure.

STRESSES IN FLAT PLATES

The deduction of formulae for determining the stresses in flat plates supported at their edges and loaded by forces perpendicular to their flat surfaces forms one of the most difficult chapters in the theory of elasticity. The theories most widely accepted are those of Professor Grashof deduced from the equation of the elastic curve. For a circular flat plate such as the heads of a boiler or tank, when the edges are riveted to the shell, the following formula has been devised:

$$(8) \qquad S = 0.75 \left(\frac{P \times R^2}{t^2}\right),$$

where:

S = the stress in the plate, not to exceed 10,000 pounds per square inch.
P = maximum safe working pressure in pounds per square inch.
R = radius of the head in inches.
t = thickness of the head in inches.

Unstayed flat plates are, however, practically prohibited in pressure vessels of any kind, but the above formula is often of great value in determining the proportion of the stress which is actually carried by the plate, even though the latter is braced.

The problem of a continuous flat plate supported at a series of points (see Fig. 9) is, however, an extremely important one and is probably the only condition of flat plate with which we have to deal directly in the design of steam boilers. This condition very clearly refers to all staybolted and braced surfaces, such as the furnaces of vertical firetube and locomotive type boilers and the combustion chambers of Scotch type boilers.

In the case of Fig. 9 it is assumed that any diagonal strip of plate connecting two adjacent rows of rivets or stays is in reality a simple beam fixed at the ends and uniformly loaded.

Fig. 10 represents an imaginary beam between two adjacent stays, where p is the maximum pitch of stays, b the width of the imaginary beam, and t the thickness of the plate, all expressed in inches. Denoting the maximum steam pressure by P, the total load on the beam is expressed thus:

$$(r) \qquad W = \text{total load on beam} = p \times b \times P.$$

The maximum bending moment for a continuous beam fixed at the ends and uniformly loaded may be taken as:

$$(s) \qquad M_b = \text{maximum bending moment} = \frac{W \times p}{12}.$$

Now since $W = p \times b \times P$ (equation (g)), then equation (h) becomes:

$$(t) \qquad M_b = \frac{(pbP) \times p}{12}, \text{ or } \frac{Pbp^2}{12}.$$

* Adamson furnaces.

The unit fibre stress in any beam is expressed by:

(u) $S = \text{unit fibre stress} = \frac{M_b}{Q}$, where Q is the section modulus of the beam section.

The section modulus of a rectangular beam section is found by the following equation (see Fig. 10 for notations).

(v) $Q = \text{section modulus} = \frac{bt^2}{6}$.

Substituting the proper terms for M_b and Q in equation (k), it becomes:

(w) $$S = \frac{\frac{Pbp^2}{12}}{\frac{bt^2}{6}}, \text{ or } \left(\frac{Pbp^2}{12} \times \frac{6}{bt^2}\right),$$

which by means of cancellation is finally reduced to the following simplified form:

(9) $$S = 0.5 \frac{Pp^2}{t^2}$$

When it is desired to determine the working pressure, the above equation takes the form:

(9_a) $$P = \frac{S t^2}{0.5 p^2}.$$

If we give the bending stress S a constant safe working value of 12,000 pounds per square inch, formula (6_a) reduces to the form:

(9_b) $$P = 25{,}500 \frac{t^2}{p^2}$$

A formula somewhat similar to (9_b) is given by the A. S. M. E. boiler code for the safe working pressure allowed on braced and stayed surfaces. It is:

(10) $$P = C \frac{T^2}{p^2}$$

where:

P = working pressure in pounds per square inch.
T = thickness of plate in sixteenths of an inch.
p = *maximum* pitch of stays in inches.
C = a constant varying from 112 for ordinary screwed staybolts to 175 for through rod bracing.

Example.—What is the safe working pressure that would be allowed on a staybolted surface under the following conditions: ordinary screwed staybolts; plates ⅜ inch thick; maximum pitch of staybolts 6 inches.

By formula (9_b);

$$P = 25{,}500 \left(\frac{0.375 \times 0.375}{6 \times 6}\right) = 100 \text{ pounds per square inch.}$$

By formula (10). (A. S. M. E. code formula):

$$P = 112 \left(\frac{6 \times 6}{6 \times 6}\right) = 112 \text{ pounds per square inch.}$$

(Note the value of T is 6, because ⅜ inch = 6/16.)

Since formula (10) gives a higher pressure than according to our deductions, it appears that the A. S. M. E. code allows a higher bending stress in the plate than 12,000 pounds per square inch. The maximum pitch of screwed staybolts should never exceed that determined by formula (10), but it will be found in practice that the majority of stayed surfaces fall more closely in accordance with formula (9_b).

The "Yazoo" Railroad Shops at Vicksburg

BY JAMES F. HOBART

When a man visits Vicksburg and tramps around a while he surely realizes the "ups and downs" of life as forcibly as though he were in Pittsburgh or in Duluth. However, in both the latter places it is uphill both ways, while it is a long day downhill in Vicksburg when you are going anywhere, and a much longer way uphill when you are going back.

Away down in the river valley the Yazoo and Mississippi shops of the Illinois Central Railroad are tucked away on a level plateau or bench which extends for a long distance along the river side, yet far above the reach of the floods.

Tube Cleaning and Welding

The writer has never seen in any other shop old boiler tubes cleaned so well as in the Vicksburg shops. There is not even a skin of white dust on a tube when it is sent to be put into a locomotive again. When tubes are removed they are piled upon a high, flat push car or truck, which brings the level of the piling surface within easy reach of the man who is taking the tubes out of the boiler.

The tubes may be pushed directly to the tube room on the car or, as is usually done, they are carried by negroes, two or three tubes at a time, on their shoulders and placed directly inside of a wet tube rumbler as shown by Fig. 1. When the tubes come from this machine, and after they have dried, hardly a particle of dust or dirt can be found upon them.

The secret of the great cleaning power of this rumbler is that the tubes run in water during the entire process of tumble cleaning, that the water is being constantly changed and renewed, and that all the dirt is washed away as fast as it is knocked from the tube surfaces.

Noise and dust are both absorbed and the water rumbler is found to be a very desirable machine and neighbor. Its construction, as shown by Fig. 1, is quite simple. The tank, *A*, may be made of any convenient material—brick, concrete or old tank sheets. The bottom of the tank may be square, but preferably it should be round so that dirt can be easily washed out and not allowed to lodge in the corners of the tank.

A circular watertight cover, *B*, is fitted over the tank and a section, *C*, at one end is hinged and is fitted with rope tackle and hoist for raising and lowering the section. The rumbler proper, *D*, is made in the usual manner, mounted upon gudgeons or trunnions, which in turn are supported in the bearings *F-F* in the usual manner. The heavy gear, *G*, serves to transmit power to the rumbler shell.

At one end of the shell, *D*, there is a door, shown open, at *E*, through which the tubes are placed in the rumbler and re-

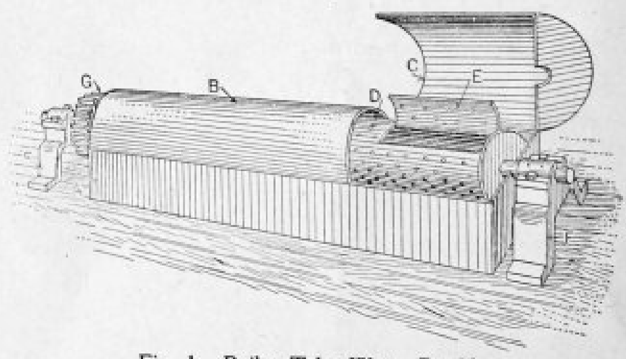


Fig. 1.—Boiler Tube Water Rumbler

moved therefrom. It will be noted that door *E* does not extend the entire length of the rumbler, as is usual with other machines of this kind, but the tubes must be slipped in endwise and removed one by one in the same manner, instead of all coming out with a rush when the whole length door might be opened. A little more time is required to load and unload this rumbler than is needed with other tube rumblers, but the work done by this machine is so superior that the little extra work of loading and unloading can well be afforded.

The water pipes are not shown in the drawing. The tank *A* is filled full enough with water so that the tubes in shell *D* will be fully immersed in the water which circulates freely through the holes shown in shell *D*. A stream of water is kept running into the tank all the time and a corresponding stream is permitted to run out, thereby keeping the water reasonably clean and removing all dirt from the tubes.

Scattered around both tube and boiler shop the writer noticed a number of steel trestles, which served not only as very efficient trestles in the tube shop but were doing duty elsewhere, both as ordinary "horses" and for holding piled material of various kinds. Fig. 2 shows one of these trestles, which is made entirely of black steel standard shapes and weighs less than 100 pounds complete.

The "backbone" of the trestle, *H*, is a piece of T-iron, about 4-inch being used in this instance, and made about 42 inches long. Two pieces of black steel, *I-I*, are forged for legs and fastened to the web of the T-shape by two rivets to each leg and one rivet in either flange. The webs are cut back on either side of the flange at each end for about 4 inches, to permit stakes *J-J* being bolted on. One of these stakes, forged from ½-inch by 1½-inch black steel, is placed

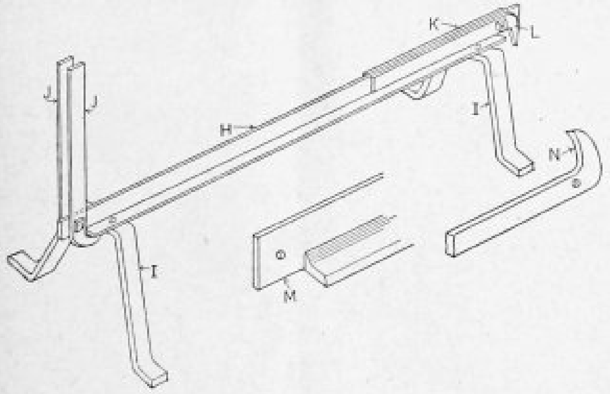


Fig. 2.—Folding Tube Trestle

on either side of the flange and both pieces secured by a bolt.

The lower ends of pieces *J-J* are drawn down and turned at right angles so as to pass under the web of *H* and prevent stakes *J-J* from leaning backward when loaded. The small sketch *M* shows the manner in which the T-iron was cut at either end, and sketch *N* shows how each stake was forged and bent.

Fig. 2 plainly shows how these trestles may be used with stakes up, as at *J*, or folded down as shown at *K*. In the tube shop four trestles were used under each bank of tubes, the trestles being used in pairs, two being placed end to end, with outside stakes raised as at *J*, while the inside stakes were down as at *K*. This gave a continuous tube table with a width equal to two trestle lengths. By placing the trestles out of line with each other a couple of inches the tube bearing surface was made continuous.

An oil furnace was used for welding tubes, the rolling being done in a rotary machine, the crimping or reducing of the ends of the finished tubes being done in a little belt-driven vertical reciprocating machine—a cross between a drop hammer and a squeeze-forging press. At any rate, it did the work well. A stop had been provided which made it impossible to put the tube too far in the machine; therefore the reducing of the end of the tube could never be carried too far.

Tube annealing was done in an oil furnace. After a batch of tubes had been welded they were passed, one at a time, into the heating furnace, each end of the tube, one after the other, brought to a fair red heat and then piled upon a rack to cool.

For use around the boiler shop there were some very handy rivet heating forges which had been made fully portable by building each forge upon a steel truck—two-wheeled affairs, but built entirely of odds and ends of metal, bar and sheet, which could be picked up around the shop. When the truck was set down upon its two wheels and its two legs the fire pot stood fair and level in the middle of the truck length.

On either side of the fire pot was a steel box—one designed to hold a couple of shovelfuls of coal. The other rectangular box contained a supply of rivets. When the forge was to be moved the air hose would be disconnected, the little truck picked up by its short pipe handles and wheeled to wherever it might be required for the next riveting job. Arrived there, it was only necessary to drop the truck handles, attach the air hose and the forge was all ready for work.

Old steam brake cylinders are made use of very freely in these shops for various operations. The forming clamps were operated by a pair of these old cylinders, which, instead of being placed upon the ground at either end of the clamp, thereby taking up nearly three feet of shop floor space, the cylinders were placed on top of a framework which had been built above the clamp. Advantage was taken of the space between the cylinders to locate a receiving air cylinder, which much accelerated the action of the clamps, as it was not necessary for the air to flow a long distance through a small pipe.

A short section of tube showing a freak tube failure was shown to the writer. It presented something of the appearance of Fig. 3, where *O* was a small dent which had been made in some unknown manner in the tube before it had been inserted in a locomotive. This tube began to leak long before the other tubes showed signs of weakness, and upon its removal was found with a small hole entirely through the wall of the tube at *P*, right in the bottom of the dent *O*.

The hole was a little to one side of the dent *O* and on the side of the dent which was toward the firebox of the boiler. It was finally decided that the bits of coal and dirt hurled against the side of dent *O* by the draft would strike the metal at *P* and eventually actually pounded a hole through the wall.

Tool Room and Tool Regulations

A small room has been set aside as a tool room, in which all tools not in use belonging to the boiler shop are kept and maintained in first-class condition, ready for work upon instant call. A double wheel dry grinder stood in the middle of the floor, tool racks were conveniently arranged around the sides of the room, with lockers for the tube rolling and expanding tools and for other fine tools.

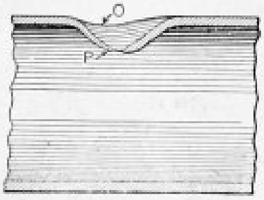


Fig. 3.—Example of Tube Failure

A man was in charge of the tool room who certainly was very much "on the job" all the time. He never was anywhere else when wanted and he kept the tools up, sharp and in condition, as well as in their places in the racks. No man in the shop was permitted to grind a tool save while in actual use, as it required sharpening from time to time. Whenever a tool was broken by any man or required drawing or hardening that tool was brought to the tool room and exchanged for another.

No man was allowed to take any tool to the shop blacksmith—the tool dresser—save the tool room man. This method was found to serve several purposes along the line of efficiency. It stopped the everlasting running of man after man to the smith, and the universal tendency to "wait for it" was torn up by the roots.

The writer was very much impressed with the air of activity which pervades the Vicksburg shops. The work was going through with a snap and vigor which was good to watch.

Special Factors Influencing Locomotive Design*

Eliminating Causes of Crack Formation in Boiler Shell and Flue Sheet Reduces Maintenance Costs

BY M. H. HAIG†

AFTER discussing various restrictions and limitations in the design and construction of large locomotives, due to the inability of existing bridges and tracks to carry the necessary weight, and because dimensions must be governed by clearances of bridges and structures, the author expresses the opinion that the physical conditions of a road should be adjusted to the requirements of the locomotive, and that the only controlling factors should be the size of train and the traffic of the territory.

Leading features of locomotive construction such as relative size of cylinders, total heating surface, grate area, principal dimensions, etc., have been treated at length by various writers. Features which have not been so discussed, however, are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. And it is in order to arouse interest in those details which are not always given the attention to which they are entitled, and in the quality of material entering into the construction of locomotive parts, that the author proceeds to their consideration. These, in the order of their treatment, are: Counterbalance, crossheads, driving wheels, crosshead pins, piston rods, cylinders, frame braces, boiler cracks, back flue sheet, grate rigging, water columns, cab equipment and tender capacity.

Sections of the paper devoted to problems affecting work in the boiler shop are given below:

Boiler Cracks

In using the boiler to supplement the frames in forming a backbone or foundation from which to brace machinery parts, the boiler shell is subjected to additional stresses which result in cracks in the sheets. The most frequent causes of these cracks are guide-yoke braces, valve-motion braces and the ordinary belly braces to frames. Guide-yoke and valve-motion braces are often very stiff and are bolted securely to the frames and studded to the boiler. When the boiler expands, the braces and connections are held rigidly by the frame and there is a tendency for the boiler to tear itself loose from these fastenings. This sets up strains in the metal which are aggravated by the vibration and pounding to which braces are subjected.

In an effort to overcome these cracks, outside welt plates have been riveted to the boiler to reinforce it where the brace pads are studded on. Experiments have been made with flexible, or partly flexible braces, some of which have so far been successful.

On engines where breakage of braces has occurred, some of them are being replaced by braces with a pin connection at the lower as well as upper end. Where the use of pins is not favored, however, a thin plate in connection with a cast-steel brace should provide sufficient flexibility for expansion of the boiler and proper stiffness for bracing machinery parts.

The Back Flue Sheet

Boiler back flue sheets of large locomotives are renewed and patched more frequently on account of cracks in the knuckle near the top flange than from any other cause. On at least one road the average life of flue-sheet knuckles is 3 years and 3 months, the maximum and minimum varying within rather a large range.

A minimum limit of distance of top flue holes from top of flue sheet that is considered practical is shown in Fig. 1. To omit flues near the top of the flue sheet sacrifices heating surface. To raise the top of the flue sheet above the usual location of flues increases the weight in the firebox, adds to the amount of water necessary to cover the crown sheet, and by requiring increase in diameter of boiler to maintain steam space above the crown sheet, increases the weight of the boiler and consequently the weight of the locomotive as a whole.

Considering the stresses and the peculiar punishment to which flue-sheet knuckles are subjected, it is important to specify this material carefully. The following limits have been demonstrated by experience as practical:

Tensile strength	52,000 to 60,000 pounds per square inch
Elongation	Not less than 25 percent
Carbon	0.12 to 0.25 percent
Sulphur	Not over 0.25 percent

The Ashpan

Various details at the rear of a locomotive should be arranged to permit a large ashpan with smooth slope sheets at

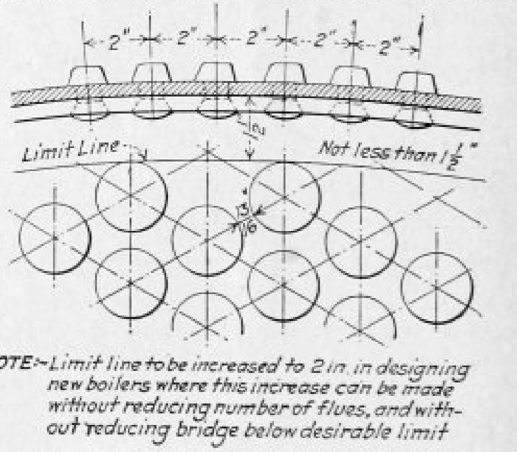


Fig. 1.—Minimum Distance Between Top Row of Flues and Flanges of Back Flue Sheet

an angle that will permit cinders to fall to the hopper without obstruction, and its design should be decided on before the designs of surrounding parts have progressed too far. Equally as important is area between the ashpan and mud ring or through parts of the pan, to admit air to support combustion. This area should be at least equal to the area through the boiler flues, and preferably a little greater.

The Grate Rigging

The place for grate rods, which operate the grates, is near the center of the grates and above the deep portion of the ashpan. On locomotives without stokers this arrangement is not difficult to provide for. With some stokers, however, grate rods in this position are interfered with, and this has resulted in some grate rods being located along the sides of pans, in certain cases very close to the flat portion or shelf of the pan under the mud ring. In this position the rods collect cinders close to the air openings and obstruct the admission of air for combustion. With steam grate-shaker equipment and

* Abstract of a paper, "The Design of Large Locomotives," presented at the spring meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers.

† Mechanical engineer, Atchison, Topeka and Santa Fe Railway Company.

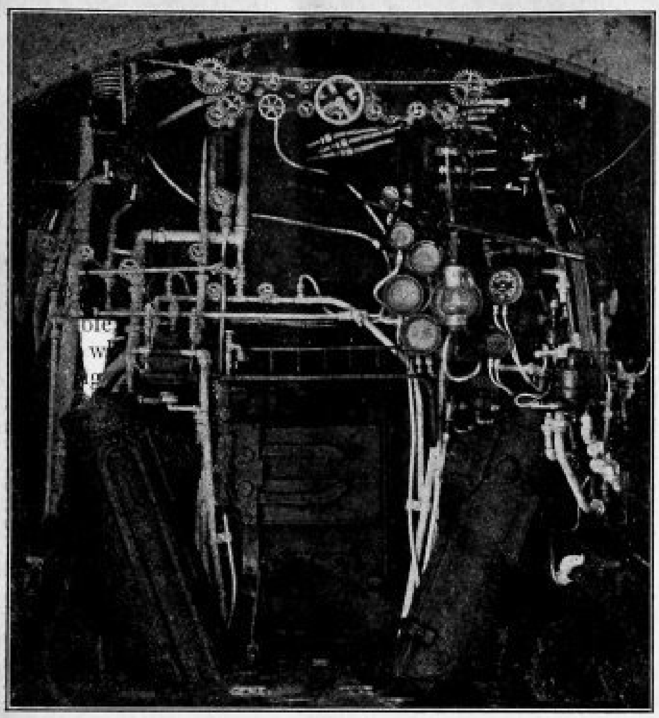


Fig. 2.—Location of Boiler Back-Head Fixtures in Large Locomotive

stoker the grate rods can be located near the center of grates by applying a set of intermediate rockers.

Water Columns

A very thorough investigation into conditions affecting the performance of water columns indicates that the most satisfactory service is obtained with a column and connections conforming with the following specifications:

Inside diameter of water column, 3½ inches.

Inside diameter of top steam pipe, 2 inches.

Inside diameter of connection of column to top steam pipe, not less than 2 inches.

Inside diameter of bottom connection to boiler, ¾ inch.

Top steam pipe as short as possible consistent with required location forward of boiler back head flange.

Minimum number of bends in top steam pipe to column. This pipe to be lagged.

No valves between water column and boiler either in top steam pipe or in bottom connection.

Water column bottom connection should extend into boiler far enough to clear nearby T-irons or other obstructions, approximately 4½ inches from inside of sheet.

Cab Equipment

The back wall of the cab should be far enough away from the boiler back to give room for a satisfactory seat, for the application of the required equipment, and for a man to pull the throttle open without striking his arm against it. A distance of 46 inches from the face of back head at the center of fire door to the back wall of cab will meet these requirements.

Engineers' and firemen's seats should be located where the men can see ahead and their vision should not be obstructed by air pumps located too high, classification lamps misplaced, running boards too high at the front, or other obstructions that might interfere with their seeing semaphores, switch stands, etc.

Blow-off cock handles should be so located that they can be operated by a man in position where he can see the water glass, and preferably without leaving his seat. The water glass, steam gage, air gages, etc., should be so located that they can be seen by the engineer when in usual position on his seat.

The throttle lever, power reverse lever, cylinder cock lever, sander valves, brake valves, etc., should be located where the engineer can reach them handily when sitting in usual position on his seat or sitting with his head out of the window. It appears like a small detail, but it is a worth-while one to locate the straight air valve where it can be reached easily by an engineer when in such a position that he can see a man at the back of the tank giving signals for coupling to a train.

The lubricator must be at such a height that a man can see the feeds, and it must be high enough to avoid pockets in the oil pipes. It must be far enough below the cab roof to be filled easily.

Cab equipment requires careful study, and it is difficult to locate the various appliances by drawing, but it has been done. A cab with a large amount of equipment on the boiler back head, yet which is regarded as being reasonably convenient, is shown in Fig. 2.

The use of clear-vision windows has made it somewhat difficult to arrange the seats so that either seat or window will be a height to suit different men. This problem, however, has been solved for one road by its motive-power department chief, who has developed an adjustable seat made of steel and having a spring cushion and an upholstered back. The back being secured to the seat and independent of the back of the cab prevents any vibrations resulting from shaking of the cab wall.

Furnace Design and Boiler Efficiency*

BY DR. D. S. JACOBUS†

To approach perfection from a thermal viewpoint, a boiler and superheater, including its economizer and air heater, if used, should absorb a maximum amount of heat with a minimum draft drop. There are commercial elements entering into the problem that limit the application of this principle, and so many variables that each case must be considered by itself in order to arrive at the best arrangement. A relatively large amount of boiler heating surface, with large flow spaces for the gases, if properly insulated to prevent undue radiation, would more nearly meet the requirements of absorbing a maximum amount of heat from a given weight of fuel burned with a minimum draft drop than a smaller amount of surface, although the latter would in most cases be preferable from a commercial point of view. Adding an economizer will ordinarily add to the thermal efficiency.

Determining Whether an Economizer Will Pay

In determining whether it will pay to use economizers in a new plant, the problem should not be approached by comparing the efficiency of a boiler with that of the same boiler with an economizer added to it. The proper way is to compare the results to be expected from boilers best suited for the service without the addition of economizers to those to be expected for the best combination of boilers and economizers.

It will sometimes be found for exceptional load conditions that a larger boiler properly designed and baffled will give better commercial returns, all features considered, than a

* Abstract of a paper delivered before the Cleveland Engineering Society and local section American Society of Mechanical Engineers at Cleveland, and the Akron section at Akron, Ohio, April 26 and 27, 1921.

† Advisory engineer, the Babcock & Wilcox Company, New York.

smaller boiler with an economizer—or, for that matter, for any boiler that can be selected with an economizer.

For peak load service it does not usually pay to install economizers on all boilers. A good arrangement may be secured for some classes of service by adding economizers to, say, one-third of the boilers, operating them at a more nearly uniform load than the rest and cutting in those that have no economizers during the peak load periods.

Another case where it does not pay to apply economizers is where boilers are used for stand-by service. The cost of fuel is a governing factor, and because of the increase in fuel costs during the last few years we are approaching more closely to European practice in the number of boilers so fitted.

In designing a boiler for use without an economizer, additional efficiency may be secured by adding to its height. Increasing it from, say, 14 to 20 tubes high will result in a considerable increase in efficiency without a corresponding increase in the draft loss, as much of the draft loss in boilers comes through the turns made by the gases in passing over the baffles.

To avoid exterior corrosion through the condensation of moisture from the flue gases, the temperature of the feed water to the economizers must be kept above a temperature of about 120 degrees F., and for most work we recommend 140 degrees F., as this allows for some leeway in case the water is fed intermittently.

It is becoming more general practice to use an individual economizer on each boiler and not to install connections for by-passing the gases around the economizer. A by-pass connection as a rule allows some leakage of the hot gases and causes a continual loss of efficiency and its omission is also advantageous in simplifying operation and lessening the chance of trouble with the economizers.

Danger of Overheating Brickwork

For securing the highest efficiency the furnace temperature should be the maximum that can be maintained, and combustion should be completed within the furnace chamber. The furnace brickwork employed today will fail if saturated with heat at the full temperature that is available with many classes of fuel. In furnace design, therefore, some efficiency must be sacrificed in most cases in order to maintain the furnace brickwork and keep the cost of repairs within a reasonable figure.

Where furnaces are operated under a suction that causes the cool air to be drawn inward through the brickwork, there is a cooling effect that serves to prevent overheating, whereas if they are operated under a pressure, there is a tendency for the hot gases to leak outward and overheat the brickwork.

Brickwork will fail by plastic deformation before it reaches the melting point. The greater the load carried by the brick, the more likely it is to fail. Fireclay brick of the best quality ordinarily obtainable begins to show plastic deformation under a load of 20 pounds per square inch at from 2,200 to 2,400 degrees F. Reduction to a load of 10 pounds per square inch will increase the permissible temperatures about 200 degrees F. As furnace temperatures considerably higher than this exist with certain grades of fuel and stoker practice, say 2,700 to 3,000 degrees F. as a limit, it is apparent that the necessity of maintaining the brickwork below the temperature of the furnace is a vital one. First-class clay bricks have a fusion point slightly above 3,100 degrees F. and yield through plastic deformation long before they fuse.

In ordinary furnace design the walls and arches are heated on one side only in order that the brickwork may be maintained at a lower temperature than that of the furnace. A wall of a given thickness that would give good service as a battery wall might fail under the same fuel and combustion if used as a supporting wall between two combustion arches, as the heat would not be conducted away from the wall to the extent that it would when used as a battery wall, and the reflected heat from the arches would also increase its temperature. Such a supporting wall should be used between combustion arches only in cases where a low grade of fuel is burned, which does not result in high temperatures, or it should be ventilated.

To consume the combustible gases within the furnace chamber there should be a proper length of flame travel before the gases strike the tubes and a sufficient furnace volume. Furnace volume and length of flame travel are not, however, the only elements that must be considered in designing an efficient furnace, as there must be a mingling action within the furnace to cause any unconsumed combustible gases to reach the excess air.

Effect of Radiant Heat Absorption

The effect of the absorption of radiant heat on the boiler tubes should be considered in designing a furnace. With certain fuels such as blast furnace gas, wet wood or bagasse, where the highest attainable temperature can be carried by the brickwork, it is best to absorb but little radiant heat in order to maintain a high furnace temperature and thereby increase the efficiency of combustion. With the stronger fuels it is necessary to absorb a considerable amount of the radiant heat in order to prevent the collapse of the brickwork or an undue amount of deterioration.

Exposing more or less of the boiler surface to the direct radiant heat of the fire has a comparatively small influence on the efficiency, as any increase in the heat absorbed through direct radiation is counterbalanced to an extent by the diminution of the amount of heat absorbed through conduction. Ordinarily, the higher the furnace temperature, the higher the efficiency. Higher furnace temperatures, however, lead to increased cost of brickwork maintenance, especially when the boilers are operated at high ratings, and for a strong fuel it usually pays to expose a considerable proportion of the heating surface of the boiler to the direct action of the radiant heat.

Rating for Economical Operation of Boilers

The economical rating is naturally influenced by the presence or absence of economizers and the service to which the boilers are put. Where there are short peak-load periods, the greatest commercial economy is usually secured by operating the boilers to as high a capacity as can be secured during these periods.

The general practice in this country is to drive boilers at a higher rating than is done in European practice, and the stress of war conditions has undoubtedly led to a number of plants being run beyond the point of the best commercial efficiency.

A furnace for operating at high capacities should be larger than for operating at lower capacities; a furnace to give economical results at high ratings therefore involves special problems in caring for the expansion of the brickwork and especial care in the construction of buckstays for holding the brickwork in alinement. The general tendency in large furnace walls which are highly heated is to bulge inward toward the fire, and unless means are provided to prevent this they may collapse.

In our present practice we use bonding tile, which are held by cast iron bulb pieces attached to the buckstays in such a way that the wall can expand in any direction in a generally vertical plane, whereas it is prevented from either bulging inward or outward. Another means that may be employed to prevent the walls bulging inward toward the fire is to build them with a camber having a vertical axis—that is, curved slightly, with the concave side next the furnace.

Trouble from Slag Adhering to Tubes

In operating at higher ratings, difficulties are encountered with some grades of fuel through slag adhering to the boiler tubes and restricting or closing up the passageways for the flow of the gases. The difficulty through slag can be reduced by providing a relatively large area for the flow of the gases on entering the spaces between the tubes and by furnishing access doors through which the slag can be detached from the tubes. An air lance, which is used both for cooling the slag and as a rod for striking it to remove any portion that may adhere to the tubes, forms an efficient tool for use in connection with the access doors.

With certain grades of coal there will be some accumulation of slag on the boiler tubes with the stokers most carefully operated, and it is advantageous in such cases to provide access doors for removing the slag.

Reducing Clinker Trouble

Trouble from clinker at the sides and front walls of the furnace where underfeed stokers are used is often reduced by admitting air through a number of openings in the walls at the sides of the fuel bed. The air flows in a layer against the inner face of the wall and prevents the clinker adhering to them. It also serves to partly cool the wall and reduce its erosion.

It can readily be seen that furnace design and boiler design must be co-ordinated in order to secure the best results. It is impossible to separate boiler efficiency from the efficiency of the stoker and furnace. Many have worked on this problem, and the ground has probably been gone over more thoroughly than any other feature of boiler testing codes. The result has always been in reaching the conclusion that it is impossible to separate the furnace and stoker efficiency from the combined efficiency of the boiler, stoker and furnace in such a way that the result may not be misleading.

Practical Method of Welding Locomotive Fireboxes and Flues

AT a recent meeting of the Metropolitan Section of the American Welding Society in New York City, the programme consisted mainly of brief talks describing shop methods carried out by practical welders. Details of a cast iron flywheel repair and of engine cylinder work, as well as the application of gas welding to refrigerating apparatus, locomotive frame welding and other repair work, were given.

In connection with the use of welding in the railroad boiler shop, Edward Eldridge, foreman of electric welders at the Elizabethport shops of the Central Railroad of New Jersey, stated that at this shop entire locomotive fireboxes are welded in some cases, while in others the fireboxes are half welded. Other welding at this shop includes half throat sheets, back heads, door rings, patches, long cracks, flues and tank patches. An abstract of the sections of Mr. Eldridge's paper devoted to firebox and flue welding is given below.

Firebox Welding

In welding complete fireboxes, we use a butt weld. The sheets are beveled on the inside and set in space on the mud ring, then tacked in the water space. All fireboxes are welded on the floor. Starting in the center of the flue sheet at the bottom, the weld is made up to the ear or lap. The firebox is then turned over and the welding continued from the center of the crown sheet to the mud ring, giving 1/8 inch reinforcing. After completing the weld on this side, the box is again turned and with a round-nose chisel a groove about 3/16 inch deep is cut in the seam in order to get all the scale and dirt off. This groove is then reinforced with 1/8-inch or 1-inch layer of welding metal. On the flue sheet we put 1/2-inch by 3-inch round mild steel bars and weld around them. On the throat sheet five bars are used in the same way. The reason for putting on these bars is to stiffen the flue sheet when the flues are rolled. In welding half throat sheets and backheads the sheets are beveled the same as the firebox side and welded before rivets are put into place, thus giving about 3/16-inch by 1/8-inch reinforcing.

In welding mud ring corners we put a fillet weld on the inside through plug holes and reinforce 1/2 by 1 1/4 inches by 12 inches on the outside.

In welding half fireboxes we use a staggered seam, starting the cut back from the throat sheet two staybolts, then up one staybolt. The seam then goes back two staybolts, down one, back two and so on the length of the firebox. By staggering seams, expansion and contraction is scattered in all directions.

In welding patches in fireboxes we use an oval patch so there will be no sharp corners. The patch has a 3/16-inch radius, so that there will not be any strain after the weld has been made. In applying the patch after the top and sides have been tacked on, the weld is begun at one end of the patch and continued across the top. The ends of the patch are welded from the top down, first welding about 3 inches on one end and then the same amount on the other, until the ends are completely welded. The patch welding is then completed by beginning at one end at the bottom and continuing to the other end, and reinforcing about 3/16 inch. By welding this way the heat from the welding travels up into the patch and the contraction will straighten out the patch.

In welding cracks in fireboxes where they are over 4 inches long, the crack is V'd out to a feather edge. The welding is begun 3 inches from the top and the weld continues to the top. Welding is then begun about 3 inches further down and continues upward as before and so on until the crack is filled up. The next step is to take a welding hammer and bob up the welding material that has been applied and put on 3/16-inch reinforcing. Cracks welded in this manner we have had hold for two or three years.

In welding door holes we weld some with the lap and some with butt weld. In welding a lap weld, care must be taken to keep the sheets layed up tight at all times, and a fillet weld is applied on the edge. Care must also be exercised to see that the weld is as thick as the sheet in all places.

Flue Welding

In welding flues in the firebox end, we put the flues in the same as before welding was practiced. The boiler is then filled with warm water so that it will not sweat, and with a roughing tool all dirt and scale was cleaned from the sheet. With an acetylene torch or blowpipe all grease and oil are burned from the flue and sheet. The work is begun at the top of the flue sheet and progresses across so that the smoke will get on the flues that are already welded and not on the ones to be welded. Always start to weld a flue at the bottom, welding up each side to the top. Care must be taken that there is no copper sticking out of the sheet, as this will cause blow holes in the weld. In welding upright boilers, roll and expand the flue, and do not bead or use any copper ferrules. Leave the flue about 3/16 inch from the sheet and weld the bead on.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the secretary of the committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval.

Case No. 322 (Reopened)—Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety valve body, for safety valves to be operated at a pressure of 225 pounds? May cast iron be used for this purpose?

Reply: It is the opinion of the Committee that the Y-fitting referred to may be made of cast iron, provided the temperature does not exceed 450 degrees F., as stipulated in Par. 12. The safety valve body need not be of steel unless it is to operate with superheated steam. (See Par. 289.)

Case No. 337—Inquiry: In applying reinforcing plates within the drums of watertube boilers to strengthen the shell where the tubes enter, as shown in Fig. 1, what is the requirement of the Boiler Code for the thickness of the plate and the strength of the riveting to compensate for the material removed in forming the tube holes?

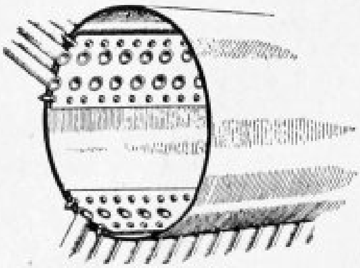


Fig. 1.—(Case No. 337) Reinforcing Plates in Drum of Watertube Boiler

Reply: There is no rule in the Code for the design of reinforcing plates to be used for this purpose. The Committee advises against such reinforcing plates, but if they are to be used the Committee is of the opinion that if the thickness of the plate be made sufficient to give, when added to the thickness of the drum shell, a ligament efficiency under Par. 192 or 193, at least equal to that of the longitudinal joint of the shell, it will then only be necessary to so rivet the plate to the shell that the joint will calculate to an efficiency also equal to the longitudinal joint of the shell.

Case No. 342—Inquiry: Is it permissible in a heating boiler to be operated at a pressure not to exceed 15 pounds per square inch, where cross-bracing is required in the side furnace sheet of a locomotive type boiler between the centerline of the cylindrical portion and the crown sheet, to locate a through cross rod one-half of the staybolt pitch below the centerline, as shown in Fig. 2?

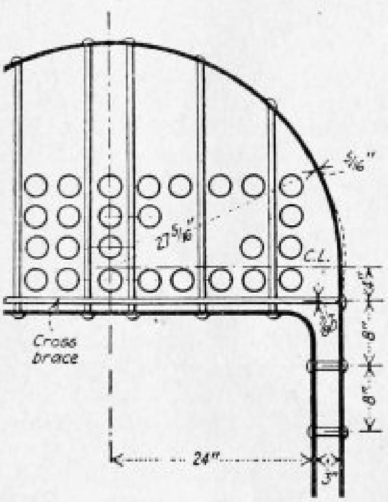


Fig. 2.—(Case No. 343) Allowable Location of Through Cross Rod for 15 Pounds Maximum Pressure

Reply: It is the opinion of the Committee that the method of staying described does not conflict with the requirements of the Code when the working pressure does not exceed 15 pounds per square inch.

Case No. 343—Inquiry: What constant will it be necessary to use in the formula in Par. 199 of the Boiler Code for a surface braced with through stays having inside and outside nuts, but omitting washers?

Reply: It is the opinion of the Committee that where through stays are used with inside and outside nuts, but omitting washers, the constant of 135 should be used in the application of the formula in Par. 199.

Case No. 344—Inquiry: In complying with the requirements of Par. 289 for a safety valve used on a superheater, is it necessary that the entire casing of the safety valve be made of steel?

Reply: It is the opinion of the Committee that the intent of Par. 289 is that the body of a safety valve includes all parts of the body and casing which come in contact with the boiler steam or the steam discharged, and therefore in the construction submitted the casing shall be made of cast steel for use with superheated steam.

Case No. 345—Inquiry: Is it the intention of Par. 335b of the Boiler Code that hot water boilers must be built according to the rules for power boilers when either the grate area exceeds 10 square feet or the maximum allowable working pressure exceeds 50 pounds per squire inch, or is it the intention that this requirement applies only when both of the above limits are exceeded?

Reply: It is the opinion of the Committee that the requirement of Par. 335b applies only when both of the limits therein specified are exceeded in the hot water boiler.

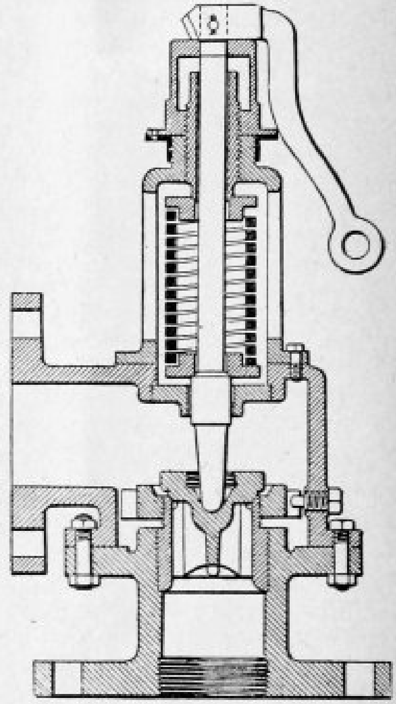


Fig. 3.—(Case No. 344) Typical Safety Valve Design

Case No. 346—Inquiry: Is it permissible, in the application of the requirements in the A. S. M. E. Boiler Code for safety valves for heating boilers, to take advantage of the proportional difference between bevel-seated and flat-seated valves provided for in the safety valve rules for power boilers?

Reply: It was the intention of the Commitee that Table 9 of the Boiler Code should cover the application of safety valves to all heating boilers, no matter what the character of the seat. Attention is, however, called to the fact that where the conditions specified in Table 9 are exceeded, the formula in Par. 358 may be used.

Bending With the Aid of the Torch

Repair men using welding torches soon learn to apply them when bending and straightening shafts, bars and structural parts. A workman who understands heating in just the right spots can quickly straighten a badly bent piece with the expenditure of very little gas and strength.

A secret of easy bending is heating a small area to a bright red or yellow heat and bending no more than necessary. Several heats may be necessary, each followed by angular displacement, which restores the part to the original lines.

Heating in a forge fire is at a disadvantage for bending and straightening, because of the impossibility of confining the heat to a small section. Hence, the bend cannot be exactly localized where wanted.

A skilled straightener using the oxy-acetylene torch can bend his work with very little or no hammering, a matter of great importance when working on finished pieces. When bending structural steel it will be necessary often to cut flanges and remove parts to allow the bends to be made without distortion. The cutting torch is a most convenient tool for the purpose, of course. In fact, wonders can be accomplished by a welder and helper, using a cast iron floor plate to anchor and aline, a welding torch to heat, and a cutting torch to vee out for bending. The cuts can be so made that the flanges are readily welded again after bending, thus producing fabricated parts of any shape, still having the strength and characteristics of the original section before bending.

—*Autogenous Welding.*

Safety Features of Steam Boiler Accessories*

By Warren Hilleary †

The work of the designer in providing a boiler with adequate safety features and that of the boiler maker in properly carrying out the actual construction are the principal factors governing the future safety of operation of that boiler. The subject of boiler fittings which should be provided to render a boiler safe are dealt with in the follownig paper.

SAFETY valves should be at least two in number on every steam boiler, for the reason that if only one valve is provided it may fail.

The question of mounting the valves on a "Y" or other base, the single outlet of which connects with the boiler, has been frequently debated upon, and apparently there is no objection to the "Y" base.

There should be an easily accessible means of lifting the valve disk from the seat for testing purposes. If both the pressure-gage and the water-gage glass are visible from the point where the disk may be raised, the action of the water in the glass will very often indicate to the attendant whether the disk should be instantly dropped or whether it is safe to hold it open for a few seconds.

The discharge outlets of the safety valves should, of course, be so arranged that there will be no likelihood of any person being scalded, or having dust blown into his face and eyes when the safety valves open, but it is not desirable that the outlet should be piped farther than absolutely necessary. The character of the piping should be as straight as possible and with no more than one bend or elbow in the line.

Water-Gage Glass

It is generally conceded that the gage glass should be provided with a guard to prevent flying particles of broken glass from striking the attendants, but it is not easy to obtain guards which will leave a free and unobstructed view of the water level, where the water column is located ten or fifteen feet above the boiler room floor.

The newer forms of connections for the gage glass permit considerable misalinement of the glass and more expansion than the types heretofore used, so that glasses will be breaking less frequently, but no device, other than a guard around the glass itself, may be expected to eliminate the very considerable danger incident to a breaking glass.

The only safe gage-glass valve is the quick opening, chain-operated type, which permits the operator to stand some distance from the glass and control the line of steam and water to it by merely pulling on one of two chains to either open or close the valves as the case may require. With the screw type of gage-glass valve, it is necessary for the operator in opening and closing the valves to expose himself to the likelihood of a glass breaking, and the exposure is for a considerable length of time since it takes considerable time to either open or close the two valves.

Gage Cocks

The non-thread weighted, or self-closing gage cocks, have many advantages over the screw type, and can be used to more advantage in a greater number of places than the screw type, the latter being improper for any condition except locomotive work where the vibration and jar is so great that the screw type is better. The only reason that the self-closing type has not met with more favor, is because attendants will not give them the attention to which they are entitled, with the result that they leak.

High and low water alarms have their advantages, but they also have their disadvantages. In my opinion they should not be used, for the simple reason that attendants invariably come to rely solely on the automatic action of the alarm, with the result that frequently the water level runs dangerously low, through failure of the alarm.

Pressure gages as a rule do not cause accidents, and yet, if they are not equipped with a syphon in the form of a loop or "U" bend, the tube will shortly harden and cause the gage hand to show improper reading.

Danger of Large Blow-Off Pipes

A common danger which has, without any good reason, existed for many years, exists in the use of a 2½ inch diameter blow-off pipe on certain types of watertube boilers. The type referred to has a drum capacity of about forty-four cubic feet, and, under average conditions, the drum would be half filled with water during normal operation, that is, there would be, roughly, twenty to twenty-five cubic feet of water in the drum. With 160 pounds gage pressure, which is the normal pressure for the type, it is possible to blow all the water out of the drum in between eight and ten seconds, which means that even with quick opening and closing blow-off valves, the attendant would have great difficulty in properly blowing the boiler down without blowing out so much water as to leave the drum and certain of the tubes empty and exposed to the hot-furnace gases. It is strange that the manufacturer, the user, and the multitude of inspectors do not realize this danger and reduce the diameter of the blow-off pipe to 1½ inches, which would be ample for the particular type referred to. A boiler with less than seventy-five cubic feet of water between the point registered by the center of the gage glass and the highest point of contact with the furnace gases, and carrying a pressure of 160 pounds, should have a blow-off pipe no greater than two inches in diameter, for with any larger diameter the proper blowing down of the boiler will lower the water level to below the highest point of the gases and thus create a dangerous condition.

Our boiler codes give us the minimum and maximum diameter of the blow-off pipe, without taking into account the cubic capacity of the boiler. The size of the blow off equipment on fire-tube boilers is seldom found to be too great for the water capacity of the boiler. On watertube boilers it is frequently found to be too great. Attendants soon learn that they cannot, with safety, open the blow-off valve wide when blowing down, so they adopt the practice of opening it only part way, the result being that proper blowing down is not accomplished, and sediment lodges in the valve, causing various inconveniences, expensive repairs and danger.

Non-Return Valves

Guessing of the proper time to open the stop valve from a boiler to a header which is being supplied by other boilers, sometimes results in disastrous explosions. A non-return is procurable, which will not only prevent the boiler from being cut into the line too soon, but will also protect the entire system in the event of a tube bursting in one boiler. If it is not beyond the jurisdiction of the Boiler Code to deal

* Abstract of a paper read before the joint meeting of the Engineering Section of the National Safety Council and the Philadelphia Branch of the A. S. M. E., Philadelphia, February, 1921.

† Superintendent, Royal Indemnity Company, Boston, Mass.

with non-return valves, then certainly the Code should state that non-return valves should be used on every boiler connecting to a header with one or more other boilers.

Rotary Tube Cleaners

Rotary tube cleaners, motor or turbine driven, are the only mechanical means for cleaning the interiors of tubes of watertube boilers. With curved tubes, the cleaner, in its efforts to follow a straight line through the curved tube, more or less rapidly wears away the metal of the tube at certain points near the bends, and not infrequently the tubes are so thinned by the cleaner that they burst during operation. There is no object in running the cleaner through the tubes until there is some scale present. The greater the amount of scale the slower the cleaner will travel through the tube, and, since the rotary speed of the cleaner is constant, it follows that if it stands still, or practically still, at any one point in the tube, and its cutting parts continue to revolve, a spot in the tube will be worn by the cutters. The extent of this wearing cannot be determined by any process of inspection; therefore, a danger is present, the character of which makes it highly advisable that the boiler washer be most carefully instructed in the proper use of the cleaner, having the dangers of improper use explained to him, and further advisable that tubes which are apparently still good should be cut out at certain intervals, depending upon the frequency of use of the cleaner, and replaced with new ones; the old one being examined at the curves by sawing through to determine the remaining thickness.

Steam turbine cleaners have an added danger of the steam hose bursting, and this hose, in addition to being wire wound, should be discarded and replaced with a new one at least twice each year, regardless of the amount of actual use, for both the rubber and the fabric used in the manufacture of the hose deteriorate with age, and bursting steam hose has caused a great number of very serious accidents.

Concrete Floors Under Boilers

If concrete floors are not accessories, they nevertheless deserve comment when they form the bottom of the ash pit and combustion chamber of any type of boiler in countries where the atmospheric temperature reaches or falls below the freezing point. A substantial concrete floor laid on clay, or most any soil other than dry sand, becomes dangerous when heated through to a temperature of more than 212 degrees F., for the moisture which collects under the floor is converted into steam by the heat, and there is probability of the floor being burst with great violence, due to the pressure under it. There are records of accidents resulting from what amounted to an explosion of the floor, caused by steam pressure forming under it.

Furnace Door Locks

There have been a number of accidents to boiler attendants in the nature of scalds and hot fuel burns, resulting when bursting tubes or flues push open the fire or ash pit doors and allow steam and live coals to pass into the boiler room, at a point where the attendant may be expected to be stationed. A great many, if not all, of these accidents could have been prevented by the installation of automatic door locks, types of which are now on the market, and which, when the doors are even somewhat carelessly closed by the attendants, still lock, so that no amount of pressure inside the furnace or ash pit will throw the doors open.

The steam flow meter has not met with the welcome reception to which it is entitled, and there is probably no good reason why every boiler operating in a battery with one or more other boilers should not be equipped with a steam flow meter which will be a positive indication to the fireman that each boiler is or is not delivering through its steam line its proper proportion of steam.

In any battery of boilers, even when each boiler has precisely the same theoretical capacity as its fellows, there will be one or more either delivering less steam or more steam than it should deliver, and this inefficient and rather dangerous condition is instantly detected by the reading of the steam flow meter. The increasing or decreasing of the fire intensity can immediately be accomplished to exactly the degree required for the boiler to do its proportion of steaming.

Oil Burners

All steam or air-atomized oil burners either are in themselves dangerous or the equipment necessarily used in connection with them becomes dangerous through their use. Mechanical atomization is reasonably safe; since mechanical atomization is more economical, by a considerable margin, than steam or air atomization it may be expected that sooner or later all atomization will be done by mechanical process to the complete exclusion of the steam or air process. The most economical steam-atomizer oil burner will require from two to four percent of the total steam generated in the boiler for atomization of the fuel oil, whereas mechanical atomizers use none of the power generated by the boiler, exclusive of that required to pump the oil to a given pressure and furnish heat for it, and this power is also required with the steam atomizer. With steam atomization, carbonization takes place at the burner tip, resulting in an unequal spread of the fire, and this, in addition to reducing efficiency, produces a danger, in that it frequently causes the fire to concentrate upon one or more relatively small areas on the tubes or sheets, causing burns and bags which are admittedly sources of danger. This condition does not exist with mechanical atomization.

The one possible objection to mechanical atomization is the necessity of bringing the oil to a high temperature before it enters the burners, the temperature being necessary to reduce the oil from a heavy to a light condition, and it seems to be the practice to heat the oil to 250 or 275 degrees F., yet I have learned of no accidents attributable to bringing the oil to a Fahrenheit temperature of 275 degrees. Careful damper regulation is paramountly necessary when oil fuel is used. If the attendant is burning coal and forgets to open the damper before firing up after a short or long shut down, there may not be an explosion of confined coal gas, but with oil fuel it is extremely dangerous to start the fire or admit any oil to the furnace until after the damper may have been opened at least a few seconds, for fuel oil is converted into gas very quickly by relatively low temperatures, and the explosive power of this gas is considerable.

Explosions of Gases in Fireboxes

Burns from hot gases passing through the furnace doors into the boiler room are rather too common. These burns are not always caused by explosion of furnace gas, but the person burned and those who may make a perfunctory examination into the case are apt to state that there was an explosion of gas in the furnace.

If a boiler is manually fired and has a thick, long flame, the fire burning with a strong draft, and if, for any reason, the damper is suddenly closed, hot gases and the flames themselves frequently pass through the furnace doors into the fire room, and any person in line with the fire door, and no more than three or four feet away from it, is apt to be burned whether he is actually attending to the fire or whether the door was closed.

The sudden closing of the damper is something which does not frequently take place accidentally, although there are one or two types of damper regulators which, under certain conditions of bad repair, permit a rather rapid closing of the damper. None of these regulators, if in good repair, will close the damper rapidly enough to cause flame and hot gases to pass into the boiler room. A manually operated damper should be weighted in a manner to hold the damper open.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-President and Treasurer*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,900 copies were printed; that of these 4,900 copies, 4,042 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 53 were mailed to advertisers, 66 were mailed to employees and correspondents, and 723 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 29,900, an average of 4,983 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

	PAGE.
GENERAL:	
Expanding American Boiler Trade in the Orient	157
Government Examinations for Boiler Inspectors	158
Saving Fuel with Exhaust Steam Injectors	159
Wrecked Shear Reclaimed by Oxy-acetylene Welding	160
Testing Covered Electrode Process Welds	161
Calculating Stresses in Pressure Vessels	163
The "Yazoo" Railroad Shops at Vicksburg	166
Special Factors Influencing Locomotive Design	168
Furnace Design and Boiler Efficiency	169
Practical Method of Welding Locomotive Fireboxes and Flues	171
Work of the A. S. M. E. Boiler Code Committee	171
Bending with the Aid of the Torch	172
Safety Features of Steam Boiler Accessories	173
EDITORIAL COMMENT	175
ENGINEERING SPECIALTIES FOR BOILER MAKING	176
QUESTIONS AND ANSWERS FOR BOILER MAKERS:	
Tapering Elbow Sections Forming a Compound Curve	179
Dry Back Boiler	179
Stays and Stayed Surfaces	179
Staying Submerged Combustion Chamber of V Type Boiler	180
Hardening and Tempering Tool Steel	180
BUSINESS NOTES	180
LETTERS FROM PRACTICAL BOILER MAKERS:	
Advantages of Triangulation Method of Laying Out Plate Work	181
Layout of Single Sweep Tee	181
Items of Interest to Boiler Makers	182
ASSOCIATIONS	183
TRADE PUBLICATIONS	183
SELECTED PATENTS FOR BOILER MAKERS	184

In the July issue of THE BOILER MAKER the first of a series of articles on the design of riveted joints will be published. Leading up to this work, a number of subjects have been dealt with in the earlier issues of the year, including the fundamental principles of trigonometry and applied mechanics so far as they have been necessary in dealing with boiler design. In addition to these and serving as a direct introduction to the work on riveted joints the article "Calculating Stresses in Pressure Vessels" completed in this issue, explains the factors affecting the construction of boilers, storage tanks, vacuum tanks and other cylindrical vessels subjected to internal or external stresses. A clear understanding of the calculations involved is necessary for those who are studying the subject for the first time, before attempting to proceed with the work on riveted joints.

Although a great deal has been written on this subject by prominent authorities, the discussions of the various points to be considered are essentially theoretical and of value only to trained engineers. The author of the forthcoming series on riveted joint design has attempted to present the matter so that it will be useful not only to the student, but to the designing engineer as well.

Among the various means for increasing the operating efficiency of boilers, Dr. Jacobus in his paper on furnace design published in this issue discusses the value of air heaters and economizers. There are instances, however, as he points out, where slight changes in the design of a boiler will adapt it to a special service and accomplish greater operating economies than the installation of economizers. When several boilers are installed in a battery it is not generally the best practice to equip all of them with economizers, nor is it advisable to apply them where boilers are to be used for standby service.

Increased pressures and temperatures have brought about great changes in boiler design and operation. The basic principle on which a design is carried out is the absorption of a maximum amount of heat by the surfaces with a minimum draft drop. This result may best be accomplished by a large amount of heating surface properly insulated with large flow spaces for the gases. Increasing the height of a boiler, for example, from fourteen to twenty tubes high will increase the efficiency without increasing the draft loss proportionately. As there is danger of the brickwork failing from plastic deformation when furnaces are operated under a positive pressure, it would be more advantageous to operate them under a slight suction, for in this case the temperature of the brickwork would be maintained below the plastic point.

Since the operating efficiency and maintenance cost are the measures by which a boiler design is judged, all factors entering the problem—economizers, furnaces, stokers, superheaters—must be properly coordinated for the best results.

Beginning Monday, June 20, the American Boiler Manufacturers' Association will hold its thirty-third annual convention at Bedford Springs, Pa., and will continue, alternating business sessions with a golf tournament, tennis and other sports, until Wednesday, June 22.

The program will include reports on the American Uniform Boiler Law Society, by E. R. Fish and Charles E. Gorton; discussion of the "Simplification of Data Sheets" and the "Standard Stamping of Boilers," by Joseph F. Scott, of the New Jersey Board of Boiler Rules, and C. O. Meyers, of Columbus, Ohio; an address by Judge William H. Speer, of Jersey City, N. J., on "Current Menaces to Industry"; a talk by L. H. Parks, on "The Proper Method of Filing and Numbering Drawings." At the evening session, Monday, moving pictures will be shown of the production of iron and steel at the plant of the Midvale Steel & Ordnance Company. Reports of the standing committees will be taken up and discussions held on the "Height of Hand-Fired Return Tubular Boilers Above the Grate," and on a paper on "Tolerances," prepared by S. F. Jeter, of the Hartford Steam Boiler Inspection and Insurance Company. The last day of the convention will be devoted to the election of officers and to the reading of a paper, "Duties and Possibilities of a Board of National Boiler Inspectors," by F. R. Low, editor of *Power*.

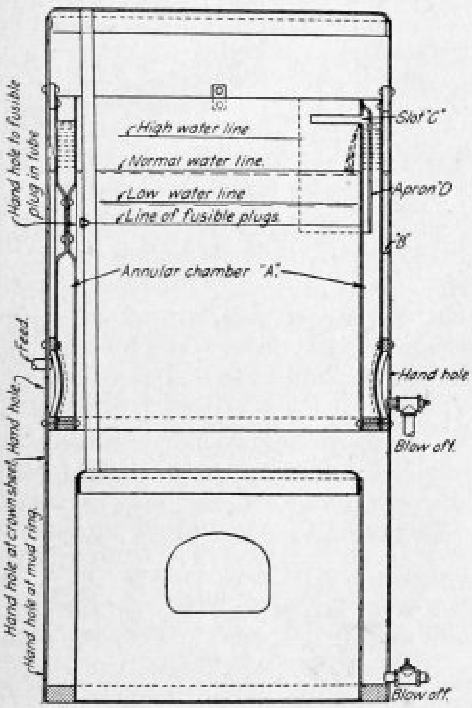
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Scale-Proof Boiler for Locomotive Cranes

The Industrial Works, Bay City, Mich., has recently built a new patented locomotive crane boiler equipped with an annular scale chamber between the tubes and the shell plate. The design of this scale chamber in conjunction with the rest of the boiler design is such that the various impurities in the feed water are precipitated and held where they can do no damage.

In this boiler the feed water is slowly passed through the scale chamber (at about 1/200 of the speed through the in-



Vertical Section of the Boiler

take pipe) and attains a temperature at which the scale-forming impurities will be liberated from solution without the use of any chemicals. The impurities are then carried in suspension, and as the movement of the water is slow, these suspended precipitates settle down readily to the bottom of this chamber. This settling is accelerated by the decrease in its fluid friction.

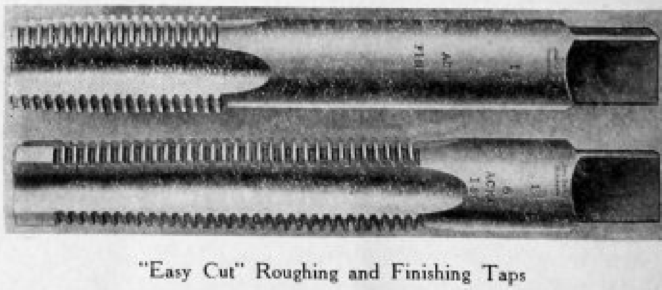
The purifier consists of the annular scale chamber "A" extending completely around the tubes, with a 1-inch water space "B" between this chamber and the boiler shell. The outlet into the main portion of the boiler is the slot "C," guarded by the apron "D." The feed water is admitted directly to the scale chamber "A" at a point farthest from the outlet slot. It then travels slowly around this chamber to the outlet, the apron "D" keeping any floating impurities from being discharged into the main boiler.

The sulphates of calcium are the hardest of the scale-forming impurities to get rid of. They are precipitated at 280 degrees F., corresponding to a boiler temperature when holding steam at only 35 pounds gage pressure. The carbonates and magnesia are precipitated at lower temperatures. These are all caught in the scale chamber together with mud, oil and, in fact, all solids except common salt, for the first application of heat is what causes the liberation of these solids. The impurities left in the scale chamber do not bake into scale, as they do not come into contact with the hot furnace sheets, but are left as a soft mud, which may be readily blown or washed out.

In a test of a 42-inch diameter boiler of this type, feed water naturally carrying 5 grains per gallon was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gallon. The feed was taken from a barrel agitated with carbonic acid gas to form calcium carbonate. After about 1,200 gallons of this kind of water had been passed through the boiler it was allowed to cool. The heating surfaces and the lower mud ring were found to be perfectly clean, with mud about 6 inches deep in the scale chamber. The blow-offs were both plugged so all impurities remained in the boiler. It was interesting to note that the presence of so much precipitated impurity in the scale chamber did not interfere to any appreciable extent with its operation.

New Development in Roughing and Finishing Tap Design

A new development in the design and manufacture of roughing and finishing taps has been placed on the market by John Bath & Company, Inc., Worcester, Mass. The roughing tap is designed with a pilot and the first few teeth similar to the U. S. S., gradually taking the acme form. The pilot squares the tool concentric with the hole, and, being well tapered, the tap starts easily and the cutting is distributed over its full length. Alternate sides of the teeth are relieved so that only one side of a tooth is cutting. It is claimed that of a series of broad nose tools, and roll the chips out easily of a series of broad nose tools, and rolls the chips out easily into the clearance of the flutes. There is no jamming of chips in the flutes to choke the tap, and the excessive effort exerted in hand tapping is reduced 50 percent, due to the free cutting qualities of the Bath tap.



"Easy Cut" Roughing and Finishing Taps

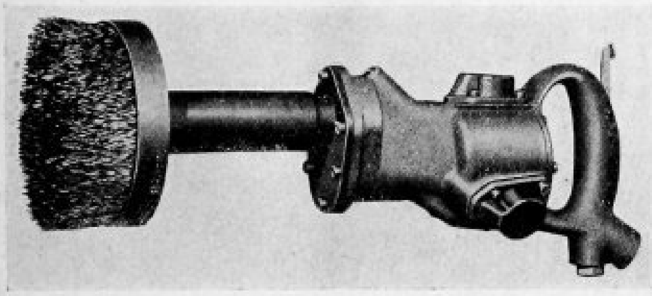
The finishing tap has the same special relief and is ground on the Bath production thread grinder, correcting the lead, angle, hardening distortions, and making a finished cutting tool. The tap cuts its own size, and it is claimed to be the only tap which will produce threaded holes in conformity with the close fit tolerances and specifications laid down by the national screw thread commission.

The taps are known as Easy Cut and are available in U. S. standard or National coarse and S. A. E. or National fine thread standard sizes. They are also obtainable in Lowenhertz or International metric sizes and in special diameters and pitches. The action of the 60 degree Easy Cut tap is similar to that of the Acme, and for ordinary sizes the use of a roughing tap is unnecessary, the thread being cut and finished with but a single tap.

It is stated that although giving unusual accuracy, these taps are made essentially as production tools.

Standard Drill Equipped with Wire Brush Cleaner

A wire brush of rugged design has recently been placed on the market by the Ingersoll-Rand Company, New York, for use with its standard No. 6 "Little David" drill. It is a brush with face diameter of 5 inches and is made up of wires of a special heat-treated steel which has been found to have good wearing qualities. It is sturdily constructed and will stand up under severe service.



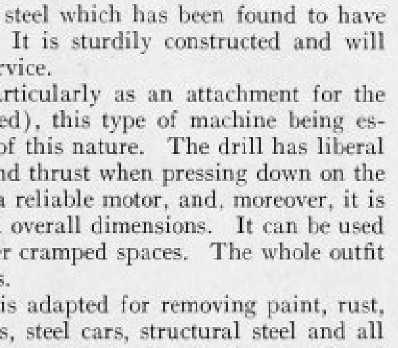
Drill Fitted With Wire Cleaning Brush

It is manufactured particularly as an attachment for the No. 6 drill (as illustrated), this type of machine being especially suited for work of this nature. The drill has liberal bearings to take up the end thrust when pressing down on the work, a high speed and a reliable motor, and, moreover, it is of light weight and small overall dimensions. It can be used in sharp corners and other cramped spaces. The whole outfit weighs only 11½ pounds.

The wire brush outfit is adapted for removing paint, rust, scale and dirt from tanks, steel cars, structural steel and all sheet metal surfaces. It is useful for cleaning iron, steel and aluminum castings.

Cleco Pressure Seated Air Valve

THE Cleveland Pneumatic Tool Company, Cleveland, Ohio, has recently brought out an air valve designed to eliminate air losses through leakage in transmission. The object sought was to construct a valve in which the air could not come in contact with the seat, thus avoiding replacement of seats, and also to utilize the air pressure as a seating agent to hold the valve plug on its seat, thus eliminating packing, gaskets, stems and springs and reducing the valve parts to three, i.e., body, plug and handle.



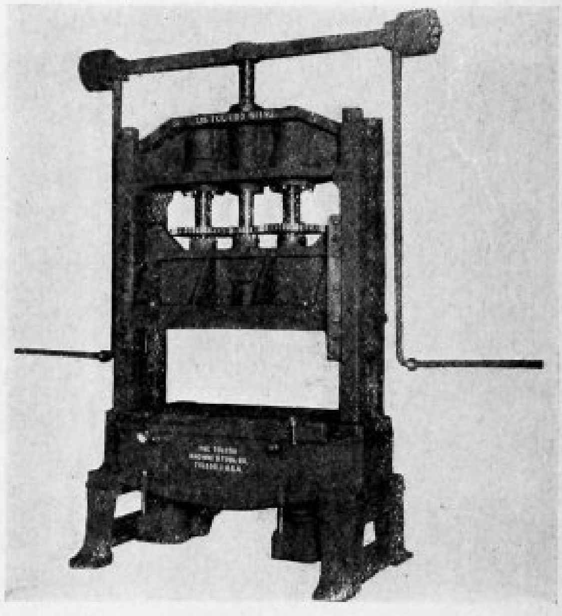
Section of New Air Valve

This was accomplished by using a "hollow taper plug" with the large end uppermost; the air entering at the top, passing through and out of an opening in one side of the hollow plug into the supply chamber which connects directly with the air hose without the air coming in contact at any time with the valve seat, which is the outer wall of the plug as indicated by *C* on the drawing. The long arrow shows the direction of the air in its travel through the wide unobstructed air passage of the valve which is free from any angle turns to impede its progress. The short arrow indicates the point on the large end of the plug where the air pressure is constant, forcing the taper plug against the walls of the valve body.

The valve is provided with a unique waste arrangement to allow the accumulated pressure in the air hose to escape to atmosphere when the valve is shut off as shown by air ports *A* and *B* on the drawing: this is to safeguard the operator, who, when disconnecting the hose from the valve, often receives a gush of air in the face and accidently gets scale or grit in his eyes.

Large Double Screw Press for Plate Work

To meet a demand for a screw press with sufficient capacity and bed area to try out sheet metal blanking, forming, drawing, stamping and other dies which are too large for the ordinary single screw press, the Toledo Machine and Tool Company, Toledo, Ohio, has designed and built the large double screw press shown in the accompanying illustration. Below are some of the principal dimensions:

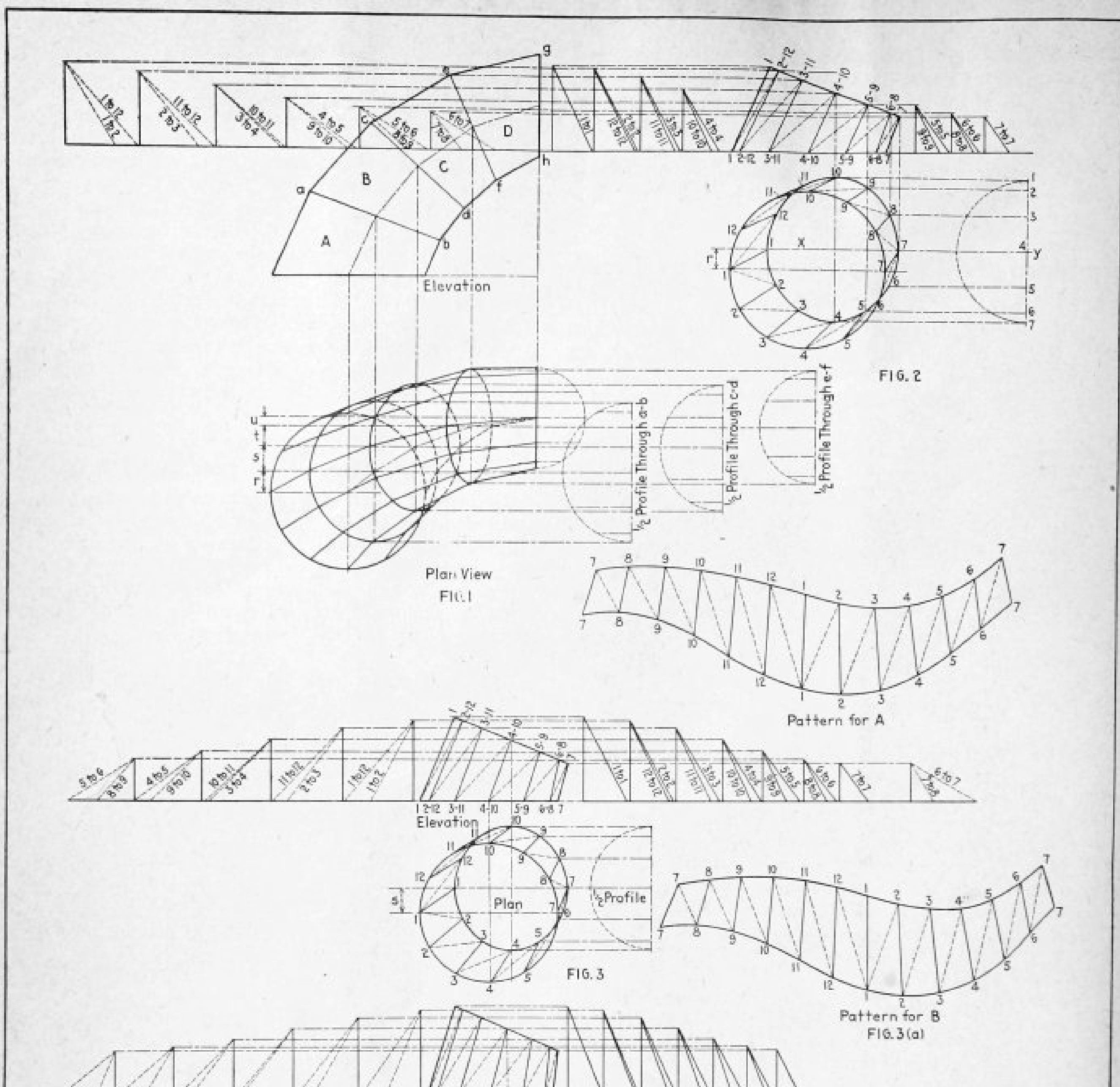


Double Screw Press for Use in Plate Work

The weight is about 14,000 pounds; area of bed, 30 inches by 54 inches; opening in bed, 20 inches by 48 inches; area of slide, 24 inches by 49 inches; shut height on top of bed, 14½ inches; open height on top of bed, 32½ inches, and thickness of bolster plate, 2½ inches.

The press is fitted with two 4-inch diameter screws. The bed of the press is arranged with a spring pressure drawing attachment, which is used when trying out combination and deep forming dies.

E. C. Sattley, associated for twenty years with the Page Steel & Wire Company at Pittsburgh and Monessen, has joined R. J. Jones, formerly manager, and Oliver G. Boyd, former secretary, of the Tube & Pipe Supply Company, in forming a new corporation under the name of the Iron & Steel Products Company, with offices at 230 Fifth avenue, Pittsburgh, Pa



Layout of Tapering Elbow Pipe Sections Forming a Compound Curve

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

CONDUCTED BY C. B. LINDSTROM

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Tapering Elbow Sections Forming a Compound Curve

Q.—Please give me information on the layout of an elbow forming a double curve, each section being tapered. A. J.

A.—The example given some time ago in THE BOILER MAKER on a tapering helical elbow demonstrated the principles of triangulation which may be applied in this case. In Fig. 1 the plan and elevation indicate the general arrangement of the pipe sections. The plan shows each section offset and the centers on the respective miters are back of each other, as indicated by the distances *r-s-t* and *u*. The miters in the elevation are straight lines, as *a-b*, *c-d*, *e-f*. By making these miters as in this case, the sections *A-B-C* and *D* may be laid off as transition pieces, and, using triangulation development, the patterns will form or shape up so as to give the proper angle connection between the pipe sections. If the true miters bisecting the angle between the pipe's axes are used, then the twist for giving the rise or fall of each pipe must be established as explained in the helical pipe problem given in a previous issue.

Having determined the distances *r-s-t* and *u*, and laid off an elevation as in Fig. 1, proceed with the development of each section. This work is done as shown in the layout of section *A*. Transfer from Fig. 1 the elevation of section *A*, and from this view lay off the plan. We may assume that the profile on the miter is circular in form and drawn with radii equal to one-half of miter lengths *a-b*, *c-d*, and *e-f*. For the base of *A* in the plan, draw a circle and then set off the distance *r*, on *x-y*, and from point *y* draw a semicircle and divide it into equal parts, and from these points draw projectors parallel with *x-y*. On the miter 1-7 of the elevation set off the distances 1-2, 2-3, 3-4, 4-5, etc., of the semicircle. From the points 1-2-12, 3-11, etc., of the elevation draw vertical projection lines to intersect those drawn from the semicircle, thus locating points 1-2-3-4-5, etc., in the plan. Draw in the triangulation ends in both views, from which data their true lengths can be found by drawing right-angled triangles shown to the right and left of the elevation of section *A*. The completed work for the other sections being shown, the layout should be readily understood.

Dry Back Boiler

Q.—Will you please tell me what a *dry back* boiler is and where it is used? S. T.

A.—Dry back boilers are similar to single-ended Scotch boiler types and resemble these in outward appearance. The difference in the two types is in the construction of the combustion chambers. The combustion chambers in Scotch marine boilers are surrounded by water, whereas in the dry back boiler the combustion chamber is not, but is attached to the back end of the boiler and bricked in. This explains how the dry back boiler derived its name. By making the dry back boiler in this manner, the cost of construction and weight as compared with the Scotch type is considerably reduced. This type of boiler is also spoken of as the *Clyde*. It is used mainly in England for small vessels, as tugs, etc.

Stays and Stayed Surfaces

Q.—Will you please give me your opinion as to what you consider the largest size radial that can be applied in a crown sheet, with the proper factor of safety? That is, I wish to know the largest size hole that can be tapped in the crown sheet without weakening the crown sheet below the proper factor of safety. If you have any rules or formulas covering this subject, I would be pleased to hear from you. G. E. R.

A.—From the rules given in the A. S. M. E. code on braced and stayed surfaces, the size of stay and maximum allowable working pressures for various thicknesses of braced and stayed flat plates may be found. Internal cylindrical furnaces and crown sheets of fireboxes are stayed as flat surfaces.

By the formula given in Article 199 of the A. S. M. E. code,

$$P = C \times \frac{t^2}{p^2}$$

$$p = \sqrt{\frac{C \times t^2}{P}},$$

where:

P = maximum allowable working pressure in pounds per square inch.
t = thickness of plate in *sixteenths* of an inch.
p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches.
C = 112 for stays screwed through plates not over 7/16 inch thick with ends riveted over.
C = 120 for stays screwed through plates over 7/16 inch thick with ends riveted over.
C = 135 for stays screwed through plates and fitted with single rivets outside of plate.
C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than 0.4 p and thickness not less than t.

The cross-sectional area in square inches of a direct stay required to support a flat surface under a given load is given by the following formula:

$$a = \frac{AP}{T},$$

where:

a = cross-sectional area in square inches.
P = working steam pressure, pounds per square inch.
T = tensile strength allowed per square inch of cross-section of stay in pounds.
A = supported area in square inches.

The *Table* 4, "*A. S. M. E. code,*" gives the maximum allowable stresses for stays and staybolts.

It is unnecessary and impractical to use stays larger than required to carry a given load with a margin of safety. By using the rules given on staying as just described you will be able to determine the size of stay needed and the allowable working pressure on stayed flat surfaces. The pitch between stays on the inside crown sheet is used in determining the allowable working pressure.

Staying Submerged Combustion Chamber of Vertical Type Boiler

Q.—I would like to be advised just how the required number of staybolts, etc., are obtained fully in the cone top vertical tubular boiler, etc. No authorities I have been able to find have dealt in detail with the bracing and stays of the submerged conical top vertical type boiler. I would be glad to see information on this matter published in THE BOILER MAKER giving the various calculations necessary. I am of the belief that it will help other readers of the magazine besides myself. C. R.

A.—Par. 231, A. S. M. E. code, on "Maximum Allowable Working Pressure on Truncated Cones" states as follows: "Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38 inches diameter at the large end may be used without stays if figured by the rule for plain cylindrical furnaces (Par. 239), making D in the formula equal to the diameter at the large end."

Par. 239: "Unstayed furnaces more than 12 inches diameter when riveted, of seamless construction or when lap welded by the forging process, shall have walls not less than 5/16 inch thick. The maximum allowable working pressure for such furnaces, from 12 inches to 18 inches diameter inclusive, and of a length not more than four and one-half diameters; also for furnaces more than 18 inches diameter and not exceeding 38 inches diameter, shall be determined by one or the other of the following formulae:

(*a*) Where the length does not exceed 120 times the thickness of the plate:

$$P = \frac{51.5}{D}\left[(18.75 \times T) - (1.03 \times L)\right].$$

(*b*) Where the length exceeds 120 times the thickness of the plate:

$$P = \frac{4.250 \times T^2}{L \times D},$$

where:

P = maximum allowable working pressure, pounds per square inch.
D = outside diameter of furnace, inches.
L = total length of furnace between centers of head rivet seams (not length of a section), inches.
T = thickness of furnace walls, in sixteenths of an inch.

"In determining the maximum allowable working pressure for unstayed furnaces more than 18 inches diameter and not exceeding 38 inches diameter, if over six diameters in length, L in the formula shall be taken as six times the diameter."

When over 38 inches in diameter, that portion over 30 inches in diameter shall be fully supported by staybolts or gussets to conform to the provisions for the staying of flat surfaces.

The stays should be placed at right angles to the slope of the frustum of the cone, if possible. Par. 221, A. S. M. E. code, gives the following on stresses in diagonal and gusset stays:

"Multiply the area of a direct stay required to support the surface by the slant or diagonal length of the stay; divide this product by the length of a line drawn at right angles to surface supported to center of palm of diagonal stay. The quotient will be the required area of diagonal stay."

Hardening and Tempering Tool Steel

Q.—Ours is a plant repair shop in which all sorts of jobs have to be done, generally in a hurry through breakdowns, and consequently our machinery, which is rather old, is subjected to a good deal of rough usage. Our chief trouble at present is with the shearing and punching press, and I have come to the conclusion that an improvement may be effected if I can find out the proper method of tempering the blades. The last pair we tempered were too hard and warped 1/32 inch. Our punches and dies do not last as long as they should, and this also is partially due to bad tempering. How are new tubes annealed? H. B.

A.—Tempering tool steel is a science and trade in itself. Trouble and delays usually arise from tools and equipment improperly treated for the heavy duty imposed on them in boiler shop work.

Tool steel manufacturers usually explain the method and temperature to which their steel should be subjected for getting best results. The best way to get good results is to follow their advice or employ an experienced tool maker who understands such work.

HARDENING AND TEMPERING THE DIE

Heat the die evenly and very slowly in a clean fire and harden the die at as low a heat as possible so as to avoid cracking and warping it. When the die is brought to the proper heat, quench it in a brine solution (composed of water and as much salt as it will dissolve), keeping the die in the solution until it is perfectly cold. Hardening steel depends mainly on the rapidity with which heat is abstracted from it and to a less extent the temperature range through which it passes. The next operation is to temper the die. First clean and brighten the upper surface. Place the die on a piece of heavy plate in the fire, and during the period of heating move the die about so as to avoid local heating. The color to which it should be drawn depends of course on the work the die is to perform. For light work the die is made harder than for heavy work; the average color to which the dies are usually drawn is a deep straw. Experience alone is the best teacher in work of this kind.

The punch is hardened and tempered in the same manner as the die. Make the temper so that the punch is a little softer than the die. This can be determined when drawing the temper. When heating and cooling tool steel there is liability of changing the shape of the tools somewhat. Both the punch and die must be tried for alinement after the hardening and tempering process.

ANNEALING TUBE ENDS

Some boiler tubes should be annealed so as to make them soft or ductile; thereby they are easily expanded and beaded without splitting. The ends are heated to a red heat and the heated ends are then set on end in a box or barrel containing a mixture of air-slaked lime and charcoal, of equal parts. A layer of this mixture 6 or 7 inches in depth is sufficient.

BUSINESS NOTES

N. W. Kistler has resigned from the safety department of the Youngstown Sheet & Tube Company, Youngstown, Ohio, to become safety inspector of the Whitaker-Glessner Steel Company, Portsmouth, Ohio.

The Power Specialty Company, manufacturer of Foster superheaters, economizers and oil stills, has opened additional offices at 512 Reliance building, Kansas City, in charge of W. F. Meyer, and 627 Linz building, Dallas.

The Quigley Furnace Specialties Company, 29 Cortlandt street, New York City, has appointed W. H. Gaylord, Jr., formerly president of the Gaylord International Engineering Construction and later sales manager of the McPhee Cement Company, as assistant traveling sales manager.

Ralph S. Cooper, vice-president and general sales manager, Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, who has just returned after eight months in Europe, establishing branch offices and agencies for the company, has been appointed general manager.

G. E. Price, Jr., has resigned his position as purchasing agent of the Davis-Bournonville Company, Jersey City, N. J., to accept a similar position in the Middle West. Owing to present business conditions it is the intention of the Davis-Bournonville Company to eliminate the position of purchasing agent, and H. H. Meixsell, of the works manager's office, will have direct supervision over purchases for the present.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Advantages of the Triangulation Method of Laying Out Plate Work

One of our subscribers in England indicates in a recent letter that certain methods used for laying out boiler and plate work in this country are more complicated than those used in British shops. Some of our readers may be interested in replying to the matters discussed in this letter, which follows:

I am greatly interested in your notes on plate development and observe in connection therewith that you have a system of development called "triangulation." I am wondering what advantage is claimed for this system. Is it quicker or more accurate, or both? There appears to be a great amount of paper work about it—I mean calculating and marking off.

After all, with regard to marking off, is there much in it?

Now and again, of course, something out of the ordinary turns up, but this is so rare that one may be allowed to work out the problem without being accused of carelessness of method.

Developing the Frustum of a Cone

I remember once I had to make the frustum of a cone, the sides of which I was unable to produce to a point. I marked the job out on a plate, using a protractor to obtain the correct angles of the sides, which, of course, enabled me to find the angle at the apex of the triangle by producing the sides of the cone to a point. I then measured the amount of slope per foot of height, thus obtaining the vertical height of the triangle. I now had sufficient data to mark off the top part of the cone, and this I did for a length of 6 feet, drawing the base curve as if for development. This curve I divided into a large number of equal parts, and, by placing the point of a set of trammels on each of these in turn and describing an arc at the trammel length, I eventually obtained a second curve, concentric with the first and 12 feet from the apex of the cone. The process is now apparent. Proceeding from this curve precisely as from the first, I gradually worked down the cone until I came to the curve required for the top of the job in hand and the last curve of all, which was, of course, the base of the cone. I may add that I used only two plates for marking out, rubbing out each section in turn with the exception of the centerline and a parallel line each side, which I retained for lining up as I changed the plates over.

I may add, also, that I know better now how such a job should be done correctly, but I maintain that marking off for plate development is not generally a complicated affair and hardly calls for any new system.

Layout of a Spiral Conveyor

I admit that I am up against it sometimes. I had no formula for marking out conveyor screw blades until I saw the method given on page 181 of the June, 1920, issue of The Boiler Maker. We make a lot of them from templates, but now and again an out size is required for experimental purposes.

Of course the method was not exact and could not be for a warped plate, but I have obtained some good results and hope to get out a few constants by experiments in the near future which will adapt the system to all spiral conveyor layouts.

I find the formula very good for screws of small diameter and pitch, with blades of 1/16-inch plate to be set cold, but for larger screws with thicker blades the hole obtained by the formula is too small and I am adding 1/16 inch to the diameter for every inch in the diameter of the pole or tube to which the blades are to be fitted. Thus if the formula determined a 5½-inch hole in a blade to be stretched over a 4-inch pole or tube, I would make the hole 5¾ inches, extending also the outer diameter of blade. This does not make the formula perfect, as it ignores the pitch of the screw, but it is something in the right direction.

Another very important thing is the setting of the blades. All work done with the hammer or fuller must be done around the inner circumference. It is quite apparent that by working on the outer circumference the plate is stretched on that edge, and as it must stretch in a rotary direction, the size of the hole is lessened and the blade is tight on the pole before the proper length of pitch has been obtained. By working on the inner circumference, this tendency is counteracted.

Gravesend, Kent, England. H. Bull.

Layout of Single Sweep Tee

Of late years there has arisen an increasing demand for piping for use in dust exhaust systems, and as the efficiency of these systems is dependent almost wholly upon the correct design of the elbows and branches, to give easy turns with as little loss by friction as possible, it is essential that more thought be given the layout of these branches than is usually necessary in the case of smoke connections and the like.

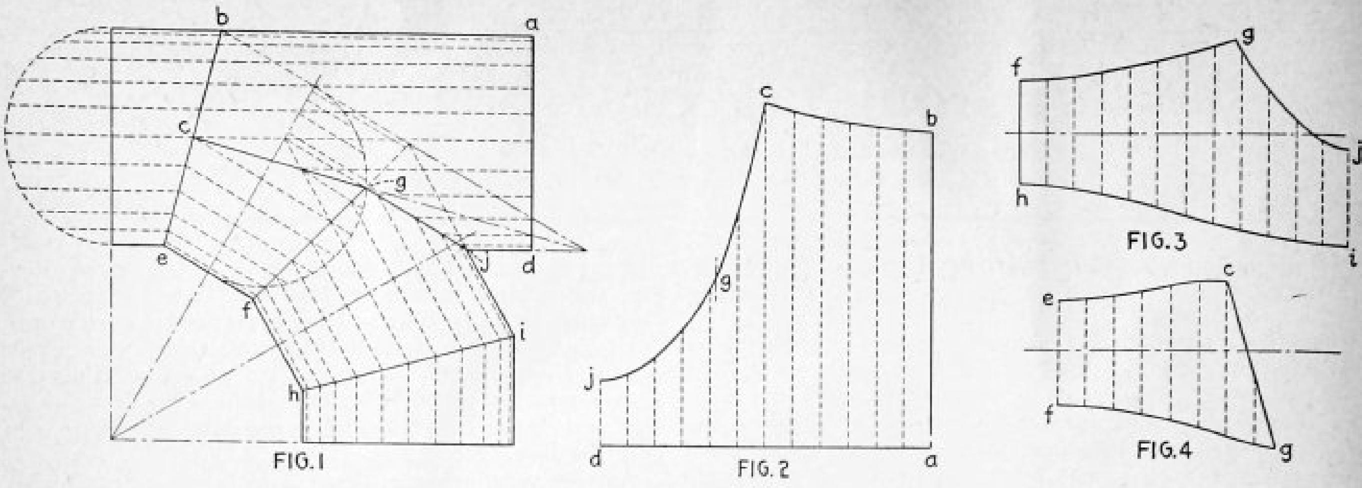
The tee connection shown in Fig. 1 was required for a case where the whole of the air might be sucked from either the end or the side outlet, or half from each, and, as may be seen, the air has as easy a lead as it is practicable to get.

To prove the necessity of making the tee in this way it has been found by tests that a common right-angled tee will cause a loss in the velocity of the air of nearly 75 percent, while a branch curved as shown, with a radius to the center of the pipe equal to one and a half times its diameter, will cause a loss of only 17 percent. The extra expense of making the sweep tee is therefore a very good investment.

To lay out Fig. 1 we draw the elbow precisely as we would for any lobster back elbow. The intersection of the two parts of the tee, shown by lines *c-g* and *g-j*, being found as follows: Produce the dotted line representing the upper side of the elbow from point *b* downwards until it strikes line *j-d*, produced if necessary. Then draw a line from point *c* to the last point, which will give us line *c-g*. From the intersection of the centerline of the tee body and the centerline of the lower section of the elbow draw a line to point *j* and we have the line *g-j*.

To develop the plates, divide up the circumference of the pipe into any convenient number of equal parts and project lines from these points on both the tee and the branch parts, as shown in Fig. 1. One-half of plate *a-b-c-d* is shown developed in Fig. 2, both halves being exactly the same. To lay this out, make line *a-d* equal to one-half the circumference and divide into the same number of parts as before. This method takes slightly longer than the common one of stepping off spaces of the same length as found in dividing the semi-circle in Fig. 1, but is more accurate and leaves less chance for error.

At each point so found in line *a-d* raise perpendiculars, the true lengths of which perpendiculars can be taken from the corresponding lines in Fig. 1. Adding the required amount for the lap will complete the layout of this plate.



Development of "Tee" Connection Used in Dust Exhaust System

In Fig. 3 is shown the development of one-half of the plate *f-h-i-g*, and in this case we lay out the centerline first equal in length to one-half the circumference, allowing for the plate being either an inside or an outside course. This line is divided up and perpendiculars drawn, precisely as explained for Fig. 2, and the lengths of these perpendicular lines taken directly from Fig. 1.

Fig. 4 is the development of one-half of plate *c-e-f-g*, and is laid out precisely the same way as the others, except that as the plate does not make a complete circle we make the distance *e-c* equal to one-quarter of the circumference and step off one more division past the perpendicular at *c*. The distance of the point *g* from the last perpendicular is found by projecting this point onto the semi-circle in Fig. 1 and measuring this distance along the circumference.

The other parts of the elbow are easily laid off, the edges being cut as shown in curved line *h-i*, Fig. 3, which is the same as for the lobster back elbow.

New Glasgow, N. S. JOHN S. WATTS.

Items of Interest to Boiler Makers

The braced area for the back head of a locomotive boiler should extend to within 1 inch of the centerline of the flange radius, and within one-half of the staybolt pitch from the nearest row of staybolts.

The braced area for the front tube sheet is to extend within 3½ inches of the outside of the flange and 2 inches of the outside of the nearest row of tubes. Compute the area to the vertical centerline of the boiler (each side separately) and deduct one-eighth of the area outside of the dry pipe ring when there is sufficient space for crowfeet below the tube sheet ring. Deduct one-sixth of the area outside of the dry pipe ring when there is not sufficient space for the crow feet. Concentrate braces as much as possible at the lower ends of the tees and around the dry pipe ring. The shearing stress for steel rivets in single and double shear is about 8,900 pounds per square inch.

INSTALLATION OF BRACES

Space the tube sheet, tee iron and crowfeet far enough apart so that the brace pin may be easily applied. Always have both sides of the brace jaws bearing directly on the brace pin. Do not cramp the jaws. Do not apply the braces when hot unless it is absolutely necessary. Use brace rods with a diameter one-eighth greater than the calculated diameter to offset losses due to corrosion. Eliminate all braces with bad welds. When applying the braces, equalize the tension as nearly as possible. Do not pull the braces tight with the nut on the jaw end. Make them the proper fit and put the tension on them with the brace pins.

In order to insure the application of proper material, all sling stay parts should be tested by the inspection department. Sling stay material should be of the very best. Holes for the pins in sling stays must never be punched. They should be drilled and as much lap as possible left from the centers of holes to the ends of the stays. Do not bend or offset sling stays. Line up the tee bars or crowfeet to eliminate bending. Always set up the work so there will be a straight pull on sling stays.

BOILER EXPANSION PLATE ATTACHMENT

Use 6-inch by 4-inch by ½-inch angles riveted to the bottom of the boiler shell for attaching the waist expansion plates. For engines having cylinders of 22 inches diameter or over use 6-inch by 6-inch by ⅝-inch angles riveted to the bottom of the boiler shell. Whenever it is possible, locate angles so they will approximate the position of the engine frame braces in order to facilitate proper alinement. Angles should be bent carefully with the 6-inch side up, and then double riveted to the boiler shell with bull rivets. Rivets are to be the same size as those used in the circumferential seams of the boiler to which they are applied. The rivet pitch should vary from 3½ inches to 6 inches. Make the distance from the back of the flange to the first row 2½ inches; between rows, 2 inches; from the outside row to the edge of the plate, 1½ inches.

Rivet holes in the shell should be slightly countersunk on the inside, and the rivets driven with full snap heads (except when the angle comes within 3 feet of the throat sheet, when the rivet heads are to be half countersunk on the inside of the boiler with bulls-eye heads.

Calk all rivets inside the boilers. Space the expansion plate holes in the vertical flange of the angle as follows: From the back of the flange, 3½ inches; between rows, 1¼ inches; from the outside row to the edge, 1¼ inches. For short expansion plates over the guide yoke space the holes to suit the proportions of the expansion plate. For 6-inch by 6-inch by ⅝-inch expansion and guide yoke angles on boilers use ⅝-inch plate. Countersink all liner holes to a feather edge and fit the liners in hot. Then rivet them in place and calk the edges with a heavy round nose tool.

Leslie H. Allen, who has recently been with Fred T. Ley & Company, contractors of Springfield, Mass., first as an industrial housing engineer and then as sales manager for New England territory, has joined the staff of the Portland Cement Association, 111 West Washington street, Chicago, as assistant manager of the Cement Products Bureau.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; A. G. Pratt, Babcock and Wilcox Company, Bayonne, N. J.; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio.; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence avenue Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

REILLY EVAPORATOR.—The Reilly self-scaling submerged type evaporator is described in detail in a pamphlet sent out by the Griscom-Russell Company, New York. Diagrams of typical installations of the type evaporator to use in special cases are outlined and the general specifications given.

COMMERCIAL POSSIBILITIES OF THE UNION OF SOUTH AFRICA.—This book, issued by the National Foreign Trade Council, New York, contains a survey of the recent industrial expansion in the mineral and agricultural resources of the South African market, which presents great possibilities for the development of American trade.

HIGH POWER VERTICAL SURFACE GRINDERS.—Grinders of the direct motor drive, floor motor drive, overhead motor drive, countershaft drive, vertical surface type, manufactured by the Blanchard Machine Company, Cambridge, Mass., are described in a catalogue issued by this comany. Important details of the construction of each type are given as well as the general specifications.

ALLOY STEELS.—The methods of producing alloy steels are discussed in a non-technical way by G. Van Dyck, manager of the special steel department of the Joseph T. Ryerson & Company, Chicago, Ill. In detail, shop equipment, furnaces, heat treating process, case hardening and testing are taken up in such a way that the average shop superintendent may select and buy the proper steel for any special work which he might have to handle.

COAL AND ASH HANDLING SYSTEMS.—Catalogue No. 40, seventy-two pages, illustrated and descriptive of various types of coal and ash handling systems for boiler houses, has been issued by the R. H. Beaumont Company, Philadelphia, Pa. The text of this booklet is descriptive of the various classes of material handling machinery which this company installs, such as skip hoists, crushers, cable drag scrapers, ash cars, hoppers, larries, bunkers, conveyors.

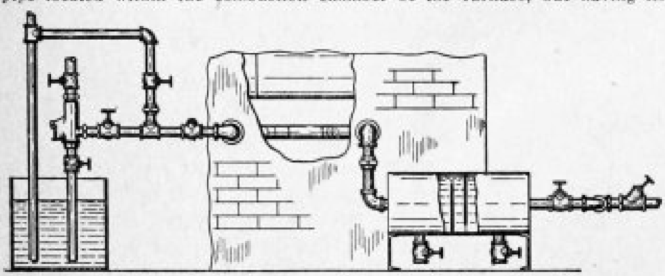
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D .C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,372,393. WATER-PURIFYING SYSTEM FOR STEAM-BOILERS. JOHN C. BEATTIE, OF LONDON, ONTARIO, CANADA, ASSIGNOR OF ONE-HALF TO M. WHITE & SON, OF LONDON, ONTARIO, CANADA.

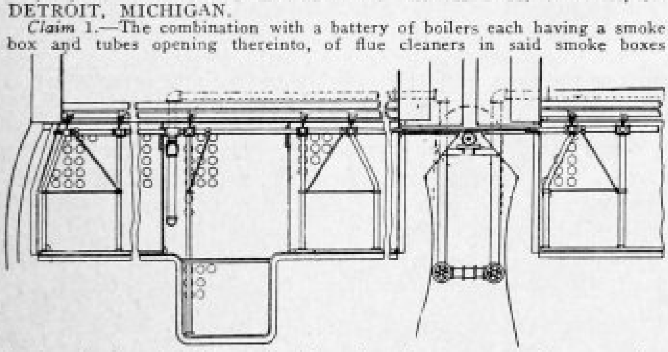
Claim 1.—The combination with a boiler and furnace of a water heating pipe located within the combustion chamber of the furnace, but having its



ends extended through the furnace wall; an inspirator adapted for connection with the steam space of the boiler and a source of water supply; a pipe leading from the outlet of the inspirator to one end of the water heating pipe; a settling tank; a pipe connected with the other end of the water heating pipe and the settling tank; a pipe leading from the upper part of the settling tank to the boiler; and a blow-off valve at the bottom of the settling tank. Three claims.

1,375,123. BOILER TUBE CLEANER. HOWARD M. VARIAN, OF DETROIT, MICHIGAN.

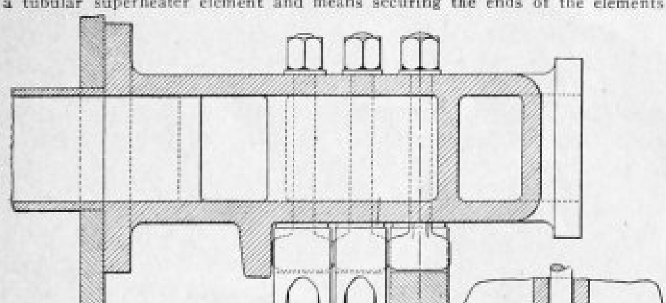
Claim 1.—The combination with a battery of boilers each having a smoke box and tubes opening thereinto, of flue cleaners in said smoke boxes



having headers in alinement with each other, an operating connection for said headers arranged in the space between boilers and including a rack-bar connecting said headers, an air conduit at the side of the boiler through which said rack-bar passes, and a tubular housing for said rack-bar in sand conduit, to prevent leakage of air.

1,372,491. SUPERHEATER FOR LOCOMOTIVE, MARINE, AND OTHER BOILERS. RICHARD BROOKE DORMAN, OF MIDDLESBOROUGH, ENGLAND.

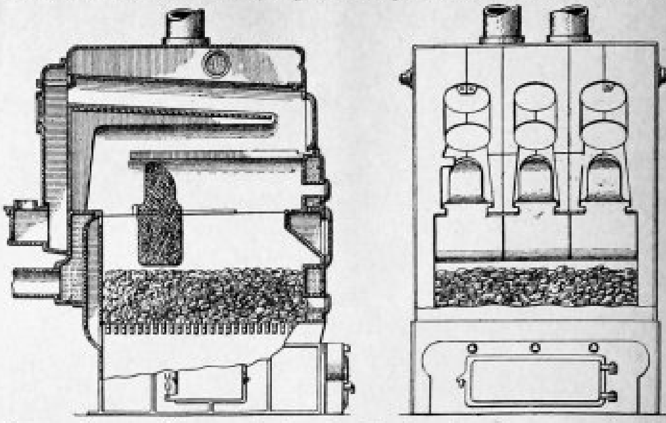
Claim 1.—In a device of the class described, the combination of a header, a tubular superheater element and means securing the ends of the elements



to the header comprising a flange or connecting piece provided with an undercut slot, and a bolt, the head of which lies in the slot, the longitudinal dimension of the slot in the flange when in position being always at right angles to the axis of the shank of the connecting bolt. Five claims.

1,373,226. BAFFLE CONSTRUCTION IN BOILER FURNACES. ANDREW C. EDGAR, OF NEWTOWN SQUARE, PENNSYLVANIA.

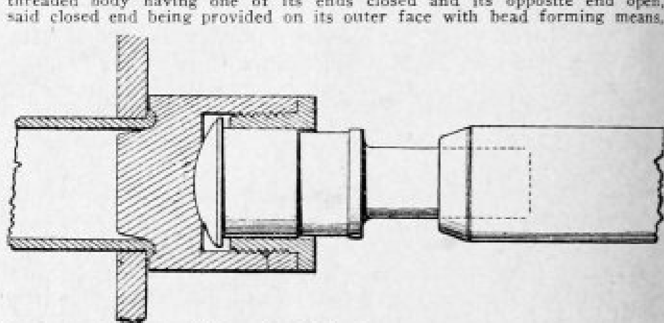
Claim 1.—A furnace comprising a plurality of assembled sections having communicating water spaces, said sections having laterally extending portions which form flue walls, a grate arranged in the lower portion of the



furnace for providing an ash pit and a chamber above the same, a plurality of substantially vertical refractory members arranged in the upper chamber and disposed near the rear end wall thereof and spaced therefrom for providing forward and rear chambers, said members forming a baffle having its lower end slightly spaced from the normal fire bed upon the grate to form a contracted lower passage which connects the forward and rear chambers, and a preheating air passage having its lower end leading from the ash pit and its upper end into the rear chamber behind the baffle, said rear chamber discharging into the flues. Five claims.

1,365,915. BOILER-FLUE TURNER AND BEADER. GEORGE W. HOOKER, OF NORTH LITTLE ROCK, ARKANSAS, ASSIGNOR OF ONE-HALF TO ALBERT KROHN, OF NORTH LITTLE ROCK, ARKANSAS.

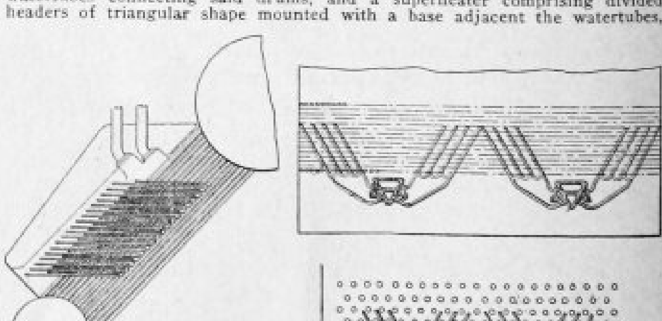
Claim.—A flue beading tool comprising a hollow internally screw-threaded body having one of its ends closed and its opposite end open, said closed end being provided on its outer face with head forming means,



the inner face of said closed end having a concave seat formed therein, a ring nut threaded into the screw-threaded portion of the hollow body, its inner end being spaced away from the concave seat, and a plunger rod provided with a portion adapted to fit snugly in the ring nut, said plunger rod being also provided with a head having a convex portion to engage the concave seat and a flange to engage the inner end of the ring nut to limit the movement of the said plunger rod, said plunger being further provided with a portion for attachment to a motor.

1,375,174. WATERTUBE BOILER AND SUPERHEATER THEREFOR. ROLAND SYDNEY PORTHAM AND JAMES DORNAN, OF LONDON, ENGLAND.

Claim. 1.—A watertube boiler comprising upper drum and lower drums, watertubes connecting said drums, and a superheater comprising divided headers of triangular shape mounted with a base adjacent the watertubes,



and elements of multiple U-formation connected to the slant sides of said headers and projecting diagonally into but not beyond the banks of watertubes, each element being disposed between adjacent diagonal rows of boilertubes whereby the superheater elements are subjected to the same degree of heat as the adjacent boilertubes and at the same time, insertion or withdrawal of the superheater elements being effected in a direction parallel to the slant sides of the headers, as set forth.

THE BOILER MAKER

JULY, 1921

Fitting Liners to Smoke Tubes in Superheater Boilers

By E. W. Fell

The fitting of copper liners in the firebox tube plate of superheater boilers has proved to be successful in British locomotive shops and has tended to increase the life of the plates. In the following article the procedure employed in carrying out the work and examples of operating records of engines so equipped are given. American superheater practice is essentially different from the British methods and the two systems will be compared in detail in an early issue of THE BOILER MAKER.

THOSE who have had practical experience with superheater boilers of the smoke tube type understand something of the difficulties arising from the deterioration of tube holes and the almost constant leakage resulting from this action. Large smoke tube holes become badly distorted in service so that the diameter on the horizontal axis is oftentimes from 1/4 to 1/8 inch larger than on the vertical axis. This is especially true of that class of boilers fitted with heavy pattern girder stays. As a result of this distortion in tube holes, the joint between the tube and tube plate is frequently broken, permitting leakage and a corresponding waste of pressure. Obviously the life of a tube plate under such conditions is short, cases being known where renewal has been necessary in less than two years. Any device designed to assist in overcoming this tendency to failure is of great value to those whose duty it is to keep locomotives on the road.

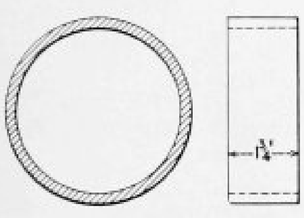


Fig. 1.—Short Lengths of Tube Cut in Lathe

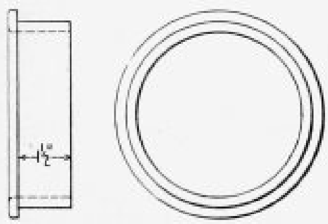


Fig. 3.—End of Tube Ferrule Beaded Over

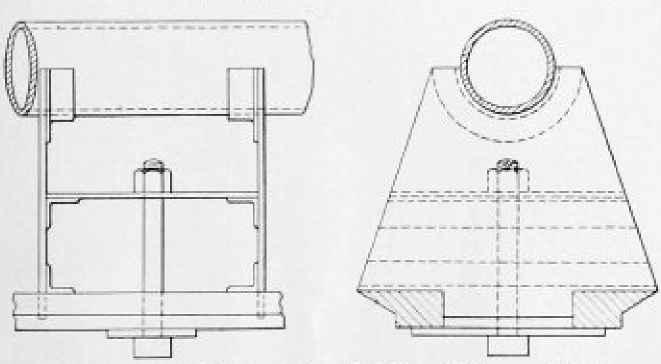


Fig. 2.—Special Stand for Holding Tubes in Lathe

Copper pipes of suitable diameter and thickness are cut into short lengths on a small lathe in a manner similar to that shown in Fig. 1. The special stand on the lathe, Fig. 2, serves to carry one end of the pipe as it revolves in the lathe and also to hold the pipe in position when the short length against the face plate is severed by the cutting tool. This operation is both simple and speedy, for when the tool has once been set the right distance from the face plate all that is necessary to repeat the operation when one section has been cut off is to release the clamps, carry the pipe forward to the face plate, secure it by the face plate dogs and set the lathe in motion again.

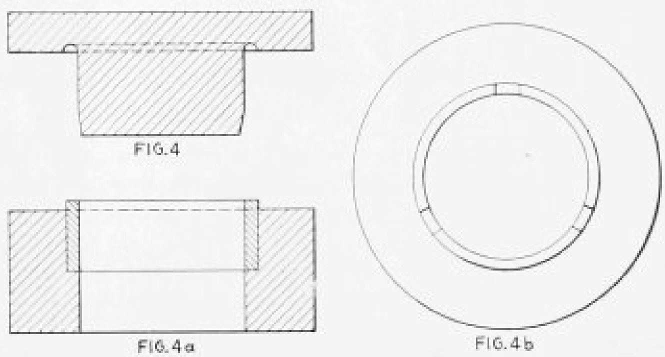
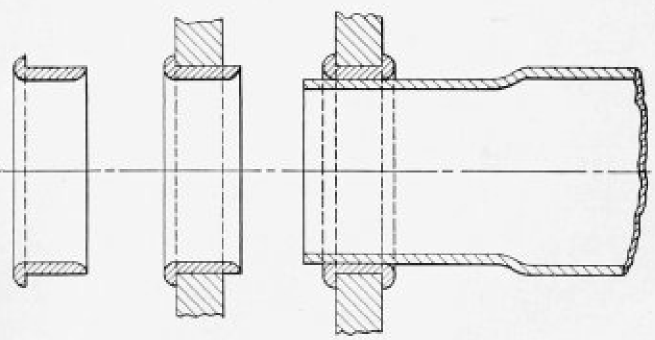


Fig. 4.—Sections of Block Used in Beading Operation



Figs. 5, 6 and 9.—Stages in the installation of Liners

The short sections thus cut to length are taken to the steam hammer and one end beaded over as shown in Fig. 3. Sections of the blocks used in this operation are shown in Fig. 4. After the beading is completed, an operation which is merely the work of a single blow with the steam hammer, the bottom block, Fig. 4 (a), is turned over and the liner driven out of the block by holding the set hammer in the slots shown. The final operation at this stage of the work is annealing the liner, after which it is returned to the lathe for completion. In order to insure that the liner is perfectly round and the walls of equal thickness throughout, it is secured on an expanding block in the lathe. This block is built up of segments having a cone center, the steady travel of which combined with the light hammering of the liner when necessary, is sufficient to insure a true circular form for the inside of the liner. After this, the outside is turned down to a diameter equal to one of the standard sizes and

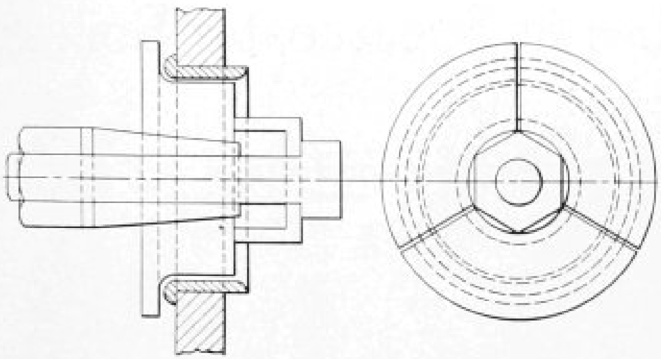


Fig. 7.—Tool Used for Expanding Liners in Plate

then serrated in order to obtain a better grip on the tube plate.

The beaded end of the liner is also finished off in the lathe and properly shaped for fitting up to the tube plate. The opposite end is also finished on the inside so that it may conveniently be beaded over in position. This is the final operation in preparing the liner for insertion in the tube plate, the finished work being shown in Fig. 5.

Preparing the Plate for Installation of Liners

But little explanation is necessary in connection with the preparation of the tube plate for fitting the liners. First, the defective tube hole is reamed out to the smallest diameter

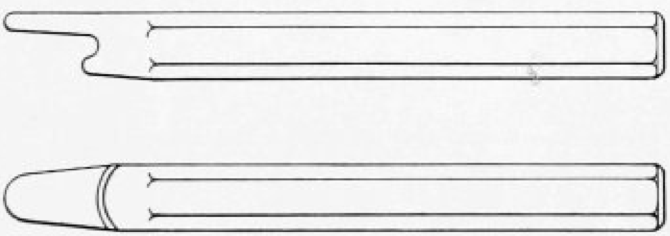


Fig. 8.—Tool Used for Beading Ends of Liner

at which a round hole can be obtained and then the face of the plate is trued up either with a facing tool or a hammer and chisel.

The liner is now driven into the tube hole from the firebox side of the plate as shown in Fig. 6. Next it is tightened in the plate by means of the expanding tool, Fig. 7. The tightening process having been completed, the plain end of the liner is beaded over with a tool similar to the one shown in Fig. 8. While this is being done, the holding-on hammer is kept in position on the opposite side of the liner to where the beading tool is being applied. The liner is also closed slightly on the front side with the beading tool in order to insure a metal to metal joint, the hammer again being held against the liner opposite the beading tool. Next, the liner is tightly rolled into the plate by means of the tube expander and if it is found necessary the two flanges or shoulders may again be closed up with the beading tool. These operations complete the work of inserting the liner. The tube having been made of suitable diameter on the firebox end is then inserted and rolled or expanded in the same manner as in any ordinary tube hole and if the work has been carefully done the repaired plate may be at least as strong as the original plate with the prospect of giving less trouble under steam pressure. This is due to the special shape of the liner which tends to reduce leakage to a minimum. Fig. 9 is a view of the finished liner in position after the insertion of the tube.

A heavy type passenger engine used on the main line between London and Carlisle built in June, 1913, had superheater tube holes in the firebox tube plate 4⅜ inches in

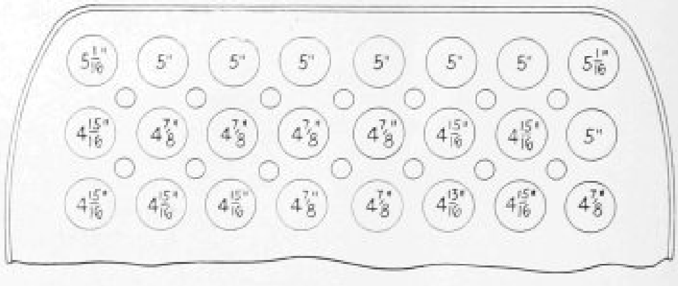


Fig. 10.—Tube Plate in Service Four Years and Seven Months

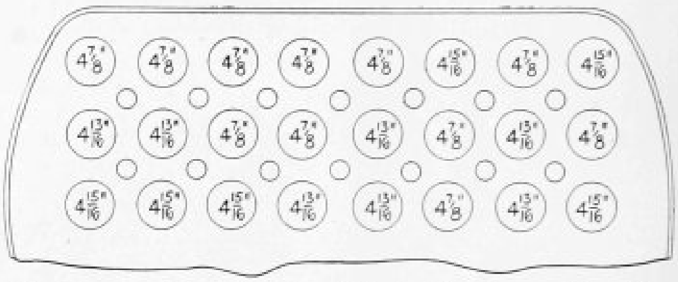


Fig. 11.—Condition of Plate Fitted with Liners After Five Years and Eight Months

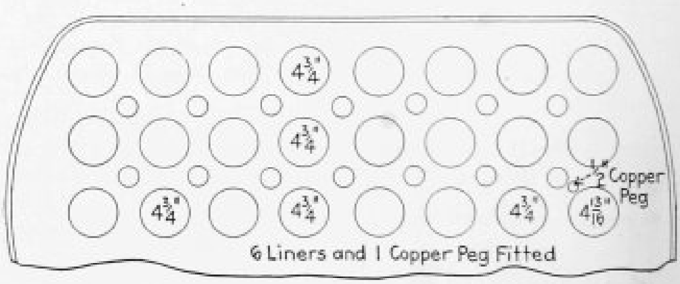


Fig. 12.—Liners Used in Repairing Cracked Tube Plate

diameter. This locomotive gave constant trouble with leaky tubes, necessitating frequent rolling of the tubes, which resulted in rapid deterioration of the plate. So bad did this action become that in February, 1915, it was necessary to fit a new firebox tube plate after only a year and ten months' service. Tube holes in the new plate were also 4⅜ inches in diameter. After a year and eight months' more service the locomotive came into the shop again for repairs. By this time copper liners had been introduced in shop practice and advantage was taken to fit eleven of them in the tube plate of this boiler, the work requiring a much shorter lay-off in the shop than if it had been necessary to fit a new tube plate.

After running approximately 71,000 miles this engine was in the shop again for repairs in December, 1917. The tube plate was in good condition, so it was decided to take out the eleven liners formerly fitted and install a complete set of twenty-four, although the plate was then two years and eight months old, or ten months older than the first plate when it was condemned. The diagram of this tube plate is shown in Fig. 10 before the complete set of liners was fitted. Following this repair the engine was again put into heavy traffic service and continued until September, 1919, at which time it was found necessary to withdraw it for the purpose of installing a new firebox tube plate. The great service performed by the use of liners is evident from the fact that while the first plate had a life of one year and ten months, the second one, working under identical conditions except for the introduction of liners had a life of four years and seven months, or 2½ times that of the first plate.

Another example of the value of these liners is that of an engine built in January, 1914, the tube plate diagram of which is shown in Fig. 11. A full set of liners was fitted in January, 1918, a repair which carried the boiler until September, 1919, at which time it was necessary to fit a new tube plate. The original plate, due to the service of the liners, had a useful life of five years and eight months, although it will be seen from the diagram the plate was far worn when the plate was four years old, many of the holes being 4⅞ inches in diameter and a few 4 15/16 inches.

While these liners were primarily designed for the repair of copper tube plates that were getting far worn, they have also been of great service in many engines fitted with steel fireboxes. It is a fact that the difficulty of properly fitting the tubes tightly in the plate, as well as maintaining them in this condition, has been a great drawback against the introduction of steel fireboxes in England. This difficulty has been to some extent minimized by the introduction of electric welding. Where electric welding has not been resorted to, these liners have performed a useful service. Introduced and fixed in exactly the same manner as in a copper tube plate, they provide a broader surface than the narrow bridge of a steel plate on which the tube may be rolled. They have proven of value in increasing the life of plates.

Liners Used in Repairing Cracked Tube Plate

These liners have also been successfully applied to the repair of cracked tube plates, as indicated in the following example. As is well known in the boiler makers' trade, it is not practical to renew a tube plate on the first appearance of a cracked bridge, for if this were done boiler shops would have to be increased a hundred fold. Yet it is absolutely essential that sound repairs to the cracked bridges be made or they become a constant source of trouble by permitting a loss of pressure. By the judicious application of a copper peg screwed into the cracked bridge and then riveted on both sides and the fixing of liners in the adjoining tube holes, a sound and lasting repair has often been effected. A repair of this nature is shown in Fig. 12.

The Manufacture of Charcoal Iron Boiler Tubes

In this day of quantity production and the intensive application of machines to manufacturing processes, the methods of charcoal iron tube manufacture employed by the Parkesburg Iron Company offer a distinct contrast to industrial methods that have as their sole object high tonnage outputs. This article outlines the methods and machines that are employed at the Parkesburg plant.

EIGHTEEN thousand tons of charcoal iron boiler tubes are turned out yearly from the mills of the Parkesburg Iron Company, Parkesburg, Pa., yet this amount in normal times is insufficient to meet the demands. Production of these tubes entails a great deal of hand working, especially the "knobbling" of the iron, which operation is the basis of quality on which the finished tube depends. The process is divided into three distinct stages; the production of the charcoal iron bloom; the manufacture of the flat plate of charcoal iron (called skelp) and the fabrication of the tube.

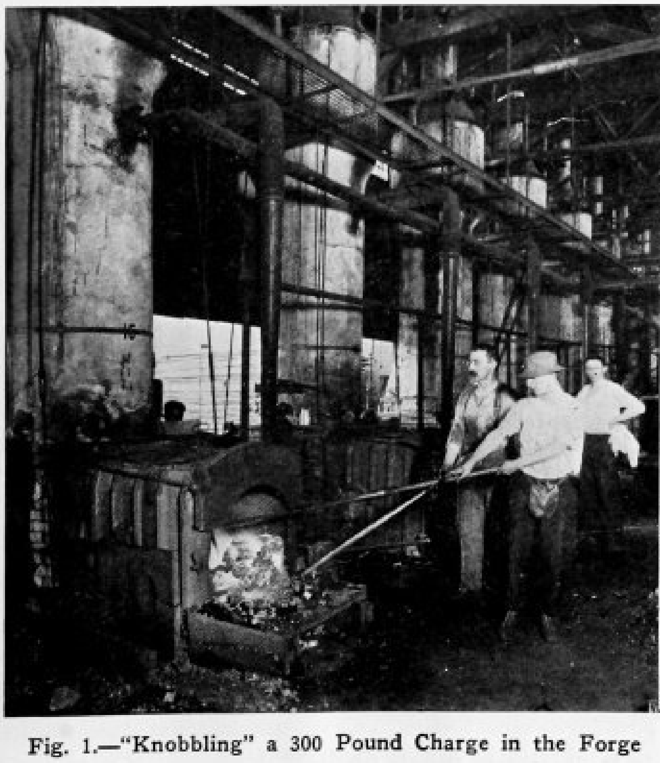


Fig. 1.—"Knobbling" a 300 Pound Charge in the Forge

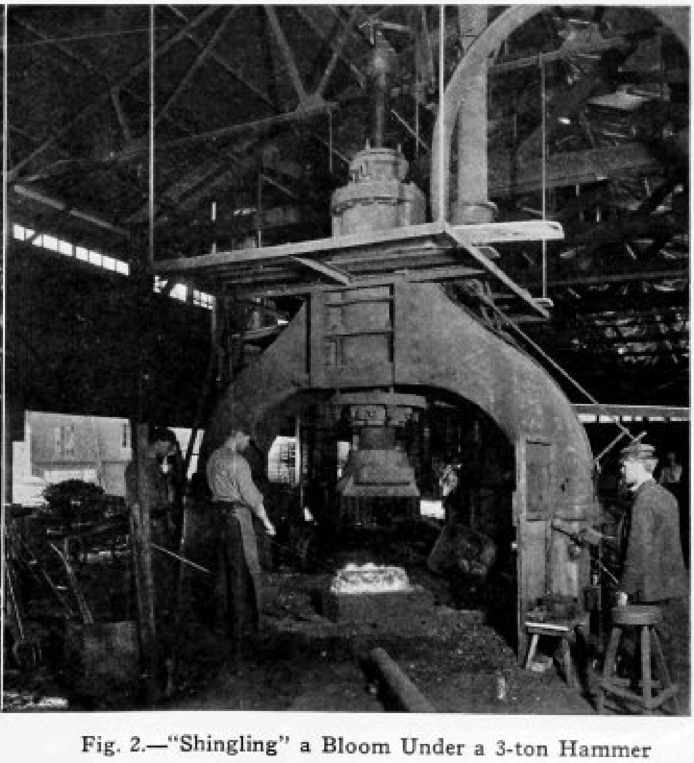


Fig. 2.—"Shingling" a Bloom Under a 3-ton Hammer

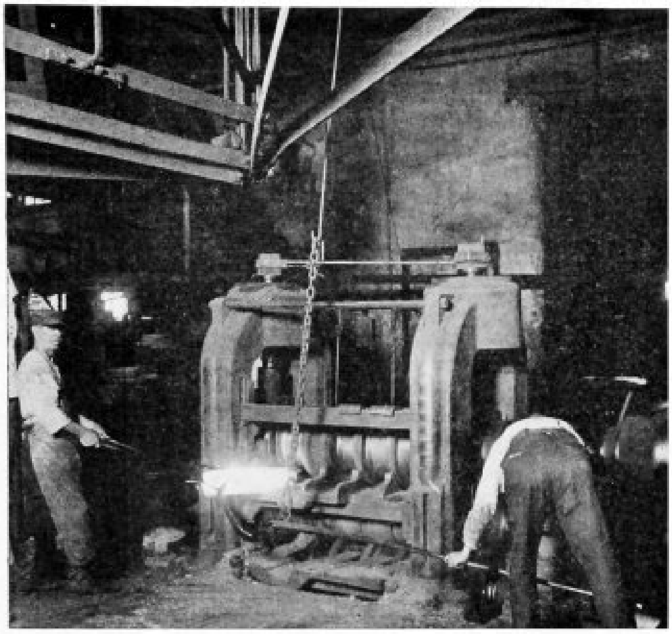


Fig. 3.—Running the Heated Blooms Into Bars

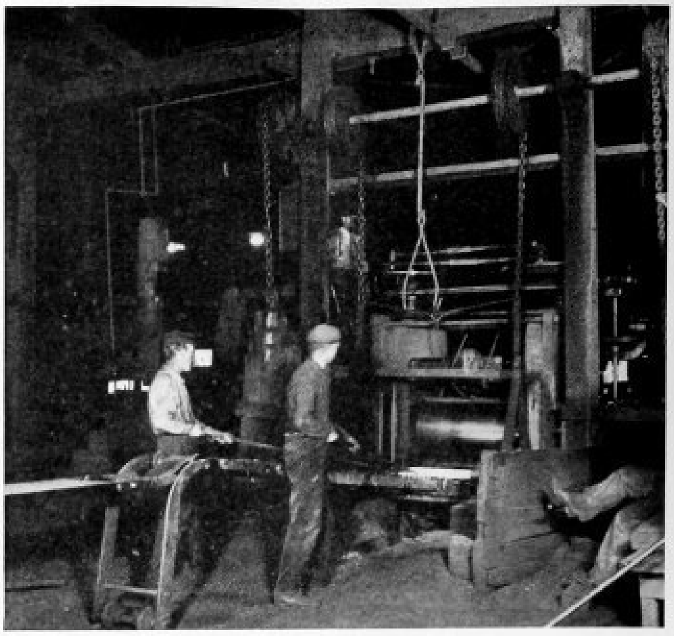


Fig. 4.—Rolls Which Give Plates Proper Width and Length

Rigid Specifications for Scrap Metal

Only selected scrap, purchased to rigid chemical specifications from plants using highly refined material and tested and analyzed before it is unloaded from the cars at Parkesburg, is used. Metal containing copper, tin, nickel, chromium or more than one-half of one percent silicon is unfit for use, as these elements tend to make the finished product dry or brittle and unweldable. From piles of this carefully sorted scrap, mixed charges are weighed out into three-hundred pound lots, the standard charge for a fire. If more than three hundred pounds could be handled successfully, larger charges would be used. However, this quantity has proven most satisfactory to work.

The charges are placed in small forge fires, Fig. 1. These little furnaces are to all intents and purposes identical with the historic forges used in ancient times. In a rectangular hearth about 16 inches deep by two feet square, with a cast-iron box about three feet high, and open in the front, the charges are slowly melted in incandescent charcoal, the required oxygen being furnished by a blast of air, introduced through a tuyere in the side of the furnace and about eight inches from the bottom.

Under the action of the blast, which enters the charcoal bed at an angle at about half its depth, the fire becomes hotter and the light scrap begins to melt. The fire is not forced at first, however, and the scrap gradually increases in temperature until it commences to melt and forms drops or globules.

During the heating, the impurities, such as carbon, manganese, silicon and sulphur are slowly oxidized. Most of the carbon and some of the phosphorus and sulphur go off as gas. The higher the temperature of the metal the more avidly does the oxygen attack it, so that when the melting point is reached, the remaining impurities have been oxidized, together with a relatively large proportion of iron. They have also united to form a highly basic slag (principally ferrous

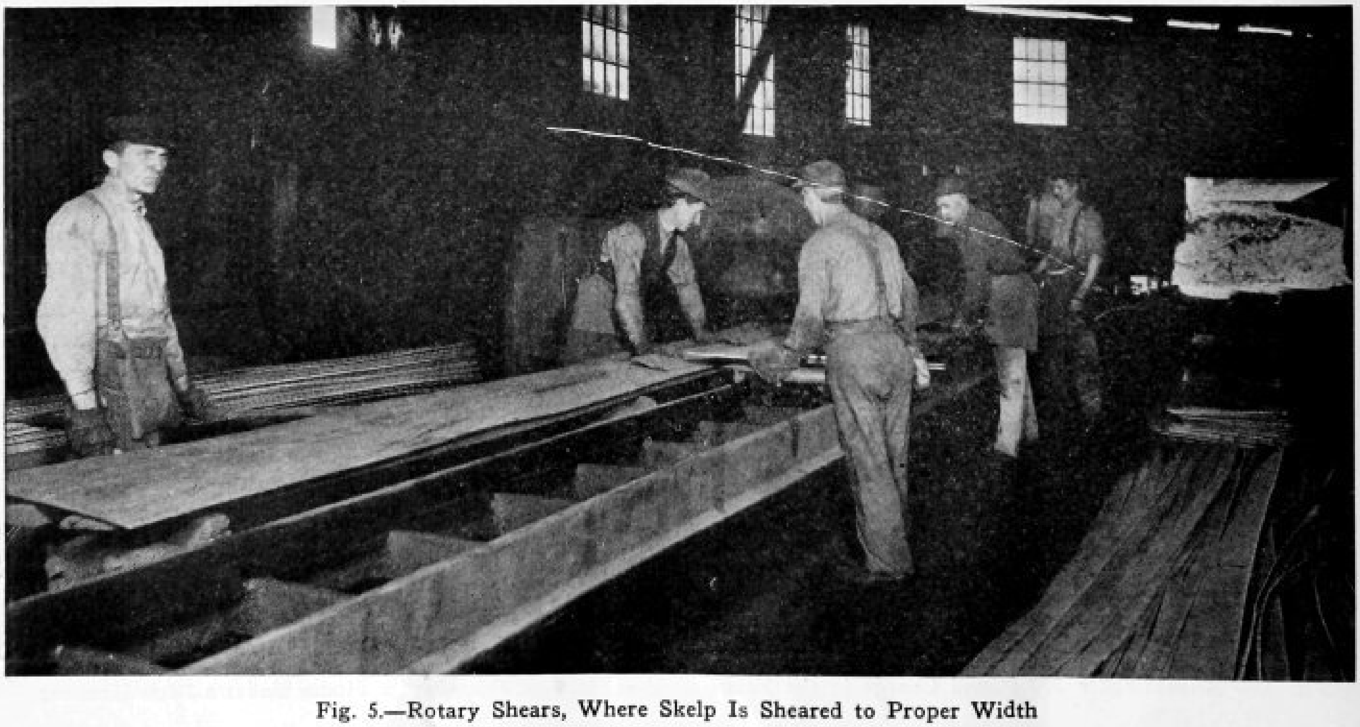


Fig. 5.—Rotary Shears, Where Skelp Is Sheared to Proper Width

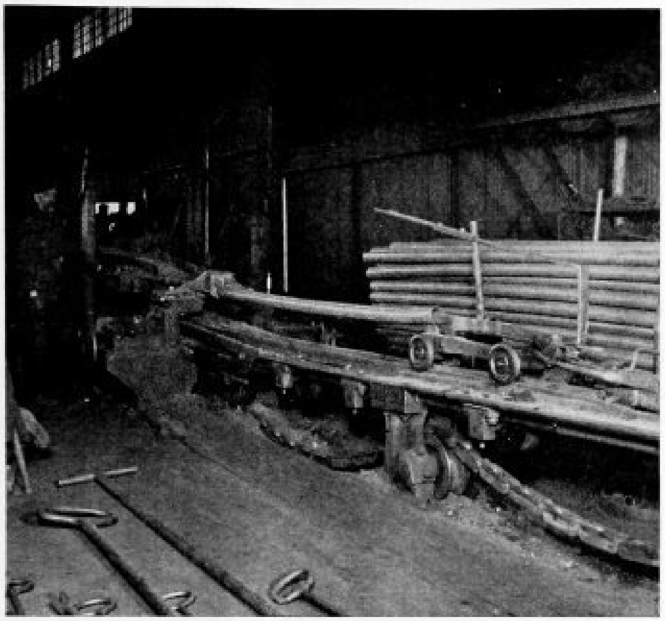


Fig. 6.—The Heated Skelp Is Drawn Through Dies to Give It a Cylindrical Shape

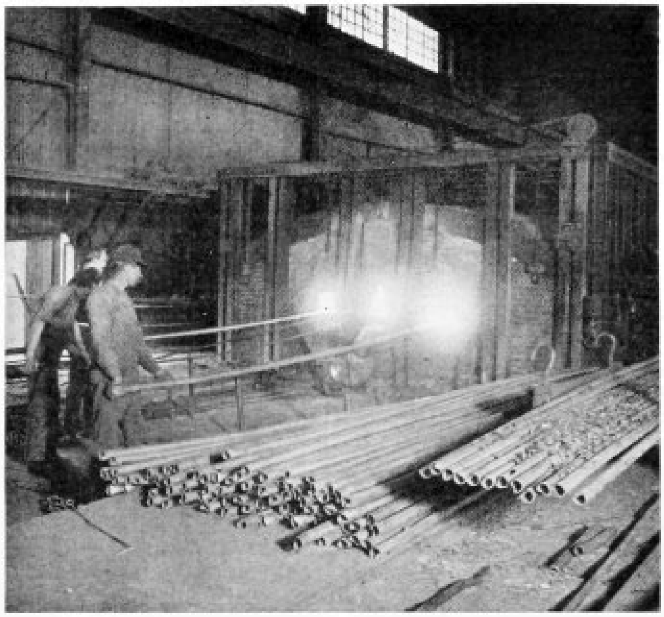


Fig. 7.—Welding Furnace Where the Bent Skelp Is Given the Welding Heat

oxide) with a comparatively low melting point, and therefore quite fluid at this temperature.

As the slag, or cinder as it is called in the forge, exudes from the charge, the scrap begins to change its nature, and the carbon having been burned off, the mass becomes pure plastic iron composed of microscopic grains each covered or glazed with a film of slag that has not escaped. The excess slag, which remains molten during the entire operation, runs out of the lump during its removal from the forge fire, as well as during subsequent heating and hot working operations.

Producing the Bloom

The incandescent lump is removed on a buggy to a steam hammer where it is forged or "shingled", as it is called, to a bloom about 30 inches by 5 inches by 6 inches, Fig. 2. The lump when placed under the hammer resembles a sponge, the holes of the sponge being filled with the molten slag, the whole being covered with a husk of iron oxide and partially consumed charcoal. Under the hammer the husk falls away, the grains of iron become welded together, and much of the molten slag or cinder is forced out. The remaining slag is almost entirely worked out in the heating and rolling operations which follow. From the shingling hammers the hot blooms are charged into coal-fired reheating furnaces, drawn at a welding heat and rolled, as shown in Fig. 3, into bars 7 inches by 9/16 inch cross section and about 15 inches in length.

After cooling, the bars are sheared into required lengths, depending on the weight, size and thickness of the skelp desired and are piled five, six or seven high, according to the weight of the iron wanted.

These piles are charged into a coal-fired heating furnace and brought to a welding heat, when they are removed and rolled in a two-high plate mill. The rolling is done trans-

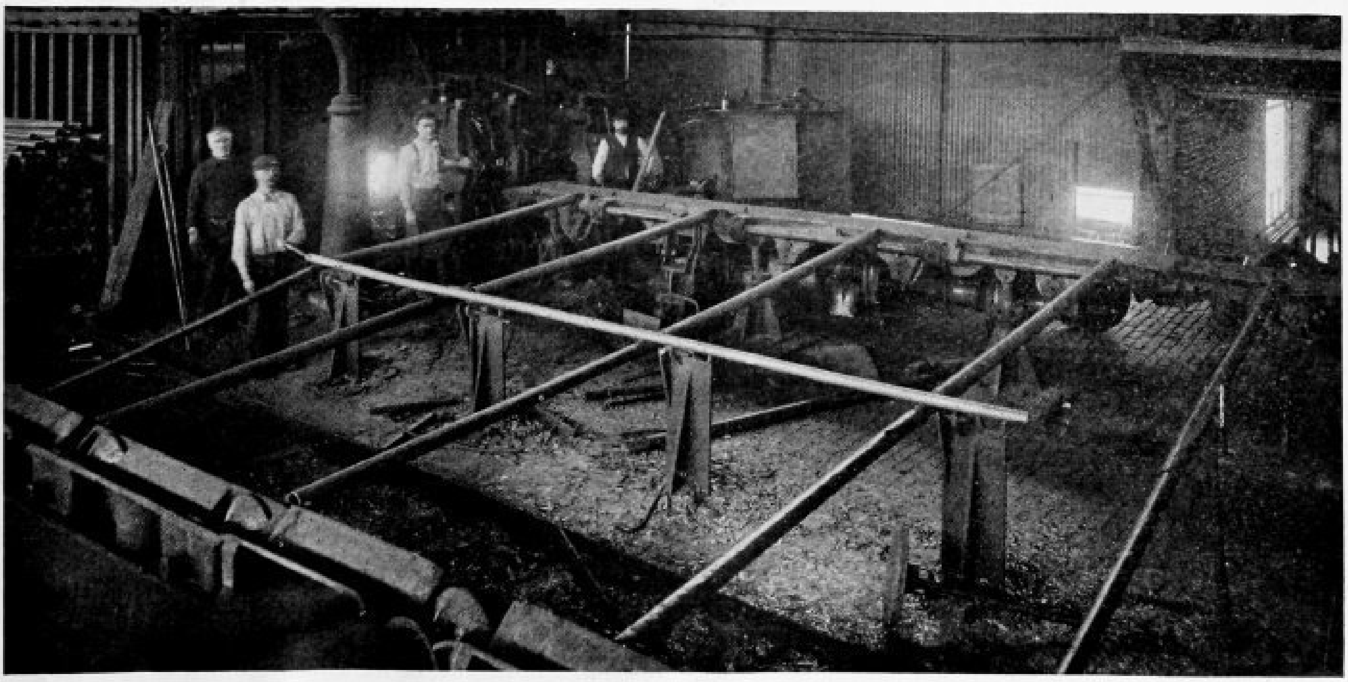


Fig. 8.—Welding the Tube Over a Mandrel Held on the End of a Rod Between Rolls

versely, i. e., the length of the pile is parallel with the axis of the rolls.

The pile is run through the mill until the length of the resulting slab is the desired width of the finished plate. The slab is then turned through 90 degrees and rolled for length and thickness. By this means, the iron is given cross fiber or additional strength across the grain, Fig. 4. At Parkesburg, the metal is always rolled in the same direction, the plates being sent back over the top of the rolls. This accomplishes two desirable objects: The few impurities left are worked to one end of the plate, which is cropped off, and a much better surface is obtained.

The plates, rolled to a certain fixed amount heavier than the desired gage of the tubes into which they are to be made, are next sheared or cropped on the ends and then trimmed on rotary shears into strips of the proper width to make the tubes for which they were ordered. The width is in excess of the finished tube, so as to allow for the lap. The shearing to width is shown in Fig. 5. Sheared skelp, it is claimed, is better than grooved skelp, because it welds better and easier, and makes a safer tube.

After the skelp is sheared, it is carefully inspected by experts. This work is always performed in daylight.

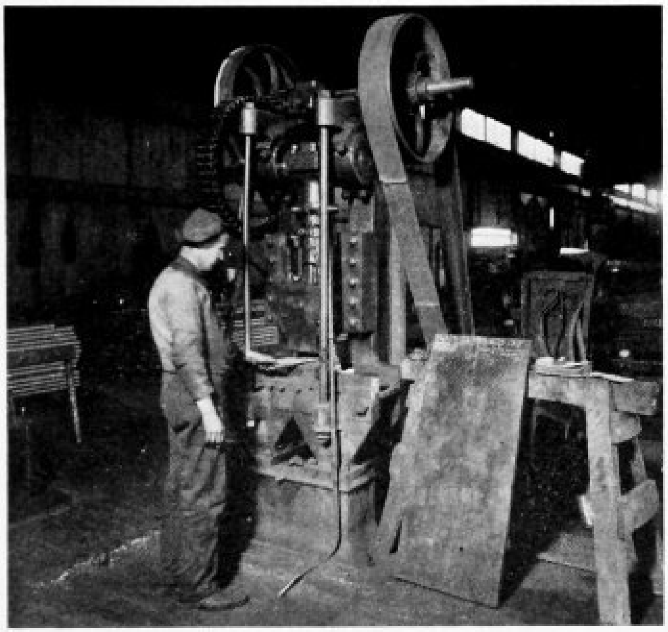


Fig. 9.—Crushing the End of a Tube, Weld Being Held at the Side. This Test Discloses Imperfectly Welded Tubes, Which Are Scrapped

Owing to the care and skill exercised in their manufacture the tubes are remarkably free from blisters, run true to gage, and are so soft and ductile that they bead over the flue sheet with ease.

Beveling the Plate

The first operation in the fabrication of a tube is the scarfing or beveling of the plate to insure a complete weld and one not too thick in comparison with the normal gage of the tube. The scarf is rolled on, the strip of skelp passing through a pair of hardened tool steel rolls, ground to the desired shape and diameter. The strip after scarfing, is charged into the bender, a producer-gas fired furnace where it is heated to approximately 2,000 degrees F., and subsequently drawn through dies and over a mandrel to give it a cylindrical shape, with the necessary lap ready for welding, Fig. 6.

The bent skelp is charged cold into a welding furnace, Fig. 7, in which is maintained a temperature of 2,600 to 2,800 degrees. When it reaches a welding heat the tube is pushed through the furnace by a long rod in the hands of the welder and into the weld rolls, located just in front of and on a line with the bottom door of the furnace. In front of the welding rolls, and about 30 feet distant, is a mechanism called the bar puller, which moves forward and back a steel bar of a diameter corresponding to the diameter of the tube to be welded. The tube, lap upwards, goes directly into the grooves in the rapidly revolving welding rolls. The white hot unwelded tube is rapidly carried through the water cooled cast iron rolls, passing over the ball which acts as an anvil for the weld and a mandrel for the inside of the tube, Fig. 8.

The skelp is always rolled heavier than the required gage of the tube. The additional thickness increases the pressure and therefore the friction between the tube, the ball and the rolls, and insures both a weld and a stretching of the metal in the direction of rolling, thus increasing strength and ductility and equalizing wall thickness.

As the tube passes through the rolls it falls into a cast iron trough. The bar is withdrawn and the trough rotated 90 degrees, when the tube rolls out and down a skidway. Tubes are generally run through the welding operation a second time, not that this is necessary to insure a safe weld but to make the weld less noticeable and to improve the general appearance of the tube.

Sizing the Tubes

The tube is then run through sizing rolls, each tube being given three passes to insure a true circular exterior. From the sizing rolls the tubes go to another cast iron trough, from which they are delivered to a cooling table, consisting of chains passing over sprockets mounted on shafts, one of which is driven by a motor and rotates very slowly. Equally spaced dogs catch the tubes and carry them up the incline, so slowly that when they fall over the edge and into the cradle they are practically cold.

During the progress of the tubes over the cooling table, ends of tubes selected at random are gaged to make certain that the work is running within gage limits. After cooling, the tubes are given a final straightening under dies, the upper die reciprocating vertically at each revolution of a large gear.

The crop ends of the tube as removed by the saw are tossed to the operator of a gear-driven press, called a masher, Fig. 9. The ends are mashed one at a time, the weld being held at one side so as to subject it to the greatest amount of bending. If a crop end opens in the weld the tube from which it is cut is rejected. The tubes are then cut to length on circular saws. The rough edge of the tube is then faced on a turret lathe. The next step is a flat surface inspection, for the defects on the outside and ends.

Application of the Hydrostatic Test

A severe trial of the quality of the tube is the hydrostatic test which follows. All tubes under 5 inches outside diameter are tested to 1,000 pounds per square inch, and all tubes 5 inches and greater to 800 pounds per square inch. While under the test pressure, each tube is struck sharply near its end with a two-pound hammer. This sets up vibration in the walls of the tube, already strained by the internal pressure, thereby increasing considerably the severity of the test.

The tubes are then given a final and most careful inspection, inside and out, including gaging and measuring for diameter.

A number of test pieces, representing each order or lot of tubes, are taken for examination by the testing department and subjected to flange flattening, crush and expansion tests, after which, if they pass successfully they are stenciled with white lead: "Knobbled Charcoal Iron, Parkesburg Iron Company, Tested to 1,000 Pounds." They are then ready for the customer's inspection, or for shipment.

(*Continued on page* 212)

Principles of Riveted Joint Design

By William C. Strott*

The series of articles on riveted joints commencing in this issue of The Boiler Maker *has been so arranged by the author that the information will be of value both to the student designer of boiler and tank work and to the practising engineer. In this article the subject is introduced by a discussion of the types of plate and rivet failures, joint efficiency and the calculations involved in determining the strength of a given riveted seam.*

When a riveted joint fails the fracture may take any one of three different forms; the plate may break between rivet holes, the rivets may shear, or the plate may be crushed in front of the rivets. In addition to these possibilities, riveted joints of complex design may fail from combinations of the stresses which bring about the three general types of failure. Each of these types will be treated in connection with various riveted joint designs in the following paragraphs:

Plate Failure

The manner in which a joint usually fails by breaking of the plate is illustrated in Fig. 1.

If we imagine a transverse load applied to the joint in the direction indicated by the arrows, it may be readily understood that this method of failure is due to tensile stress. Rupture of the plate will occur when the net cross sectional area of metal through the line of rivets is so small as to be incapable of resisting the load on the joint. It must be understood that the strength of only one overlapping plate is considered, because each plate receives the full stress. When both overlapping plates are of the same thickness, it is theoretically possible that both will fail simultaneously.

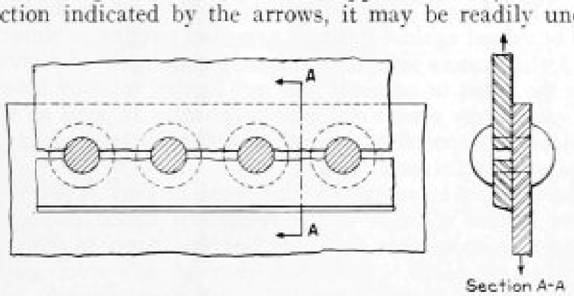


Fig. 1.—Illustrating Failure of Plate by Tension

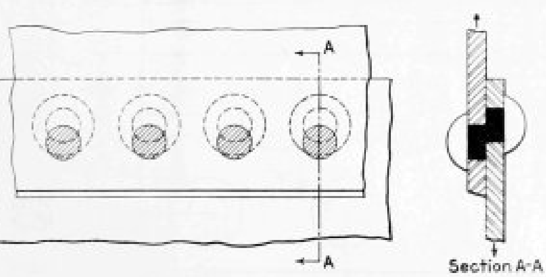


Fig. 2 (a).—Rivet Failure by Single Shear

The net length of the plate ligament in the joint, Fig. 1, is evidently equal to the full width of the plate, less the sum of the rivet hole diameters. This value multiplied by the thickness of the plate, will give the *net* cross sectional area of metal in the joint. By multiplying this latter value by the ultimate tensile strength of the material in pounds per square inch, the product obtained will obviously represent the *plate breaking strength* of the joint.

Rivet shear may be most conveniently explained in connection with the accompanying illustration, Fig. 2 (a) and (b).

If sufficient stress be applied to a joint as at (a), it may at once be surmised that the rivets will be cut or sheared on the line which forms the juncture between two overlapping plates; this is termed *single shear*.

In the case of Fig. 2 (b), however, it will be seen that the rivets must be cut or sheared on two lines which form the juncture of the surfaces of three overlapping plates; this method of failure is termed *double shear*, and it should be apparent that a rivet in double shear is exactly twice as strong as one of the same diameter in single shear.

The single shearing strength of a rivet is evidently equal to its cross sectional area multiplied by the shearing value of the rivet material in pounds per square inch. For double shear we of course figure on the combined strength of a rivet through two cross sections.

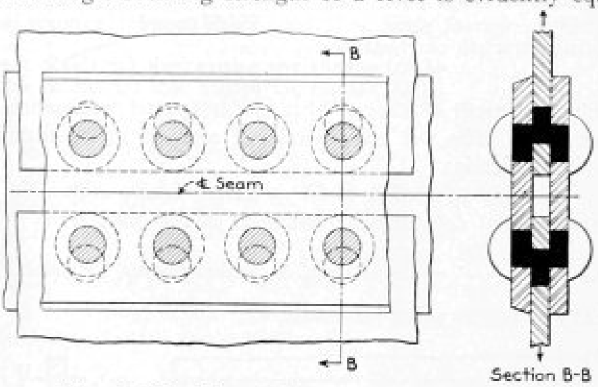


Fig. 2 (b).—Rivet Failure by Double Shear

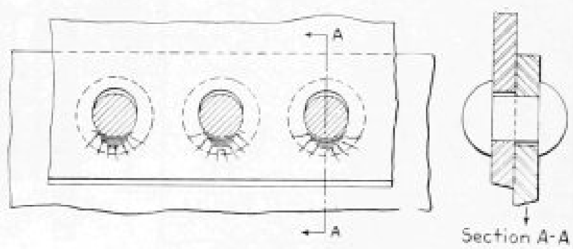


Fig. 3.—Failure of Plate by Crushing

Failure of a Joint from Crushing Stress

The failure of a riveted joint by crushing of the plate is clearly illustrated in Fig. 3.

This method of failure occurs by the plate crushing in front of the rivets when an excessive force is applied to the two surfaces; such failure results in stretch or elongation of the rivet holes. Riveted joints do not often fail by crushing, except when the plates are very thin. The bearing surface between plates and rivets is the projected area of plate in front of the rivets, which for one rivet is equal to the diameter of the rivet hole multiplied by the thickness of the plate. This product when multiplied by the crushing strength of the material will give the bearing value for one rivet. The crushing

*Engineering department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa. and Union Iron Works, Erie, Pa.

strength of a joint is a function of the plate thickness and rivet diameter only, since it depends entirely for its value on the amount of bearing surface between plate and rivets; it has nothing whatever to do with the pitch of the rivets.

For the purpose of more thoroughly explaining the function of the three foregoing methods of riveted joint failure, a practical example in simple riveted joint design will now be given.

Example: Check the joint design illustrated in Fig. 4, for a maximum load of 36,000 pounds, with a factor of

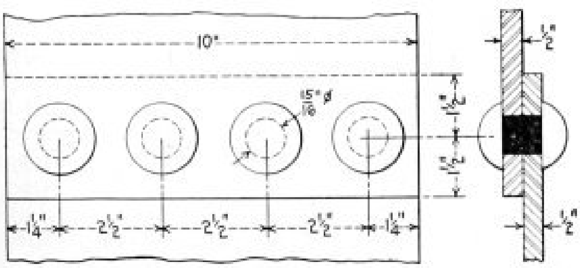


Fig. 4.—Detail of Single Riveted Lap Joint

safety of 5. If not correct, redesign the joint. Assume the following ultimate values:

Tensile strength of plate............55,000 pounds per square inch.
Shearing strength of rivets,
44,000 pounds per square inch for single shear.
88,000 pounds per square inch for double shear.
Crushing strength of plate...........95,000 pound per square inch.

Solution: The net cross sectional area of metal through the rivet holes is:

$$10 - (3 \times 0.9375) \times 0.5 = 3.59375 \text{ square inches.}$$

Then the total *safe* working strength of the plate is:

$$3.59375 \times \frac{55{,}000}{5} = 39{,}531 \text{ pounds, which proves the joint sufficiently strong to resist plate failure.}$$

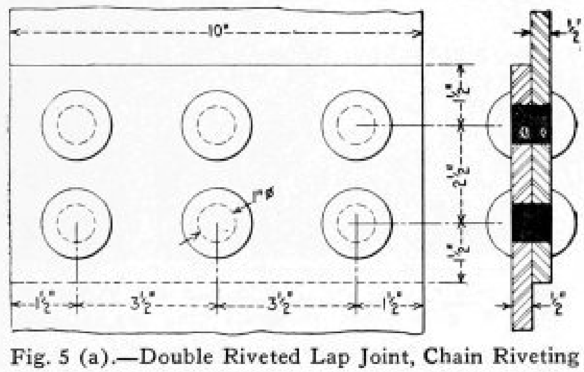


Fig. 5 (a).—Double Riveted Lap Joint, Chain Riveting

In order that any riveted joint may be capable of developing its full strength in the plate, the rivet shearing strength must be at least equal to that of the net plate section, for it is evident that the rivets must transmit the full load from one side of the joint to the other. If the rivets are not sufficiently strong, however, the joint will fail by shearing before the maximum resistance of the plate to failure has been reached. Since all the rivets in this joint are in single shear, their total safe shearing resistance is:

$$4 \times (0.9375^2 \times 0.7854) \times \frac{44{,}000}{5} = 24{,}299 \text{ pounds.}$$

This value is (36,000 — 24,299) or 11,701 pounds below the total required working load which the joint is to carry, from which we reach the conclusion that more rivets are necessary. The total rivet cross sectional area required may be found by dividing the total load on the joint by the safe unit shearing strength of the rivet material:

$$\text{Total rivet cross sectional area required} = \frac{36{,}000}{8{,}800} \text{ or 4.1 square inches.}$$

The cross sectional area of a 15/16 inch diameter rivet is 0.6903 square inch, whence the total number of such rivets required is:

$$\frac{4.1}{0.6903} = 5.8 + \text{say 6 rivets.}$$

If it were permissible to increase the joint width, this would become:

$$(5 \times 2.5) + 1.25 + 1.25 = 15 \text{ inches wide.}$$

The net plate strength then becomes:

$$[15 - (6 \times 0.9375)] \times 0.5 \times \frac{55{,}000}{5} = 51{,}563 \text{ pounds per square inch.}$$

If in a practical case it would not be possible to increase the original joint width, then double riveting would have to be used. (Note—Higher rivet strength is possible by increasing the diameter of the rivets, but this necessitates the use of rivets of disproportionate sizes. The plate strength is also reduced on account of the removal of more metal for the larger rivet holes.)

Chain riveting, Fig. 5, (a) is seldom employed at the present time, but may be used where strength is the only requirement. For vessels designed to hold liquids, where the seams must be calked against leakage, staggered riveting as shown in Fig. 5 (b) is more satisfactory, from a standpoint of economy. Since the rivets in adjacent rows are located midway between each other, they render the joint practically as tight as when the rivets are spaced but two-thirds that distance apart in a single or chain riveted joint.

The riveting arrangement illustrated in Fig. 5 (b) would be the logical solution to the design in hand, although it should be noticed that there are but five rivets in the joint, owing to its width. This deficiency of one rivet may be readily compensated for by employing rivets slightly larger

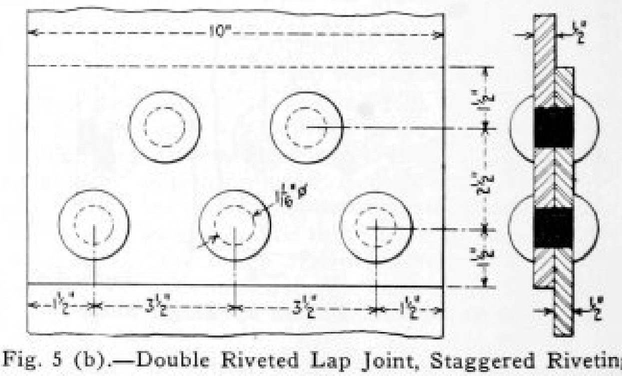


Fig. 5 (b).—Double Riveted Lap Joint, Staggered Riveting

than 15/16 inch. The correct rivet diameter is determined as follows:

Total rivet cross sectional area required = 4.1 square inches.
Number of rivets employed . . = 5

$$\text{Required cross sectional area of 1 rivet} = \frac{4.1}{5} \text{ or 0.82 square inch.}$$

This value corresponds to a diameter of approximately 1 1/16 inches, which may be taken as the diameter of the rivets after they are driven, or what is the same thing, the rivet hole diameter. Since the rivets are always 1/16 inch less before driving than the diameter of the holes, we would call for one inch diameter rivets on the drawing. The total safe rivet shearing strength of the joint is now:

$$5 \times (1.0625^2 \times 0.7854) \times \frac{44{,}000}{5} = 39{,}010 \text{ pounds per square inch}$$

The final consideration is the crushing strength of the joint. This method of failure was previously explained in connection with Fig. 3. The total bearing surface between the plate and rivets in our case is 5 × 1.0625 × 0.5 = 2.656 square inches. With an allowable crushing stress of $\frac{95,000}{5}$ or 19,000 pounds per square inch of bearing surface, the total safe crushing resistance of the joint will be 2.656 × 19,000 or 50,569 pounds.

Application of Unit Lengths to Seam Design

In our previous example, all calculations were based on the full length of the joint. This process is feasible, or rather practical only when dealing with joints of medium width. For long seams, such as the circumferential and longitudinal joints of steam boilers, or any other cylindrical pressure vessels for that matter, it is more convenient to deal with *unit lengths* of the joints. By unit length is meant that part of a joint contained between the center lines of two rivets of maximum pitch. In Fig. 4, any one of the 2¼ inch dimensions would be called a unit length of the joint. In Fig. 5 (a) and (b), each of the 3¼ inch dimensions is also a unit length, because it is said to be a repeating section and represents the same conditions for each equivalent portion of an entire seam, regardless of its total length. This matter of unit length may be very clearly defined by means of a more complex type of riveted joint as illustrated in Fig. 6.

Dimension *A* represents a unit length of that part of the

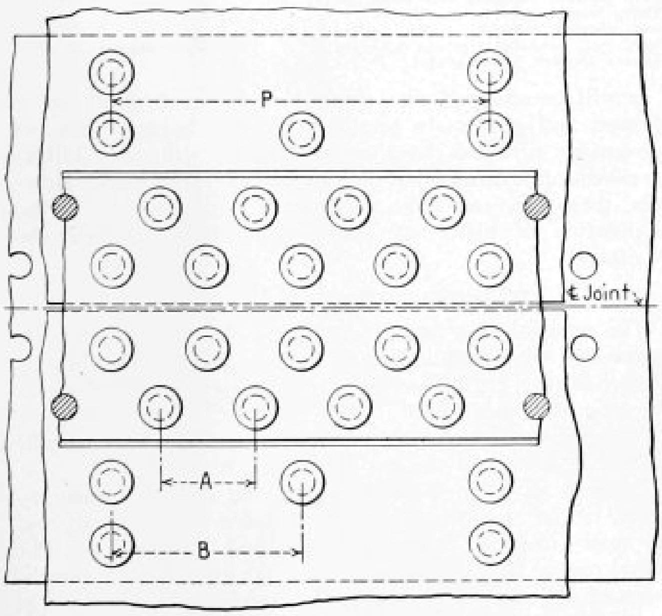


Fig. 6.—Illustrating "Unit Length" of a Joint

joint included by the rivets in the upper butt strap, but it does not apply to the full width of the joint. Although dimension *B* represents in every sense of the word, a unit length of the full joint, the repeating sections are alternately right and left hand. The usual practice is to consider all that part of the joint contained within the dimension *P*, which is of course the maximum rivet pitch. Such a length represents a true repeating section of the entire joint, regardless of its length.

It should be understood when making computations involving rivets that only one-half the rivets which project into any unit length are included in that section of the joint. For instance, in the first or outermost row of Fig. 6, a half rivet is included at each end between the pitch *P* which of course is the equivalent of one full rivet acting in this row; in the second row, it should be noted that the equivalents of 2 full rivet diameters are included, (one full and 2 half rivets). In the third row there are, of course, 4 full rivets in evidence, and in the fourth or innermost row there are also 4, but these are represented by 3 full and 2 half rivets.

Calculation of Load on Longitudinal Joint of Cylindrical Vessel

In our previous example in connection with Fig. 4, we were given a specified load which the joint had to withstand and the design was developed accordingly. The load on the longitudinal joint of a cylindrical vessel under internal pressure may be calculated in the following manner:

A boiler shell 72 inches diameter by 18 feet long is subjected to an internal pressure of 150 pounds per square inch; then the total force tending to rupture the shell longitudinally would be 72 × (18 × 12) × 150, or 2,332,800 pounds. If the shell be made in two courses of equal length, then the total stress in each longitudinal seam will be $\frac{2,332,800}{4}$ or 583,200 pounds.

Suppose now, that a joint similar to Fig. 6 were to be employed for the longitudinal seams of this shell; then by dividing the total load on each joint by the number of its unit lengths (of which we shall assume there are 7), the total stress per unit length would be ¼ of 583,200 pounds, or 83,314 pounds. With but a comparatively small section of the entire seam to deal with, it should be obvious that the labor involved in calculating the strength of the joint is not nearly as arduous as would otherwise be the case.

An entirely satisfactory method would be to predetermine the load on a riveted joint by the process outlined above, but even this is unnecessary and may be greatly simplified. It is improbable that the true stresses developed in the shell are uniformly distributed throughout the length of the joint on account of its rigidity due to the several thicknesses of overlapping plates and rivets. Nevertheless it is so assumed in practice, and to the extent that each unit length of a joint receives a load equal to the strength of the net section of plate between the two rivets in the outer row.

The Meaning of Joint Efficiency

The strength of the solid plate in a unit length of any joint is 100 percent, but after rivet holes have been punched out, its strength is evidently reduced and the amount available is obviously equal to only a certain percentage of the original, as 50 percent, 65 percent, 90 percent, etc. For example, suppose that the maximum pitch *P* of the rivets in the joint, previously illustrated in Fig. 6, is 15 inches; the plate thickness ½ inch, and the diameter of the rivets, after driving one inch. Then the solid plate strength in a unit length of this joint would be equivalent to:

15 × 0.5 × 11,000 pounds = 82,500 pounds.

But the available plate strength is only equal to that provided by the net section of plate between the two rivets in the outer row, or:

(15 — 1) × 0.5 × 11,000 pounds = 77,000 pounds.

Therefore, the efficiency of the joint, with regard to its actual plate strength, may be found by dividing the available strength by the solid plate strength, or

$$\frac{77,000}{82,500} = 0.933.$$

This value simply implies that the available plate strength is only 0.933 times that of the solid plate, or for convenience, the maximum net plate section of this joint would have an efficiency of 93.3 percent.

The efficiency of the net plate section may not always represent the true efficiency of any joint, for the reason that the breaking of the net plate section indicates but one of several different possible methods of riveted joint failure.

(*Continued on page 212*)

Speeding Up Boiler Repairs by Use of Autogenous Welding Processes

By C. E. Lester

It is true that fully 50 percent of the locomotive and boiler shops in the United States have not availed themselves of the oxy-acetylene and electric arc welding processes where they are permitted in new construction and in repair work, in spite of the fact that autogenous welding accomplishes savings that in many cases mean the difference between profit and loss in shop operations. While there are many ways in which the processes are made available for savings, the writer will confine himself at this time to new back and front flue sheet work.

We will assume that two locomotives require, one a new front flue sheet and the other a new back flue sheet and that it is desired to use the electric arc welder and the oxy-acetylene cutter to the greatest extent possible, in the removal and application of the new sheets. These are assumed to be in different engines, so that full advantage may be taken of the several operations involved. The savings in utilizing the processes may be divided into three distinct classes; that is, time, labor and material.

Savings in Time by Use of Welding

The time element is the most important in the removal of the front sheet. An examination of the sheet after the draft appliances have been removed indicates that the brace area and the flange area of the sheet are in good condition and that a section of the sheet may be removed by cutting along the dotted lines as shown in the diagram, Fig. 1. The layer-out marks the sheet for the cutter, at the same time checking dimensions A-B-C-H developing the fact, on reference to flue sheet sizes as shown on a chart of sizes that a number 2 unflanged sheet cut to size at the mill, may be used for the repair. He then lays out this sheet. After the sheet is laid out it is punched and drilled for flue holes. At the same time the flues are being cut off in the firebox and with a rotary cutter in the front end. The old sheet is then burned out and removed before the flues are taken out. Stub ends of flues are removed after the sheet is on the floor. The old sheet is then taken to the boiler shop to be used as a template in trimming the new sheet. This method allows each operation to proceed in an orderly manner and eliminates the transfer of flues behind the steam pipes, with no hold up between operations.

Preparing the New Sheet

While the flues are being pulled from the boiler and the boiler washed, the new sheet is brought to completion. In the meantime after several flues are removed from the boiler a number of flue coppers are applied to the back sheet in order to give the flue shop the proper size for a swaging fit for the back sheet, so that stock flues may be prepared ready cut to finished length as soon as the new sheet is applied.

The new sheet, now ready for application, is clamped into position and about six places each three inches long spaced around the circumference as shown in Fig. 1 are chipped and the sheet tacked fast with the electric welder. In order that there be no delay to the flue work, operations are here interrupted long enough to take the flue lengths of the boiler. This allows the flues to be made ready as soon as the sheet is far enough along to receive them. Immediately after the flue lengths are taken, the remainder of the sheet is chipped for welding and on completion of this operation the sheet is welded in place. During the welding of the sheet the boiler is scaled and the flue coppers applied to the back sheet. The preparations for welding are made as shown in Fig. 2, and the finished operations given in Fig. 3.

Working two shifts of eight hours each in all departments permits this job to be made ready for flues in 29 hours from the time the engine enters the shop. It may be urged that the flue sheet should be laid out and drilled before the engine enters the shop. This would of course be preferable, but if the work be handled in the manner indicated, without delay between operations, the sheet will be ready by the time the flues are out and the boiler washed. The sheet described is about 52 inches in diameter and has approximately 250 flues.

The time of operations may be divided as follows:

Operations		TIME Hours and Minutes
Remove front, draft appliances, exhaust pot		2—45
Laying off old sheet for cutting		15
Laying out, punching, drilling new sheet Cutting flues, front and back, burning out sheet Knocking out stub ends, delivery of sheet to boiler shop	Simultaneous	6—00
Trimming sheet to size and chipping Removing flues and washing boiler Swaging flues for firebox fit	Simultaneous	3—00
Sheet applied, clamped and tacked		2—30
Taking flue length		30
Sheet chipped, welded Flues, cut, annealed, tested, delivered Coppers applied, boiler scaled	Simultaneous	6—00

It will be observed that ample time for each operation is allowed and can easily be done. It may be said that the autogenous processes have nothing to do with the skillful arrangement of details that permits of such rapid work. However, these processes have made such work possible by the elimination of many operations that would otherwise be necessary.

Operations Formerly Necessary

The removal of a front sheet in the old way required the removal of steam and dry pipes, tee head, all the front braces, smokebox ring, etc., as well as their replacement, all of which are long and heavy jobs.

Material is saved in that smaller unflanged sheets may be carried in stock and the use of rivets eliminated.

Labor is saved in the time length and the fewer men engaged in the operations. One man takes the sheet out and one man can finish it after it is clamped into position. The actual cost of labor for removing the old sheet, laying, punching and drilling and applying the new sheet at the present scale of wages is about $30. No overhead is taken into account in these figures.

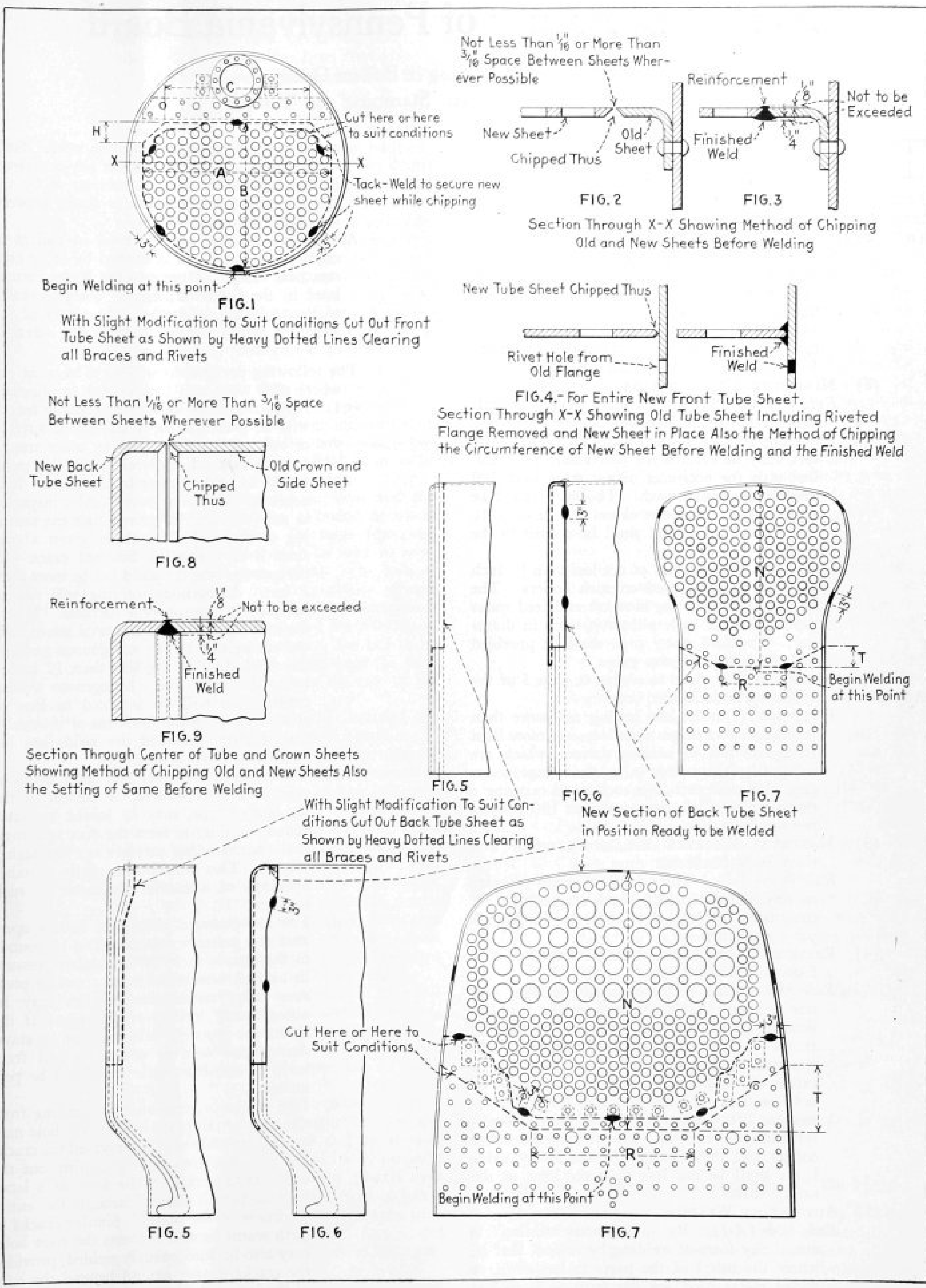
Substantial savings may also be made in the renewal of an entire sheet in practically the same manner; however not to such an extent, as considerable stripping is necessary. The manner of application is shown in Fig. 4.

Defective Flue Sheets

In the examination of fireboxes for defective back flue sheets, especially of the wide and semi-wide types, if it is found that the bottom section of the sheet below the flues is in good condition this section is not removed and the sheet is cut off as is shown in Fig. 7, with various modifications.

The operations may be carried on in practically the same manner as those on a front sheet and the savings are practically as great except for the fact that the sheet must be flanged.

The letters N-R-T in Fig. 7 indicate the dimensions that must be checked before cutting out the old sheet in order to keep within the limits of the sizes of the stock half sheets.



Details of Welding Operations Used in Repairing Flue Sheets

Boiler Code Rulings of Pennsylvania Board

Use of Autogenous Welding in Boilers Outlined—Inspection and Standard Stamping of Boilers

THE following rulings pertaining to steam boilers were adopted on May 24, 1921 by the Industrial Board, Department of Labor and Industry, Commonwealth of Pennsylvania, and are herewith submitted as a supplement to the Pennsylvania Boiler Code:

(a) Steam Boilers.

(1) REPAIRING OF NON-STANDARD BOILERS.

Rule 002 (*A-I*). The workmanship, materials, fittings and attachments used in the reconstruction or repairing of non-standard boilers shall meet the requirements for such workmanship, materials, fittings or attachments as required for new Pennsylvania standard boilers.

(2) MINIATURE STEAM BOILERS.

Rule 003 (*N-I*). Steel boilers having a grate area of not more than one square foot, or a heating surface of not more than 15 square feet, may be constructed of commercial seamless pipe for pressures of not more than 100 pounds per square inch. The heads shall be of flange or firebox steel not less than 5/16 inch in thickness, and shall be riveted to the shell.

Spring pop safety valves of not less than ½ inch diameter shall be used on such boilers. The minimum sizes of the blow-off and feed water pipes shall not be less than ½ inch in diameter. The feed water pipe shall be provided with a check and stop valve.

New paragraph (f) to be added to section 6, page 5 of the Administration, Pennsylvania Boiler Code.

Paragraph (*f*). Boilers having not more than one square foot of grate surface, nor more than 15 square feet of heating surface, which are equipped with a safety valve, steam gage, water gage glass and two gage cocks, and carrying a steam pressure of not more than 100 pounds per square inch.

(3) MAXIMUM WORKING STEAM PRESSURE FOR CAST IRON BOILERS.

Rule 004 (*A-I*). The maximum steam pressure on any boiler in which steam is generated, if constructed of cast iron, shall be 15 pounds per square inch.

(4) RELIEVING CAPACITIES OF AND OPENINGS FOR SAFETY VALVES.

Rule 005 (*N-I*). The minimum number and size of safety valves required on new installations of all fire tube boilers at any pressure in excess of 15 pounds per square inch, and watertube boilers operated at pressures not in excess of 160 pounds per square inch shall be not less than the sizes required for the intermediate lifts given in Table 15 of the Pennsylvania Boiler Code. The area of the boiler outlets and the openings in the safety valve bases shall be not less than the area of the safety valves.

(5) AUTOGENOUS WELDING.

Rule 006 (*A-I*). By "autogenous welding" is meant any form of welding by fusion, that is, where the metal of the parts to be joined or added metal used for the purpose is melted and flowed together to form the weld. Such welding is accomplished by the oxy-acetylene, hydrogen or other flame processes, or by the electric arc; no distinction is made between any of these processes.

Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the Rules formulated by the Industrial Board, Commonwealth of Pennsylvania, and where the safety of the structure is not dependent upon the strength of the weld.

The following paragraphs will serve to point out where such work will be accepted or rejected:

1. Any autogenous weld of reasonable length will be permitted in a staybolted surface or one adequately stayed by other means so that, should the weld fail, the parts would be held together by the stays. It is necessary for the approved boiler inspector to use judgment in interpreting the meaning of reasonable length as given above, since it may vary in different cases. In the average case it should not be more than 3 feet. Autogenous welding will not be accepted in unsupported surfaces. Where the heads and furnace sheets of steam boilers are welded by the autogenous process, the weld shall be not less than 12 inches below the water line. Autogenous welded construction will be accepted in lieu of riveted joints in the fireboxes of internally fired boilers, provided the welds are between two rows of staybolts.
2. The edges of the inner and outer sheets of vertical firebox boilers, or boilers of the locomotive type, may be joined by autogenous welding to form the door openings, if the surrounding surfaces are thoroughly stayed. This would also apply to other openings of a similar character in such surfaces.
3. For low-pressure plate-steel boilers operated at a pressure not exceeding 15 pounds to the square inch, or for higher pressure in unfired vessels subjected to water pressure only, rectangular headers may be autogenously welded at the edges if the sheets are properly held together by stays. Autogenous welding of cracks and fractures in cast-iron boilers will not be permitted.
4. Fire cracks in girth seams extending from the edge of the plate to the rivet hole may be autogenously welded provided the cracks are properly prepared by cutting out the metal at the crack in the form of a letter "V" to permit fusion through the entire thickness of the plates. Similar cracks in girth seams located between the rivet holes may also be autogenously welded, provided the cracks do not extend beyond the edge of the lap of the inner plate. In the latter

class of cracks it is advisable to drill a hole not exceeding 3/8 inch in diameter at the end of the crack before the weld is made. Cracks extending from rivet hole to rivet hole on girth seams cannot be welded. Calking edges of girth seams may be built up by autogenous welding between rivet holes and the calking edge where the original section of the metal to be built up averages the equivalent to 1/4 of the diameter of the rivet hole; and the portion of calking edge to be replaced does not exceed 30 inches in length in a girthwise direction. In all repairs to girth seams by autogenous welding the rivets must be be removed over the portions to be welded and for a distance of at least 6 inches at each end beyond such portions. After repairs are made the rivet holes should be reamed before the rivets are re-driven.

5. Stayed sheets which have corroded to a depth of not more than 40 percent of their original thickness, may be reinforced or built up by autogenous welding. In such cases the stays shall come completely through the reinforcing metal so as to be plainly visible to the inspector.
6. Where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist between the tube ligaments, autogenous welding may be used to reinforce or repair such defects. The ends of such tubes may be autogenously welded to the tube sheets. The above-mentioned repairs for tube sheets and the welding-in of the tubes in the sheets, are not to be permitted where such sheets form the shell of a drum or boiler, as in the case of the Stirling type of boiler.
7. When external corrosion has reduced the thickness of the plate around handholes to not more than 50 percent of the original thickness and for a distance not exceeding 2 inches from the edge of the hole, the plate may be built up by autogenous welding.
8. Pipe lines will be accepted where the flanges or other connections have been welded autogenously, provided the work has been performed by a reputable manufacturer and the parts properly annealed before being placed in position. Such welding when made with the part in place and unannealed will not be acceptable.
9. Autogenous welded-in patches in the shell of a boiler will not be acceptable regardless of the size of such patches. Autogenous welding of cracks in the shell of a a boiler (except those specified in paragraph 4) regardless of the direction in which they may lie will not be permitted, unless such welding is only for the purpose of securing tightness and the stresses on the parts are fully cared for by properly riveted-on patches or straps placed over the weld. The plates at the ends of joints may be welded together for tightness, provided the straps or other construction are ample to care for the stresses on the parts so welded.
10. Re-ending or piecing of tubes for either firetube or watertube boilers by the autogenous process will not be permitted.
11. For low-pressure steam and hot-water heating boilers, autogenous welded construction for unstayed surfaces will be permitted, provided the thickness of the material in the shell plates and tube sheets is not less than that required for power boilers. (See paragraphs 18 and 20 of Pennsylvania Boiler Code.)

(6) STAMPING OF THE HEATING SURFACE ON PENNSYLVANIA STANDARD STEAM BOILERS.

Paragraph 332—Page 89 of the Pennsylvania (American Society of Mechanical Engineers) boiler code has been revised to read as follows:

332. Each boiler shall conform in every detail to these rules, and shall be distinctly stamped with the A. S. M. E. symbol, denoting that the boiler was constructed in accordance therewith.

After obtaining the stamps to be used when boilers are to be constructed to conform to the Pennsylvania (A. S. M. E.) boiler code, the approved Pennsylvania boiler inspector, or such inspector regularly employed by an insurance company authorized to do a boiler insurance and inspection business in the state in which the boiler is built, shall, if such boiler is to be shipped into the commonwealth of Pennsylvania for erection, or constructed within the confines of said commonwealth for such purpose, be notified that an inspection is to be made, and that he shall inspect such boiler during construction and after completion. At least two inspections shall be made, one before reaming the holes and one at the time the hydrostatic test is made.

In stamping the boiler after completion, if built in compliance with the code, the builder shall stamp the boiler in the presence of the inspector after the hydrostatic test, with the Pennsylvania code stamp, the builder's name, the serial number of the manufacturer and the number of square feet of heating surface.

A data sheet shall be filled in and signed by the manufacturer and the inspector. This data sheet, together with the stamp on the boiler, shall denote that it was constructed in accordance with the Pennsylvania (A. S. M. E.) boiler code.

Each boiler shall be stamped adjacent to the symbol with the following items, with intervals of about one-half inch between the lines:

1. Manufacturer's serial number.
2. State in which boiler is to be used.
3. Manufacturer's State standard number.
4. Name of manufacturer.
5. Heating surface in square feet.
6. Year put in service.
7. Maximum working pressure when built.

Items 1, 2, 3, 4, 5 and 7 are to be stamped at the shop where built.

Item 6 is to be stamped by the proper authority at point of installation.

Industrial Relations Conference to Be Held

An industrial relations conference, authorized by Governor William C. Sproule, Pennsylvania, is being arranged by Dr. Clifford B. Connelley, commissioner of department of labor and industry of the commonwealth of Pennsylvania, to be held at Harrisburg, Pennsylvania, October 24 to 27.

American Boiler Manufacturers' Convention

Standardization of Boiler Inspection Methods Discussed—Recommendations for Cooperation with the Stoker Manufacturers

THIS year the American Boiler Manufacturers' Association held its thirty-third annual convention at Bedford Springs, Pa. In spite of the general business depression, the attendance was good, about fifty-five members and associates being present at the sessions. The plan inaugurated last year of including golf tournaments in the program of entertainment was continued this year with success. The convention officially began with the registration of members at 9:30 o'clock on June 20, and continued until the afternoon of June 23.

Retiring president of the association A. D. Schofield opened the proceedings with an address outlining conditions in the industry and the necessity of cooperation between the members of the association in order that the present adverse conditions of business might more quickly be overcome.

American Uniform Boiler Law Society

E. R. Fish, representing the American Boiler Manufacturers' Association in the American Uniform Boiler Law Society, next reported on the work of this society during the past year. The function of the organization in promulgating the adoption of the American Society of Mechanical Engineers' Boiler Code throughout the United States does not require any explanation. The expense of carrying on the work, however, has greatly increased and the original quotas assigned to the various organizations and societies supporting the movement have had to be raised in proportion. In addition to the contributions to the Uniform Boiler Law Society, the support given to the newly formed National Board of Boiler and Pressure Vessel Inspectors, which is made up of the chief inspectors from the various states and municipalities enforcing the American Society of Mechanical Engineers' Boiler Code, has assisted greatly in getting the Board into operation. As soon as the Board is functioning fully, there will be many ways in which the work of the manufacturers will be lightened; new designs will be passed upon, stamping of boilers will be standardized and much of the difficulty attending the transfer of boilers from one state to another will be eliminated.

Following this report Charles E. Gorton, chairman of the American Uniform Boiler Law Society, outlined the work carried on during the past year in preserving the unity of purpose of the Boiler Code among the states that have already adopted boiler legislation and in urging others to do so. Mr. Gorton's report will be published in a later issue of THE BOILER MAKER.

Joseph F. Scott, chairman of the Boiler Inspection Bureau of New Jersey and president of the National Board of Boiler and Pressure Vessel Inspectors, read a paper on one phase of the subject of standardization. An abstract of this paper follows:

Simplification of Data Sheets and Standard Stamping of Boilers

The purpose of this paper is to create a thought among you who design and construct vessels that are utilized to generate and store heat of the necessity of universally adopting and bringing into use one standard manufacturer's data report sheet. A few years ago in New Jersey it took practically the entire time of the boiler inspection division to ferret out the data which each report was supposed to contain. If permission were requested to transfer a boiler between states or cities even, records had to be obtained from the builder, the state or municipality under whose regulations it was operated, the insurance company's record, if it were insured, and if not, ascertain why it was not insured; and last but not least, look up the various style stamps with which the boiler was branded. A great deal of trouble could be avoided if a national boiler information bureau were in existence to supply all this information. A complete record of boilers could be obtained and the number of years of useful work from such boilers increased.

UNIFORM INSPECTION REPORT OF INSURANCE COMPANIES

The necessity of insurance companies using a uniform inspection report is, in my opinion, of equal importance. The Boiler Code Committee of the American Society of Mechanical Engineers made a big stride in arriving at uniformity in data and inspection report sheets when it formulated standard report forms and recommended their adoption. The Boiler Code Committee in the last year has improved these data report forms considerably. Before this, the New Jersey boiler inspection department required all manufacturers and insurance companies to use only the report forms adopted by the New Jersey Board of Boiler Rules. Since the revision of the Boiler Code report forms, however, the New Jersey boiler inspection bureau has authorized all manufacturers and insurance companies to use their own individual data and report sheets, providing they are of the form prescribed by the Boiler Code committee of the American Society of Mechanical Engineers.

The information I have at hand does not indicate that other states and municipalities who are operating under the same standard as New Jersey have adopted this system. Most of them still require the use of data and inspection reports as adopted by each individual state or municipality. The result is that no matter how many states or municipalities enforce the Boiler Code, if the boiler happens to be transferred, the authorized inspectors or the proper authorities are required to fill out the form that is used in that particular territory.

States and municipalities which adopt the Boiler Code of the American Society of Mechanical Engineers and enforce it, by such adoption recognize that the Boiler Code is about the most satisfactory system to follow, yet these same states will require that every boiler used be stamped by the individual stamp adopted by each of the states. I appreciate the fact that the laws in some states are such that it is impossible to do otherwise, but with one standard recognized stamp adopted any law could easily be amended to obviate the present method of stamping boilers in that particular territory.

All states and sections of any state that adopt the Boiler Code as formulated by the American Society of Mechanical Engineers should harmonize and eliminate any unnecessary and intricate method of building and recording boilers. One standard stamp should be adopted and applied to every boiler built in accordance with the specifications as incorporated in the Boiler Code, one manufacturer's data report form should be used, and also one standard inspection report form.

A method should be adopted so that if a boiler was built in Pennsylvania or Ohio or any other state operating under the same standards, a qualified inspector from that particular territory where the boiler was being built would be authorized to inspect the boiler during construction, and certify thereto on the manufacturer's data report sheet which is to be filed in the territory where the boiler is to be used.

In 1919 after considerable thought and discussion an organization was launched known as the National Board of Boiler and Pressure Vessel Inspectors.

In February, 1921, the National Board had its first organization meeting in Detroit, at which representatives of every state and municipality which had adopted the Boiler Code of the American Society of Mechanical Engineers were present. Attending this meeting were representatives of boiler manufacturers who wished to get an idea of the purpose of the organization. I feel safe in saying that every one present after becoming acquainted with the object of this National Board will cooperate and assist in every way possible to get this board in actual operation. The office of the secretary of the National Board will be practically a clearing house for every boiler constructed under the American Society of Mechanical Engineers' Boiler Code and it will soon be possible to obtain records when they are wanted by the states, municipalities, manufacturers or insurance companies.

Examination Requirements for Inspectors

The examining committee of the National Board will formulate standard examination papers from time to time. Applicants for boiler inspectors qualifying under this examination will receive a certificate authorizing them to inspect boilers in any state or municipality enforcing the Boiler Code without further examination. The same procedure will apply to all forms used. The purpose of the board is to help the states, the manufacturers, the insurance companies, and the user of boilers, eliminating delays in obtaining information on any particular boiler.

This National Board will form a connecting link between the Boiler Code committee, the builder and the user. The interpretations by the Boiler Code committee of any particular paragraph or other decisions of the code committee will practically become standardized through the National Board, thereby eliminating the varied interpretations of paragraphs in the code that appear to be prevalent in the states or municipalities where it is in operation. Every member of the Boiler Code committee realizing the necessity of uniformity which can be arrived at through an enforcement board has extended his counsel and assisted in every way possible for its successful realization. This also applies to the representative of the Uniform Boiler Law Society, who has cooperated with the National Board in every way possible.

It is not out of place for me to state that the real beneficiaries of this National Board will be the boiler manufacturers and the insurance companies. My experience in dealing with these two great bodies has made me realize—under the present system—the enormous amount of extra detail work they must necessarily do in dealing with every state or municipality that adopts boiler regulations. As these regulations increase, unless relief is obtained by standardization, these difficulties will become more complex. The boiler inspection authorities of the states and municipalities throughout the country can operate under different systems without any great amount of trouble or inconvenience, as they have a law behind them which requires them to see that it is properly enforced. It should be the duty of the National Board, however, to consolidate and simplify the present method of steam boiler regulation. We extend to the manufacturers, insurance companies, in fact, to all other interested parties, an invitation to cooperate with us in every possible way, to make suggestions, offer constructive criticism and do everything possible to launch this National Board into successful operation. I wish to emphasize the fact that this board is not organized for any political purpose or to be used for any unjust influence in any way, its main purpose is to minimize, standardize and to eliminate in every way possible the complex system prevalent in the steam boiler field which is in operation today.

Uniformity in Boiler Inspection

Another phase of the work of the National Board was discussed by C. O. Meyers of Columbus, Ohio, covering the stamping of boilers and details of the work in Ohio. An abstract of the paper is given below:

The Ohio authorities have been asked a number of times to accept boilers stamped with the American Society of Mechanical Engineers' symbol, in the interest of uniformity. To make our position clear in the matter it was necessary to relate to you the exact conditions as they exist, and at your last annual meeting at French Lick Springs, Indiana, I called your attention to a few facts regarding the way inspections are made and the American Society of Mechanical Engineers' symbol applied to newly constructed boilers.

I am now very much pleased to inform you that we have received the assistance of some of the members of your association, who are lending all the aid possible to forward a movement which will tend to get a clear understanding between all code states, and a uniform enforcement of the code.

This work has been the principal object of the National Board of Boiler and Pressure Vessel Inspectors, the first convention of which was held at Detroit in February.

Proceedings of First Convention

This meeting has proven to us that whatever misunderstandings have taken place in the past have not been arbitrary or intentional on the part of any of the chief inspectors of the states, but were due to a lack of cooperation and a proper system of mediation between code states. This meeting was carried out as scheduled, and the first day was devoted to the reading of papers by representatives of the various interests affected, in order to acquaint the chief inspectors with the confusion that has been created by individual rulings. The second day was devoted entirely to a meeting of the Boiler Code committee, so that the chief inspectors could see how this committee functioned. The third day, the members of the National Board went into session for the purpose of effecting a permanent organization and the entire day was devoted to the formulation and adoption of a constitution and bylaws which would correct some of the evils now obstructing uniform boiler construction and installation.

The constitution and bylaws as well as the complete proceedings of the first convention of the National Board were published in the February, March, and April issues of The Boiler Maker.

Necessity demands that the National Board be placed upon a permanent basis, and it would be very unsatisfactory to secure funds for its support through contributions. It was therefore thought that a small fee be charged for each boiler stamped and registered in accordance with the by-laws of the National Board, and in this manner the expense will be justly distributed and can be charged to the construction of the boiler. This fee will be regulated by the actual expense of maintaining the work of the Board.

Appointment of Committees and Secretary's Report

The auditing and nominating committees were next appointed and H. N. Covell, secretary and treasurer of the Association, read his report. At the present time there are 80 members active in the work of the Association and 20 associates. Two members were added during the current year and one associate admitted during the convention. The finances of the Association are in excellent condition.

Discussion of Constitution of National Board

E. R. Fish: I am going to suggest that we take advantage of Mr. Meyers' offer to read over the constitution and by-laws of the National Board so that we will be sure everybody knows about it. I think this matter is one of interest and importance and deserves the consideration of every boiler manufacturer.

The Constitution of the National Board was then read. It appears in detail on page 107 of the April issue of The Boiler Maker.

E. R. Fish: I should like to ask Mr. Meyers a question with respect to the inspection of steam boilers and other pressure vessels. I want to know how far the jurisdiction of the National Board will extend.

C. O. Meyers: At the present time the Board is not functioning. The Code Committee has no rules out now. We are expecting in the near future to have laws governing pressure vessels, and in such case we will be prepared to take care of them and the construction of them will be in accordance with the A. S. M. E. Code.

C. C. Cunningham: Would it cover superheaters, separators, and all that sort of thing?

C. O. Meyers: No.

G. W. Bach: If a boiler were constructed in strict compliance with the code, would it be necessary to get the National Board to approve of that design?

C. O. Meyers: Suppose the boiler has some new design, but all mechanical details are in compliance with the code, that could be stamped with the code stamp.

W. C. Connelly: Have you thought of how you are going to finance this organization?

J. F. Scott: We thought of charging a fee for each boiler that is stamped and registered.

Monday Evening Session

At the Monday evening session Judge William H. Speer of New Jersey gave an able address on "Current Menaces to Industry." Following this G. A. Richardson of the Midvale Steel and Ordnance Company exhibited an interesting set of films and slides showing the processes involved in making steel boiler plate and tubing from the mining of the ore to the inspection and test of the finished product.

Tuesday Morning Session

The meeting Tuesday morning was mainly taken up with the reading of standing committee reports.

American Society of Mechanical Engineers' Code

The first report given was by E. R. Fish on the work of the American Boiler Manufacturers' Association committee acting in conjunction with the American Society of Mechanical Engineers' Boiler Code Committee. This report follows:

Your committee on the American Society of Mechanical Engineers' Boiler Code has not been called upon to exercise any great activity during the past year. A few matters have been suggested, however, on which it might be well to comment.

Some months ago some of you will recall having received a questionnaire from C. S. Blake of the Hartford Steam Boiler Inspection and Insurance Company which referred to limits of tolerance in the construction of boilers. Mr. Blake is chairman of a subcommittee of the American Society of Mechanical Engineers' Boiler Code Committee which was to draw up a standard form of inspection bill. Your committee is of the opinion that the incorporation of limits of tolerance in boiler construction in laws and ordinances is a matter that must be approached carefully and with much thought and consideration, for it is quite possible to unintentionally establish limits that might lead to great and unnecessary hardships on some manufacturers. The very nature of the problem makes it one that must be dependent largely upon the judgment and discretion of inspectors. If, however, Mr. Blake's committee should enlarge their activities to include matters of this sort, it should be only after conference with a considerable number of manufacturers and we suggest for that purpose that a committee of at least five of the A. B. M. A., including the present American Society of Mechanical Engineers' Boiler Code Committee, if you so desire, should be appointed.

As a matter of fact a request has been received by the secretary of the A.B.M.A. for the appointment of two* members from the American Boiler Manufacturers' Association to serve on this committee too, but he suggested that inasmuch as the association has a Boiler Code committee that it should be the clearing house for this matter.

We bring this up at the present time in order to suggest the matter for discussion.

Questions have been asked by one or two members in reference to the American Society of Mechanical Engineers' Boiler codes of 1914 and 1918. The latest code is, of course, ordinarily to be the one by which to be governed, but some states and municipalities having definitely adopted the first one have found it a little inconvenient and burdensome to make a change, but we believe that in all such cases the authorities are perfectly willing to accept boilers built strictly in accordance with the latest code. In many such cases the change has been formally made. At any rate this is something that this committee is unable to deal with, it being an activity for the American Uniform Boiler Law Society, within whose scope this point very definitely comes.

Some of the states have made special rulings as regards minor matters. It seems quite impossible to prevent this, although the American Uniform Boiler Law Society is making every effort possible to keep the regulations the same. It was to avoid these minor differences and keep the practice the same that the National Board of Boiler Inspectors was formed.

It should be thoroughly realized by everyone that this committee has no power whatsoever to make any changes in the code but should any questions be asked can only give what is their opinion. If there appears to be any uncertainty, a formal opinion from the American Society of Mechanical Engineers' Boiler Code committee should be obtained and we take occasion to point out that anyone who has any question to ask is at liberty to write to the code committee and the inquiry will be given prompt attention.

Revision of the Boiler Code is now in process of being made with a view to issuing a revised code in 1922. Suggestions for any changes that will add to the clarity of the code will be thankfully received. Such suggestions may be sent to this committee, in which case they will be properly transferred to the Boiler Code committee or they may be sent direct to the Boiler Code committee itself. However, before the revised code is promulgated the revisions will be made public and hearings held in order that everyone desiring to be heard may have opportunity before the final draft is put out.

Formulating Rules for Inspection

S. F. Jeter of the Hartford Steam Boiler Inspection and Insurance Company representing C. S. Blake, chairman of the subcommittee of the Boiler Code committee which is at present taking up the matter of uniformity of inspection and among other subjects the one on tolerances, outlined the aim of this committee and the way in which the American Boiler Manufacturers' Association could cooperate with its members.

* It was later proposed to request the council of the American Society of Mechanical Engineers to increase this number to three members.

There seems to be a tendency to change the code slightly in some states, and this cannot be guarded against too carefully if uniformity is to be maintained. If the rules are not uniform the boiler manufacturers, the insurance companies, and the inspectors are going to be in difficulty all of the time. It was incorrectly assumed that the work of Mr. Blake's committee was solely on tolerances because of the questionnaire on this subject recently sent to members of the American Boiler Manufacturers' Association. Tolerances are only a small part of the committee's work. The committee in question is known as the one on "Rules for Inspection" and this title explains its scope quite fully.

Mr. Jeter went on to explain that the committee wished to cooperate fully with the association and to take advantage of the expert knowledge of the members in the matter of boiler design. It has been suggested that three members of the American Boiler Manufacturers' Association be made members of this committee. Starr H. Barnum, F. G. Cox, and Lawrence E. Connelly were named for this purpose. It was further explained by Mr. Jeter that there would be ample opportunity to see and discuss the report of the subcommittee before it was adopted by the Boiler Code committee and that it would have to be approved by the council, published and be the subject of a public hearing before it could become part of the code.

The discussion of a proposition that the safe working pressure of all commercial boilers be computed upon a tensile strength of 55,000 pounds per square inch was deferred until the fall meeting.

The next order of business was the reading of a paper on "The Proper Methods of Numbering and Filing Drawings," by L. H. Park, chief draftsman of the Arthur G. McKee and Company, Cleveland, Ohio. This paper explained the special filing systems installed in a number of large engineering organizations, which have proved most successful. An abstract of this paper will be published in an early issue of The Boiler Maker.

Further Reports of Standing Committees

A. G. Pratt read a short report of the related industries committee, which will be combined with a report on the Stoker Manufacturers' committee, published below.

G. S. Barnum, chairman of the committee on cost accounting, had no formal report to make, but suggested that the paper by Mr. Lazarus, of the United States Chamber of Commerce, on this subject would be of interest to members of the Association. He also emphasized the importance to every member who had not already done so of establishing a system of accounting in his plant.

The commercial committee report was corrected at the winter meeting of the Association in Cleveland and W. C. Connelly, chairman of this committee, stated that it had been decided to send out the report several weeks ago from the secretary's office, which had been done. No additional report was necessary at the convention. Details of the work of this committee will be published in a later issue of the magazine.

Ethics in the Boiler Industry

The report of the committee on Ethics was read by George W. Bach, and is in part as follows:

The report of the committee on Ethics reflects great credit on the conduct of the boiler industry in general. By that we mean that in spite of the unsatisfactory business conditions prevailing and the extremely keen competition we meet on all propositions, there is not one single case on record where any of our members has so far violated reasonable business principles and ethics as to warrant a report of the committee and action on same.

We all show our good side forward when things are rosy and business is good, and we must carry on in the same spirit in times of depression, when there are many times exasperating circumstances and conditions to be met that would try the patience of us all.

Let us, therefore, hope that in the coming year we will go on in the same honorable, dignified manner, regardless of what the circumstances may be, and conduct ourselves so that we will command the respect of the people with whom we do business, whether buying or selling, and that will justify making the next report of the committee as satisfactory as the one herewith presented.

Related Industries' Committee Report

The principal work of the related industries committee has been in conjunction with the Stoker Manufacturers' Association, and the report of this committee was read by A. G. Pratt, chairman. It is given below:

At the Cleveland meeting February 22, 1921, a committee from this Association was appointed to meet with a committee from the Stoker Manufacturers' Association to discuss matters of common interest. The following committee was appointed. A. G. Pratt, the Babcock & Wilcox Company; E. C. Fisher, the Wickes Boiler Company; S. H. Barnum, the Bigelow Company; L. E. Connelly, the D. Connelly Boiler Company, and George W. Bach, Union Iron Works.

The representatives of both associations were instructed to confer and make recommendations to their respective association and nothing tentatively agreed upon to be binding unless approved by the two associations.

The joint committee met in New York March 18, 1921. A. G. Pratt was elected chairman and John Van Brunt secretary. The proceedings of that meeting follow:

After a general discussion, specific items were agreed upon for discussion and recommendation by the committee. Where the discussion of any item brought out any differences of opinion each member of the committee voiced his views and every conclusion reached was unanimous.

The following report is submitted for the approval of this association, in part or in its entirety. If specific recommendations are not approved the Association should go on record as to what modifications will meet with its approval:

1. It is recommended that firing tools, if required, be furnished by the stoker manufacturer.

2. It is agreed that combination drawings of boilers and stokers cannot be eliminated and that these should be prepared by the boiler manufacturer.

3. It is recommended that the boiler and stoker companies interested in any contract exchange information sheets which will set forth contract conditions or details in which the other is interested, this in order that terminal points may be known, and whether any items have been omitted by either contractor which are necessary in the combined unit.

4. It is recommended that when stokers are installed under existing boiler installations that the stoker manufacturer furnish the boiler manufacturer with drawings of the stokers to be installed, for record purposes.

5. The Joint Committee referred to the Engineering Committee of the Stoker Manufacturers' Association the question whether stoker manufacturers can and will agree upon a standard height of front under which each stoker can be placed. If this can be worked out it will enable the boiler manufacturer to quote on standard fronts in all instances.

6. It is recommended that when I-beams or other supports are required to carry front boiler walls that these should be furnished by the boiler manufacturer.

7. It was recommended that stoker manufacturers should erect and connect all water backs, regardless of by whom furnished.

8. The fact was brought out that it is the policy of both boiler and stoker manufacturers to furnish erecting superintendence only and that the purchaser be required to furnish common labor.

9. It was recommended that boiler and stoker manufacturers should standardize if possible on minimum setting heights for various types of boilers with the different types of stokers. Two heights were discussed: First, minimum; that is, absolute

minimum. Second, preferred minimum; that is, minimum height the committee would like to see installed. There was no discussion or thought of limiting maximum setting heights.

Definitions for "Setting Height" for the different types of boilers follow:

Watertube: Horizontal; floor line to bottom of header above stoker.

Watertube: Inclined; Horizontal Mud Drum; floor line to center of mud drum.
Vertical Mud Drum; floor line to top of mud drum.

Watertube: Vertical; Horizontal Mud Drum; floor line to center of mud drum.
Vertical Mud Drum; floor line to top of mud drum.

Horizontal Return Tubular; floor line to under side of shell.

The following table shows minimum and preferred minimum setting heights unanimously agreed upon by all members of the Joint committee:

	Taylor, Westinghouse, Riley, Jones A. C.		Type E		Jones Single Retort		Murphy Detroit		Roney		Chain Grate: Natural Draft		Chain Grate: Forced Draft	
	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.
Water tube, horizontal	10	12	10	12	8	10	8	11	8	10	10	12	12	14
Inclined (hor.m.d.)	7	8	6	8	6	8	5	7	6	8	6	8	7	8
Inclined (ver.m.d.)	5	6	5	6	3'6	5	3'6	5	3'6	5	3'6	5	6	8
Vertical (hor.m.d.)	3	4	3	4	3	4	3	4	3	4	3	4	3	4
Vertical (ver.m.d.)—150 hp	4'6	5	4'6	5	4'6	5	3'3	..	3'6	4'6	4'1	4'7	5	5'6
250 hp	5'6	6	5'6	6	5'6	6	3'3	..	3'6	4'6	4'1	4'7	5	5'6
500 hp	6	6'6	6	6'6	6	6'6	3'3	..	3'6	4'6	4'1	4'7	6	6'6
H.R.T. 72-in	8	10	8	10	7	10	7	8	6	8	7	8	8	10
84-in	8	10	8	10	7	10	8	9	6	8	7	8	8	10

10. The Stoker Manufacturers' Association representatives agreed that stoker manufacturers will continue to make such evaporative and capacity guarantees as may be necessary, stipulating, however, that boiler manufacturers should on their part guarantee the exit gas temperatures and draft losses through the boiler with a given gas flow or at different boiler ratings. Your committee was requested to bring to the attention of this Association the advisability of having each manufacturer prepare tables giving this information for each type of boiler manufactured.

11. The stoker representatives stated that their contract forms specify minimum draft over the fire at maximum ratings named in their contracts.

Your committee desires to state that it found the representatives from the Stoker Manufacturers' Association to be fair, earnest and sincere in their attempt to cooperate with members of this Association, and, above all, desirous that boiler and stoker installations should be so made as to give complete satisfaction to the purchaser.

Your committee feels that its work may be made of great importance to this Association and will be glad to receive suggestions upon matters other than those herein reported for study and recommendation.

Discussion of Related Industries Report

Wherever any discussion took place on the items given in the report of the related industries, the section in question will be given and the detailed discussion of each member repeated.

2. It is agreed that combination drawings of boilers and stokers cannot be eliminated and that these should be prepared by the boiler manufacturer.

A. G. Pratt: The stoker manufacturer will send to the boiler manufacturer the stoker drawings and they will show what foundations are necessary for the stoker.

W. C. Connelly: In order to see that the customer gets a complete foundation plan, I should like to have it understood that the manufacturer furnish these complete.

This addition to the recommendation was approved.

5. The joint committee referred to the engineering committee of the Stoker Manufacturers' Association the question whether stoker manufacturers can and will agree upon a standard height of front under which each stoker can be placed. If this can be worked out it will enable the boiler manufacturer to quote on standard fronts in all instances.

A. G. Pratt: This is probably one of the most important things in the joint committee report. If we can get the stoker manufacturers to do this we will be able to figure a boiler coming down from the top to a certain height above the floor and it makes no difference to us what stoker is used. The stoker manufacturers look upon that recommendation as one they can comply with and if they can do so I think our past troubles will be eliminated.

6. It is recommended that when I-beams, or other supports, are required to carry front boiler walls that these should be furnished by the boiler manufacturer.

A. G. Pratt: It seems to me that if we do furnish supports at all, this I-beam or other front wall support should be included in the front supporting columns. It strengthens our structure, or weakens it if not strong enough and we should set the size for these supports to be sure of the strength.

A Member: In many cases how would you know that such would be necessary?

A. G. Pratt: There are many stokers that do not carry the brick work. In the Babcock and Wilcox specifications we state specifically that support is furnished, or not furnished. There is a place in the specifications to cover this point.

W. C. Connelly: I think the recommendation of the committee is all right. I feel that the boiler manufacturer ought to furnish this support as it is really a part of the steel gallows and the drawings for the steel work in that case are made by the boiler manufacturer. In our particular case we always furnish an I-beam support no matter what type of stoker is going in and there is never any trouble from the customer if anything is missing. I would like to move the adoption of this recommendation.

9. It was recommended that boiler and stoker manufacturers should standardize if possible on minimum setting heights for various types of boilers with the different types of stokers. Two heights were discussed: First, minimum; that is, absolute minimum. Second, preferred minimum; that is, minimum height the committee would like to see installed. There was no discussion or thought of limiting maximum setting heights.

A. G. Pratt: This was the one thing on which we expected to have a very considerable difference of opinion. It shows that the boiler manufacturer is progressing, not only from the standpoint of building his apparatus, but also operating it. It shows that he is a better engineer than he used to be. I feel that it is very much to the advantage of ourselves, stoker manufacturer and the customer to go just as near to these heights as possible. We are going to find certain boilers installed where stokers have got to be put in with less setting height and also the boilers will have to be moved, piping changed, etc. I do feel that it is for our own protection, as well as that of the customer, to stand out for these heights as far as possible in construction work. One other thing that makes this necessary is the fact that there are smoke ordinances in a great many municipalities and it will help us in overcoming the smoke difficulty. We wish it understood that there is no objection to going higher than the minimum, just so we do not go below these heights.

10. The Stoker Manufacturers' Association representatives agreed that stoker manufacturers will continue to make such evaporative and capacity guarantees as may be necessary, stipulating, however, that boiler manufacturers should on their part guarantee the exit gas temperatures and draft losses through the boiler with a given gas flow or at different boiler ratings. Your committee was requested to bring to the attention of this Association the advisability of having each manufacturer prepare tables giving this information for each type of boiler manufactured.

A. G. Pratt: It seems to me that we should be willing to permit the stoker manufacturers to continue to make guarantees if they want to do it, and we should simply go on record here to the effect that the boiler companies should take this matter up with the stoker companies individually rather than to try to do so through this committee. It seems that this is something on which the individual stoker manufacturer and boiler manufacturer should come to an understanding.

A. G. Pratt: I do not want you men to go away from here and forget all about this. It is going to mean better installations and better satisfied customers. The committees who have worked on this did not do it for their own glorification but to be of help to the members of the Association and we feel that if you follow these recommendations that they will prove to be a big advance in the work of this Association.

W. C. Connelly: I would like to suggest that after these recommendations are fixed, we all embody them in our catalogs.

A. G. Pratt: There is one other thing that I would like to ask and that is that some of you other men who have problems with stoker companies communicate with us and we can get together with the stoker companies and straighten out the difficulties. We don't know all the troubles that you have and we do feel that we can establish a point of contact which will be beneficial to every boiler manufacturer. If you are not prepared to make any suggestions here today, I do wish you would write us about them so that we can consider them.

G. S. Barnum: In regard to heights of fire tube boilers, we have just published a new horizontal return tubular boiler catalog and have put in the heights suggested by the Hartford Steam Boiler Inspection and Insurance Company.

W. C. Connelly: That is the sort of table we want.

Wednesday Morning Session

The nominating committee reported the officers for the following term, and these were elected by the unanimous vote of the Association.

President, A. G. Pratt, of the Babcock & Wilcox Company, New York.

Vice president, G. S. Barnum of The Bigelow Company, New Haven, Conn.

Secretary and treasurer, H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee:

F. C. Burton, Erie City Iron Works, Erie, Pa.

E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.

C. V. Kellogg, Kellogg-MacKay Company, Chicago, Ill.

W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.

W. A. Drake, The Brownell Company, Dayton, Ohio.

Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.

F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.

J. A. McKeown, John O'Brien Boiler Works Co., St. Louis, Mo.

Duties of the National Board of Boiler Inspectors

F. R. Low, editor of *Power*, spoke of how any action on the part of the government toward supervising the design and construction of boilers has at times been resented as an unwarranted interference with private enterprises. This attitude has cost industries of America and through them the American people thousands of lives and millions of dollars. Whenever it is acknowledged that a certain amount of government supervision is necessary, such supervision should be uniform.

Since we have no federal control of boiler construction, the closest approach to this condition is that the legislatures in many states have adopted uniform boiler laws. The work of the Uniform Boiler Law Society in cultivating public opinion and introducing bills into the legislatures for the promotion of uniformity has been effective. Even after having induced every state in the Union to adopt the American Society of Mechanical Engineers' Boiler Code as a standard, there would still remain a necessity of uniting the different state boards together with a committee formed for the discussion of questions of common interest, especially uniformity of methods.

This object was accomplished by the formation of the National Board of Boiler and Pressure Vessel Inspectors.

One of the first problems to be considered by this body was that of interstate inspection. When a state department through a certified inspector has once accepted a boiler built in accordance with the American Society of Mechanical Engineers' code this boiler should also be acceptable in other states where the code is enforced. A committee of the National Board will examine and certify inspectors who will be authorized to pass judgment on boilers in "code" states.

The National Board has also determined to standardize the stamping of boilers. After the board had been active for a short time a single stamp bearing the name of the manufacturer of the boiler, the serial number and the code symbol will be used to signify that the boiler has been built according to code standards. This stamp will be put on by the boiler manufacturer or his agent in the presence of the shop inspector. The shop inspector will then make out a certificate that he has inspected the boiler and that it has been built in accordance with the boiler code. This certificate will be filed with the secretary of the National Board, whose office will finally become a bureau of vital statistics for all boilers built in the United States. The statistics thus maintained will give exact knowledge at all times of the boiler power of the country and its condition.

Registration at Convention

The following members, associates and guests of the American Boiler Manufacturers' Association were in attendance at the convention:

G. W. Bach, Union Iron Works, Erie, Pa.
G. S. Barnum, The Bigelow Company, New Haven, Conn.
B. F. Bart, Standard Seamless Tube Company, New York.
W. H. S. Bateman, Parkesburg Iron Company, Champion Rivet Co., Philadelphia, Pa.
C. P. Berry, Oil City Boiler Works, Oil City, Pa.
G. T. Bliss, Erie City Iron Works, Erie, Pa.
L. S. Blodgett, Simmons-Boardman Publishing Company, New York.
C. A. Brandt, The Superheater Company, New York.
M. H. Broderick, Broderick Company, Muncie, Ind.
W. S. Cameron, The Frost Manufacturing Company, Galesburg, Ill.
David Champion, Champion Rivet Company, Cleveland, Ohio.
J. F. Coburn, J. F. Corlett & Co., Cleveland, Ohio.
W. C. Connelly, D. Connelly Boiler Company, Cleveland, Ohio.
H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
F. G. Cox, Edge Moor Iron Works, Edge Moor, Del.
C. C. Cunningham, The Christopher Cunningham Co., Brooklyn, N. Y.
W. A. Drake, The Brownell Company, Dayton, Ohio.
C. W. Edgerton, Coatesville Boiler Works, Coatesville, Pa.
J. G. Eury, Henry Voght Machine Company, Louisville, Ky.
E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.
E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.
Michael Fogarty, Michael Fogarty, Inc., New York.
N. H. Genung, Coatesville Boiler Works, Coatesville, Pa.
D. W. Glanzer, Otis Steel Company, Cleveland, Ohio.
F. B. Godley, *Power*, New York.
A. R. Goldie, The Goldie & McCulloch Co., Ltd., Galt, Can.
J. T. Goodwin, National Tube Company, Pittsburgh, Pa.
Charles E. Gorton, Uniform Boiler Law Society, New York.
S. F. Jeter, Hartford Steam Boiler Insp. & Ins. Company, Hartford, Conn.
Robert June, Diamond Power Specialty Company, Detroit, Mich.
C. V. Kellogg, Kellogg-MacKay Company, Chicago, Ill.
T. L. Kirk, Standard Seamless Tube Company, Pittsburgh, Pa.
Harry Loeb, Lukens Steel Company, Philadelphia, Pa.
J. V. Loughlin, Dover Boiler Works, Dover, N. J.
F. R. Low, *Power*, New York.
C. J. Manney, secretary, Ohio Board of Boiler Rules, Columbus, O.
J. E. Mason, *Power*, McGraw-Hill Company, New York.
L. P. Moore, Kewanee Boiler Company, Kewanee, Ill.
M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.
C. O. Meyers, Ohio Board of Boiler Rules, Columbus, Ohio.
A. G. Pratt, Babcock & Wilcox Company, New York.
G. A. Richardson, Midvale Steel & Ordnance Company, Cambria Steel Company, Philadelphia, Pa.
G. N. Riley, National Tube Company, Pittsburgh, Pa.
G. E. Ryder, The Superheater Company, New York.
A. D. Schofield, Macon, Ga.
J. F. Scott, New Jersey Steam Boiler Inspection Dept., Trenton, N. J.
William H. Speer, Jersey City, N. J.
L. S. Thomson, Midvale Steel & Ordnance Company, Cambria Steel Co., Philadelphia, Pa.

T. E. Tucker, Gem City Boiler Works, Dayton, Ohio.
C. M. Tudor, Tudor Boiler & Manufacturing Company, Cincinnati, Ohio.
E. G. Wein, E. Keeler Company, Williamsport, Pa.

Changes in Massachusetts Boiler Rules

The steam boiler rules of Massachusetts, as formulated by the Board of Boiler Rules, Department of Public Safety, are being reprinted, and at an executive session of the board, following a public hearing in the State House, Boston, on May 5, 1921, the following changes in the rules as previously published under date of January 3, 1919, were adopted:

Page 14, paragraph 2, section 2, part 2—(Add to Condition C): Where two steam mains carrying different pressures are connected together, a safety valve or valves installed on the connecting pipe and equal in area to the area of the pipe and set at the lower pressure allowed shall be considered to meet the requirements of the foregoing paragraph.

Page 45, paragraph 13, section 1, part 3—Strike out the word "heat" and make the paragraph read: "Each plate shall be distinctly stamped by the manufacturer with the melt or slab number."

Page 138, paragraph 3, section 6, part 3—Boilers in state prior to May 1, 1908, may be reinstalled:

Boilers in this commonwealth prior to May 1, 1908, where both ownership and location are changed, which do not conform to the rules of construction formulated by the Board of Boiler Rules, may be installed after a thorough internal and external inspection and hydrostatic pressure test by a boiler inspector of the division if inspection of the Department of Public Safety, or by an inspector holding a certificate of competency as an inspector of steam boilers for this commonwealth and employed by an authorized insurance company.

The pressure allowed on such boilers when reinstalled shall be ascertained by the use of the following factors of safety:

(a) Six for boilers the longitudinal joints of which are of lap-riveted construction, diameters up to and including 36 inches.

(b) Eight for boilers the longitudinal joints of which are of lap-riveted construction, diameters over 36 inches.

(c) Five for boilers the longitudinal joints of which are of butt and double strap construction, age not exceeding ten years.

(d) Five and five-tenths for boilers the longitudinal joints of which are of butt and double strap construction, age over ten years.

It was also decided to take steps soon looking toward the formulation of rules for low-pressure steam boilers.

Why Do Rivets Leak?

THE underlying cause for leakage at the riveted joints of boiler plates is oftentimes difficult to place, necessitating a thorough consideration of the details in their design and construction. Modern investigation has, however, revealed the fact that the answer is partly found in the rivet itself—its constitution and its physical structure.

It will be of interest to many to know that scientific methods of steel making combined with rigid chemical and physical testing does exclude the possibility of sulphur or phosphorus being present in high enough amounts to cause ruinous "cold" or "red shortness" in the rivet metal. In addition to this, the physical structure of the metal is given the greatest consideration by progressive rivet manufacturers of today, who subject their steel to a process of cold working and annealing which increases greatly the strength and ductility of the rivet.

Improper Selection of Rivet Sizes Causes Trouble

Failure of a joint is due at times to the selection of unsuitable rivets of such proportions that they must be unduly worked and strained to fill the rivet hole and form the head. It is also necessary that there be enough material to form a head that is at least as strong as the body of the rivet; and that the body length be not more than six times the diameter, since the stresses induced by contraction of the body increase with the length and may become so great as to cause the head to fly off.

Faulty design of joints is another contributor to leaking and failure. So careful consideration must be given to the type of joint to be used—whether it be lap or butt; single riveted, double riveted, triple riveted, etc. The pitch and diameter of the rivets must be so proportioned that the strength of the rivets in shear will approximate the strength of the plate against tearing; while both must be of such strength to withstand any shearing, bending or tensile stress they may receive. Well established formulæ provide ample evidence that the stress in a girth lap seam worked is one-half the stress in a longitudinal joint. As a consequence it is permissible to use a lap joint for a girth seam, even though its strength is only a little better than one-half that of the butt seam. It should be noted, however, that the lap seam has a tendency to break or crack along the seam, which of course results in leaks.

Methods of Forming Rivet Holes

Even the method of making the rivet holes may be responsible for the leaking of a boiler. Punched holes decrease the tensile strength of the plate between holes from 8 to 35 percent. This may be corrected if the diameter of the hole is increased ¼ inch by seaming or drilling—thereby removing deformed material. If the holes are drilled instead of being punched the tensile strength of the plate between holes is increased ¼ inch by reaming or drilling—thereby removing many cases it happens that rivets are overheated before being driven and are consequently very susceptible to failure.

Riveters themselves are sometimes at fault for there are many factors in driving rivets that need to be carefully observed if the resultant joint is to be tight. The plates being riveted should be held firmly together with tack bolts; and the rivets themselves should be hammered in place until redness disappears. This will prevent yielding of the head of the rivet, and the tension created by the contraction of the rivet shank in cooling will create high friction between the plates and prevent them from slipping. The importance of this point will be appreciated when it is considered that the rivets also contract laterally and do not completely fill their holes when cold. Before shearing can take place in rivets it is consequently necessary that the plates shall slip on each other. This slipping, which if in any appreciable amount will cause leaking, is prevented by the contact friction of the plates induced by the tension in the rivets and increased by proper calking.

The final operation to prevent leaks is calking. A good job of calking, as stated above, increases the strength of a joint by increasing the resistance of the plates to slipping. To secure a maximum of safety and strength rivets and plates should be calked on both sides.

The Dominion Oxygen Company, Ltd., has contracted for a new $250,000 oxygen plant in Montreal, Canada. The building will be 100 feet by 100 feet and substantially a duplicate of the company's Toronto plant.

On June 9 the Greenfield Tap & Die Corporation, Greenfield, Mass., purchased the entire capital stock of the Greenfield Machine Company, manufacturers of cylindrical and universal grinders. The Morgan Grinder Company of Worcester, Mass., manufacturers of internal grinders, was also purchased at this time.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

Edward A. Simmons, *President* — Roy V. Wright, *Secretary*
Henry Lee, *Vice-President and Treasurer*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. — Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. — Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1,
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,500 copies were printed; that of these 4,500 copies 3,960 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 53 were mailed to advertisers, 66 were mailed to employees and correspondents, and 405 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 34,400, an average of 4,920 copies a month.

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

CONTENTS

	PAGE.
GENERAL:	
Fitting Liners to Smoke Tubes in Superheater Boilers	185
The Manufacture of Charcoal Iron Boiler Tubes	187
Principles of Riveted Joint Design	191
Speeding up Boiler Repairs by Use of Autogenous Welding Processes	194
Boiler Code Rulings of Pennsylvania Board	196
Industrial Relations Conference to be Held	197
American Boiler Manufacturers' Convention	198
American Uniform Boiler Law Society	198
Simplification of Data Sheets and Standard Stamping of Boilers	198
Uniformity in Boiler Inspection	199
American Society of Mechanical Engineers' Code	200
Formulating Rules for Inspection	200
Related Industries Committee Report	201
Duties of National Board of Boiler Inspectors	203
Registration at American Boiler Manufacturers' Convention	203
Changes in Massachusetts Boiler Rules	204
Why Do Rivets Leak?	204
EDITORIAL COMMENT	205
ENGINEERING SPECIALTIES FOR BOILER MAKING	206
QUESTIONS AND ANSWERS FOR BOILER MAKERS:	
Blower Connection	208
Cleaning Boiler Tubes	208
Removing Damaged Tubes	209
Beveling Plate for Welding Repairs	209
Stirling Tubes and Mud Drums	209
Boiler Head Segments—Rivets, Rivet Heads and Laps	209
Painting Boilers	210
Retubing Boilers	210
BUSINESS NOTES	210
OBITUARY	210
LETTERS FROM PRACTICAL BOILER MAKERS:	
Severe Test on Low Pressure Welded Boiler	211
Notes on Locomotive Shop Practice	211
Scale to Aid in Solving Right Angle Triangles	212
Setting Dividers Accurately for Spacing Off a Given Distance	212
ASSOCIATIONS	213
TRADE PUBLICATIONS	213
SELECTED BOILER PATENTS	214

Examples of the practical application of autogenous welding are given in this issue of The Boiler Maker. New front and back flue sheets are being installed in many locomotive shops when engines are brought in for repairs, by cutting out the old sheets with the oxy-acetylene torch and welding in new sheets with the electric arc. The greatest saving in an operation of this kind is time—and in cutting down this element, the cost is materially reduced and the revenue earning power of the locomotives increased. In the matter of material, savings are also accomplished, for unflanged sheets of comparatively small size may be kept in stock to replace sections cut from the old sheet with the torch. If any roads are failing to take advantage of the economies made possible both in the repair shop and in new construction where welding is permitted, it is about time that serious consideration should be given the subject.

There is another application of welding mentioned in the "Letters" section of this issue which indicates that at least one manufacturer of heating boilers has realized the great importance of the process in this branch of the boiler industry. All welded, steel heating boilers have been built and operated with an absolutely clear record for seven years. In spite of the fact that these boilers are built for only 15 pounds per square inch pressure, they are made to stand a hydrostatic test pressure up to 300 pounds without any action in them, except possibly the slight bulging of the heads.

In England, welding has not been restricted to small boilers as evidenced by the Hawthorn-Wyber Scotch marine boiler which was described in the January issue of this magazine. This type of construction has been accepted by Lloyds' Bureau and promise to give entire satisfaction.

With the application of fusion welding to boilers of this type coupled with the success of the process in small heating boiler construction in this country in mind, it would seem quite logical that boiler designers and welding engineers could work together to produce in America a power boiler that would be entirely acceptable to the various authorities.

The importance of the apprentice or better, student boilermaker question is brought out at nearly every meeting of railroad shopmen and contract manufacturers. Attempts have been made to put in operation practical training courses for young men who enter the boiler industry with a belief that it holds a future for them. The Santa Fe railroad for thirteen years has been conducting courses in all departments of its shops and roundhouses with success. Apprentices on this road under the supervision of competent instructors turn out a creditable amount of work, even when this work comes under the class of study. However, the production thus obtained is only incidental, the primary object being the training of a corps of men from which foremen and superintendents may be chosen. Salaries for the men who act as instructors in the shops are not considered as a production expense, for in addition to conducting classes these instructors are able to supplement the work of the foremen and to relieve them in the case of temporary absence.

In small shops wherever it is necessary to maintain only a small class of apprentices, methods of instruction may be developed that will not necessitate the addition of special instructors. In each department, one man well versed in his trade and interested in teaching the students the best practice in that department is able to carry on his own work while at the same time supervising the apprentices. After having worked for a time in each department of the shop and passed suitable examinations, testing their ability as practical boilermakers, the apprentices graduate into the shop as real producers.

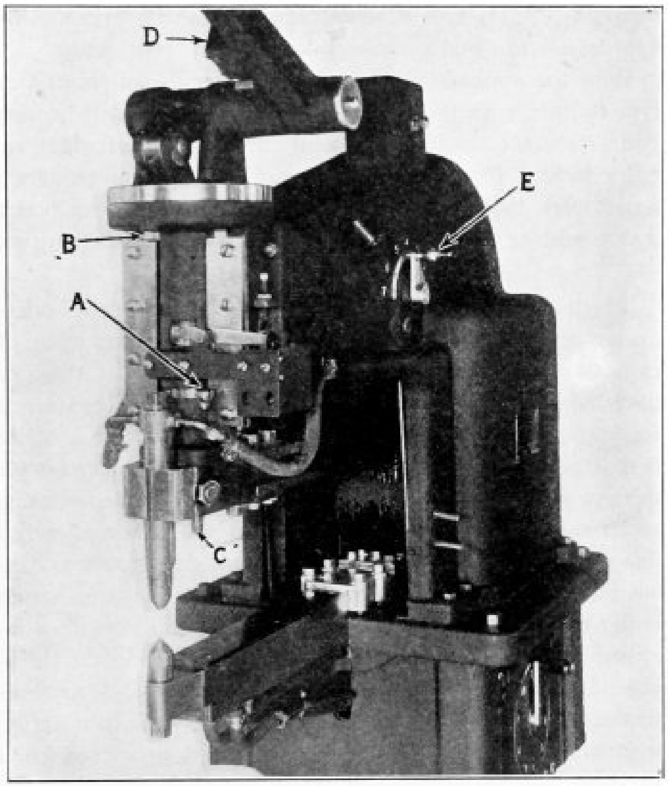
The present depression in business has served in many industries as an opportunity to build up the personnel, so that productive efficiency is high. This is also an excellent time for manufacturers to select a number of desirable young men and put them through a course of training in the shops that will fit them for positions of authority in the future.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

New Design Spot Welding Machine

For welding heavy stock a new spot welder has been developed by the Taylor Welder Company, Warren, Ohio. The head on this machine has square slides and steel caps instead of round spindles, as formerly, so that any looseness due to wear may be readily taken up and the alinement of the electrodes maintained. The hand lever will swivel 90 degrees from each side of the center, and can be locked in any position by screw *B*. When operating by foot, the hand lever remains in the upper position. The height of hand lever can be changed to suit the operator by a segment on the side of lever *D*. The travel of the hand lever and the foot treadle can be regulated to seven different positions by means of lever *E* on the overhanging arm. The foot treadle swivels to right or left and can be removed when not in use without making any disconnections. Pressure on the work may be changed by adjusting screw *C* in the center of the upper electrode holder. Changing from automatic to a non-automatic switch is accomplished by moving the small lever *A*. Water circulates through the upper and lower welding electrodes, prolonging the life of the electrodes.



Taylor Series 4 Water Cooled Spot Welder

The Series 4 machine, illustrated, has a capacity to weld two pieces of sheet steel 1/64 inch to ¼ inch or 28 to 3 gage. A 25 kilowatt transformer operating at 220 or 440 volts, 25 to 60 cycle, single phase, is generally used. There is a 10-step, self-contained regulator for adjusting the current. Automatic and non-automatic auxiliary switches operate a magnetic controlled switch on the rear of the machine.

The distance between the lower horn and the copper bands on slide horn machines, with the horn at the top of the slide, is 6 inches and with the horn at the bottom of the slide, 26 inches. The distance from the floor to the welding electrodes is 42 inches, the greatest movement of the upper electrode being 3 inches. One set of 1¼ inch water cooled electrodes, consisting of two straight, two offset and one flat electrode, are standard equipment.

The operation of this type machine is by hand lever and foot treadle, either together or independently. When using the automatic switch, the electrodes are brought in contact with the work under spring pressure. Further movement of the hand lever or foot treadle turns on the current and the work heats immediately to a welding temperature. Further movement of the lever or treadle turns off the current and applies a positive pressure to the molten metal, completing the weld. The non-automatic switch is operated by a button in the end of the hand lever, the electrodes being brought into contact with the work under positive pressure. This permits the operator to apply a heavy pressure before and after the current is turned on and off, additional pressure also being applied with the foot treadle. The machines can be furnished in single or double currents.

Portable Plate Drilling Machine

The portable plate drilling machine shown in the accompanying illustration has been patented by E. L. Fogleman, Box 245, Balboa, Canal Zone. While the illustration shows quite clearly the construction of the machine and its method of operation, it should be mentioned that it has a capacity for drilling holes to any depth up to 6 inches, and the design is such that the drill will always be maintained in a position at right angles to the surface of the work, regardless of whether or not the work is held in a horizontal position.

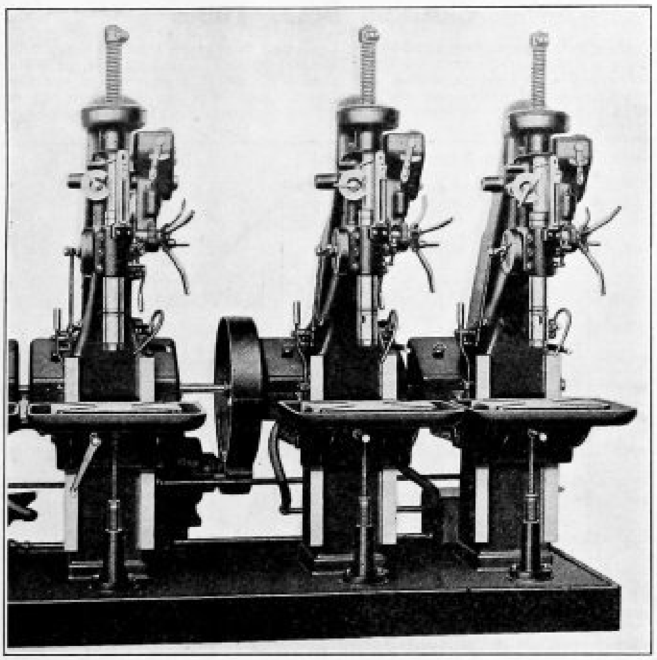

Portable Plate Drilling Machine of New Type

While the machine is intended primarily for drilling and countersinking holes with the tool held at right angles to the base of the work, it is a simple matter to drill holes at any desired angle by adjusting the screw shown in contact with the work at the right of the drill.

Self-Oiling Gang Drill

A self-oiling, all geared drilling and tapping machine, made in two, three and four-spindle units, has been developed by the Barnes Drill Company, Rockford, Ill. All bearings, aside from the spindle sleeves and cross spindles, are continuously oiled automatically, oil being forced by a geared pump in the reservoir of each machine to all gears and bearings, including the crown gears and feed box. Transmission gears, aside from the friction clutch gears and including the crown gear and pinion, are cut from a special high-grade chrome nickel steel, heat treated and tempered to reduce wear and to increase strength and stiffness. This steel has a high tensile strength and the transmission gears are therefore able to resist severe stresses.

There are eight changes of speed for each spindle, all controlled by levers within easy reach of the operator from his position in front of the drill. Each spindle may be stopped by placing its shifter lever on neutral position or by throwing out the driving clutch. With one to one crown gearing, speeds from 58 to 575 revolutions per minute are available. For tapping, two to one crown gears are used, giving eight speeds from 28 to 280 revolutions per minute.



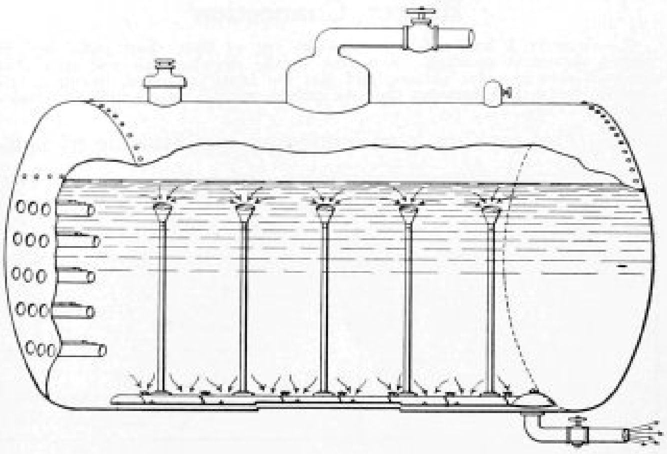
Barnes 22-in. Gang Drill Made in 2-, 3- and 4-Spindle Units

Any or all spindles may be equipped with an automatic reversing mechanism, particularly desirable for depth tapping. The trip can be set so that the instant the tap reaches the depth required, the spindle will automatically reverse. Again, the shifting lever can be set so that when tripped automatically (or by hand) it will return to neutral position, thus stopping the spindle instantly instead of reversing it. The small hand trip lever, shown, is always ready for instant use if desired to reverse or stop the spindle at any point in the operation. If the automatic reverse is not required, drills can be furnished with a plain hand reverse lever instead.

The Barnes gang drill is designed to drive ½ inch to 2 inch high speed drills in solid steel. The height of the machine is 85½ inches. The distance from the center of the spindle to the face of the column is 11 inches and from center to center of spindles (2- and 3-spindle machine) is 28 inches. The center spindles of 4-spindle machines are 40 inches apart. The spindle travel is 14 inches. The ratio of back gearing is four to one and the vertical travel of the table is 23 inches. The speed of tight and loose pulleys is 500 revolutions per minute. Ten, 15 and 20 horsepower motors are recommended for driving the 2, 3 and 4-spindle machines, respectively.

Automatic Boiler Cleaner

A new automatic boiler cleaning attachment, preventing the formation of scale and causing the elimination of old scale, adjustable to any type of boiler has been developed by the Automatic Boiler Cleaner Company, New Orleans, La. The principle of the device is to throw out all impurities, sediment or foreign matter from the interior of the boiler. It accomplishes this by the application of the syphon principle which eliminates impurities in circulation in the water as they rise to the surface and also carries off the sludge and sediment from the bottom of the boiler.



Cleaner Applied to Horizontal Return Tubular Boiler

The accompanying illustration showing the installation in a horizontal tubular boiler shows in a general way of what the device consists. Risers of ⅜-inch pipe are screwed into brass saddles on the mud tiling which is fitted to the bottom of the boiler and the mud drum. This tiling is dressed off where it comes in contact with rivet heads and is tapered at the joints of the sheets in the boiler. The only openings required are the V cuts provided in the mud tile. Brass syphon cups are placed in the upper ends of the riser pipes. The top of the syphon cup should be 4 inches below water level. In general it is only necessary to operate this device at the regular blow off intervals and at this time impurities and scale are removed. When using water which is unusually muddy or salty, or having scale forming properties it is well to blow off the boiler between regular shifts.

In the personal notice published on page 154 of the May issue of THE BOILER MAKER giving an outline of the career of George Austin, the fact that he worked for the Northern Pacific Railroad at Brainerd, Minn., and Mandan, N. D., from 1889 to 1903 was not clear. His only change during this time was for a period of eight months, when he was with the Great Northern Railroad.

In this same issue it was incorrectly stated that Thomas F. Powers was system general boiler foreman of the Canadian and Northwest Railway. This should have been the Chicago and Northwestern Railway.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

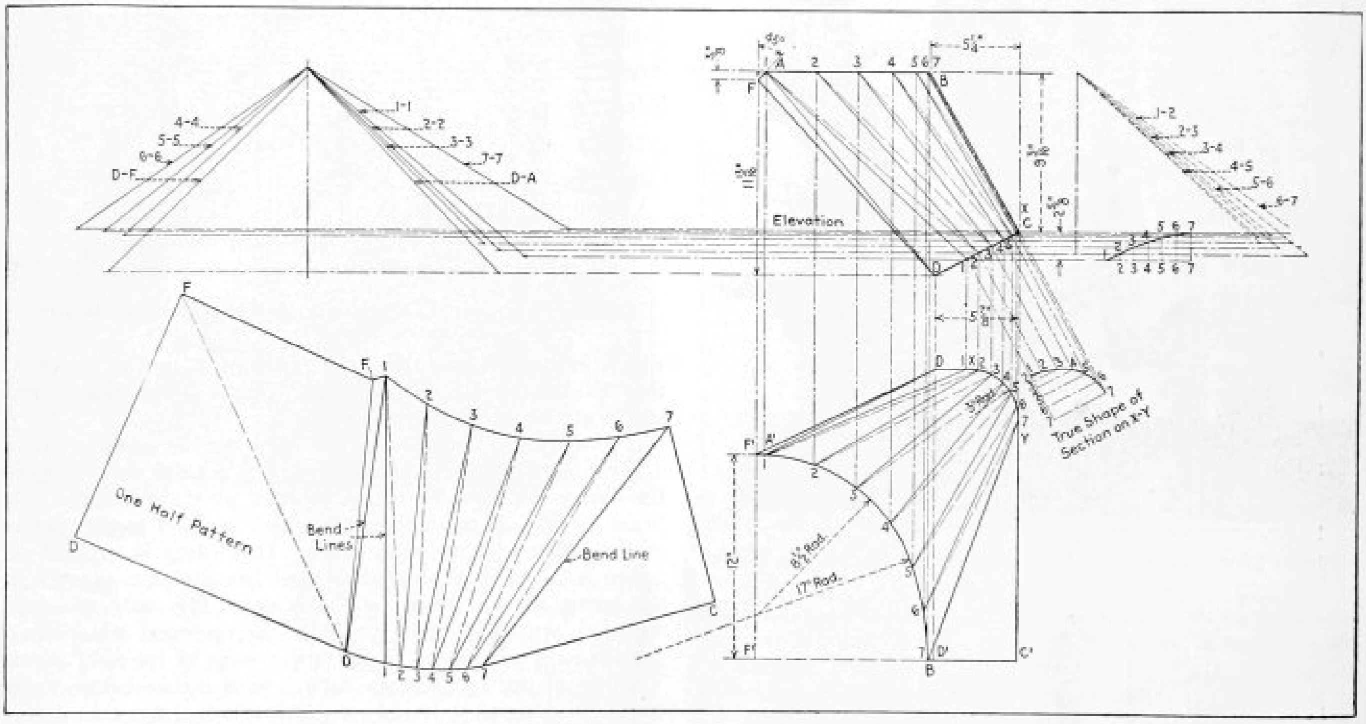
Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Blower Connection

Q.—Recently I had a layout to make out of light sheet metal and it proved somewhat puzzling. Referring to the drawing you will note that the back side is a flat surface, and that the front is curved, having a triangular flat section between the two curved parts. How would you make this layout?—O. B.

A.—This problem is an interesting one involving triangulation, but it is no more difficult than a regular tapering piece varying from round to square. To illustrate the development a complete layout is made for one half of the pattern. Each construction line being numbered in both plan and elevation makes the layout work easy to follow. A true profile on *x-y* is shown at right angles to *D-C* of the elevation. In the event that such a view is not given the true length of the spaces on the curved section could readily be obtained by the development given at the right of the elevation or as indicated by the layout for the profile view. After the one half plan and elevation are drawn, step off the arcs at the top and bottom into the same number of equal parts. Draw the triangulation lines and number them. The next step is to find their true lengths, as shown to the left and right of the elevation. Transfer the bases from the plan and the vertical leg of each of the triangles is equal to the vertical distance between the extreme points of corresponding lines of the elevation. These are shown projected in the triangles.

In the pattern these true lengths which are the hypotenuses of the triangles are assembled. Use the arc lengths on *A-B* of the plan for the top section of the pattern and those of the profile on *x-y* for the lower part. Make your allowances for the required joints.



Layout and Pattern for Blower Connection

Cleaning Brass Tubes

Q.—Owing to firebox troubles we have had to remove a lot of brass tubes from a couple of locomotives which are nearly new. These tubes, of which there are nearly one hundred, are, except for the firebox end, in excellent condition and doubtless we shall use them again later on. Can you tell me of a practical and economical method of cleaning them? We don't want any special apparatus system, as the necessity will probably not arise again.—H. B.

A.—We would suggest the use of a strong solution of common washing soda and water. Place the tubes in the solution, which should be kept at the boiling point. We would be glad to hear from the other readers on this point.

Cleaning Boiler Tubes

Q.—We would like to inquire if you know of any solution that will be economical for the purpose of dipping boiler flues to take off the scale or accumulation of mud satisfactorily in place of running the flues through the rumbling process. The work that we are contemplating requires the handling of a very large quantity of flues to be cleaned.—G. R.

A.—To facilitate the removal of scale and mud in the tubes of water boilers and around tubes of fire tube boilers without removing the tubes, use a strong solution of common washing soda. For watertube types use about 25 pounds of soda for each ton of water content, and for fire tube types 1 pound of soda to 25 square feet of heating surface. It will take about 12 hours continued boiling to loosen the scale. Pressure should be kept at approximately 40 pounds per square inch. Allow the steam to escape through the safety valve. Blow off 1 inch of water at 2 hour intervals through the blow off cocks; add fresh water to keep the water at its proper level.

At the end of the boiling period in watertube types first draw the fire, blow off the water and clean the tubes with wire brushes. In fire tube boilers allow the fire to die out and the water to cool, then remove enough water to leave the upper tubes uncovered, clean the tubes with scrapers and wire brushes. Handle each of the remaining rows the same way. Also clean the boiler plate heads and drums, flush the boiler with fresh water to remove all dirt.

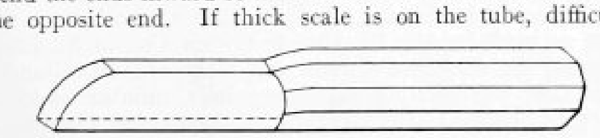
Rumbling the tubes after they are removed from the boilers seems to me the best practice and the most economical.

Another method of cleaning boilers is to draw the fires, leaving the water to cool before drawing it off. Open the hand holes and manholes, then with the use of scaling hammers, chisels, etc., remove the scale. Tubes are cleaned with rotary cutters and hammers operated with air or water motors. The tube cleaners are moved slowly forward and backward through the tubes. Scale cutters as operated in tubes of watertube boilers should be handled so as to avoid damaging the tubes. Allowing the tube cleaner to work too long in one place is liable to injure the tube. Flush the boiler with clean water after the scale and dirt have been loosened from the boiler plate and tubes.

Removing Damaged Tubes

Q.—How are defective tubes removed from boilers; are special tools necessary?—K. B.

A.—Chip off the bead and split the tube back a distance of from 1 to 2 inches using a cape or a narrow cross-cut chisel. Bend the ends inward so that the tube can be drawn out from the opposite end. If thick scale is on the tube, difficulty



Ripper FIG. I

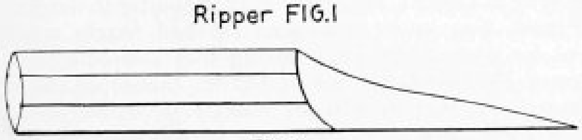


FIG. 2

Tools Used in Retubing Boilers

will be found in removing it. If the tube is on the outside, chip off the other bead and split the tube and drive it in so that it falls to the bottom of the boiler, removing it through manhole or clean out openings.

Tools known as a *ripper* and another having a flat top and rounded bottom, Figs. 1 and 2, are used in this class of work. The ripper is used in splitting the tube and the other in bending back the split ends.

Beveling Plate for Welding Repairs

Q.—In locomotive boiler repair work, is it customary or practicable to bevel the firebox sheet with the cutting torch when sections are being cut out, so that these portions of the sheet may be made ready for welding? To my mind time would be saved if this practice could be allowed. I should like to have the matter discussed in THE BOILER MAKER. J. B. U.

A.—It is good practice when burning out sections of boiler plate, preparatory for welding, to burn the plate on a bevel. Scale and slag after burning should be chipped away from the beveled edges, otherwise if such material is incorporated in the weld the strength and homogeneity of the weld are greatly reduced.

Stirling Tubes and Mud Drums

Q.—I have wondered why the tubes in a Stirling boiler are bent, where they join the lower and upper drums; also for what purpose are mud drums used? F. B.

A.—In the Stirling type boiler the three upper drums are connected to a lower drum with three banks of tubes (watertubes). These are bent at the top and bottom to allow the different parts of the boiler to expand and contract without setting up excessive strains.

A mud drum is a chamber or cylindrical vessel into which mud or sediment contained in the boiler water is collected and blown out at intervals through a blow off valve.

Boiler Head Segments—Rivets, Rivet Heads and Laps

Q.—(1). The American Society of Mechanical Engineers Boiler Code, 1918 edition, page 58, paragraph 218, states that when a portion of the head below the tubes in a horizontal return tubular boiler is provided with a manhole opening the flange of which is formed to a depth of not less than three-quarters the required thickness of the head, measured from the outside, the area to be stayed may be reduced by 100 square inches.

Now suppose that we build a small horizontal return tubular boiler, say 36 inches by 14 feet, and place a handhole opening below the tubes, say 3½ inches by 4½ inches, and place the manhole opening above the tubes instead of below the tubes in the head, Par. 218. In addition, we will build the boiler with the opening below the tubes and brace it just enough, deducting the 100 square inches we are allowed under Par. 281. However, we decide for some unknown reason to turn the boiler over so as to place our attachments, etc., on the former bottom side. Now we have the opening above the tubes and the bracing will not be adequate inasmuch as we have 100 square inches more to brace. Why is it that it can be deducted only when below the tubes? Would the difference of it being in the steam space have any effect?

(2). As to riveting a longitudinal seam, we must add 1½ times the diameter of the rivets to the lap, as stated on page 44, section 183, except at the end of the butt strap. However, what is the least that can be allowed on the end of the butt strap in the following case:

Double riveted butt joint, inside strap at the front end.
Pitch 2¼ inches and 4½ inches; 13/16 inch holes.
Efficiency 81.8 per cent.
Plate 5/16 inch thick.
Butt straps ¼ inch thick.

Would not this end of the butt strap be faulty inasmuch as there is no lap at all?

(3). On a girth or circumferential seam what is the least lap we may have from the center of rivet hole to edge of plate? Say, for instance, we have 1-inch holes in a drum 50 inches in diameter spaced 2.6 inches apart.

(4). Suppose rivets are driven in a boiler and the rivets are too short to make a large enough head. For instance, a ¾-inch rivet is driven and a ⅝-inch die is used. The head I know will be too small. My understanding is that page 72, American Society of Mechanical Engineers Boiler Code, paragraph 253, Fig. 20, shows the least amount allowed. If a steeple head rivet were used it should be 2 inches across and be 1 inch high at the point. But supposing I did not know it was a 1-inch rivet. Suppose the holes were 1⅛ inches and a 1-inch die were used, how could I detect that the head is too small?

A.—(1) The rule stated in paragraph 218, A.S.M.E. code, on staying a segment of a boiler head having a manhole below the tubes is also applicable in case the manhole was placed above the tubes as you mention. Pressure on the head is considered to be uniform. However, at the bottom the pressure is greater, due to the weight of the water. The deduction of 100 square inches is for the manhole. Flanging the manhole in the head is sufficient to support the pressure on the manhole cover, but the cover must be of sufficient thickness and so made as to safely stand the working pressure. End to end stays are used to support the area of the head surrounding the manhole.

(2) Distance from center of rivet hole to edge of plate in lap joints and butt joints shall not be less than one and one-half times the diameter of rivet in accordance with paragraph 183, A.S.M.E. code. Exception to this is made in butt strap ends. Sufficient material, however, made in such cases must be allowed to provide a proper bearing for the rivet heads.

(3) For lap in circumferential seams allow 1½ times diameter of rivet, which is the material from center of rivet hole to edge of plate. If too much is added it is difficult to calk the seam if required.

(4) The shank of the rivet is usually 1/16 inch less in diameter than the rivet hole, so as to allow the heated rivet to be inserted easily. Sufficient rivet material for the rivet head must be provided and also to fill up the rivet hole. If too much stock is allowed the head will have a thin fin at the

bottom. The proportions for rivet details given by the code should be followed. When in doubt as to the size of rivets driven, obtain a copy of the boiler specifications, check the rivets using the die sets required for the respective diameters of rivets, or cut out one of the rivets, measure the rivet hole diameter, then check the rivet head.

Painting Boilers

Q.—Please give me some information on boiler paint used for exterior and interior painting.—L. B.

A.—First clean the boiler parts, removing rust, scale and old paint flakes. A heavy wire brush is good for this purpose.

A mixture of red lead, kerosene and linseed oil is a good serviceable paint for exterior parts. Zinc white, kerosene and linseed oil to bind the mixture is used for interior parts, especially along the waterline, where corrosion generally arises.

Retubing Boilers

Q.—Please advise the best method for retubing old boilers. Should tubes be rolled with a tube roller and beaded over with hand tools, or should a spring tube expander be used —G. S.

A.—The method of removing tubes depends on conditions and tools supplied to handle such work. In another inquiry on page 209 the matter of removing tubes is explained.

Refitting new tubes does not vary from the method applied in handling new work. After the old tubes are removed examine the tube holes to see if they are round. If they are out of round, the holes should be reamed and if this operation makes them too large, use copper ferrules over the tube ends, so as to reduce the amount of expanding, that otherwise would be needed to make them tight.

Tubes may be expanded by either a *sectional* or the *roller tube expander,* care being taken to avoid too much expanding of the metal. Both methods of tube expanding have proven satisfactory and each has its advocates. After the tubes are expanded the metal for the bead is turned down, by hand or with a pneumatic hammer and cone shaped tool, the beading being done with the regular beading tools.

BUSINESS NOTES

John M. Hartman has resigned from the Aluminum Co. of America to join the engineering staff of the Kewanee Boiler Co., Kewanee, Ill.

The Canadian Locomotive Company, Ltd., Kingston, Ontario, is carrying out improvements at its shops, to include two additional pits to the erecting shop and the construction of a storage building 200 feet by 75 feet.

It is announced by the Page Steel & Wire Company that W. H. Bleecker, Jr., formerly district sales manager of the Chicago office, will be transferred to the New York office, in the Grand Central Terminal, in the same capacity, and E. J. Flood has been appointed district sales manager for the Page products in the Chicago office, at 208 South LaSalle street, succeeding Mr. Bleecker.

Frank H. Cunningham has been appointed special engineer with the Franklin Railway Supply Company, Inc., New York. Mr. Cunningham was born in Roanoke, Va., May 23, 1886. After serving an apprenticeship as machinist on the Norfolk & Western, he attended the University of Virginia. Following his graduation with the degree of mechanical engineer he returned to the Norfolk & Western as machinist, subsequently becoming material inspector, mechanical inspector, assistant engineer of tests and supervisor of locomotive stokers. In 1914 he went with the Standard Stoker Company as fuel engineer, being appointed later to plant manager at Erie, Pa., and assistant general manager, a position which he filled at the time of his resignation to enter the services of the Franklin Railway Supply Co., Inc., as above noted.

The Mahr Manufacturing Company, Minneapolis, Minn., announces that H. B. Wilson has taken charge of the company's branch office at St. Louis, Missouri. The address of this branch is 915 Olive street, St. Louis, Missouri.

C. J. Burkholder has been appointed special engineer of Franklin Railway Supply Co., Inc., with offices in New York. Mr. Burkholder started his railroad work at Tyrone, Pa. He later became a locomotive fireman, locomotive engineer on the Union Pacific. Leaving the Union Pacific he went with the Kansas City Southern, as locomotive engineer, then traveling engineer, trainmaster, general road foreman of engines and division superintendent. He resigned from the Kansas City Southern to become mechanical representative of the Economy Devices Corporation, which later merged into the Franklin Railway Supply Company. In November, 1918, he resigned from the position of western sales manager of the Franklin Railway Supply Company to become master mechanic of the Kansas City Southern Railroad, which position he held at the time of his appointment above noted.

OBITUARY

James Prentice Sneddon, of the Babcock and Wilcox Company, who died on June 11, at Johns Hopkins Hospital in Baltimore, after undergoing two operations, has left a record of executive ability and technical knowledge written deeply in the history of the boiler industry.

He was born in Newmains, Scotland, July 7, 1863, and came to the United States when fourteen years old. He attended school at St. Louis and Carbondale, Ill. After this education, he was employed by the Carbondale Coal & Coke Company at Carterville, Ill., on maintenance and operation and finally on the construction of a 40-mile railroad. This experience showed him that his abilities were along mechanical lines and he decided wisely to start at the bottom. He went to work for the Rankine & Fritsch Co., at St. Louis, learning the machinist's trade and afterward installing engines and refrigerating machinery in a number of cities. Then he became master mechanic of the Crystal Plate Glass Company at Crystal, Mo., but returned shortly to the Rankine & Fritsch Co., as its manager. He had nearly completed plans for reorganizing and buying that company when the panic of 1893 rendered this project impracticable and it was necessary for him to turn his hand to whatever work presented itself. For about two years he was busy in this way and eventually was employed by the Hawley Furnace Company of Chicago, where he made the acquaintance of E. R. Stettinius, at that time manager of the Stirling Company. Mr. Sneddon was first employed by the Stirling Company in 1899 at its plant at Barberton, Ohio. Shortly after his arrival there, the organization was completely changed and he became superintendent in general charge of manufacturing. From 1899 to 1905 the shop methods and the products of the Stirling Company were so improved that in the latter year the company found it desirable to purchase the boiler business of the Aultman & Taylor Machinery Company, of Mansfield, Ohio. This combination was called The Stirling Consolidated Boiler Company, of which Mr. Sneddon became vice president in charge of manufacturing. In 1906, when The Babcock & Wilcox Company took over The Stirling Consolidated Boiler Company, Mr. Sneddon became its general superintendent and directed its manufacturing policies until his death. In addition to his interest in this company, he was vice president of the Pittsburgh Seamless Steel Tubes Company, and a director of the Mechanics Trust Company of Bayonne, N. J.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Severe Test on Low Pressure Welded Boiler

It is with considerable interest that I have followed the different articles which have recently appeared in THE BOILER MAKER regarding welded boilers and pressure vessels, and on account of being located continually in the plant of the General Boiler Company, Waukegan, Ill., I thought your readers would be interested in a recent test on one of their boilers.

These people make a specialty of an entirely welded low pressure boiler for heating purposes and manufacture them in all sizes from 22 inch diameter up to 72 inch diameter, inclusive. Their record of over 7 years' manufacture of entirely welded boilers has yet to show a single explosion or serious accident to any one of them, although several hundred are in operation throughout the United States.

The test in question was made on a 40 inch diameter shell, constructed of ¼ inch Illinois flange steel having a tensile strength of 55,000 pounds per square inch. The heads were of the same quality steel ⅜ inch thick, the rear head being offset 15 inches, forming a flat surface 15 inches wide and 40 inches long. This surface was stiffened with ribs ⅜ inch by 3 inch by 15 inch set on edge and spaced 8 inches between centers. The shell contained 51 three inch tubes and the portion above the tubes on the heads was supported by diagonal braces welded to the sheet and passing through the heads.

Upon putting on the required hydrostatic pressure to test the boiler no movement whatever was observed while it was slowly raised to 200 pounds, at which pressure the pump was stopped and the heads and shell carefully measured. On the pressure being increased, a slight movement was observed at the flat portion of the rear head at 225 pounds. This increased and showed a deflection of ⅛ inch at the center, when the pressure reached 300 pounds; otherwise no weakness or distress was observed and no movement or distortion or leakage along the longitudinal seam or head seams.

Inasmuch as these boilers are only constructed for a maximum working pressure of 15 pounds, the above test clearly shows the strength and safety of welded boilers for low pressure if they are properly and carefully constructed. Those present at the test were G. Gearon, assistant chief boiler inspector of Chicago; R. Cooper and A. Baker of Cooper & Baker, heating engineers of Chicago; O. T. Nelson, president of the General Boilers Co., and the writer. It was agreed by all present that the above test was a success.

Chicago, Ill. J. H. PETHERICK, JR.,
Inspector, Maryland Casualty Co.

Notes on Locomotive Shop Practice

In testing a new boiler fill it with warm water (not over 150 degrees F.) and raise the pressure (by use of an injector or pump) to 25 percent above the working pressure. (The term "working pressure" is the maximum working pressure for which the boiler is designed.) Then fire the boiler and test under its own steam to 20 percent above the working pressure. Blow the boiler out entirely and let it stand until it is thoroughly cooled down, and refill with warm water (not over 150 degrees F.). Fire the second time to 20 percent above the working pressure. In blowing down a boiler, lower the steam pressure slowly. When testing a new boiler, put soda ash in before the first heat to cut the oil from the interior.

Use a single sheet for the firebox and combustion chamber on boilers where the size of the plate does not exceed rolling mill limitations. Do not use the continuous inside throat sheet, but as short a one as the shape of the boiler will permit. For large boilers, where the size of sheet exceeds mill limitations, weld the sheet, forming the crown of the combustion chamber with the firebox crown sheet. Make all combustion chamber seams on the sides.

REINFORCING HOLES IN SHELL

Reinforce all holes for the injector check, whistle and safety valves when screwed into the boiler. Reinforce all holes in the barrel of the boiler, firebox roof and all unstayed surfaces where the diameters exceed 3¼ inches or 4½ times the thickness of the plate. For reinforcement, use a liner inside the holes not less than 75 percent of the plate thickness. In addition to a liner all heavy blowoff cocks having a large overhang should be studded when applied to any part of a boiler. All studs should be in alinement with the fittings they are to support, so that it is not necessary to make changes after the boiler is assembled.

HOLES IN PLATES

The die side of all punched holes is to be taken as the punched size. All rivet holes in the boiler shell, and firebox seams should be drilled if possible. Holes in the longitudinal seams of the boiler barrel are drilled 1/16 inch smaller, and reamed 1/16 inch larger than the nominal diameters of the rivets. Reaming is to be done after the plates are assembled. After the holes are reamed, loosen the bolts, wedge the plates apart and blow out all cuttings. Remove all burrs from both sides of rivet holes.

Drill all holes for staybolts and crown stays 3/16 inch smaller than the diameter outside the thread, and ream to the correct tapping size after the plates are assembled. Where the stays and staybolts pass through the outer sheets at an angle drill the holes sufficiently small to insure smooth holes for threading.

WORKING PRESSURES FOR SUPERHEATED ENGINES

Passenger and all compound engines may carry 200 pounds working pressure; freight compound may carry 180 pounds. Except when the engines are to operate in bad water districts, the following working pressures may be used: all compound locomotives, 200 pounds; passenger, 180 pounds; freight, 160 pounds.

When sloping the backhead of a boiler, use about 1 inch in 6 inches. Allow iron staybolts to project through the sheet 3/16 inch for proper size heads. Allow copper staybolts to project through the sheet ⅜ inch for proper size heads. Snap all staybolt heads inside and out, and be sure to cut off all burrs left by the snap.

Use copper ferrules on both ends of the arch tubes whenever it is possible to do so. Keep the arch tubes in perfect alinement. Set ferrules 1/16 inch projecting on the fire side of the firebox. Tighten them in the holes with a roller expander, but do not roll all the life out of them.

Use standard tools, especially in all tube setting. If you have no standard tools, have them made and use them.

Pittsburgh, Pa. G. L. PRICE.

Scale to Aid in Solving Right Angle Triangles

From time immemorial almost, mathematicians have worried over the old bugbear of extracting the square root of the sum of the squares of the two sides of a right-angled triangle in order to find the length of the hypotenuse.

Boiler makers are troubled with that same problem very often. One of the instances is illustrated herewith.

To find the length of c, we do this:

$$c = \sqrt{a^2 + b^2}$$

in longhand. And after we are all through we do it again to see whether or not we are right, and even then we may not be sure.

I have therefore devised this little scale which has the advantages of quickness and sureness. You don't have to worry about the decimal point when using this because the answer is "there" without guessing about the number of digits and the number of places to point off.

For example, let us take a triangle where:

$$a = 3$$
$$b = 4$$

Just glance across the scale from the left column to the right column and add those two figures:

$$a^2 = 9$$
$$b^2 = 16$$
$$(a^2 + b^2) = 25$$

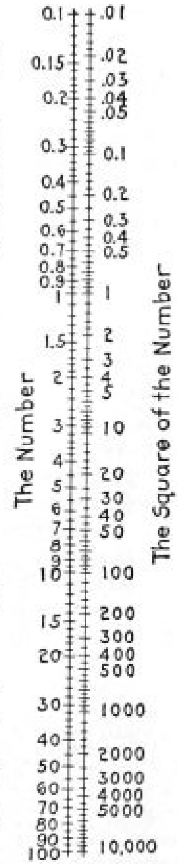
Now go down to the 25 (on the right-hand side, of course) and glance across to the left. The answer is "5" because:

$$\sqrt{25} = 5$$

Inversely the scale can be used for finding b where c and a are known, or for finding a when b and c are known.

A little practice will soon indicate its several advantages over the old longhand way of figuring and the use of troublesome tables.

Brooklyn, N. Y. W. F. SCHAPHORST.



Scale for finding squares of numbers.

Setting Dividers Accurately for Spacing Off a Given Distance

While watching a layer-out divide a given distance into a certain number of equal divisions I have often thought that he was not doing it the easiest way. By stepping off with a certain setting of the dividers he might come ¼ inch short of the end, whereupon he lengthens the dividers and the next time he falls beyond the end. As it is difficult to set dividers right down to the thousandth of an inch it quite often happens that a number of settings of the dividers are necessary before it steps off accurately enough to be satisfactory.

In dividing a distance into a number of equal parts, I use a method which gives better results than the method described in the preceding paragraph. I have thought that perhaps others might be interested in this method so the following explanation of it is given.

Suppose we have a given distance about 3 feet long to be divided into seventeen equal spaces. I would start out in the usual manner and set my dividers by guess or else by means of a ruler after having found by division the length to which it should be set. Suppose this steps off about ¼ inch short which would mean that my dividers were set about 1/64 inch short of what they should be. Use the dividers as they are without trying to lengthen them out any and mark off the first space from one end. The remaining distance must be divided into sixteen equal parts and this is easily and accurately done by halving this space, halving each of these two resulting spaces, and then halving each of these four spaces, and then each of the eight spaces.

Of course by this method the first space is 1/64 inch too short, but the other sixteen are only 1/16 of 1/64th inch too long. If more accurate results than this can be gotten by the straight divider method I will be very much surprised because it would mean that in order to do so your dividers must be set accurately enough so that upon stepping off the spaces you must come within 1/64 inch of the end. If 1/64 inch error in one space is more than is desirable greater accuracy can be gotten by this method by setting your dividers a little more accurately so that less than ¼ inch error occurs at the end upon stepping off the spaces.

Suppose you had wanted to divide the distance into fifteen equal spaces instead of seventeen. Suppose that a certain setting of your dividers comes out ¼ inch short upon stepping off the spaces. Use this setting of the dividers and lay off one space beyond the distance. This combined with the original distance now gives a slightly greater distance which must be divided into sixteen equal parts, which is done as described above. In this case one of the end spaces will be about 1/64 inch too long while the other fourteen spaces will be about 1/14 of 1/64 inch too short.

Galesburg, Ill. H. W. SIBERT.

Manufacture of Charcoal Iron Tubes

(*Continued from page* 190)

The Parkesburg Iron Company was established in the early 70's by Horace A. Beale, Sr., who had long been identified with the iron industry. The buildings of the original mill were formerly the shops of the Pennsylvania Railroad and were purchased by Mr. Beale after the removal of the Pennsylvania shops to Harrisburg.

In 1916 the Parkesburg Iron Company added to the charcoal iron making capacity of its 26 knobbling fires by the purchase of the plant of the Spring City Bloom Works, Spring City, Pa., with eight knobbling fires and other equipment for producing charcoal iron blooms which are shipped to Parkesburg.

In the summer of 1908, a modern electrically driven tube mill was built. This mill, one of the finest of weld tube mills in the country, is capable of producing approximately 1,000,000 two inch boiler tubes per year.

Principles of Riveted Joint Design

(*Continued from page* 193)

The strength of any joint, with reference to each of the possible methods of failure must always be determined, and the lowest of the several values will then determine the true efficiency.

We shall now refer again to our original example which was given in connection with Fig. 5 (b). For convenience, the strength of this joint will be tabulated with respect to a unit length of the joint, for each possible type of failure.

Tensile strength of solid plate section:

$$3.5 \times 0.5 \times 11{,}000 \text{ pounds} = 19{,}250 \text{ pounds.}$$

Tensile strength of net plate section:

$$(3.5 - 1.0625) \times 0.5 \times 11{,}000 \text{ pounds} = 13{,}406 \text{ pounds.}$$

Shearing strength of rivets:

$$2\ (1.0625^2 \times 0.7854) \times 8{,}800 \text{ pounds} = 15{,}604 \text{ pounds.}$$

Crushing strength of plate:

$$2 \times 1.0625 \times 0.5 \times 19{,}000 \text{ pounds} = 19{,}588 \text{ pounds.}$$

It is at once apparent that the weakest part of this joint lies in its net plate section, so that the true joint efficiency is:

$$\frac{13{,}406}{19{,}250} = 0.696 \text{ or } 69.6 \text{ percent.}$$

(*To be continued*)

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I. L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

THE STRONG ARM OF INDUSTRY.—Examples of approved applications of electric hoists in practically every manufacturing industry are illustrated and described in a bulletin sent out by the Electric Hoist Manufacturing Association, New York.

VENTILATORS.—Application of the siphonage principle of ventilating buildings as accomplished by K-S-V ventilators is demonstrated in a catalogue issued by the Kernchen Company, Chicago, Ill. Illustrations and descriptions of typical installations are included in the book together with complete diagrams and specifications of the device.

ELECTRIC DRILL STANDS.—The Thor electric drill stand recently developed by the Independent Pneumatic Tool Company, Chicago, Ill., is intended for use with a wide range of drill sizes of the portable type, adapting them to work formerly done on drill presses. The details of the construction and methods of adjustment are given in a pamphlet sent out by this company.

OXY-ACETYLENE APPARATUS.—A review of the various forms of welding equipment produced by the Davis-Bournonville Company, Jersey City, N. J., is given in their latest descriptive bulletin. Acetylene generators, welding and cutting torches, pressure regulators and portable outfits are taken up in detail.

CONVEYOR SPECIALTIES.—Ash pit doors, American duplex gates, side discharge gates and quadrant undercut gates are a few of the products of the Conveyors Corporation of America, New York, described in a pamphlet recently issued by the company.

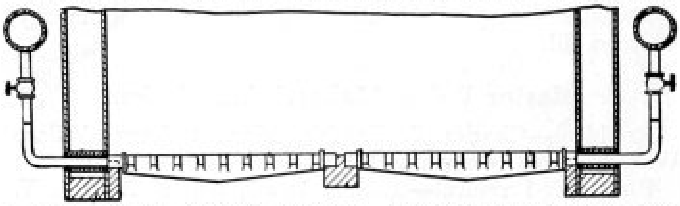
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,369,939. LOCOMOTIVE-FURNACE GRATE. DAVID L. SHAFFER, OF PITTSBURGH, PENNSYLVANIA.

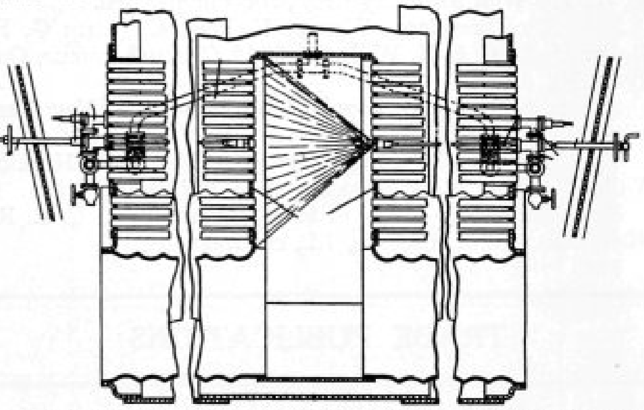
Claim 1.—In a furnace, the combination of hollow perforated grate bars,



a source of fluid pressure, connections therefrom to said hollow grate bars, a portion of said connection being formed as a heater, and a by-pass connection around said heater from the source of fluid pressure to said grate bars. Two claims.

1,370,353. APPARATUS FOR CLEANING THE SMOKE-TUBES OF STEAM-BOILERS. CHARLES PERCY PARRY, OF LIVERPOOL, ENGLAND.

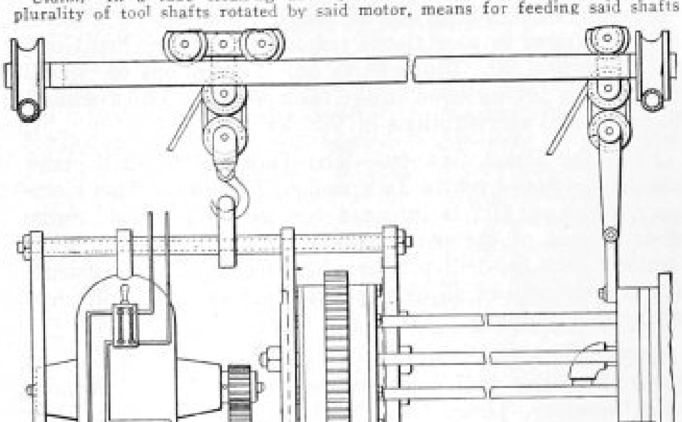
Claim.—In a steam blower for cleaning boiler tubes, in combination; a pressure reducing nozzle of the de Laval or the like expansion type;



means to supply said nozzle with steam; a deflecting nozzle the inlet of which is connected to the outlet of the pressure reducing nozzle, adapted to be rotatably carried in a tubular chamber opening into the combustion chamber and having guide surfaces shaped to provide a steam jet extending side, and the cross-section of which at the opposite tube plate is narrow. Six claims.

1,367,314. TUBE-CLEANER. ALBERT F. FROUSSARD, OF ST. LOUIS, MISSOURI.

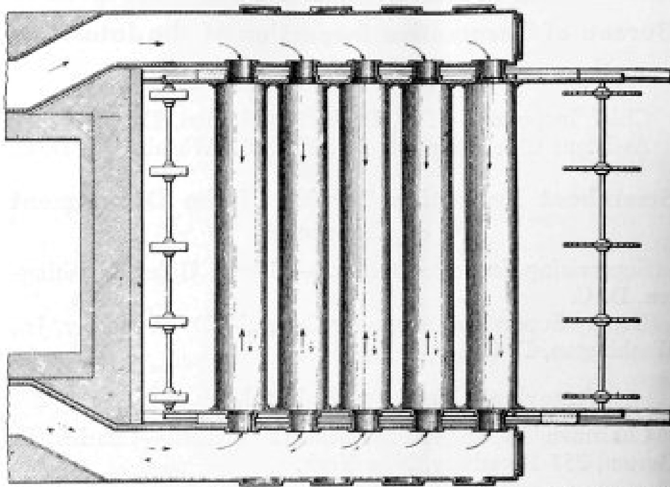
Claim.—In a tube cleaning device, the combination with a motor, of a plurality of tool shafts rotated by said motor, means for feeding said shafts



into the tubes to be cleaned, and a fluid distributing device through which said shafts pass, said distributing device consisting of two parts secured together forming an internal water chamber, said device having recesses in one face thereof adapted to receive the ends of the tubes to be cleaned, and water passage-ways connecting said water chamber and recesses.

1,365,668. FURNACE. WILLIAM M. DUNCAN, OF ALTON, ILLINOIS.

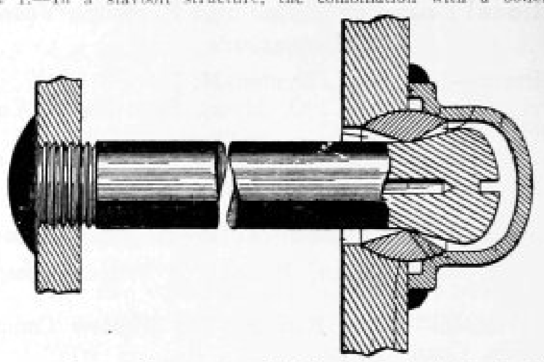
Claim 1.—A furnace provided with a grate, a draft box under the fuel supporting elements of said grate, said draft box having an opening for the discharge of air to the grate, a damper for regulating the flow of air



from the draft box to the grate, a blast producing device, conductors leading from said blast producing device to said draft box so as to direct air under pressure from the blast producing device to the interior of said draft box, one of said conductors being provided with an ash outlet for the discharge of ashes from said draft box, and a closure normally closing said ash outlet. Seven claims.

1,366,723. STAYBOLT STRUCTURE. ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

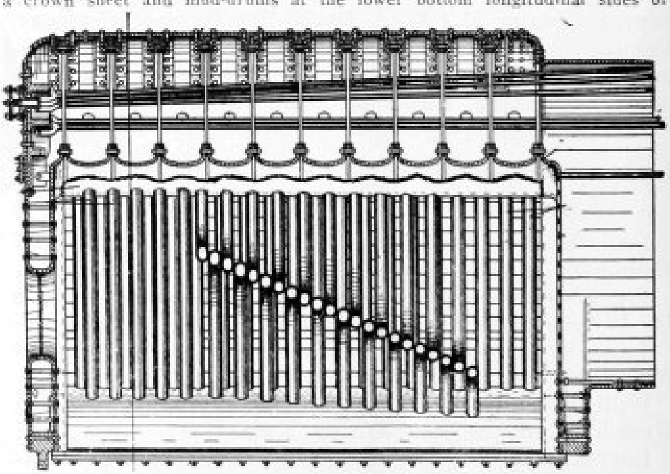
Claim 1.—In a staybolt structure, the combination with a boiler sheet



having an opening, a closure secured to the boiler sheet around said opening, and a staybolt, of a bearing member having a rounded exterior portion movably mounted against the boiler sheet and said closure and affording a mounting for the staybolt. Seven claims.

1,369,117. LOCOMOTIVE-FIREBOX. WILLIAM J. LEIGHTY, OF SPRINGFIELD, MISSOURI, ASSIGNOR OF ONE-HALF TO HENRY W. JACOBS, OF CHICAGO, ILLINOIS.

Claim 1.—In a locomotive firebox of the class described, provided with a crown sheet and mud-drums at the lower bottom longitudinal sides of



the firebox, a plurality of self-supporting water-tubes arranged in series intermediate of the crown sheet and the mud-drums, one series of tubes on each side of the firebox being arranged diagonally between the mud-drum at the bottom on one side of the firebox and a portion of the crown sheet on the opposite side of the firebox and at a distance removed from the front and rear ends of the firebox, with the oppositely disposed tubes of said series crossing one another at substantially the longitudinal center line of the firebox, the point of crossing of the successive tubes being at an increasing distance removed from the bottom of the firebox. Four claims.

The Boiler Maker

AUGUST, 1921

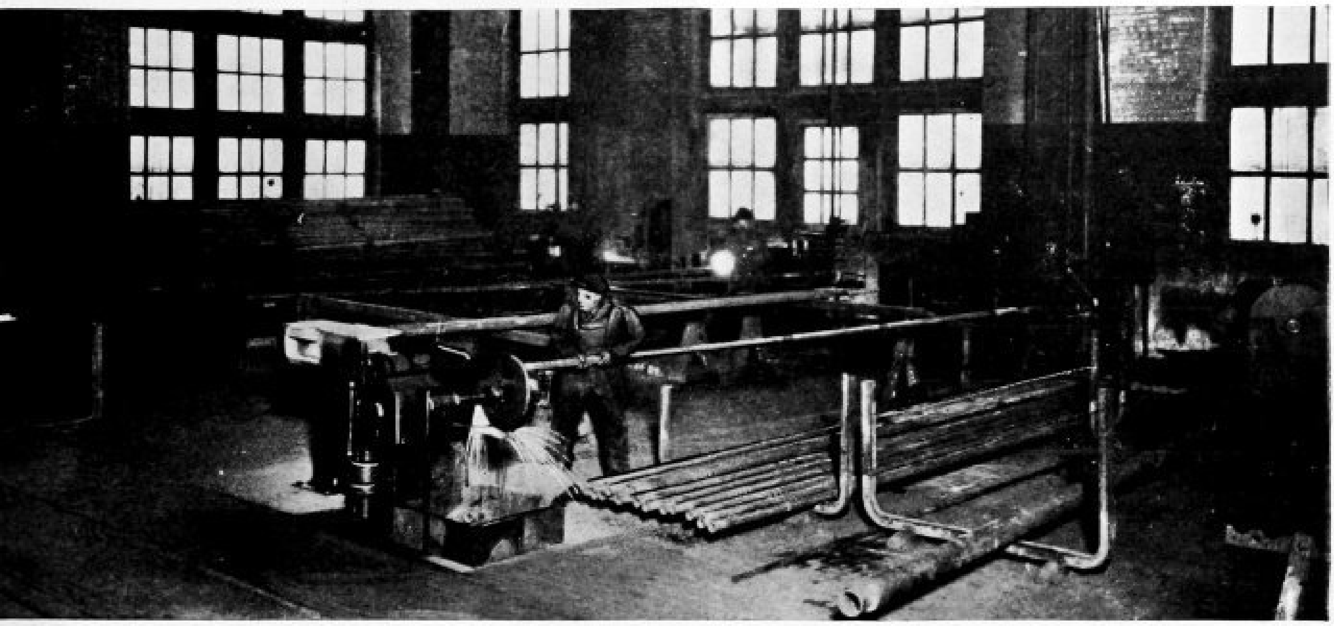


Fig. 1.—General View of Delaware, Lackawanna and Western Flue Shop at Scranton, Pa.

Speeding Up the Safe Ending of Boiler Tubes

The methods of reclaiming and safe ending standard locomotive tubes and superheater flues employed in the Scranton shops of the Delaware, Lackawanna and Western Railroad represent the latest developments in this important phase of locomotive maintenance work. All machinery in the flue shop is of the most advanced design and is so arranged that flues follow from one stage to another with a minimum of handling and with a staff of only four men to operate the equipment.

WITH a normal output of about 800 to 900 safe ended standard size tubes in an eight-hour day, the flue department of the Delaware, Lackawanna and Western Railroad shops at Scranton, Pa., has a production record that has justified the far sighted policy of the management in scrapping obsolete shop equipment and installing the most modern tools available. When the road was returned to the control of the company in 1920 after its release by the government it was decided that economies in the flue shop could be effected by the installation of an entirely new set of equipment. To this end engineers of Joseph T. Ryerson & Son of Chicago, with the cooperation of the railroad engineering staff, developed a machinery arrangement in the shop that has greatly increased the operating efficiency.

Location of Shop

The flue department occupies a space about 110 feet by 0 feet in the south end of the west bay of the boiler shop, which is made up of four departments. The west bay contains an erecting shop and the flue shop; the two center bays are occupied by light and heavy machine tool equipment, storerooms, plate shops and the like, while in the east bay is located a second erecting shop. Part of the space in the flue shop is used for tube storage which can be adjusted to suit the requirements at any particular time, depending on the number of locomotives in the shop.

The buildings are of brick and steel construction with glass walls, making it possible for the men to work under the most favorable natural lighting conditions. The shops are piped with air, water, oxygen and water gas for operating tools and heating furnaces. The east and west bays in which the erecting shops are located are each served by two Shaw electric cranes, one of 150 tons capacity and the other of 20 tons.

When an engine comes into the shop for repairs, it is dismantled and the tubes and superheater flues are cut out in either one or other of the erecting shops. The operation of cutting out the small tubes and superheater flues is done by means of air driven expanding cutters. The back ends of the tubes are cut out with an air hammer and the tubes passed out through the front tube sheet. They are then piled in racks until the entire set has been removed from the engine. In the west erecting shop, rope slings are passed around a bundle of tubes, which is then picked up directly by one of the cranes and taken to the flue department. In the east erecting shop the tubes are piled on trucks and transferred across the shop to the flue department, where the crane picks them up and deposits them in storage racks until they are put through the reconditioning processes.

Operations Carried Out in the Flue Department

Four major operations are carried out on tubes in the flue shop. They are cleaned, safe ended, short tubes are reclaimed

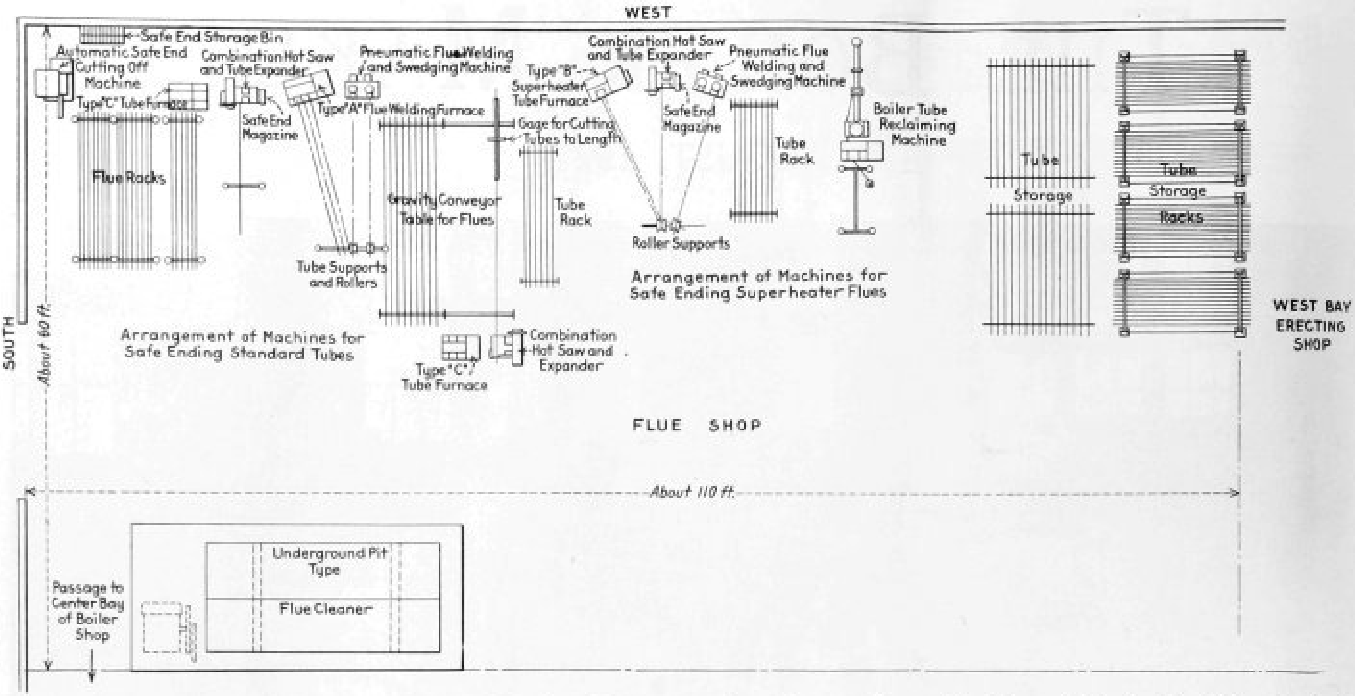


Fig. 2.—Arrangement of Machinery for Safe Ending Boiler and Superheater Flues with General Production Plan Outlined

and superheater flues safe ended. The machines are laid out as in Fig. 2, to carry out each of these operations, or combinations of several of them, without interference and with the least handling.

The cleaning operation, which is the first process through which all tubes pass when brought to the department, is carried out in a Ryerson underground pit type cleaner, Fig. 3, which has a capacity of 350 2-inch flues up to 24 feet in length at one time. In charging the cleaner, an entire set of flues is slung in chains and lowered by one of the shop cranes onto the rolling chains in the pit. The ends of the sling chains are fastened to hooks in the sides of the pit and remain hanging free from interference with the tubes in this position until after the operation is completed. Five sets of silent roller chains are fitted in the tank of the cleaner. Power is transmitted to the drive shaft through a silent chain by a 25 horsepower motor. When the tubes are in place the tank is partly filled with water and the motor started. While the chains are in motion, the tubes are drawn through the water and partly up one side of the tank, where a draining action takes place and the tubes are tumbled back into the water and the process repeated, thus keeping them in constant agitation until absolutely clean. From two to six hours are required to clean tubes, depending on the hardness and thickness of the scale and on the water district in which they had been operating. One feature of the cleaner is that even while it is in operation the noise is practically eliminated and because the covers are flush with the floor the movement of materials in the section occupied by the cleaner is in no way held up. This is a big improvement over the common barrel type cleaner as the latter is usually located outside the shop. Such a location prevents handling all the tubes together by crane and keeps two men constantly busy loading and unloading the barrel cleaner.

After the tubes are cleaned the ends of the sling chains are picked up by the crane and the bundle of tubes removed to

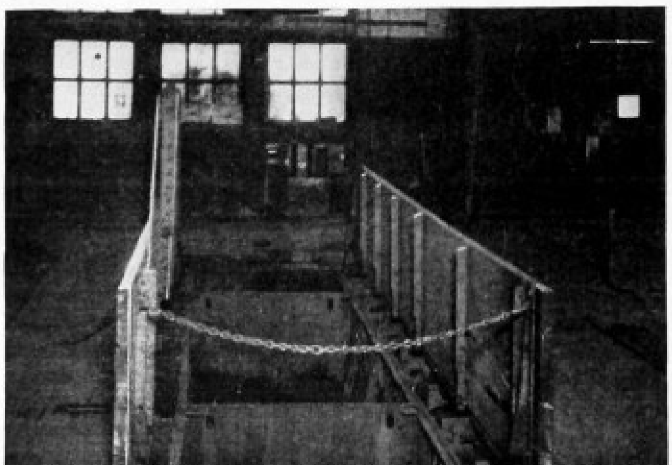


Fig. 3.—Underground Pit Type Tube Cleaner with Covers Raised Ready to Be Charged

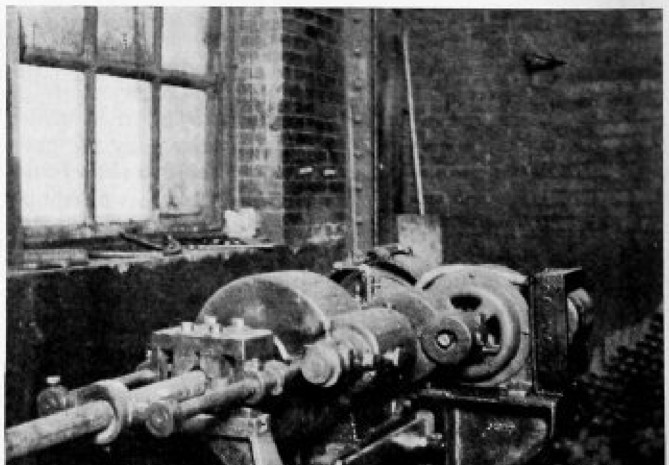


Fig. 4.—Automatic Safe End Cutting Off Machine, with Safe End Storage Shown Adjacent to Machine

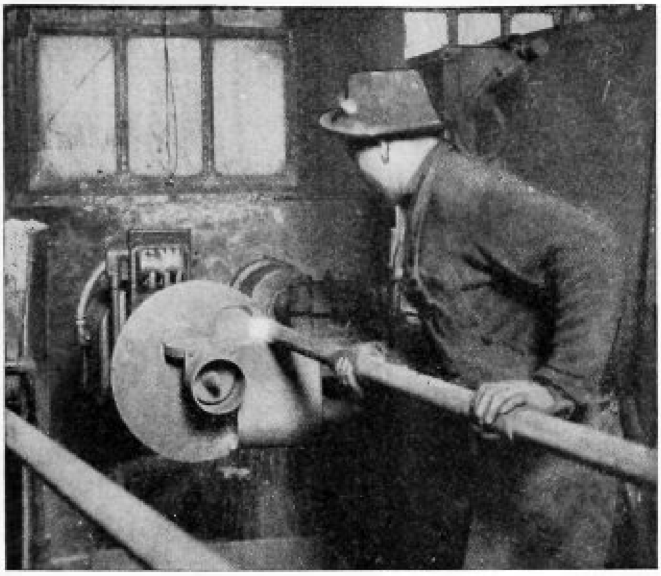


Fig. 5.—After Heating, the Fag Ends of Tubes Are Cut Off, Expanded and Safe Ends Inserted on This Combination Machine

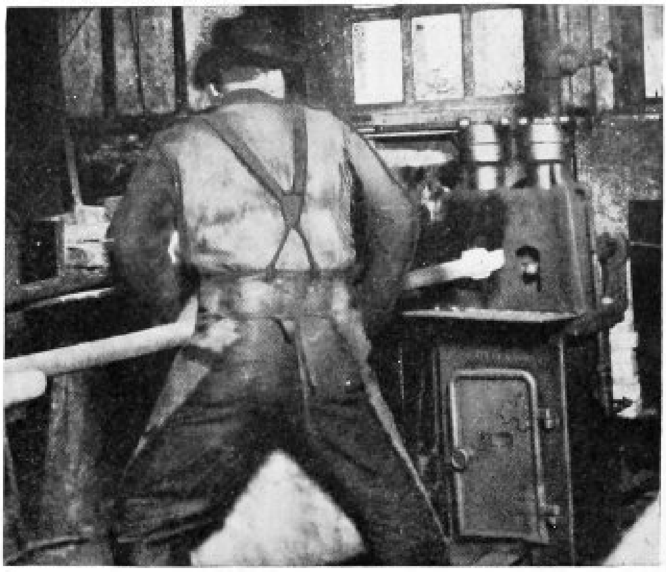


Fig. 6.—Tubes Are Heated to the Welding Point and Then Welded and Swedged on the Double Pneumatic Hammer Shown

the racks near the first heating furnace. There is no direct labor charge in the cleaning of flues in the D. L. and W. shops for the entire work of loading and unloading the cleaner is completed by the shop crane, usually under the direction of the fourth man of the repair unit. Not more than ten minutes crane time is required for handling the tubes in this department. The cleaner will also turn out a set of forty-five 5⅜-inch superheater flues in the same time taken up by the standard tubes; that is, two to six hours.

The remaining machinery on the floor is segregated in three sections with sufficient space between each unit so that the work may be carried on without interference. The standard 2-inch to 2¼-inch tube safe ending layout, having for equipment two Ryerson type "C" special tube furnaces; two Ryerson combination hot saw and tube expanding machines, one with a safe end magazine; one Ryerson type "A" flue welding furnace and one Ryerson flue welding machine, occupies a section along the west side of the department about 40 feet by 30 feet. In connection with the safe ending work one Ryerson automatic safe end cutting off machine is located in a corner of the shop.

In the section devoted to the safe ending of superheater flues are one Ryerson type "B" flue welding furnace; one Ryerson combination hot saw and tube expanding machine with a superheater safe end magazine and one Ryerson pneumatic flue welding machine and swedger.

Between the superheater section and the storage racks at the end of the department is a Ryerson boiler tube reclaiming machine, used in reclaiming tubes not possible to handle in the standard 2 to 2¼-inch repair equipment.

Preparing Safe Ends for Welding to Tubes

The first step in the actual safe ending of the tubes is the cutting of stock tubing into safe ends of suitable lengths.

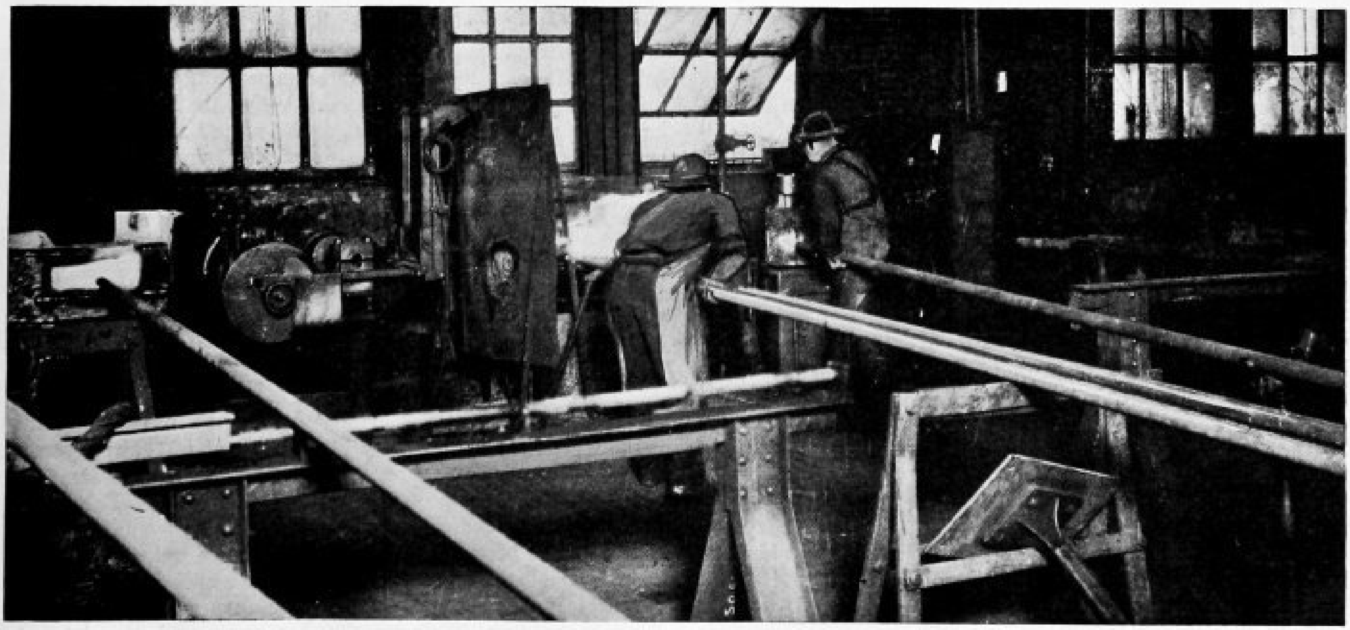


Fig. 7—The Entire Safe Ending of Boiler Tubes Is Carried Out on the Equipment Here Shown, While to Finally Cut the Tubes to Length an Additional Heating Furnace and Combination Hot Saw and Expanding Machine Are Used

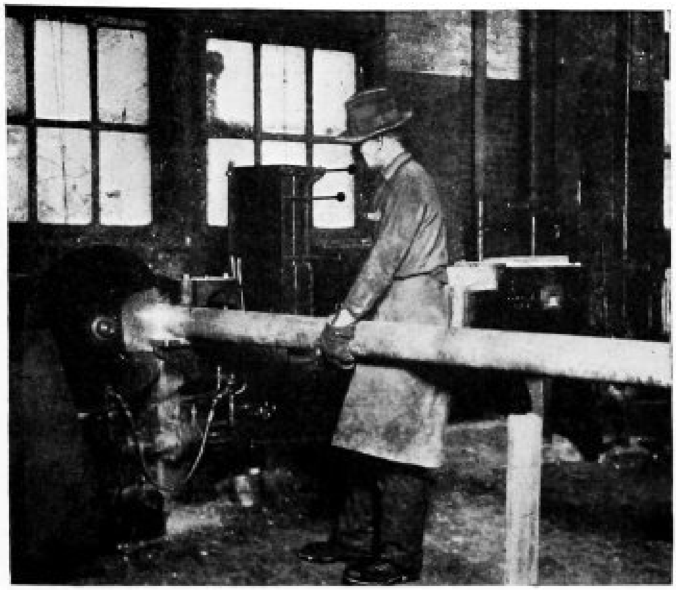


Fig. 8.—Machines for Safe Ending Superheater Flues Are Located So That the Operator Has to Move the Tube Only a Slight Distance to Complete All the Operations

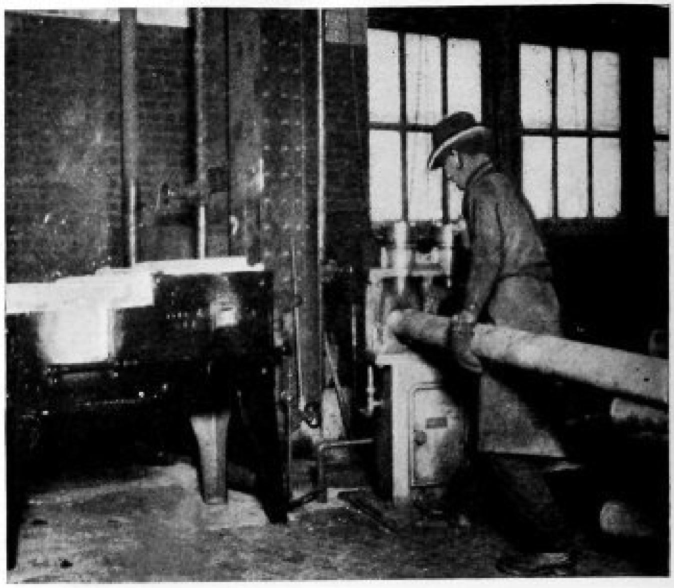


Fig. 9.—As in the Case of Small Tubes the Superheater Flues Are Welded and Swedged on a Double Pneumatic Hammer Which Operates at 80 to 100 Pounds Pressure

The cutting machine for doing this work is automatic in its operation and requires attention only when tubes are started in the feeding mechanism. Standard tubes from 1½ inch to 3 inch up to about 25 feet in length can be fed into the machine. In general, the machine consists of a cabinet base on which is mounted an automatic, pneumatic chuck for gripping the tube; a cam feed cutting off tool for cutting the tube to the proper length of safe end and, at the same time, scarfing the tube; a feeding device for moving the tube through the hollow spindle and a cutting compound circulating system. The operation consists of placing the tube in the hollow spindle, and when the machine is started, the air valve is opened by a cam and the chuck automatically grips the tube and rotates it with the spindle; the cutting tool meanwhile feeds up and cuts off the tube. The feeding chuck at the rear of the spindle then grips the tube and feeds it forward for the next cutting operation.

Safe ends ready for use are stored in racks adjacent to the cutting off machine.

Process of Safe Ending Standard Tubes

When a set of tubes is ready for safe ending, after going through the cleaner, the shop crane places the bundle on a storage table near the heating furnace. The speed of all operations on the tube preparatory to welding on the safe end are adjusted to the time taken up by the actual welding and all operations required after this are regulated by the speed of the welder. Tubes are fed by gravity down the storage table to a position near the furnace and the operator at this point, who controls the heating, places the fag ends of six tubes in the fire where they are heated to a cherry red. This furnace, a Ryerson type "C," is especially designed for use in conjunction with the hot saw and expanding machine. Although this type furnace is generally equipped with oil burners adjusted for an oil pressure of 45 pounds, in the D., L. & W. shops water gas is used for heating all furnace equipment throughout the entire plant. The capacity of the type "C" furnace is six 2-inch tubes or three 4-inch tubes at one time.

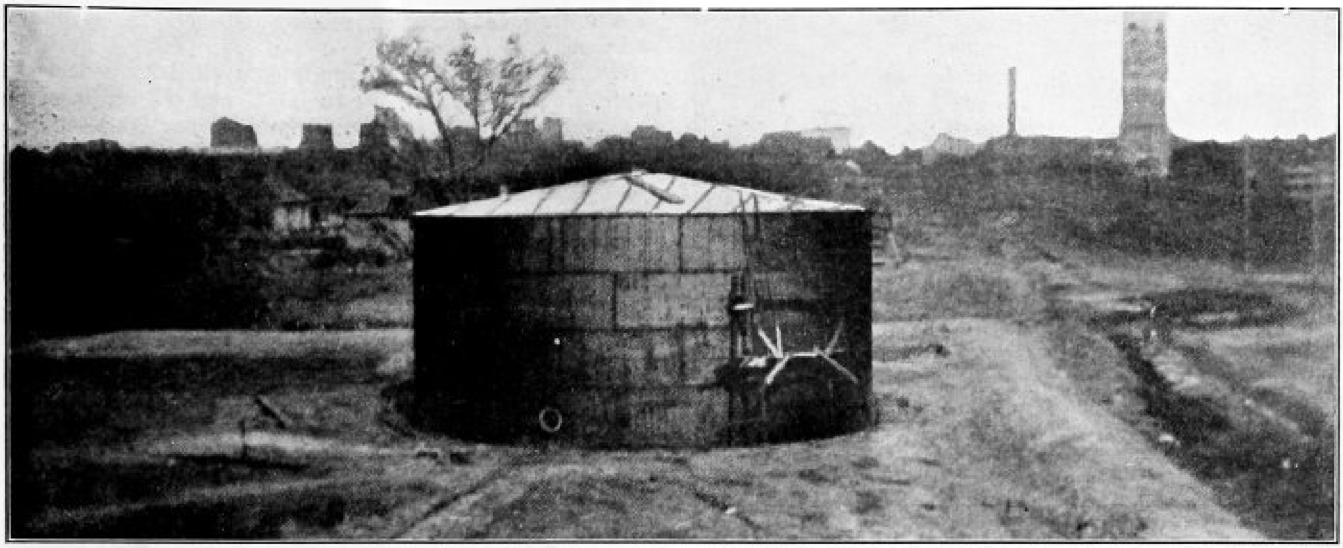
From the furnace, the tubes are pushed against the hot saw by the operator and the fag ends cut off. At the end of the shaft on the hot saw, a reamer is attached which is used to burr out the inside of the tube end and chamfer the outside edges. This same attachment is applied to all hot saw machines in the shop.

While the tube is still at a red heat the same operator places it in the expanding machine, Fig. 5, then removes it when expanded and inserts the tube still hot over a safe end which is dropped into place from the magazine. The three operations on the combination hot saw and expanding machine can be accomplished in about 12 seconds. The machine consists of a substantial base on which is mounted a small high speed saw, a pneumatic clamp and expander which operate independently, and a magazine in which the safe ends are fitted. Fag ends from the sawing operation drop into a small chute which is provided and are carried to a waste pan. The clamp for holding the tube in place for expanding has a lower stationary fluted jaw and an upper jaw mounted on a lever which is connected with a pneumatic cylinder. Back of the tube clamp is placed a horizontal cylinder with a piston rod having a taper mandrel extending toward the center of the jaws of the clamp. In carrying out the operation, a control lever on the right of the clamp is thrown into action and the valve controlling the cylinder is opened, forcing the upper jaw down and clamping the tube in place. As the throttle lever is drawn towards the operator, the valve controlling the horizontal cylinder is opened and the expanding mandrel forced into the end of the heated tube. When the lever is thrown back, the plunger recedes and at the same time a safe end is dropped into place from the magazine; simultaneously the clamping jaw opens and releases the tube which is then shoved over the safe end and is ready to go into the furnace for welding. The machine operates at an air pressure of about 80 to 100 pounds and only about 3 horsepower is required for the driving motor. The standard tube machine will accommodate tubes from 1½ inches to 3 inches in diameter.

Welding the Safe End

From the time the safe ended tube is put into the welding furnace, the second operator has charge of it. The Ryerson type "A" furnace has three openings and will heat three 2 or 2¼-inch tubes simultaneously. Instead of oil burning equipment with which the furnace is generally equipped, gas burners have been fitted. When the proper welding heat has been reached, the operator places the safe ended tube over the mandrel in the Ryerson pneumatic flue welding machine, Fig. 6, rotating it under the hammer until the joint is properly made. While still hot, the tube is moved to the

(*Continued on page* 234)



An Electrically Welded Oil Tank

Welding Storage Tanks With Electric Arc Process*

By William Schenstrom†

Fusion welding of large storage tanks by means of the electric arc process promises to decrease the leakage losses of the riveted type construction now in general use. The welded method of tank construction has been successfully used in the oil producing regions and in the eastern states. The accompanying paper compares the two types of construction and outlines the welding operations for tanks of various capacities.

THE riveted oil storage tank is the present standard, and the details of construction are well known. In fabricating materials for the riveted tank, it is generally necessary to make templates, mark, punch and ream the plates. It is important that the edges of the plates are faired and that the size of the sheets is accurate. When erecting the tank it is necessary, in many instances, to drift as the plates must be drawn up tight for riveting.

A number of joints are necessary in order to make the riveted construction possible, with angles, gusset plates, etc. The single, double, triple riveted and butt-strapped joints, as the load may require, increase the possibilities for leaks, which increase with the number of holes and calked joints.

The bottom and first course of a riveted tank are constructed on horses and after test, this portion of the tank is lowered down into final position on the foundation. The strains in lowering this portion of the tank may cause leaks which cannot be discovered. Again leaks start when calking edges have been strained unduly or often. Wind pressure, filling and emptying of the tanks, temperature changes causing breathing of the tanks and corrosion are some of the other causes of leaks.

The maintenance charges on a riveted tank start within one year of its construction.

The loss through leaks, seepage and evaporation from riveted tanks has not yet been closely estimated, but it is certain that the amount of the loss is tremendous, especially for the lighter grades of oil. One representative oil company roughly estimates its average yearly leakage loss at 5 percent of the contents of storage tanks, with a higher percentage for the lighter grades and a smaller percentage for the heavier grade of oil. It is the opinion of some experts that this estimate is too low.

It has been determined that the deterioration of the tanks starts at the points where the skin of the plates is broken As an example of the deterioration of riveted structures being mainly in the way of the riveted joints may be cited a 220 foot smoke stack which showed considerable deterioration near the top. In drilling test holes and making a general examination of the smoke stack it was found that the deterioration confined itself practically to a belt following the outlines of the riveted joints. A number of the rivets could easily be knocked out with a hand hammer while the centers of the sheets were, without exception, practically as good as new. Therefore, it is to be assumed that tanks with the skin of the plates unbroken anywhere, will last longer.

Effect of Oil on Life of Tanks

Oil and grease are used for protection of tools and machinery against rust and the conclusion might be drawn that the oil would protect oil tanks from deterioration. However, the acids in some grades of oil attack the tanks and especially the rivet joints, and the tanks holding oils with a large proportion of acids have been known to be useless after three years. The maximum life of a 55,000 barrel riveted tank, left in one position, is estimated at twenty years.

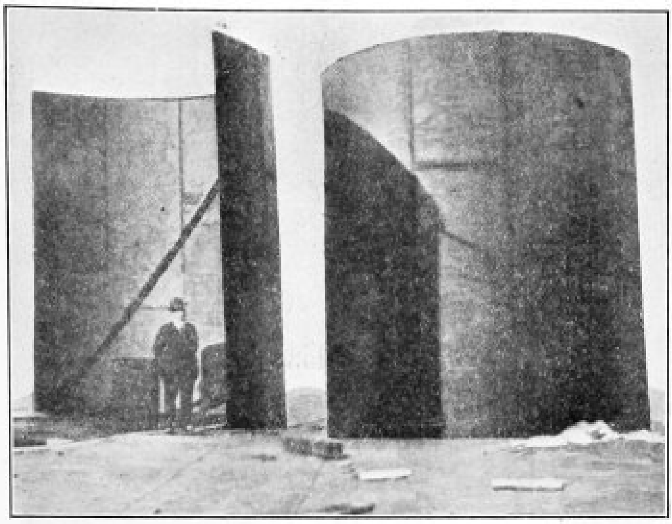
Electrically Welded Construction

The electric arc welding method has for a long time been considered as the logical one to produce a more satisfactory construction than is possible with the riveting method and recently considerable construction work of welded oil refinery equipment, including various sizes of oil storage tanks, has been successfully completed in the mid-continent, southwest oil fields, as well as in the east.

In designing a welded tank for the present time it is proper to follow the fundamental outline, such as the lapping of plates, as in riveted construction. New methods of welded construction of tanks are now being developed, which will

*Abstract of paper read before the Metropolitan Section of the American Welding Society.

†Connected with the Electric Welding Company, of America, New York.

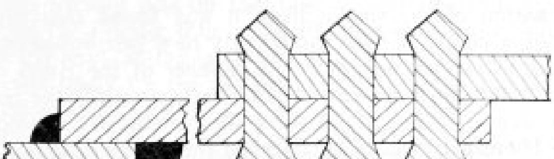


Partially Completed and Finished Tank. These Tanks Are 15 Feet in Diameter and 16 Feet High and Are Electrically Welded Throughout

involve radical changes and which seem to offer great possibilities. The only present variations are details and simplifications which are special to the adoption of the welded construction. These details include the elimination of rivet holes, buttstraps, gusset plates, angles, fairing of plates and a reduction in the laps of the plates. The plates do not have to be fabricated excepting in so far as the rolling is concerned.

Further, inasmuch as the welded lap joints are of 100 percent or more strength, the plates in the shell can be lightened 15 percent.

The thickness of the bottom and top plates is determined by practice and until it has been demonstrated over a period of years that the corrosion of welded bottoms and tops is less than that of riveted bottoms and tops, it is doubtful whether it will be permissible to reduce the thickness of the plate of this portion of the tanks. The skin of the plates of bottoms and tops being practically unbroken, it is reasonable to assume that these parts will have considerably longer life than those of the present standard.



A Comparative Sketch of Riveted and Welded Construction Showing to What Extent the Overlapping Is Reduced With the Welded Joint.

By applying the oxy-acetylene torch in such a manner as to destroy only the welding metal in the joints, it is possible to cut down welded tanks and erect them again in the same manner as is done with riveted tanks.

ENGINEERING OF WELDED TANKS

At the present time, until standards have been developed for the welded construction of the various types and sizes of oil storage tanks, considerable engineering is necessary on each problem. Expert welding engineers are an absolute necessity for getting good results at the present stage of development of this phase of the art.

It would seem a deplorable mistake if the users of oil storage tanks would decide to go in for this type of construction under their own guidance as it would, no doubt, give the electric welded design a setback such as welding got in Europe many years ago when some faulty welded containers in a power plant exploded, causing considerable loss of life and damage to property.

When such explosions happen on riveted containers the public simply feels that the engineers and the workmen on this particular job were at fault and do not think of condemning riveted construction in general.

These are some of the difficulties that a new art has to encounter. It would, therefore, seem that the conservative way of building up a welded design of oil refinery equipment would be to turn this work over to expert organizations until the proper standards have been found.

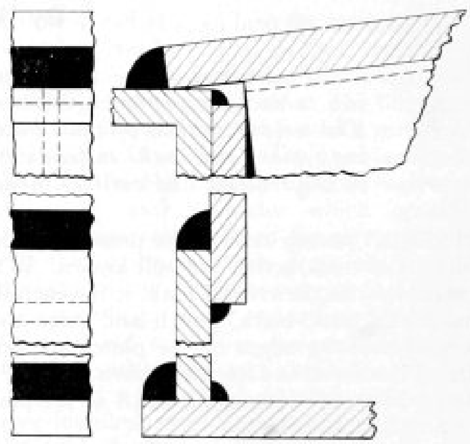
ADVANTAGES OF WELDED CONSTRUCTION

It will be years before the advantages of the welded construction can be fully determined. However, there would seem to be a few advantages which should be apparent now. The electrically welded tank is a homogeneous structure throughout and can be generally characterized as being a superior article to tanks built by any other means.

The joints are absolutely tight and will stay tight over a period of years and after a number of temperature changes and after the tanks have been filled and emptied a number of times.

No initial strains are put on the bottom as it is welded in place.

The life of a welded tank must be estimated as being at least twice that of a riveted tank, for the reason that the skin of the plates is not broken and because the volume of the welds provides a much larger factor of safety against corrosion.



Type of Welding Used in the Construction of a 500-Barrel Tank. Sketches Show Roof, Sides and Bottom Welds.

Welded tanks built on a concrete foundation can be set on this foundation without an intermediate layer or cushion. Riveted tanks will, if set directly on a concrete foundation, rest on the rivet heads and cause undue strains on these.

The electrically welded roof construction is gas tight and as is known, the saving in insurance premiums on gas tight roofs is considerable.

In fact, after the advantages of the welded construction have become more generally known, it is reasonable to assume that the insurance premiums on welded tanks will be lower than those on riveted tanks on account of reduced fire risk.

Paint will only be needed as the old paint is destroyed through age and weather. Painting on account of discoloration caused by seepage will be eliminated. In the refineries where tanks are painted white, the saving in the paint bill will amount to considerable.

The saving in crude oil over a period of years by the use of these absolutely tight tanks will run into large amounts. The savings in volatile liquids from evaporation, seepage and leakage, can hardly be estimated and will, over a period of years, run into large sums of money.

Structural Details of 100-Barrel Tank

Following is an outline used for the construction of one of the smaller tanks:

9 feet diameter, 9 feet high of 5.5 pound plate (10 gage).

1½ inch laps throughout, welded from one side only.

No chipping and calking.

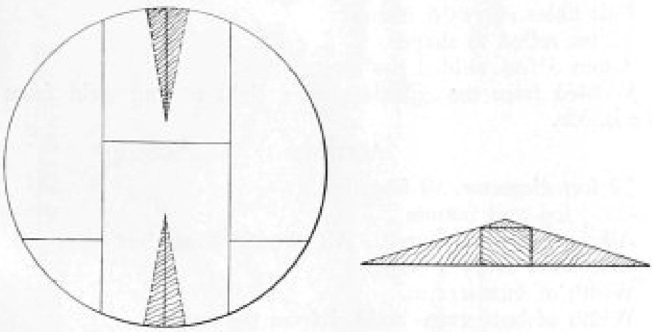
The bottom and top are in two halves.

The shell in six vertical plates.

The plates rolled to shape.

The plates punched for bolt holes.

Two bolt holes every 30 inches and at the corners.



Manner of Constructing Roof for a 500-Barrel Tank

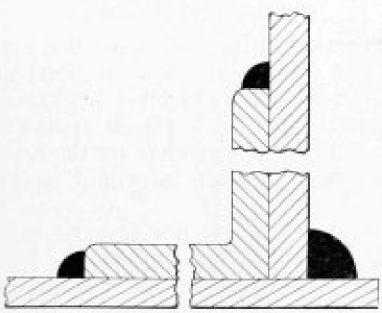
Welded with 0.134 inch diameter electrodes.

Current value about 125 amperes.

Average speed downhand welding 9 feet.

Average speed vertical welding 4 feet.

These tanks are erected by suspending an angle iron ring above the tank with six small blocks to catch each of the vertical plates and to hold them in place for bolting up and fastening to the bottom. Next, the top is put into place and bolted up. The tank is then laid on a cradle in a horizontal position and welded throughout from the outside only. The tank is turned so that all vertical seams of the finished tank are welded in a downhand position as well as the cross seams of the top and bottom. Leaving the tank on the cradle, the tank is turned as the work progresses. The circumferential joints between the top and shell, and the bottom and shell are welded in a vertical position, as are the fittings. The bolts are left in the tank and are welded to the tank from the outside.



Welded Construction Used in Joining the Sides and Bottom of a 5,000-Barrel Tank

500-Barrel Tank Construction

The important features of the 500-barrel tank construction are as follows:

15 feet diameter, 16 feet high of 5.5 pound plate (10 gage) blue sheet steel.

1½ inch laps throughout, welded from both sides, excepting roof which was welded from one side only to make it gas tight. No strains on the roof.

Size of sheets 4 feet by 11 feet.

No chipping and calking.

The bottom and top of the tank are in three courses.

The plates were *not* rolled to shape.

Six bolt holes.

Welded with 0.134 inch diameter electrodes.

Current value 125 amperes.

Average speed downhand welding 10 feet per hour.

Average speed vertical welding 5 feet per hour.

The bottom plates were laid out flat on the fundation, which was graded in the usual way and welded from one side. After this was completed, the bottom was turned over and welded from the other side.

The shell was made in a different way from the ordinary procedure. Instead of being built in several courses, it was built in one single course, giving only vertical seams in the shell, on a barrel stave idea. The plates of the shell were laid out and welded together flat on the ground, so as to make two halves. One-half of the shell was then raised by means of a gin pole and one corner of it tack welded to the bottom.

The ends of a turn buckle were fastened to the outside ends of this half of the shell about half way up, by means of clips that were welded on to the shell. By tightening this turn buckle, the shell was forced into place and tack welded as it got into the proper position on the bottom. The other half of the shell was raised in a similar manner and tack welded into position.

This left the upper part of the shell out of shape. A cable loop was then put around the top of the shell. By tightening this, the shell was forced together.

A 6 inch I-beam on edge specially prepared with bolt holes, and the web removed where it was in the way of the bolt holes, was fastened to the outside of the shell along with the length of the vertical shell seam. A similar I-beam was fastened on the inside of the same seam. There were three holes in each of these I-beams, and corresponding holes in the shell of the tank. With these I-beams, the edges of the shell were forced into position and welded.

After the vertical seams had been welded outside, the I-beams were removed and the inside vertical seams welded up. The bolt holes which were the only holes in the whole tank were then welded up. The joint between the bottom and the shell was made by setting the shell on the bottom, and consisted of one inside and one outside weld without any angle iron. The outside weld being the heavier.

A 2 inch by 2 inch by ¼ inch angle iron was welded all around the top of the shell, heel and toe. The roof was welded in three courses. The ends of the center course were slit in the middle, a V-shaped piece being cut out at each end. A block 12 inches high was put under the middle of the center course, which gave the roof the proper pitch and in this position the slits were closed and welded up. This course was then put in place and welded to the top angle and the other courses lapped to the center course and welded to it and the top angle. There was no frame under this roof. The fittings were welded in the ordinary way.

This particular tank was filled with kerosene on completion and found absolutely tight without a leak or sweat of any kind and has been in constant use for seven months. Other similar tanks have also been successfully welded.

Following are some of the construction figures which apply to other welded tanks:

5,000-Barrel Capacity Tank

43 feet diameter, 20 feet high.

Bottom of 3/16 inch plate.

First course ¼ inch plate.

Second course 3/16 inch plate.

Third course 11/64 inch plate.

Fourth course 5/32 inch plate.

Roof 3/16 inch plate.

Size of shell plates 5 feet by 14 feet.

1½ inch laps throughout, welded from one side in top and bottom, from two sides in the shell, the heavier weld being on the outside and in downhand position.

No chipping and calking.

The plates were rolled.

Bolt holes every 36 inches.

3/16 inch plate and over welded with 0.164 diameter electrodes.

Current value about 145 amperes.

Plates under 3/16 inch welded with 0.134 inch diameter electrodes.

Current value 125 amperes.

Average speed downhand welding 8 feet per hour.

Average speed vertical welding 4 feet per hour.

This tank was erected according to the standard for riveted tanks, in courses and each course was bolted together before being welded, by bolts every 3 feet.

A 2 inch by 2 inch by ¼ inch angle iron was laid on the bottom along this outside edge, leaving a ¾ inch space between the angle and outside edge of the bottom. The bottom inside flange of angle was welded to the bottom of the tank.

The first course set on the bottom and backed against the angle was welded to the bottom all the way around the side by a ½ inch weld. The angle was welded to this course from the inside by a ¼ inch weld.

A 2 inch lap between each two courses.

The outside welds were made for strength. The inside welds to seal the joint between the two plates.

The plates were scarfed where three plates came together.

The joints were simply welded in the ordinary way.

The top angle 2 inch by 2 inch by ¼ inch was welded.

The roof was of the ordinary type of steel roof with a center and radial plates.

The angles and I-beams and roof construction were all welded in the simplest way, according to common practice, developed in structural welding work.

Welding on large tanks. From the amount of work done up to date, it has been definitely established that the same procedure can be followed in the construction of any size of tanks.

Acid Tank

Acid tanks of various kinds are being welded.

One acid tank was just completed.

10 feet diameter, 15 feet high, ⅞ inch plate.

Bolt holes every 36 inches.

Plates rolled to shape.

About 3 feet welded per hour.

Welded from the outside with a light sealing weld from the inside.

Agitator

24 feet diameter, 30 feet high.

Cone top and bottom.

All joints inside butted. All outside joints butt-strapped.

Bolt holes every 3 feet.

Width of butt-straps.

Width of butt-straps welded from the outside only.

Butt-joints welded from the inside.

The plates in courses, rolled to shape.

Welded with 0.165 inch diameter electrodes.

Current value 125 amperes.

Bottom cone ½ inch.

Shell ⅜ inch, 5/16 inch.

Top ¼ inch.

Estimated time, average 4 feet per hour.

Forming and Brazing Copper Pipes.

By C. E. Lester

THE pattern of a copper pipe to be formed is placed on a sheet of copper and outlined, then it is cut from the sheet. The development of a typical pattern is shown in the accompanying sketches. The two edges of the copper that will come in contact to form the joint are beveled. Hammer the copper over the mandrel, shown in Fig. 5, until the two edges come in contact. Then the pipe is ready to be brazed.

Pipes of very large diameters that are to be bent to various radii, are filled with hot rosin and allowed to cool. They are then placed upright in the hydraulic press, as shown in Fig. 7, and bent to the curve desired. This bending is done when the pipe is cold.

There is no pressure gage on the press as the water is pumped into the cylinder by hand. The pressure used is just the amount required to bend the pipe to the radius required. This pressure is regulated by experience. A piece of steel is fastened to the end of the plunger, as shown in Fig. 7, and curved so as to fit any diameter of pipe that is to be bent.

Pipes of 1⅝-inch diameter and smaller are placed in a fire and heated. Then they are removed and clamped in a vise and bent to any desired radius, or bent to fit any section of boiler in which they are to be installed. Pipes of very large diameters are made in two sections. Each section of the pipe is cut from a sheet of copper and formed over a mandrel. The corresponding edges of each section that are to be brazed are beveled. A circle is drawn on the surface table, the diameter of which is equal that of the required diameter of the pipe, and a thin piece of steel is cut long enough to be bent around the semi-circumference of this circle. This is used as a template.

When the sections of pipe have been formed the template is placed over each section, which has to correspond with the diameter of the template, then the two sections are brought together, riveted at the ends and are ready to be brazed.

Copper Pipe Brazing

The two contacting surfaces of copper that are to be brazed are first filed and then given a bath of dilute sulphuric acid to remove all grease, dirt, and other substances that might be on the copper. Fire clay is placed around the lap joint, shown in Fig. 6, to act as a receiver for the brazing material. This keeps the material when in a fluid state from flowing over the pipe.

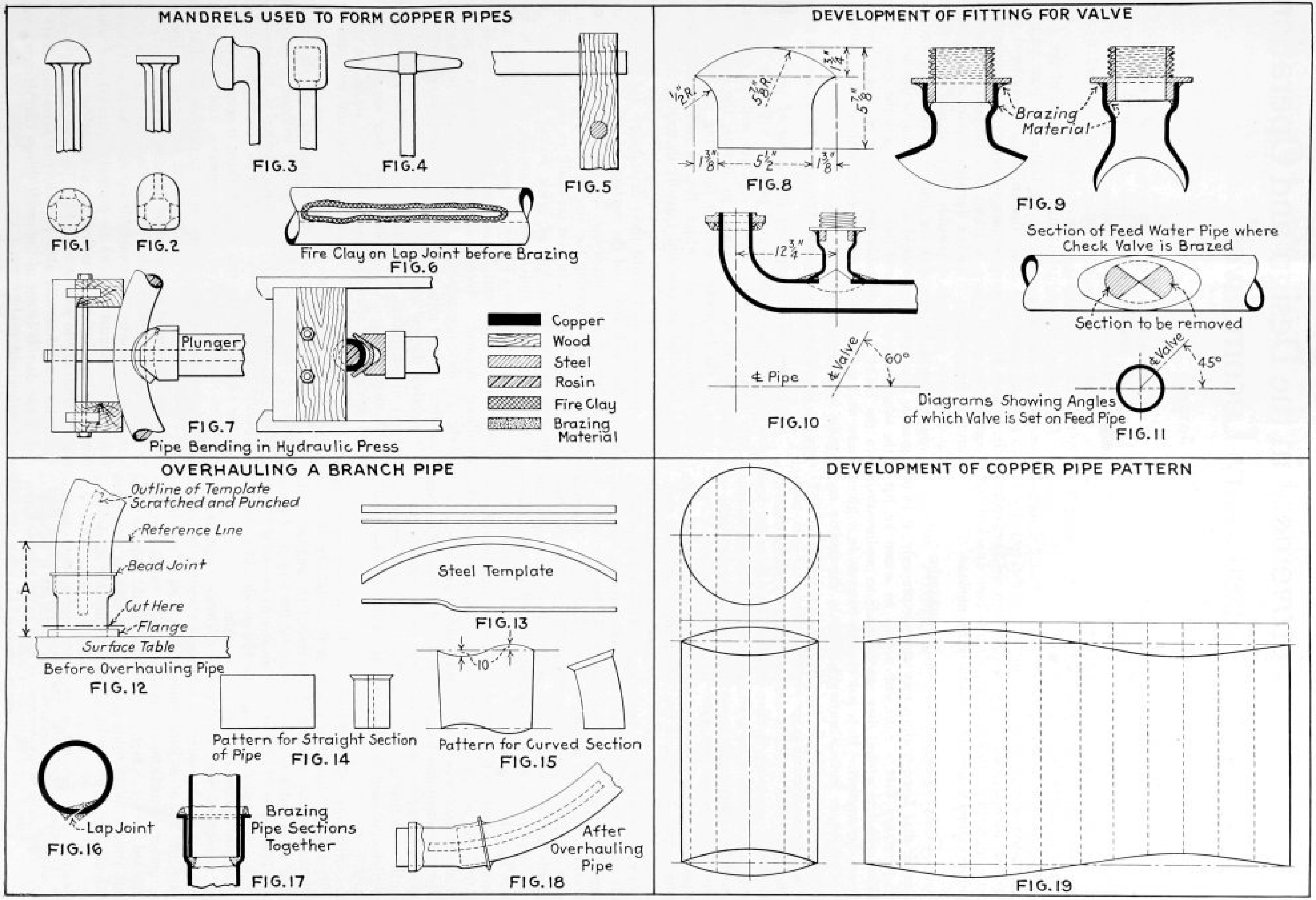
The pipe is placed in the fire and the brazing material together with a borax flux is placed over the joint. While the brazing material is being melted, borax is thrown on the joint from time to time.

After the brazing material has all been melted and spread along the lap joint, it is then removed from the fire and allowed to cool. When the pipe is cold the excess brazing material and fire clay are filed off; then the pipe is again bathed in acid.

Brazing Steel on Copper

To braze steel on copper, the two contacting surfaces are filed and cleaned from all dirt and grease. If a steel flange is to be brazed on a copper pipe, place the flange on the end of the pipe where it is to be brazed. Hammer the copper pipe to the flange until the flange is very tight on the pipe. Fire clay is put on the flange around the pipe, as shown in Fig. 10. The pipe and the flange are put into the fire, the brazing material being placed around the pipe. The procedure of brazing for steel on copper is the same as for copper on copper, using the same brazing material and the same flux.

The brazing material used is brass of the following composition: 56 percent copper, and 44 percent zinc.



Details of Copper Pipe Work

Necessity for Improvement in the Design and Operation of Present Day Locomotives*

By H. W. Snyder†

No one, it is believed, will dispute the fact that present-day operation of high-power locomotives is one of the most vital questions with which our railroads are concerned. The demands of constantly increasing passenger and freight traffic have brought about a constant increase in size and power of our locomotives.

The most vital matter which confronts locomotive designers and operating officials is that of increasing the capacity as well as the efficiency of the locomotives which we have today. In many ways these problems have already been attacked and great improvements are continually being made.

Combustion and Steam Generation

In order that large engines may operate properly, it is of course necessary that a sufficient supply of steam be furnished to cylinders so that they can be made to produce their maximum horsepower. It is not enough to provide a given number of square feet of heating surface in the firebox and the tubes so that we may be reasonably certain that sufficient water will be evaporated to supply the cylinders. It is, however, necessary that we take into account proper construction of the boiler, necessary firebox volume to produce the best possible combustion of fuel, and the design of grates so that fuel will be economically burned to such an extent only as required by the maximum evaporation of the boiler.

In producing heavy motive power it has been necessary on account of prohibitive axle loads to apply a sufficient number of axles under the engine to reduce the individual axle load to within reasonable limitations. This has lengthened out the engine to such an extent that boiler design and maintenance has become a serious problem. In the first place, it is necessary to design a boiler that will properly function with the other vital parts of a locomotive. At the same time the length has become such that the use of combustion chambers is a necessity to avoid a prohibitive length of tube. Large engines have been constructed with a tube length of 25 ft. and it seems that no definite rule has been established as to what the limit of length of tube of a given size should be. Experiments have been made on this subject and it has been said that the maximum length in inches of a tube of a given size should be approximately 100 times its diameter in inches. It would seem that this is as nearly correct as any general rule which has been devised and one which can be readily followed.

The author does not feel that any definite rule should be made in regard to length of tubes, for this might bring about a condition whereby other vital features of the engine would be involved in order to abide strictly by the length as noted above. Tubes 2 or 2¼ inches in diameter in excess of 20 feet in length are questionable, and this feature should be looked into carefully before a decision is reached.

The advent of long combustion chambers has brought along with it the necessity for increased attention to boilers. The application of a long combustion chamber requires a large number of additional staybolts and it would naturally be expected that a boiler of this kind would require more staybolt attention. For this reason, if for nothing else, there is no doubt that a proper installation of flexible stays in the firebox and combustion chamber will prevent a great deal of the staybolt trouble which has been experienced in the past. Although long combustion chambers require more attention in maintenance this will be offset by the increased firebox volume and the resulting better combustion.

On account of height limitations, the height of the dome as well as the steam space in the boiler has been reduced to such an extent that difficulties are being encountered with the proper life and maintenance of superheater equipment, because too much water is drawn over through the throttle into the superheater. This is a question requiring experiment to determine as nearly as possible the minimum steam space which should be provided for boilers working on various grades. Consideration should also be given to the height of the throttle above the water line as well as to the steam space in the boiler. Considerable development on this subject is now well under way and we can confidently expect results of value in the near future.

Increased Capacity Needed Without Increase in Size

On account of the apparent limitations of piston thrust and road clearances the greatest problem with large locomotives today is to increase their capacity without exceeding greatly present sizes. Anything to increase the hauling capacity of the locomotive without increasing the height and width limitations under which the locomotive must work might be called an essential capacity-increasing device. A few of these with which we are most familiar and which have proved beyond doubt their desirability are the superheater, the brick arch and the mechanical stoker. There are possibilities of still increasing the efficiency of the superheater without increasing the size of the boiler in which it must operate. There are also possibilities and constant improvements in the design of brick arches which lend to higher evaporation and better combustion of fuel. It has been stated that when a locomotive requires as much as 6,000 pounds of coal per hour it has gone beyond the limits of the ordinary fireman. Automatic stokers have been in use so long that their dependability for heavy power is no longer in question. Many men are studying this particular feature of locomotive design and operation and we may confidently expect in the future a gradual increase in the efficiency of these mechanisms. As they stand today they are an unqualified success, and time and study will bring about the necessary refinements so that better combustion and less coal per horsepower will be used.

We have not as yet gone very extensively into the use of feedwater heaters. It has been proved without a doubt in foreign countries that the feedwater heater is an essential capacity-increasing device as well as an economical addition to the locomotive. In this respect, then, it would seem that we are somewhat behind the Europeans, and there is no doubt that in the near future when the economies that can be effected by the use of the feedwater heater are realized it will become almost as general as the superheater today.

Another small item which has received only passing attention in this country is the variable exhaust. As is well known, a variable exhaust that can be properly operated and which will not require much maintenance attention will have a great tendency to relieve high back pressure at high speeds, and its operation will also provide the necessary draft at slow speeds. It is one of the small things that deserves consideration and study.

*Abstract of paper presented at the Spring meeting of the American Society of Mechanical Engineers. The original paper included changes in the design of the entire locomotive that would add to its operating efficiency. Only such sections, however, as apply to the boiler and appurtenances have been included in the above abstract.

†Mechanical Engineer, Lima Locomotive Works.

DETERMINING THE SIZE OF AIR OPENINGS IN ASH PANS

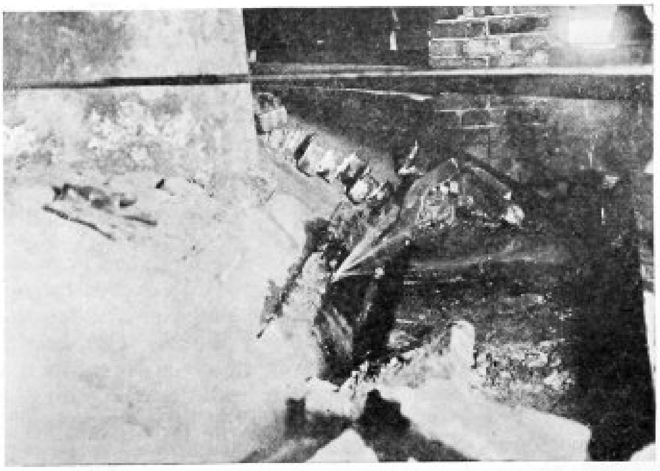
The question of ash pans is also one needing serious consideration. With the large increase in size of locomotives in many cases we have evidently lost sight of the importance of this necessity. There are in use a number of rules stating what the proper air opening in the ash pan should be, some saying that the ash pan air opening should be equal to the net gas area of the tubes and others that it should be a certain percentage of the opening through the grates. While many of these rules have in a way proven satisfactory, at the same time it would seem that to get at the question logically we should determine the amount of coal that can be burned economically per square foot of grate and then on this basis provide an ash pan air opening that will give the required amount of air to burn satisfactorily the maximum amount of coal which is expected to be consumed. The amount of air that will flow through a given opening in the ash pan, it is believed, can be very closely approximated from the vacuum produced in the smokebox. This, of course, is only a suggestion, and it may be that when the question is looked into more carefully a more desirable and accurate method of determining the required ash pan air opening for proper combustion may present itself.

CAPACITY INCREASING DEVICES

In summing up the situation, it may be said that the use of the superheater alone has increased the capacity of locomotives when compared with saturated engines of the same design to such an extent that no one would think of building a large locomotive for up-to-date railroad service without the application of superheat. This is one of the greatest strides that has been made in the construction of locomotives in the past few years. We must not content ourselves, however, with what has been done with this one device. The large locomotive of today has become a necessity and is here to stay. What we need to do now is to avail ourselves of the opportunities offered in the application of many of the labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service and at the same time look forward to the possibilities of applying other devices which are yet in their infancy, but which have proven beyond doubt that they are well worth our consideration and are of sufficient importance to warrant their adoption. There are many improvements yet to be made in locomotives and it behooves the operating officials of railroads as well as the leading minds in locomotive operation and design to get together and to continue to produce locomotives which in the next 20 years will be as far ahead of our present engines as our present locomotives are ahead of the locomotives that were built 20 years ago. Without the capacity-increasing devices which have been mentioned the large locomotive of today would be impossible—it could not be operated satisfactorily. Our large engines are an absolute justification of these improvements. Further developments are ready at hand and in their use lie the possibilities of still more powerful and economical transportation units built to operate within our present limitations of clearance and permissible rail loads.

The Value of Boiler Inspections

NOT long ago one of the inspectors of the Hartford Steam Boiler Inspection and Insurance Company made a visit to a plant for an internal inspection of a horizontal return tubular boiler, and while in the furnace he noticed a brownish stain on the shell, well up on the side where the brick wall of the furnace and the shell joined. To his trained eye this indicated a leak and he thereupon questioned the chief engineer as to whether any leakage had been noticed. The reply was in the negative but the inspector nevertheless was not satisfied. Climbing on top of the boiler he proceeded to learn, if possible, the source of the leak that had caused that stain on the boiler shell. The engineer called his attention to a water pipe running across and somewhat above the boiler, mentioning that considerable condensation collected on this pipe and that possibly there was some water reaching the boiler from this source. This did not seem an altogether satisfactory explanation, however, so the inspector ordered some of the asbestos covering of the boiler removed at a point where he believed a leak might be. The boiler was then filled with water under pressure and it was probably somewhat of a surprise to all present but the inspector to see water spraying out through a crack in the boiler shell as shown in the photograph herewith. The leakage was through a lap seam crack and it is practically certain that this boiler would have caused a disastrous explosion if it had remained in service. The watchful eye of the inspector, however, prevented further use of the boiler and thereby safeguarded life and property.



Water Shown Issuing from a Lap Seam Crack

The case just cited brings to our mind a somewhat similar one in which the owner had repairs made and only by good fortune was a serious accident averted. The engineer of the plant, a laundry, noticed some steam issuing through the covering of the boiler and upon investigation found that the steam came from a crack in the shell of the boiler. The crack was of the lap seam type but the owner did not know its dangerous character and neither did the self-styled "boiler-maker" he called in for advice. This "expert" said, "That's all right. Go ahead and use her till the end of the week and then shut her down. I'll be over Sunday and weld her up." He apparently did not know that autogenous welding in a case of this kind is a most dangerous practice, or else he had no regard for the safety of the fifty girls at work directly above the boiler.

One of our inspectors heard of the case and made a visit to the place. As soon as he saw the nature of the leak he advised an immediate shutdown of the boiler and also told the owner that the contemplated repairs would not make the boiler any less dangerous to operate.

A few days later a hydrostatic test was applied to the boiler and the results were practically identical with the first case mentioned. The demonstration and the inspector's explanation of the serious nature of the defect were sufficient for the owner, and not only the leaking boiler but also its mate, both of them of the same age, were removed and new ones installed. Had this precaution not been taken there might very easily have been a repetition of the accident which occurred at the American Palace Laundry, Buffalo, N. Y., on November 3, 1906. In this disaster, the boiler, which was of the long seam type, failed as the result of a lap seam crack and four persons were killed. The property loss amounted to $12,000.—*The Locomotive.*

Principles of Riveted Joint Design —II

Methods of Calculating Joint Efficiencies and Demonstrating Types of Joint Failures

By William C. Strott*

In any correctly proportioned riveted joint, the least efficiency of the joint should lie in the net plate section through the outer row of rivets, (except for single riveted lap and butt joints, where the rivets will be weakest). The shearing strength of a joint should, however, closely approximate that of the net plate section, since there is little, if anything, to be gained by providing a very high shearing strength with a comparatively low plate strength. The lower value nevertheless always determines the working value of the joint, regardless of whatever high efficiencies it may otherwise have.

Derivation of a Convenient Formula for Determining the Net Plate Efficiency of a Joint

Since it was just stated that the true efficiency of a well proportioned riveted seam lies in the net plate section it would be well to have at hand a simple equation by which

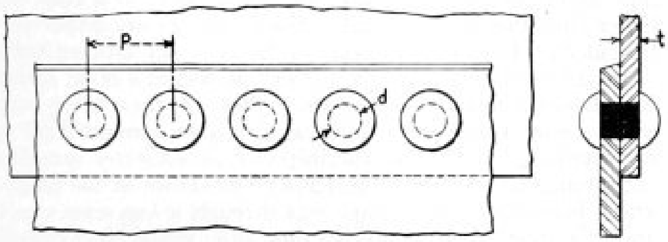


Fig. 7.—Single Riveted Lap Joint

such efficiencies may be conveniently determined. For the work to follow, let:

T_s = Tensile strength of the plate.
t = Thickness of the plate.
d = Diameter of rivets after driving.
p = Maximum pitch of rivets in outside row.

Then the strength of the solid plate in a unit length of the joint may be expressed:

(a) $P \times t \times T_s$

Also, the net plate strength takes the form:

(b) $(P - d) \times t \times T_s$

Whence dividing expression (b) by expression (a) we have:

$$\text{(c)} \quad \frac{(P - d) \times t \times T_s}{P \times t \times T_s}$$

Since the terms t and T_s appear in both numerator and denominator of the above fractional equation, they may be cancelled, and the equation takes the following simplified form:

$$\text{(1)} \quad E_p = \frac{(p - d)}{P}$$

which simply means that if we subtract the rivet diameter (after driving) from the maximum rivet pitch, and then divide the remainder by the maximum pitch, the quotient will be the *plate* efficiency of the joint, which latter is denoted in the above formula by E_p.

Applying formula (1) to the joint shown in Fig. 5 (b) we get:

$$E_p = \frac{P - d}{P} = \frac{3.5 - 1.0625}{3.5} \text{ or 69.6 percent,}$$

being the same plate efficiency as was previously determined by direct calculation.

In the "early days" before state laws were enacted to govern the design and construction of steam boilers and pressure vessels—when nearly every boiler maker worked in accordance with stereotyped standards and "rule of thumb" methods, the true efficiency of riveted joints was assumed, or rather believed, to be that given by equation (1) which we have just derived.

It is surprising how very few practical boiler makers are

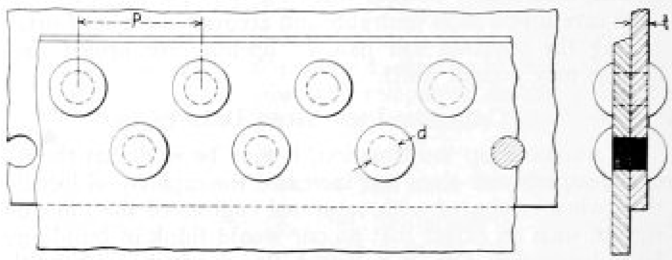


Fig. 8.—Double Riveted Lap Joint

able to explain the derivation of this equation—many believing it to be wholly empirical, (i. e., based on experience or experiment). By means of this equation, however, the designer may readily approximate just what efficiency can be expected with any given combination of plate thickness, rivet diameter and pitch.

We are finally in a position to enter into a detailed discussion of every practical type of riveted joint, together with the formula for computing their efficiencies with regard to each possible method of failure.

Demonstration of Three Types of Joint Failure

For convenience and reference, the strength of any riveted joint with regard to its three fundamental methods of failure will be itemized as follows:

T = Strength of the net plate section
Sh = Shearing strength of the rivets
Cr = Crushing strength of the plate
} In a unit length of joint.

In all future work in connection with riveted joint calculations, the following notations will be employed. (All dimensions are in inches.):

W = Strength of solid plate in a unit length of the joint = $(P \times t \times T_s)$
P = Maximum rivet pitch.
p = Calking pitch (except for saw-tooth joints).
p_1, p_2 or p_3 = Diagonal pitch.
x, y, or z = Back pitch.
t = Thickness of shell plate.
b = Thickness of butt straps (see Table 1).
d = Diameter of rivet holes.
a = Area of rivet hole = $(d^2 \times 0.7854)$.
T_s = Ultimate tensile strength of shell plate material, 55,000 pounds per square inch.
S = Ultimate double shearing strength of rivet material, pounds per square inch.
s = Ultimate single shearing strength of rivet material, pounds per square inch. (Note: For values of S and s, see Table 2.)
C = Ultimate crushing strength of shell plate material, 95,000 pounds per square inch.
N = Number of rivets in double shear in a unit length of joint.
n = Number of rivets in single shear in a unit length of joint.

*Engineering Department of the Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

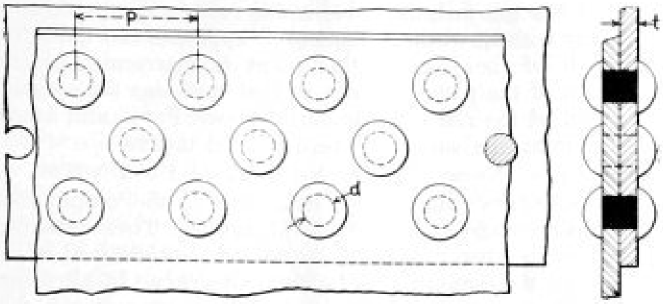


Fig. 9.—Triple Riveted Lap Joint

TABLE 1—MINIMUM THICKNESS OF BUTT STRAPS. (AMERICAN SOCIETY OF MECHANICAL ENGINEERS' CODE).

Thickness of shell plate, inch	Minimum thickness of butt straps, inch	Thickness of shell plate, inch	Minimum thickness of butt straps, inch
1/4	1/4	17/32	7/16
9/32	1/4	9/16	7/16
5/16	1/4	5/8	1/2
11/32	1/4	3/4	1/2
3/8	5/16	7/8	5/8
13/32	5/16	1	3/4
7/16	3/8	1 1/8	3/4
15/32	3/8	1 1/4	7/8
1/2	7/16		

TABLE 2—ALLOWABLE SHEARING STRESSES IN RIVETS

Iron rivets in single shear............38,000 pounds per square inch
Iron rivets in double shear..........76,000 pounds per square inch
Steel rivets in single shear..........44,000 pounds per square inch
Steel rivets in double shear.........88,000 pounds per square inch

Fig. 7 shows the most simple form of riveted joint. The three fundamental methods of failure previously explained may only occur independently of each other as follows:

$W = P \times t \times T_s$
$T = (P - d) \times t \times T_s$
$Sh = 1 \times a \times s$
$Cr = 1 \times d \times t \times C$

Divide T, Sh, or Cr, whichever is the least, by W, and the quotient will be the true efficiency of the joint.

The joint, Fig. 8, is similar to that shown in Fig. 7, with the exception that a double riveted joint has two rows of rivets, hence it is just twice as strong in shear as a single riveted lap joint of equal proportions. Because of the stagger of the rivets in adjacent rows to each other they may be pitched somewhat farther apart, as was previously explained in connection with Fig. 5 (b). Therefore, a double riveted joint will give a higher overall efficiency due to the resulting greater net plate strength than single riveting.

The three methods of failure, viz., T, Sh, and Cr, occur independently of each other as follows:

$W = P \times t \times T_s$
$T = (P - d) \times t \times T_s$
$Sh = 2 \times a \times s$
$Cr = 2 \times d \times t \times C$

Divide T, Sh, or Cr, whichever is the least, and the quotient will be the true efficiency of the joint.

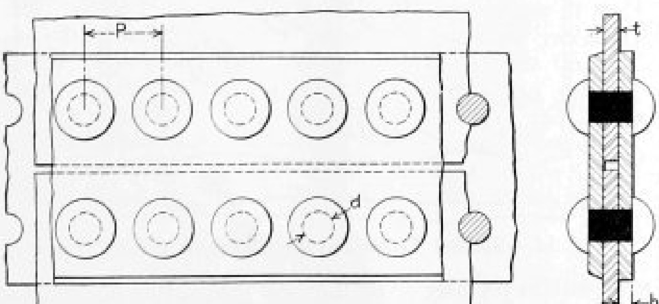


Fig. 10.—Single Riveted "Double Shear" Joint

It is evident that the number of rows of rivets in joints like Figs. 7 and 8 may be increased indefinitely, but beyond double riveting there can be no gain in efficiency for a given plate thickness and rivet diameter if "calkability" is to be maintained. For a given plate thickness and corresponding proper rivet diameter, the maximum calking pitch available for double riveting can never be increased regardless of the number of rows of rivets that are employed, consequently the only thing that may be gained is rivet shearing strength.

Triple Riveted Seam Not Used in Boiler Work

The triple riveted lap joint is extensively employed on large tanks, subjected to low pressures, but has almost become obsolete in steam boiler construction. The three methods of failure for this type seam are as follows:

$W = P \times t \times T_s$
$T = (P - d) \times t \times T_s$
$Sh = 3 \times a \times s$
$Cr = 3 \times d \times t \times C$

Divide T, Sh, or Cr, whichever may be the least, by W, and the quotient will be the true efficiency of the joint.

The maximum efficiency obtainable with the double shear joint, Fig. 10, is the same as for a single riveted lap joint of equal proportions, for it is obvious that the net plate strength between the rivets will in either case be the same because the rivet pitches must of necessity be the same. On account of the rivets being in double shear, however, higher strength is obtainable in this regard, which does not increase the true efficiency of the joint beyond that obtained by the strength of the net plate section.

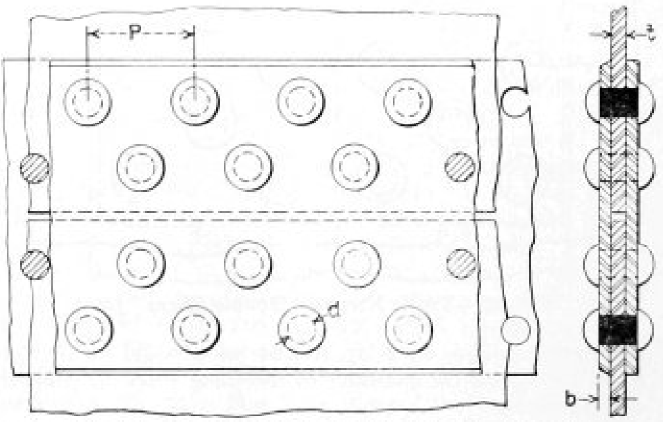


Fig. 11.—Double Riveted "Double Shear" Joint

The three methods of failure occur independently of each other, but in this case we consider the *double* instead of the single shearing value of the rivets.

$W = P \times t \times T_s$
$T = (P - d) \times t \times T_s$
$Sh = 1 \times a \times S$
$Cr = 1 \times d \times t \times C$

Divide T, Sh, or Cr, whichever is the least, by W, and the quotient will be the true efficiency of the joint.

Note.—In this case, as well as in all other double butt strap joints, the covering plates are as likely to fail by tension or crushing as are the main plates, that is if the combined thickness of both butt straps were exactly equal to that of the main plate.

The butt straps in a practical joint, however, are each made about three-quarters the thickness of the main plate, Table I. This gives the butt straps a considerably higher strength than the main plate, so that possible failure of the covering plates need never be considered.

Double shear joints similar to Fig. 10 may be increased in width and have the number of rows of rivets multiplied, thereby producing joints as illustrated in Figs. 11 and 12.

The maximum efficiencies of these joints are no greater, however, than obtainable with double or triple riveted lap joints of equal proportions which is obvious when the maximum rivet pitch, to permit calkability, is the prime necessity.

All of these types are known as double shear joints, and although not frequently employed, they are nevertheless of considerable value where high efficiencies are not required, but when it is desired to eliminate the dangers due to lap riveted construction. Another point in their favor is, that owing to the high rivet strength obtainable, comparatively small rivet diameters may be employed in very thick plates. This fact is of considerable importance when the usual size

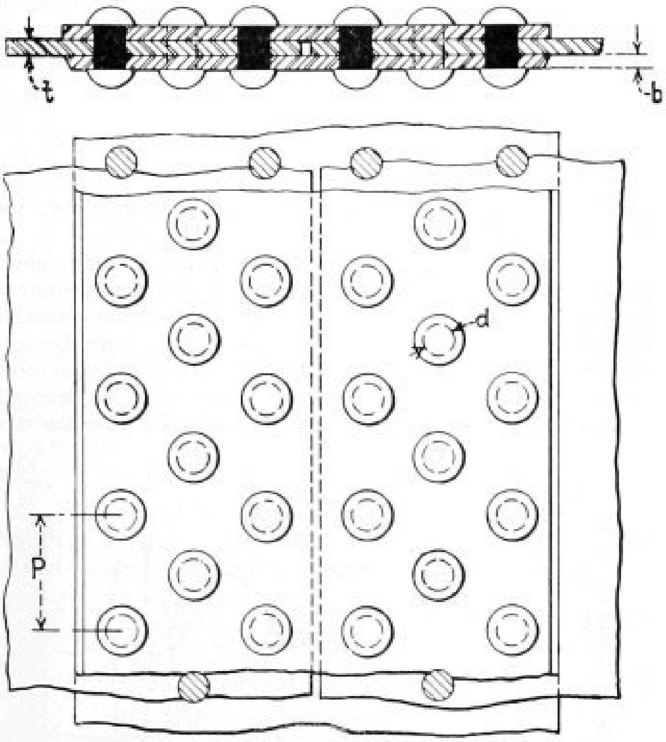


Fig. 12.—Triple Riveted "Double Shear" Joint

of rivets necessary in a lap riveted joint would be so large as to be beyond the facilities of the plate shop for properly driving them.

The three methods of failure in joints like Figs. 11 and 12 occur singly, as follows:

$$W = P \times t \times T_s$$
$$T = (P - d) \times t \times T_s$$
$$Sh = N \times a \times S$$
$$Cr = N \times d \times t \times C$$

Note: That "N" = number of rivets in a unit length of the joint, which for Fig. 11 is 2, and for Fig. 12 is 3. Divide T, Sh, or Cr, whichever is the least, by W, and the quotient will give the true efficiency of the joint.

When calkability is not essential, every alternate rivet in the outer row of a joint like Fig. 12 may be omitted, and we have the form illustrated in Fig. 13.

The net strength of the plate in the outside rows is thereby greatly increased, and together with the high rivet strength available, results in a joint of greatly increased efficiency. But this rivet arrangement cannot be used on pressure vessels containing fluids, either liquid or gaseous, because the edge of the outside butt strap cannot be satisfactorily calked against the shell plate owing to the large rivet pitches along the calking edges. Such joints cannot, therefore, be rendered tight against leakage. The first three fundamental methods of failure are determined as follows:

$$W = P \times t \times T_s$$
$$T = (P - d) \times t \times T_s$$
$$Sh = 5 \times a \times S$$
$$Cr = 5 \times d \times t \times C$$

Neither one of the above values, viz., T, Sh, or Cr, may, however, represent the true strength of this joint, for the reason that the plate section through the second row of rivets is less than that through the outside row and is therefore considerably weaker. But before the plate ligament in the second row can fail, the rivets in the outside row would have to shear with it, whence it should be apparent that the actual strength of the joint at this point is represented by the strength of the plate ligament in that row *plus* the shearing strength of the rivets in the outside row. For a unit length of the joint this value may be expressed thus:

$$(T + Sh) = (P - 2d) \times t \times T_s + (1 \times a \times S)$$

This feature evidently presents one of the combination failures referred to in a previous paragraph. These combination failures when present in any riveted joint, must of course enter into the computations for final efficiency. In all future work, when a condition similar to this is encountered, that is when rivet stress and plate tension assist each other, the method of failure will be designated by (T + Sh), which simply denotes "tension plus shear."

It should further be noticed, in connection with Fig. 13, that the plate ligament in the third or inside row has also been reduced by 2 rivet holes, which renders this section just as liable to failure as the second row, so far as the plates are concerned, but it should be realized after a study of the illustration that this plate ligament is assisted by the shearing value of all the rivets in front of it, which includes the 2 rivets in the second row plus the equivalent of one rivet in the outer row, or a total of three rivets. It is not necessary, therefore, to consider the strength of the joint through the inside row, because the strength is greater at this point than in the second row. In fact, it is only necessary to calculate the strength of any joint through its reducing sections; for instance, the second row is a reducing section because it contains more rivet holes than the outer row. Since the inside

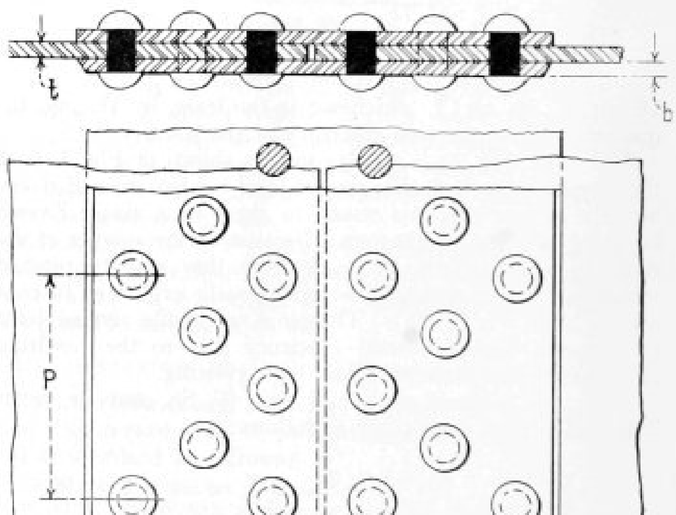


Fig. 13.—Special Triple Riveted "Double Shear" Joint

row contains no more rivets than the second it is not a reducing section, hence its strength has not been decreased, and therefore cannot possibly fail before the ligament in the second row.

Suppose now that the rivets are sufficiently strong to resist shear, but that very thin plate is being employed. Then instead of the joint being liable to fail by any one of the methods Sh, or T + Sh, it becomes dangerously weak with regard to failure by T or Cr. Since the strength equations for the latter two methods have been given, the efficiency of the joint in these respects may of course be determined. We then pass on again to the plate ligament in the second row. Instead of adding the shearing resistance of the outside rivet to the tensile strength of this ligament, we consider the crushing resistance of the plate against this outer rivet as the assisting medium. We shall in the future denote such combined failures by (T + Cr). The strength equation for this method of failure is expressed thus:

$$(T + Cr) = (P - 2d) \times t \times T_s + (2 \times d \times t \times C)$$

There are then two methods by which the joint illustrated in Fig. 13 may fail through the second row of rivets, both of which are combined failures. The first method defined was by combined plate tension and rivet shear, or (T + Sh); the second by combined tension and crushing, or (T + Cr).

We have finally encountered in all, five possible methods by which a joint similar to Fig. 13 may fail, viz., T, Sh, Cr, (T + Sh) and (T + Cr), and by dividing either of these values, whichever is the least, by W, the quotient will be the true efficiency of the joint.

(To be continued)

Progress in the Adoption of the Boiler Code*

By Charles E. Gorton†

It was the feeling of the executive committee of the American Uniform Boiler Law Society and myself, that owing to the changes that were taking place in several state governments, together with the general business conditions during this reconstruction or transition period through which we have been passing, that instead of pushing legislation which had for its object the addition of new states, to those that have already adopted the American Society of Mechanical Engineers' Boiler Code, it was our duty to lend every assistance possible to the inspection departments of states that are operating under the Code, in order that they might function to better advantage.

The chairman was called to Oklahoma in conference with the labor commissioner, deputy commissioner and chief boiler inspector, in regard to the best method to be used for the proper functioning of the Code and whether it would be advisable to exempt for the time being "oil country boilers." I would like to say at this time that valuable assistance was rendered by M. F. Moore of the Kewanee Boiler Company, and the matter settled satisfactorily to all parties concerned.

Arkansas next asked for assistance through their labor commissioner and chief inspector, as legislation had been introduced which would greatly hamper their inspection department.

Opposition Overcome in California

In November we received word from California that opposition had developed to Part 1 of the Code, during a public hearing, by interests which took exception to that part of the California safety orders relating to existing installations and second hand boilers. Your chairman spent three and a half months on the Coast, attending conferences, meetings and public hearings in California, with the result that we have every reason to believe that Part 1 of the 1918 edition of the Code will become a part of the safety orders of the State. Since returning from California we have received word that legislation curtailing the activities of the inspection department had been introduced at Sacramento, passed the legislature, and been signed by the governor; and later we received assurances, that while the department activities would be curtailed, Part 1 of the 1918 edition of the Code would, in all probability, be adopted as a part of the safety orders.

Code Adopted in Oregon

On the way back from the coast we stopped in Portland, Oregon, and had the pleasure of taking up the Code situation in that state, with chairman Marshall of the Industrial Accident Commission, Mr. Gram, Commissioner of Labor, chief inspector Thomas, and Mr. Bert Ball of the Willamette Iron and Steel Company, a member of the conference committee appointed by the Industrial Accident Commission; with the result that during the month of June we received a communication from the Industrial Accident Commission to the effect that "The Commission on June 8, 1921, adopted the rules of the American Society of Mechanical Engineers as revised for the year 1918, and also fixed the dates upon which they become effective, as follows: Part 1, relating to new installations, becomes effective July 1, 1921. Part 2, relating to existing installations, becomes effective January 1, 1922."

We also stopped in Salt Lake City, at the request of the chief boiler inspector, to offer suggestions as to the best methods of enforcing the Code, and we would like to state that we found that for the short time the state of Utah had been using the Code, they had done very efficient work.

We feel that our report would not be complete if we did not make special mention of the first convention of the National Board of Boiler and Pressure Vessel Inspectors, held in the city of Detroit, February 2, 3 and 4, 1921. Delegates representing twelve or fourteen of the code states, as well as a number of the cities that have adopted the Code, were in attendance. The objects for which the convention was called, are as follows: First, to redraft the constitution and bylaws; second, to make the temporary organization a permanent one, and third, that the representatives of the departments might get together and become personally acquainted and talk over such questions as uniform stamping of boilers, uniform examinations for inspectors, and uniform interpretations. All of these matters were satisfactorily disposed of and we wish to state that it was one of the most successful conventions that it has been our privilege to attend.

Owing to a reorganization plan, a delicate situation was created in the state of Ohio, and we lent our assistance to the boiler inspection department, in order that the board of boiler rules and the inspection department as constituted, would not be disturbed. While the department affairs are possibly in a more or less unsettled condition, yet there is a feeling that in the end everything will be adjusted satisfactorily. After leaving Ohio we were called to Lansing, Michigan, to render any assistance possible, in order that the board of boiler rules would not lose its identity in the general scheme of reorganization which was then before the legislature. The differences in this state were satisfactorily adjusted. Before going further, I would like to state for those who do not know, that John C. McCabe of Detroit has resigned his position as commissioner of buildings, and has been appointed by Mayor Couzens at the head of the city research bureau. Mr. McCabe, as you know, is a member of the Michigan Board of Boiler Rules, and chief inspector of the department.

It was our pleasure to meet with the newly appointed Board of Boiler Rules of the State of Delaware, and assist

*Abstract of report read at the annual convention of the American Boiler Manufacturers' Association.

†Chairman of the Administrative Council of the American Uniform Boiler Law Society.

them in drafting rules for the inspection of boilers, and we wish to state that within a very short time the board will send out an announcement as to the date upon which the rules will become effective.

We also received an invitation from chairman Fox of the Maryland Board of Boiler Rules to meet with the board and members of the boiler inspection department, the object of which was to formulate such rules as were necessary for the proper functioning of the Code.

Shortly after this we were in conference in Chicago with our friends who felt that the opportune time had arrived for a bill to be introduced in the Illinois legislature. After making a preliminary survey we were convinced that a bill should be introduced in the interests of Code legislation. Acting upon this, we prepared the bill which was introduced in the Senate by John Dailey of Peoria, and was known as Senate Bill No. 199. The bill was recommended out of committee for passage, passed first and second reading, and was on call for final passage, when owing to complications which arose, it was deemed advisable not to allow the bill to go to final vote, but to allow it to remain upon the calendar.

You will all no doubt remember that mention was made in our last report of the petition which we filed with the Massachusetts Board of Boiler Rules; and at this time I would like to say that at the public hearing held in Boston last November the Board of Boiler Rules upon their own initiative, incorporated some of the Code provisions in the Massachusetts rules, which we had designated as minor differences, and I feel that members of the American Boiler Manufacturers' Association will be glad to know that at the present time there exist only three or four major differences, and that the A. S. M. E. Code Committee has appointed a committee to confer with the Massachusetts Board, in order that we may ascertain if it is not possible to reconcile the differences, and we trust that the committee will be successful in this respect.

We have one or two differences occurring in the state of Indiana, which we trust will be amicably settled, the differences having been brought about by a ruling rendered by the chief inspector. We have had one conference with him up to the present time, and will in the near future take the matter up with him in detail, looking to a final adjustment which we feel will, in all probability, be satisfactory to those interested.

It might be of interest for you to know that there were some nineteen bills that were introduced during the legislative sessions of the states during the past year, some of which were inimicable to our work and the interests of the members of our Society, and we have endeavored to meet this class of legislation in a way that we felt would be satisfactory to those interested.

Our office work has been broadening out until today we are acting as a clearing house in furnishing information not only to members of our Society and those interested in the Code movement, but to others. This in itself is very gratifying to us, and in cases where we have not the information at hand we have either referred them to the proper place, or have gotten the information direct and forwarded it to them. We have received inquiries from those who are interested in furnishing their products to foreign countries, asking for information as to whether these countries have boiler laws covering the construction of boilers, and wherever possible, we have given them the desired information.

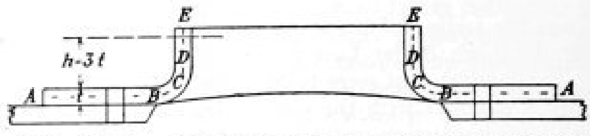
The members of this Association can readily see that our work during the past year has been of such a nature that it was not advisable to issue our usual bulletins; also that the work has been such that it would be almost impossible to go into minute details. That being the case, we have tried to give you an outline of the work that has been carried on by the members of the administrative council, executive committee and the chairman, during the past year.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the secretary of the committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval.

CASE No. 335—*Inquiry:* (*a*) Are manhole frames when

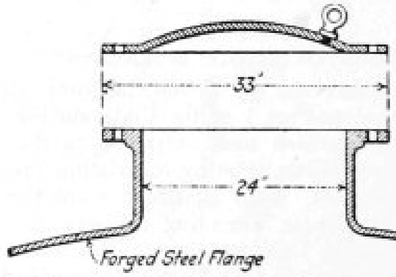


Case 335. Fig. 1.—Cross Section of Flanged Manhole Frame

of the flanged type, considered reinforcing rings and so necessitate their thickness to be at least that of the shell plate, or are they not so considered, so that they can have a thickness less than the shell plate provided their strength meets the requirements of paragraph 260?

(*b*) As no method of calculating the strength of flanged manhole frames is given in the Code, would the following method be acceptable? From twice the median line, *ABCDE*, in Fig. 1, subtract twice the rivet hole diameter and multiply the result by the thickness of the frame and this by the tensile strength.

Reply: (*a*) The thickness of the shell plate referred to in paragraphs 259 and 260 is that required by paragraph 180 and the thickness and strength of manhole frames and reinforcing rings shall conform to those required for such a shell-plate thickness. When the shell plate is made of greater



Case 348. Fig. 2.—Dished Head with Forged Steel Manhole Neck

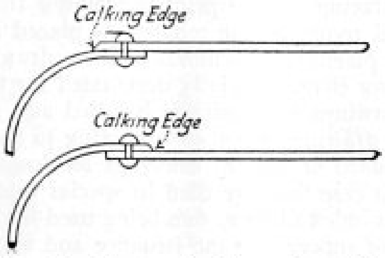
thickness, such excess thickness shall be given no consideration in the calculations in these paragraphs.

(*b*) It is the opinion of the Committee that safe results will be obtained by using as a reinforcement to the ring the flange height (*h*) up to three times the flange thickness (See Fig. 1).

CASE No. 347—*Inquiry:* Does the requirement of paragraph 195 of the Boiler Code for an increase of 1/8 inch in thickness of a dished head fitted with a manhole opening, apply only to concave heads, or to both concave and convex heads?

Reply: It was the intent of the Committee that the increase in thickness of 1/8 inch for dished heads with manhole openings shall apply in all cases whether the heads are concave or convex.

CASE No. 348—*Inquiry:* Would the attachment of a forged-steel manhole neck to a convex head, as shown in Fig. 2, be considered the equivalent of a flanged opening supported by an attached flue and thus be exempted from



Case 349. Fig. 3.—Forms of Joints for Dished Heads in Cylindrical Shells

the requirement for the 1/8 inch increase in thickness specified in paragraph 195 of the Boiler Code?

Reply: The manhole neck shown in Fig. 2 is not supported in the sense that it assists the convex head in withstanding the stress due to the steam pressure, and accordingly it is the opinion of the Committee that it cannot be considered that the head there shown is "supported by an attached flue," and therefore it cannot be exempted from the requirement for the 1/8 inch increase in thickness.

Case No. 349—*Inquiry:* Is it permissible, under the requirements of the Boiler Code, in fitting dished heads to the ends of air cylinders or steam drums, to so form the convex head that its flanged edges fit over the outside of the end of the shell, as shown in Fig. 3, instead of within the shell as is usual, in order that a tighter joint may be obtained by calking the edges of the flange to the outer surface of the shell?

Reply: It is the opinion of the Committee that the form of construction proposed is entirely in accord with the requirements of the Boiler Code.

Case No. 350—*Inquiry:* Is it permissible, under the rules of the Boiler Code, in fitting different courses of the shell of a boiler at the ends of butt-strapped joints, to weld them together autogenously, in order to avoid the use of plugs or "dutchmen" to render the joints tight?

Reply: It is the opinion of the Committee that if the stress upon the joint is fully carried by the butt straps, the use of welding to render the ends of the joints tight is fully in accord with the requirements of paragraph 186 of the Code.

Methods of Filing and Numbering Drawings*

Details of Drawing Index Systems Adopted by Various Engineering Organizations

By L. H. Park†

The indexing and filing of drawings is one of the most complex problems of the drafting room. The time wasted in waiting for information contained on a drawing which cannot be located adds very materially to the drawing cost.

Improper indexing and filing of drawings is almost entirely due to the fact that titles are not concise and clear. For example, suppose we have a drawing which shows a stack for a 500 horsepower boiler. We may find a title reading thus: "Details of Boiler Stack for 500 Horsepower Boiler," or one more concise as "500 Horsepower Boiler Stack." Both of these titles will confuse the average file clerk, whereas if the title read "Stack for 500 Horsepower Boiler," the clerk knows at a glance that the drawing is to be filed under the subject of stack and not boiler.

I will outline for you the indexing and filing systems of five engineering enterprises, namely, the Wellman-Seaver-Morgan Company, the Grasselli Chemical Company, the Koppers Company, the Austin Company, and Arthur G. McKee & Company, who have so far as possible nearly perfected filing systems best adapted to their individual lines of work.

All of the forementioned concerns use their tracings for reference, with the exception of the Austin Company and the Koppers Company, who use both tracings and blue prints. In all cases the drawing sizes are approximately the same, each having the full, half and quarter sizes. The Wellman-Seaver-Morgan Company goes one size smaller, which is about one eighth size, this being used for drawing room standard or details of parts which can be used variably.

Application of Direct Filing System

The system of the Grasselli Chemical Company, manufacturers of heavier chemicals, has been developed to suit its particular requirements. Their drawing records cover buildings and equipment for chemical manufacture in industrial plants and also the drawings of warehouses and other equipment.

When a drawing is wanted the file clerk needs only to know what works or warehouses and what departments it is for. He goes directly to the drawing file where this work's drawings are filed and is able without delay to find the particular folder in which this drawing is located and then it is a matter of a few seconds to find the drawing in question.

The custom of this company is to file the tracings in folders for reference. This is not a common practice but their experience has been that the tracings stand this kind of service very satisfactorily, eliminating the necessity of having an extra set of blue prints and doubling up the file capacity. In addition to the tracings, study drawings and blue prints of outside manufacturers who supply machinery and other equipment are included in these folders. No topical record is kept of the drawings in books, cards or otherwise. It is the practice in addition to general reference files which are kept in the drawing room to keep a complete set of all blue prints in a vault at the Cleveland plant. Altogether they have probably in the neighborhood of 1,300 drawing files and 45,000 drawings.

System Employed by the Wellman-Seaver-Morgan Company

The Wellman-Seaver-Morgan Company, builders of a widely varied class of heavy machinery, use the following system:

One man has charge of the filing and indexing on account of the great number of tracings and the limited amount of filing space. The large tracings are filed in drawers which will accommodate 200 sheets. Drawers for half size tracings are partitioned to contain 400 sheets and cross partitioned for quarter size to contain 800 sheets. All sheets are filed numerically, which necessitates considerable care in remov-

*Abstract of paper read at the annual convention of the American Boiler Manufacturers' Association.
†Chief draftsman of the Arthur G. McKee & Company, Cleveland, O.

ing and filing those tracings which are near the bottom of the drawer.

The indexing is by the card system. In the lower right hand corner of the drawing is the title block containing the contract number, title of drawing and drawing number. A card is filed in with the same information as appears in the title block and is filed under the contract number. Entrance is also made in a drawing record book in which the numbers run consecutively regardless of contract. Opposite the number which corresponds to the number on the drawing is entered the title of the drawing, the date the drawing is made and the contract on which it applies.

The system adopted by the Koppers Company of Pittsburgh, Pa., engineers and contractors for complete by-product coke oven plants, during war times and still in use, is well worthy of note.

All tracings are filed numerically in a central vault. A complete buzzer system was installed, buttons being placed on every third or fourth drawing table with the indicator inside the vault. Office girls are employed to act as carriers. When any party in the drawing room desires a tracing he makes out a requisition slip and presses the nearest buzzer button. A carrier will call for the slip and deliver the tracing. Should the tracing be in use, the possessor will either allow it to be taken or advise about when it can be obtained. If the time is too long for the other party to wait he will be given a blue print, several of which are always kept on file. His requisition slip is then changed to read "blue print" instead of "tracing." A complete and reliable check is kept as to the location of tracings and prints at all times. When a change or revision is to be made on a tracing, the vault is informed and immediately all prints from that particular tracing are destroyed. All tracings are collected nightly, placed in the vault in bundles having attached thereto a tag bearing the party's name. These are delivered to the respective parties the next morning.

Main and Office Branch System of Filing

The system adopted by the Austin Company has been developed to meet the needs of the main office and each of its branches. For work that is primarily standard, special filing racks are used for containing standard prints for individual drafting room requirements. Similar prints are placed in special folding cabinets in the sales offices; all of these prints are filed flat and in groups of about one dozen and hung in a vertical position in racks. No card system is used for indexing these drawings as they are filed numerically according to the standard building to which they pertain. Should any draftsman require the use of these drawings it is his privilege to remove them from the rack without inserting cards showing their removal. This is not true, however, for other than standard drawings. For these a general card index system is used. All drawings are numbered and indexed according to contract number and the serial number according to the classification of the work involved; for example, general drawings, structural details, heating, lighting and equipment drawings of certain numerical numbers which immediately indicate the purpose of the drawing in question.

The development department takes complete charge of any new standards or other drawings to be used by all departments, such as engineering instructions as they pertain to design, estimating, construction, sales, etc.

The sales offices are supplied with vertical filing cabinets for filing blue prints according to contract or job numbers as well as the standard drawings which are supplied by the general department.

The engineering departments located in the various cities have a separate filing system for their own jobs as well as the drawings received from the general department and standard drawings furnished by the development department. The card index system as mentioned before being used for the records which are kept on file in each office.

A separate card index system and other records are kept for drawings of finished jobs or others which are to be filed in the permanent storage in the vault.

In case a tracing or blue print is removed from the vault a special card recording the removal is placed in the filing cabinet. The placing and removal of these drawings is handled by a filing clerk, especially designated for this purpose.

Foreign drawings are similarly handled and recorded except that the drawings are filed according to the job unless they are standard or general drawings serviceable for other jobs, in which case they are filed in special cabinets for the purpose; cross index filing system being used for the purpose.

The work of supervising the issuance and maintenance of the indexing and filing systems comes under the jurisdiction of the chief draftsman.

Drawer Filing of Prints at Arthur G. McKee Company

The system in vogue with the Arthur G. McKee & Company for complete blast furnace plants, open hearth plants, sintering plants, etc., is practically the same as that used by the Wellman-Seaver-Morgan Company as regards the filing of tracings except that only half the number is filed in each drawer.

We use three colors of cards for the tracing index, all cards being the same form; yellow cards for the contract index, white cards for the subject or title index, and blue cards for the client index.

When work on a new contract is started in the drawing room, a blue card is filled in giving name and location of the client and a description in general of the work.

When a draftsman begins work on a drawing, he will go to the card index and take out two blank cards, one yellow and one white, each of which has the same drawing number stamped thereon; fill in the client's name and location or where work is to be done, and the title of the drawing.

When an existing drawing is reused, a yellow card not having a drawing number thereon is filled in complete, including the number on the drawing. The new contract number is then added to the existing white or title card.

Foreign prints or client and manufacturer's prints pertaining to a contract are filed in individual drawers while the contract is alive. When the contract is finished they are cross indexed for subject and client or manufacturer and placed in a permanent file. For ready reference to standard parts we use the scrap book system in which blue prints are filed.

Reorganization of the New York State Boiler Inspection Service

The New York State Bureau of Boilers and Explosives, which has had charge of all boiler inspection work in the state, has been abolished, and the work of inspecting boilers will in the future come under the jurisdiction of the Bureau of Inspection, which was organized to take over the work of the former bureau. Among the divisions of the Bureau of Inspection will be the Division of Boiler Inspection, having at its head the chief boiler inspector of the state. William H. Furman, who has been serving as acting chief of the old Bureau of Boilers and Explosives since the death of George A. O'Rourke, will be the head of this department.

All boilers designed to carry a pressure of more than 15 pounds per square inch will be inspected by members of the Division's inspection staff. The Division will also have charge of the records of boilers inspected by duly authorized insurance company inspectors and is to have supervision over the issuing of certificates of competency to the insurance companies' men. Mail should be sent to the Division of Boiler Inspection, Department of Labor, Capitol, Albany, N. Y.

Work of the Present Day Boiler Inspector

By J. L. Raleigh

At first looked upon as a necessary evil, boiler inspection has within recent years advanced to a position of the utmost importance in industry. Less than fifty years ago very few boilers in the United States were subject to periodic inspection and most of those only because insurance companies insisted upon the privilege of inspecting for their own protection. In those days, most boilers were built of wrought iron, were of very poor structural design and were put together in a most unscientific manner. Today the necessity of protecting lives and property by the careful inspection of boilers is clearly recognized and faulty design, lax construction methods and lack of competent inspection may in general be considered things of the past.—The Author.

THE early day inspector confined his activities almost entirely to detecting defects which developed in operation and to having such defects and their causes eliminated. He met with much opposition from both builders and users and his path was not a pleasant one to travel, but his efforts were not without reward. In a few years the frequency of boiler explosions decreased noticeably and it was a significant fact that the great majority of explosions occurred with boilers not subject to inspection.

As builders and users came to recognize the value of competent inspection service, such service grew in demand and those who were engaged in the inspection of boilers were consulted with increasing frequency by all concerned. Builders began to recognize the fact that improvements in design and methods were necessary if their products were to find favor with the users. Public authorities also became interested from the standpoint of public safety, with the result that today many states, counties and municipalities have rules regulating the construction, installation and operation of steam boilers, based on the American Society of Mechanical Engineers' Boiler Code.

Inspection Begins With Raw Material

The present day boiler inspector's activities begin with the manufacture of the materials of which the boiler is to be built. He scrutinizes the reports of chemical analyses of the different classes of metals used, notes the physical properties disclosed in various tests made by the manufacturer and satisfies himself that the materials conform in every way to standard requirements formulated by the leading engineers of the country and specified by the authorities of the community in which the boiler is to be used. He does not actually witness the making of analyses or tests, but relies upon the information contained in the manufacturer's mill test reports which are true statements of the chemical and physical properties of the product.

Shop Examinations During Construction

While the boiler is in course of construction, the inspector visits the shop at least twice. The first visit is usually made after plates and butt straps have been rolled and heads or other principal parts selected. He identifies the various parts by checking the numbers stamped thereon with the numbers appearing on the mill test reports. He observes that the shell plates and butt straps have been given the proper curvature and that all calking edges have been carefully planed. If rivet and tube holes have been punched, he makes sure that they have not been punched too near the specified size of the holes. The drilling or reaming of the rivet holes in seams is witnessed with the sheets and straps firmly bolted in place. The boring or reaming of the tube holes is also witnessed. All flanged portions are carefully inspected and flanging methods observed.

Second Inspection

The second visit is made after the riveting has been done and the tubes are about to be installed. The general workmanship is observed and before the tubes are installed the inspector makes sure that all rough edges of the tube holes have been removed by chamfering. He notes the method of installing the tubes and observes that they are properly expanded and beaded or flared as conditions require.

The third visit is made after the boiler is complete and is prepared for the hydrostatic test. A hydrostatic pressure is applied 50 percent in excess of the working pressure to be allowed and all parts of the boiler are closely observed for signs of unusual stress due to faulty workmanship or other causes. Any leaks which develop are eliminated, after which the boiler is drained and inspected internally to observe the effect of the pressure on stays, etc. When the inspector has satisfied himself that the boiler is acceptable in every way, he stamps it with certain identification numbers and it is then ready for shipment.

After the boiler has been installed it is again inspected and the setting, connections and appurtenances are observed to comply with requirements. This inspection is important because the inspector has an opportunity to detect every condition which might result in future trouble and which might be attributable to faulty arrangement of fittings or setting. The boiler is then ready for service.

After installation the boiler is inspected internally and externally at least once each year. In preparing the boiler for this inspection, it is drained and all manhole or handhole plates removed. Internal and external surfaces are cleaned, as are also the furnace and combustion chamber. The inspector examines and hammer tests every accessible portion of the boiler and inspects all connections and fittings. He then has an opportunity to note the effects of operation. By the appearance of the internal surfaces, he is able to detect any unfavorable action of the feed water upon the metal either in the form of corrosion or incrustation and to give advice concerning the elimination of any condition which endangers the boiler or will tend to shorten its life. If leaks have developed in seams or at tube ends he is able to determine the cause and specify the remedy. In fact the competent boiler inspector is the "family physician" of the boiler and his periodic attention is as necessary to its continued safe operation as is the attention of a doctor necessary to the continued good health of a human being.

Inspectors Must Be Familiar With Boiler Operation

In this connection it is well to realize that in order to be capable of diagnosing the ills of a boiler at these periodic inspections, the inspector must be thoroughly familiar with conditions met with in boiler operation. There is an erroneous impression prevalent among boiler users that only boilermakers are thoroughly competent for this work. Legislation has been attempted in various communities recently which would prevent all except men having had several years of boiler shop experience from becoming authorized inspectors of steam boilers. This is a mistake. The experience of those in a position to judge has proved that while a boilermaker may give highly satisfactory service on shop inspection work, his lack of operating experience is a serious handicap to him in the inspection of boilers in service.

The most successful inspectors of stationary boilers have been recruited from the ranks of steam operating engineers. In most cases they are men of long and varied experience, capable of giving and willing to give advice worthy of a consulting engineer. They should be welcome visitors to every boiler plant. Their work is far from pleasant and is often necessarily performed on Sundays, nights and holidays. Their greatest pleasure is found in receiving the cooperation of those whom their activities benefit most.

Speeding Up the Safe Ending of Boiler Tubes

(*Continued from page* 218.)

right hand cylinder of the machine for swedging. The double cylinder machine used consists of a heavy iron cabinet base on which is mounted the hammer mechanism. Separate foot levers control the welding and swedging hammers so that while the welding is being done, the cylinder and dies used for swedging are idle, thus keeping the air consumption low. Different size dies permit tubes from 2 inches to 4½ inches in diameter to be welded. Mandrels can also be fitted to the machine so that it is possible to weld safe ends from about 3 inches to 12 inches in length. Tube dies are attached to the lower end of the piston with a key and travel in the guides of the upper frame. The operation of the piston is similar to that of an air hammer. The lower dies are held in a steel frame and all dies are so designed that they fit the outside of the flue with the proper allowance for expansion when heated. A scale scraper is fitted on the right hand side of the frame near the lower die.

Cutting the Tube to Length

The final operation in reconditioning the tube is the cutting off of the smokebox end of the tube. The tubes roll along gravity racks from the welding machine to the third operator who places the ends in a second type "C" furnace where they are heated. As in the case of the first cutting off heating furnace, this furnace has a capacity of six tubes. When heated to a cherry red, the operator allows them to roll onto a rack having a gage at one end adjusted to the length required of the finished tube. He then places the heated end against the hot saw and after cutting off moves it to the expander. The tube is finally placed in a rack ready for installation in a locomotive in the erecting shop. Throughout the entire process the tubes are never turned nor reversed in direction. It may be said that the tubes are practically in motion from the time they leave the first rack until they are repaired and again ready for installation in an engine.

Machinery for Safe Ending Superheater Flues

The section of the shop devoted to the welding of safe ends on superheater flues is arranged in a slightly different manner from the small tube department as will be seen from the floor plan shown in Fig. 2. When a set of tubes is brought to the department and placed in the racks after cleaning, the operator places a single one of them in a type "B" welding furnace until it is heated to a cherry red. The three pieces of equipment in this department are arranged in an arc of a circle so that a tube supported at its outer end on a roller stand may be moved by the operator from the furnace to the hot saw, expander, and safe end magazine, and back to the furnace for the welding heat and finally to the welding and swedging machine by simply supporting the weight of the tube end on which the work is being done. The superheater flue welding furnace burns gas for fuel and will take tubes up to 6 inches in diameter. The combination hot saw and tube expanding machine is similar to that used in the layout for standard size tubes except that its capacity is for flues up to 6 inches in diameter. A five horsepower motor is required to operate this machine. In the case of the pneumatic welding machine the capacity is for tubes from 2 inches to 6½ inches.

Reclaiming Short Length Flues

The practice of the D., L. & W. is to apply not more than two safe ends on tubes or flues. When tubes removed from a boiler have been pieced twice, they are either cut down and used on smaller engines or have a single long tube welded on the end in the flue reclaiming machine. Flues to be reclaimed are scarfed, expanded and placed in racks adjacent to the reclaiming machine. This equipment consists of a special pneumatic welding machine of the hammer type, an oil heating furnace and a special mandrel on which the tube is placed as shown in the arrangement plan of the shop. In this operation the tube is heated in the usual way, and the short tube used to piece out the length inserted. The tube and end are then passed through the furnace and over the mandrel until the point of weld is in the proper place for heating. When the required heat is reached the tube is moved forward through the furnace to the welding dies, the hammer being in direct line with the furnace opening. A stop is arranged on the mandrel which acts as a gage to locate the welding point. When the farther end of the tube strikes this stop it operates a lever which in turn actuates the air valve of the welding machine thus automatically beginning the welding operation. As soon as the pressure of the tube is taken from the gage stop, the air supply is cut off and the welding machine comes to a standstill. The tube is then pulled back through the furnace completing the operation. Finished tubes from each department are arranged in sets containing the proper number for installation in a locomotive and picked up by the shop crane and piled in storage racks awaiting installation.

Boiler Ruptures With Man in Firebox

Stories are often told of outlandish tricks played by tornadoes in some unfortunate district of the country, but here is a real freak story—the case of a boiler that "went up" while an inspector was going peacefully about his work in the firebox, and with no pressure up.

The boiler was of the stationary locomotive type and had been out of service a long time. At the time of the explosion the inspector was inside the firebox searching for defects, and he certainly found one. He was naturally rather startled to hear a report like the discharge of a cannon and at first thought that a stick of dynamite had exploded. He found, however, that a furnace sheet had ripped open for a length of about 36 inches directly through a weld that had been made in the sheet. The rupture extended about equal distances on either side of the part built up by welding.

The explanation of this peculiar occurrence is thought to be that the sheet had been overheated in the welding process, crystallized, and was therefore under a severe shrinkage strain. The defective part was practically free of scale. The handhole plates at the bottom of the boiler were off, but the manhole plate had been replaced.

According to the inspector the condition represented by this boiler, so strikingly demonstrated in this case, may have resulted in some disastrous explosions that have occurred, the causes of which have never been determined. The incident is certainly a forceful demonstration of the dangerous stresses that may result from improper heating in the welding process.

This is an authentic report published in *Power* of an occurrence at the plant of the Calco Co., Bound Brook, N. J., where the two boilers were examined by an inspector of the Fidelity and Casualty Co. at the request of the Standard Bitulithic Co., who contemplated their purchase.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* — ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-President and Treasurer*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,600 copies were printed; that of these 4,600 copies 3,974 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 53 were mailed to advertisers, 66 were mailed to employees and correspondents, and 491 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 39,000, an average of 4,875 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

GENERAL: PAGE.
Speeding up the Safe Ending of Boiler Tubes 215
Welding Storage Tanks with Electric Arc Process 219
Forming and Brazing Copper Pipes 222
Necessity for Improvement in the Design and Operation of Present Day Locomotives 224
The Value of Boiler Inspections 225
Principles of Riveted Joint Design—II 226
Progress in the Adoption of the Boiler Code 229
Work of the A. S. M. E. Code Committee 230
Methods of Filing and Numbering Drawings 231
Reorganization of the New York State Boiler Inspection Service 232
Work of the Present Day Boiler Inspector 233
Boiler Ruptures with Man in Firebox 234
EDITORIAL COMMENT 235
ENGINEERING SPECIALTIES FOR BOILER MAKING 236
BUSINESS NOTES 237
QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Elbow Head Connection 238
Feed Water Discharge and Questions on Watertube Boilers 238
Determining Angles Between Sides of a Hopper 239
General Questions on Boiler Work 239
Tapering Y—Heavy Plate Development 240
LETTERS FROM PRACTICAL BOILER MAKERS:
Table for Use in Laying Out Rivet Spacing 241
Mechanical Locomotive Stokers 241
Repairing a Bagged Boiler 242
OBITUARY 242
PERSONAL 242
ASSOCIATIONS 243
TRADE PUBLICATIONS 243
SELECTED BOILER PATENTS 244

On the opposite page is given an account of a boiler failure which took place while an inspector was working in the firebox. Fortunately there was no pressure on the boiler at the time and the inspector was not injured. Had the boiler been under pressure, however, the accident would undoubtedly have been fatal.

To prevent the possibility of accidents of a similar nature, a Colorado legislator recently introduced a bill in the General Assembly of the state, which will make it "unlawful for any railroad company or any person, firm or corporation, using steam boilers, to command, order or permit by themselves or their agents any of their employees to enter any steam boiler, firebox, or smoke chamber thereto, for the purpose of repairing or cleaning the same or for any other purpose when the same is under steam pressure."

The object of the bill as stated is included in one of five sections which are designed to set up further restrictions against ordering a man to enter a boiler under pressure. The intention of the bill is entirely commendable and whether or not it is enacted it will have served to call attention to the fact that there is a real danger for anyone who enters a boiler before the pressure is at least reduced to a low point.

Of equal interest to both employers of professional men and to engineers of every degree of training and experience is the recent establishment of an employment bureau for technical men by the Federated American Engineering Societies, 29 West 39th street, New York.

The work of the Bureau does not end with securing employment for individuals, but through its comprehensive classification of records compiled from the applications received, which contain details of the educational and professional experience of the applicants, attempts to fit each individual into the position he is best qualified to fill. In the past there have been many technical men who have never been able to find opportunities in the particular field for which they were best suited and who have for this reason failed to succeed. On the other hand, many firms and many engineering projects have failed through losses caused by an inefficient personnel. The new service should do a great deal towards overcoming difficulties of this nature and prove of mutual benefit to employer and employee.

The normal production record of eight hundred to nine hundred boiler tubes a day obtained in the Scranton locomotive repair shops of the Delaware, Lackawanna and Western railroad indicates the possibilities of increasing shop efficiency by the installation of modern machinery. The item of flue expense in the maintenance of locomotives is a very considerable one and where flues can be reclaimed economically as in this shop the original outlay for equipment is of only minor importance.

The operation of cleaning tubes in the flue shop illustrates how an ordinarily long and costly process has been cut down both in length of time required and in expense. The old type barrel machine, which was replaced by a tube cleaner of the underground pit type, was installed outside the shop and required the constant service of two men to charge and unload it. To clean a complete set of tubes, an entire eight hour day was taken up and the cost was proportionately high. With the new cleaner, however, the crane operator under the direction of one of the men in the flue shop can load or unload a set of tubes in about ten minutes, and no direct labor charge is made against the operation. Two complete sets of tubes can now be turned out in a day from the machine without having interfered with any other operation going on in the shop.

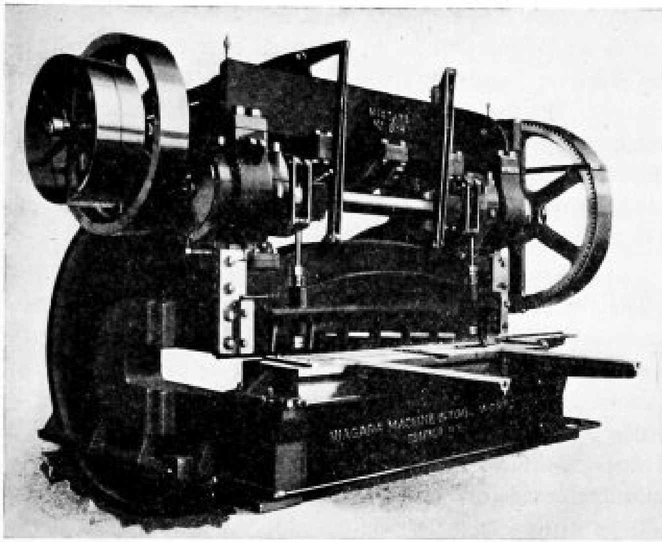
Similar savings can be made in the mechanical departments of every railroad and contract shop by the installation of adequate and modern machines. Master mechanics and shop foremen of the railroads and the engineering departments of boiler shops in general should investigate the condition of their shop equipment while production demands are not pressing, in order to determine where the lack of proper tools will hold back the work when the demand comes again, and where the continued use of old machinery will add to the cost when new tools could advantageously be used to replace them.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Power Squaring Shears

A new type power squaring shears known as the number 8-H has been added to the line of equipment produced by the Niagara Machine and Tool Works, Buffalo, N. Y. The accurate squaring of sheets on this machine is made possible by means of a set of gages, which facilitates handling and welding. The crosshead is of heavy box construction, counterbalanced and guided in liberally proportioned ways. The main shaft and eccentrics are forged in one piece of a tough grade of steel. The clutch block is a hammered steel forging and equipped with hardened and ground removable striking jaws, as well as with hardened backlash jaws. The clutch wheel is also provided with hardened, removable striking faces and with a backlash pin. The wheel is also bronze bushed. Two center bearings for the main shaft are placed close to the eccentrics, and to the hold down cams so as to give the greatest possible support to the shaft.



New Power Squaring Shears, Produced by Niagara Machine and Tool Works

The hold down cams bear against hardened steel rollers which are lubricated through hollow pins. The hold down rods are provided with springs to compensate for various thicknesses of plates. Brakes are of the self adjusting type, lined with asbestos fiber. They are made of two hinged parts equipped with an automatic spring take up for wear. The knife chuck is provided with pockets which enable the knife bolts to be easily removed from the top. The chuck has T-slots on top for gages and on the front for gage brackets. Housings for the machine are of massive construction in which the stay rods used for maximum cutting have been eliminated; if, however, stay rods and lugs are required for special purposes, they are furnished. The counterbalance rods are located outside of the housings, and so do not interfere with work being passed through the machine. The counterbalance weights are located below the floor line to comply with the safety codes of certain states.

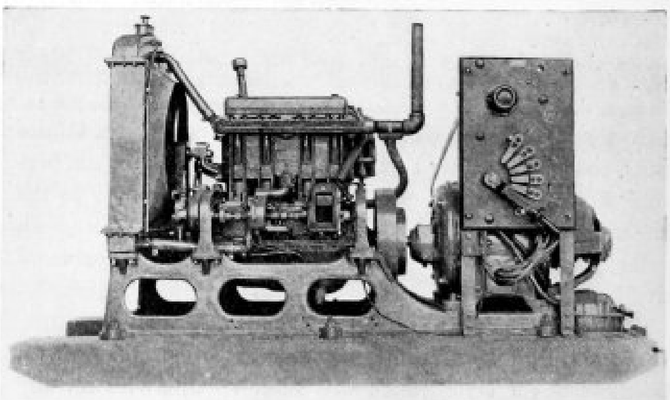
A complete set of gages is furnished including: a front, side, bevel and slitting gage and a patented automatic screw adjusting back gage. The driving mechanism is placed overhead out of the way of the operator. The capacity of the machine is mild steel plates up to 5/8 inch in thickness; its nominal cutting length, 8 feet; the horsepower required for its operation, 30; the weight of the 24-inch gap machine, 27 tons, and the weight of the 36-inch gap machine, 30½ tons.

Gas Engine Driven Arc Welding Units for Intermittent and Heavy Duty

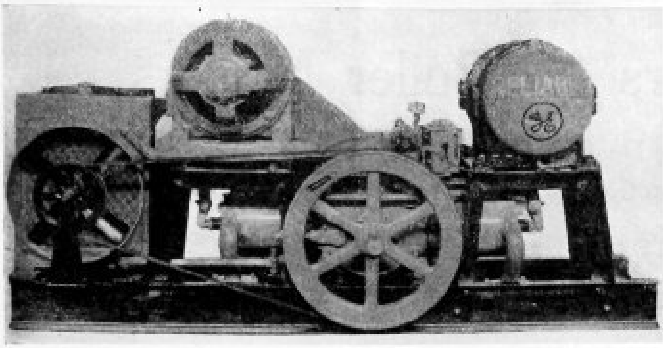
Two new types of gas engine driven arc welding sets, one for medium or intermittent duty, the other for heavy duty, have been designed by the General Electric Company, Schenectady, N. Y. These units are specially adapted to marine and industrial plants where work to be done is located in out of the way places and is not sufficient to warrant the installation of permanent equipment.

The medium duty equipment was designed particularly for intermittent duty. The generating unit consists of a type "W-D" 10-4 kilowatt, 1,200 revolutions per minute, 60/20 volt 200 ampere generator directly connected by a flexible coupling to a Matthews, Model F, 4 cylinder, 4 cycle, 20 horsepower gasoline engine. The engine, radiator, generator and welding panel are assembled on a rigid cast iron base, which in turn is mounted on wooden skids. The set is 86 inches long, 28 inches wide, and has a net weight of about 2,000 pounds. The gas engine used with this outfit has been especially adapted to the requirements of intermittent welding service. It is of the overhead valve type, having cylinders cast in a block with the upper half of the crank case. The lubrication is a combination of splash and forced feed, and the cooling a thermo-siphon system.

The generator is self exciting and regulating, giving practically constant energy throughout the working range. It gives a no-load, or striking, voltage of 60 which automatically decreases to the proper welding voltage (usually 18 to 20 volts) when the arc is struck. It is driven at a speed of 1,200 revolutions per minute, has a normal output of 4 kilowatts and delivers a maximum working current of 200 amperes. The panel carries the generator field rheostat and series field dial switch by which the current can be adjusted



Medium Duty Welding Set



Heavy Duty Welding Equipment

from 200 to 75 amperes in 25 ampere steps. A reactor choke coil mounted on the set and connected in the welding circuit protects the generator from current surges.

Heavy Duty Welding Set

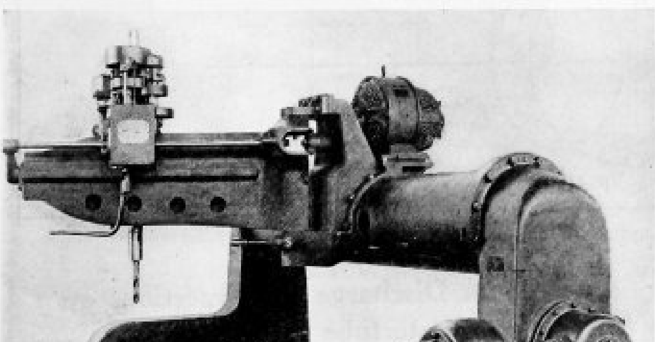
The heavy duty equipment can be arranged to supply either one or two welding circuits. It consists ordinarily of a 20 horsepower 2 cylinder opposed Reliable Heer, Model 00, gas engine, a type "WD"-9 generator and welding panel, the whole mounted on a welded structural steel base with a net weight of 2,400 pounds for the single operator equipment and 3,200 pounds for the double operator unit.

The generator is driven by a silent chain running in oil, and except for the speed its characteristics are similar to the "WD"-10 which forms part of the medium duty outfits. These generators run at 1,750 revolutions per minute, and differ somewhat in the windings because of the difference in speed and service requirements. An ammeter is mounted on the panel of each heavy duty equipment, but in other respects they are identical with the medium duty sets.

Gantry Type Drilling Machine

For use in boiler, tank or other plate fabrication where holes are to be drilled in the centers of large plates, William K. Stamets, Jenkins Arcade Building, Pittsburgh, Pa., has developed what is known as a gantry type drilling machine. Drilling machines of this type are highly specialized for certain classes of work and must be built to fit particular requirements, which do not permit their manufacture as a standard product. The machine illustrated is well adapted to boiler and tank work, but the design may be varied to fit it to other special requirements.

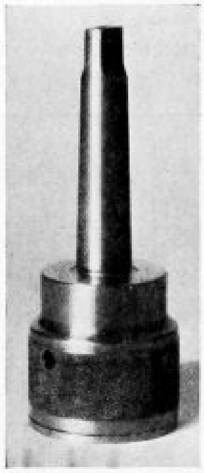
The machine illustrated is mounted on a track, the gage of which is wide enough to permit the drill to straddle the plates in which holes are to be drilled. The span of the drill and the gage and the length of the track can easily be adapted to the requirements of each special case. Provision is made for traversing the drill on the track by means of a motor and adjustable controller. A drilling head is mounted on the radial arm which swings on its support on the cross beam. Only one such radial arm and one drilling head are shown, but two, three, or four arms and heads can as readily be employed. Two arms can be used on each side of the beam, or if the span is increased, a larger number than four radial arms can be employed. More than one drilling head can be mounted on each radial arm if so desired. The motive power of the drill is supplied by a motor mounted on the beam, and with direct current an adjustable speed motor can be used, while a multi-speed motor can be employed with an alternating current, permitting a wide range of speeds through the combination of electrically controlled changes with the mechanical changes of the drilling head.



Gantry Type Drill for Large Plate Work

Chuck for Holding Broken Drill Shanks

In reducing the small tool equipment expense in shops where twist drills are used in large quantities, a new chuck produced by the Wayne Tool Manufacturing Company, Waynesboro, Pa., for holding drills which have been broken at the shank will be found quite useful.



Chuck Designed for Broken Drill Shanks

The chuck is of a simplified design, consisting of but six parts: a shank, the chuck casing, two pawls, two screws, and a casing plate. Drills formerly discarded when broken may be ground to a 60 degree point at the broken end, which permits this end to automatically center itself in a corresponding 60 degree recess in the shank of the chuck. By turning the casing the pawls are brought into action and grip the drill above the grooves, thus locking it securely in the chuck. No wrenches are required to tighten or release the chuck, the hand twist of the casing alone being sufficient to cause a positive grip of the pawls on the drill end.

BUSINESS NOTES

The Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has announced that F. T. Whiting, formerly manager of the engineering division of the Chicago office, has been appointed manager of the industrial division of that office to succeed N. G. Symonds, and that P. H. Smith has been appointed manager of the power division of the Atlanta office.

John D. Hurley, president of the Independent Pneumatic Tool Company, Chicago, Illinois, recently sailed from New York City on the steamship *Olympic*, for an extended trip through continental Europe. Mr. Hurley was accompanied by Mrs. Hurley, his wife, and will make his trip one of combined business and pleasure.

The Webster & Perks Tool Company, Springfield, Ohio, announces that its grinding and polishing stand and accessory department has been sold to the Hill-Curtis Company, Kalamazoo, Mich. All inquiries relating to this former department of the Webster & Perks Company should be addressed to the Hill-Curtis Company. The Webster & Perks Company will in the future manufacture universal and plain cylindrical grinding machinery exclusively.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

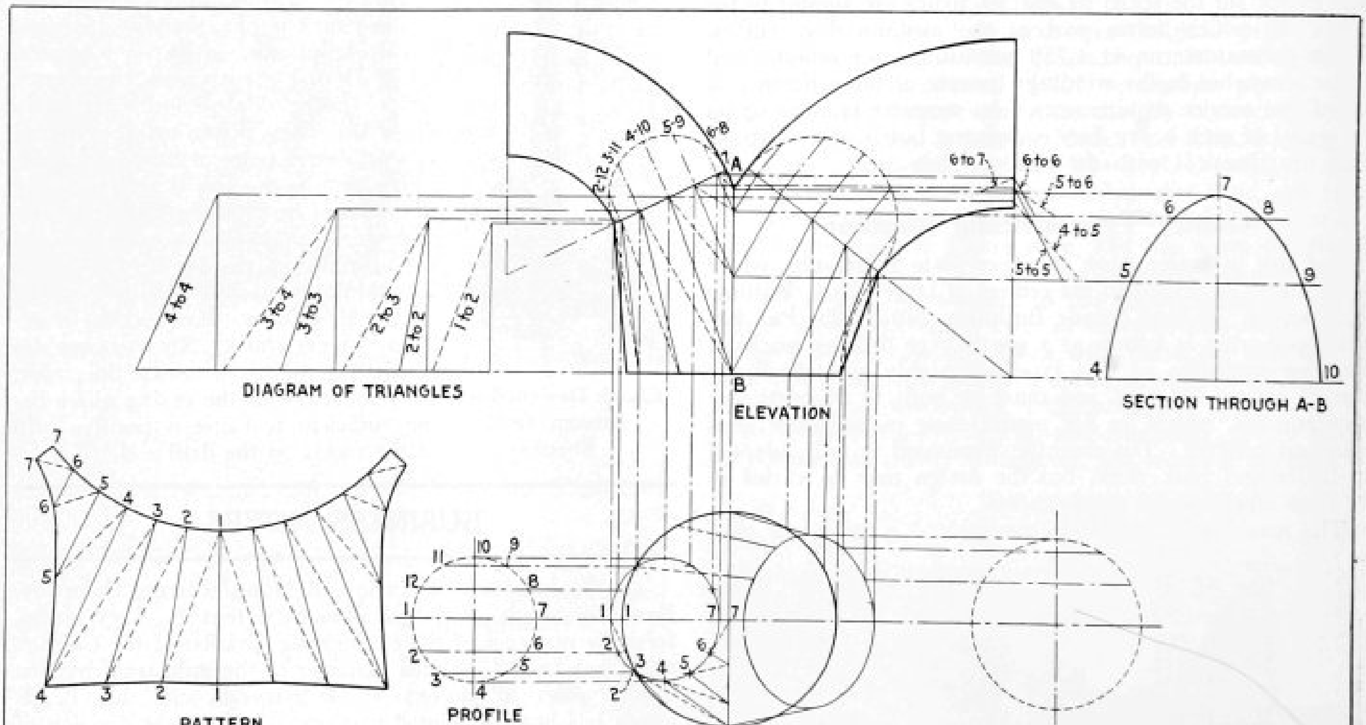
Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th Street, New York City.*

Elbow Head Connection

Q.—How can the plan elevation and patterns for a head connection where elbows of 12-inch and 18-inch diameters converge, be made?—F. T.

A.—In the accompanying drawing is illustrated one way of making this layout. We have assumed that the base area of the head should be such as to equal the combined area of the elbow sections. The elevations give the relative positions of the two elbows and the head pieces. The plan must be fully laid off. Note that the miters between elbows and head piece are elliptical in shape in the plan. To obtain their shape, use the profile sections of the elbows as indicated. Divide their outline into a number of equal divisions. Project horizontal lines from the profiles in the plan and vertical projectors from the miters in the elevation. The intersecting points between these construction lines are the required ones on the respective ellipses. Consider the head piece to be joined along *A—B*. Each half section is different, therefore a pattern must be laid off for each.

The section on the miter plane *A—B* is drawn to the right of the elevation, and the distance between points 4—10, 5—9, 6—8 are taken from the plan view along the axial line 4—7. Draw in the triangulation lines in both views. Find their true lengths by constructing triangles as shown in the diagram of triangles. Use the lines *H*, 2—2, 3—3 of the plan for the bases and the heights as projected from the elevation. The pattern is laid off for the section to the left of *A—B*, and the other half would be constructed in a similar way. For the top of the pattern use the arc lengths of the profile for the small elbow, and for the base those of the circle representing the bottoms of the head and also those of the section through *A—B*.



Suggested Method for Laying Out Elbows

Feed Water Discharge and Questions on Watertube Boilers

Q.—(1) Where is the best approved point of feed water discharge for a vertical tubular boiler and why? What are the advantages and disadvantages of discharging the feed water in the waterleg for the above? (2) What are the different causes of tube ends of watertube boilers crystallizing? (3) What explanation can be given for the tubes of watertube boilers bowing sometimes upward and sometimes downwards? W. S.

A.—The common practice is to lead the feed water to the coolest part of the boiler, if possible, for the reason that if the cold water is discharged on or near the hot plate, severe stresses are set up in the plate, especially in the seams, due to the contraction of the plate. Scale or mud is likely to be deposited when the feed water first reaches the temperature of the boiler, and for that reason the feed water should enter where sediment is likely to do the least harm.

(2) The tube ends of watertube boilers near the headers very often crystallize due to the bending stresses which arise in the expansion and contraction of the boiler parts. Rolling or working the tubes too much in installing them makes the metal brittle.

(3) Sudden distortion or bulging in watertubes indicates scale, and in all such cases the boiler should be cleaned. When clean tubes distort as you state, it shows that they were not free to expand and contract.

Determining Angles Between Sides of a Hopper

Q.—What solution in drawing can be used to find hopper angles? I do not understand geometry very well and need a simple construction or diagram.—F. B.

A.—The solution of this problem is an interesting one in descriptive geometry, and it is an aid to the layerout or boilermaker in getting the angle between the sides of hoppers, tanks and other tapering work of this kind. In sheet iron

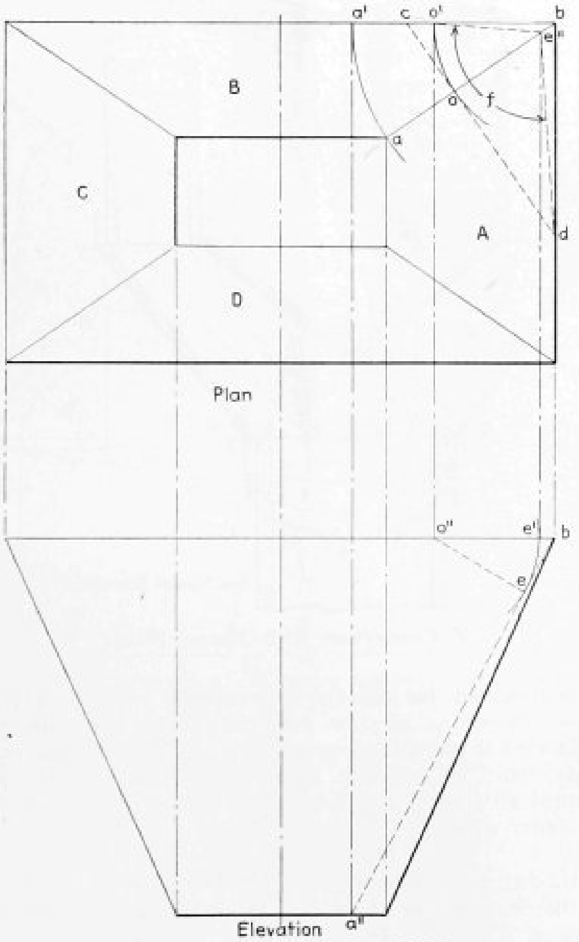


Fig. 1.—Plan and Elevation of Hopper

work it is well to know to what angle to bend the diagonal edges on line *a-b* between the sides of *A* and *B* shown in the sketch, Fig. 1.

The solution of this problem is as follows: Referring to the plan view, consider a vertical plane to be passed through the hopper at right angles to the diagonal *a-b* of the plan. Fig. 2 shows how this plane lies with respect to the sides *A* and *B*. Line *c-d* is a line of this plane and at right angles to *a-b*. Referring to Fig. 1, we find first the true length of *a-b* by revolving the line from point *b* as a center to *b-a'* in the plan. Project *a' to a''* in the elevation and *b-a''* of that view is its true length. Revolve point *o* in the plan to *o'* and project it to *o''* in the elevation. At right angles to *b-a''* and from *o''* draw line *o''-e*. Point *e* is then revolved to *e'* and

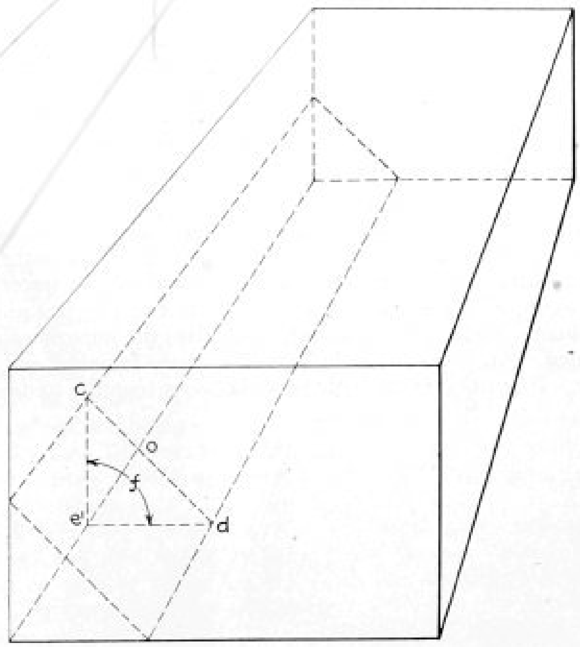


Fig. 2.—Perspective View of Hopper

projected to *e''* in the elevation. Points *c-e''-d* are then connected by straight lines and angle *f* is the required angle. Comparing Fig. 1 with Fig. 2, the steps in the layout may be better understood.

General Questions on Boiler Work

Q. Will you give me information on the following questions that arose recently in a discussion at our shop?—O. P.

1. Should rivet holes be punched smaller than the required size and then reamed out?
2. What amount of tube material should be allowed for beading?
3. How far should staybolts project beyond the sheet to allow for upsetting the stays?
4. Very often we have in new boiler and tank work, leaky seams and rivets; is it advisable to use substances as bran, etc., to stop such leaks?
5. What is meant by the expression "mud burned" boiler?
6. What produces steam?
7. What is vacuum?
8. Give the causes of priming, foaming, and corrosion.
9. What is the hydrostatic test and why are new boilers tested by this means?
10. Why is the steam dome used?

A. 1.—When rivet holes are punched it is good practice to punch them under size and then ream them out. The metal surrounding punched holes is damaged and cracks are liable to develop in the plate when the boiler is in operation. In the best boiler construction practice, the holes are drilled and all burrs removed before riveting.

2.—Allow from 3/16 to ¼ inch for beading.

3.—Allow ⅛ inch or two threads for upsetting stays. Too much material makes it difficult to head the stay properly.

4.—It is very poor practice to try to plug leaks in boilers. Leaky seams show poor riveting and laying up of seams, or the rivets are spaced too far apart.

5.—Mud and scale collecting at any point on the inside of the boiler near the fire prevents the water from coming in direct contact with the plate; as a result the plate overheats and bulges out, when so weakened. Boilers damaged in this way are spoken of as mud burned.

6.—Steam is generated from water; the vapor or gas called steam is produced by heating the water. At 212 degrees F. water boils in a vessel open to the atmosphere. In a closed vessel the steam creates a pressure and its temperature depends on the steam pressure.

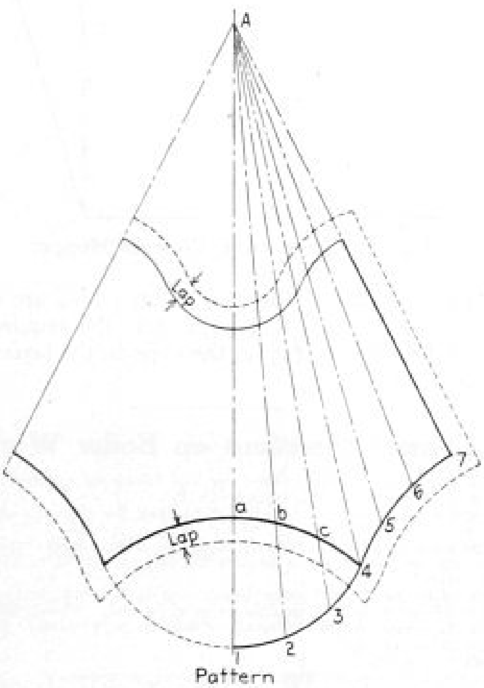
7.—A perfect vacuum means that there is no internal pressure within a closed vessel. Partial vacuum within a closed vessel indicates a pressure less than atmospheric, which at sea level equals 147 pounds per square inch.

PRIMING IN BOILERS

8.—*Causes of priming.* Defective boiler design, as too small a steam space; improper arrangement of tubes, as in cases where tubes are too close together, which interferes with the circulation of the water, or too many tubes, which will also interfere with the circulation, and also by bringing the water line too high. Irregular firing, sudden opening of the throttle also cause the water to rise into the steam space.

METHODS OF OVERCOMING FOAMING

Causes of Foaming.—Dirty or greasy feed water, which also causes priming. Dirt and grease in the feed water prevent, during the ebullition on the surface of the water, the breaking of the steam bubbles which instead rise in the form of foam. Soda is introduced to neutralize the impurities mentioned. An excess of soda will also cause foaming or priming. It is difficult to distinguish between foaming and priming as the same causes produce both and very often the same remedy will check both.



Pattern for Y Connection

INTERNAL AND EXTERNAL CORROSION

Causes of Corrosion. Corrosion is the process of oxidization, that is, the wasting away of the steel or iron by rusting, moisture being necessary to induce it. Impure feed water and acid in form due to decomposition of vegetable matter and oils, produced during the generation of steam, causes internal corrosion, as also does oxygen liberated from the water.

9.—Boilers tested by water under pressure being forced into the boiler is known as the hydrostatic test. The A. S. M. E. Code requires a test of one and one-half times the maximum allowable working pressure. During the test the pressure must be so controlled as not to exceed the prescribed test pressure by more than 6 percent.

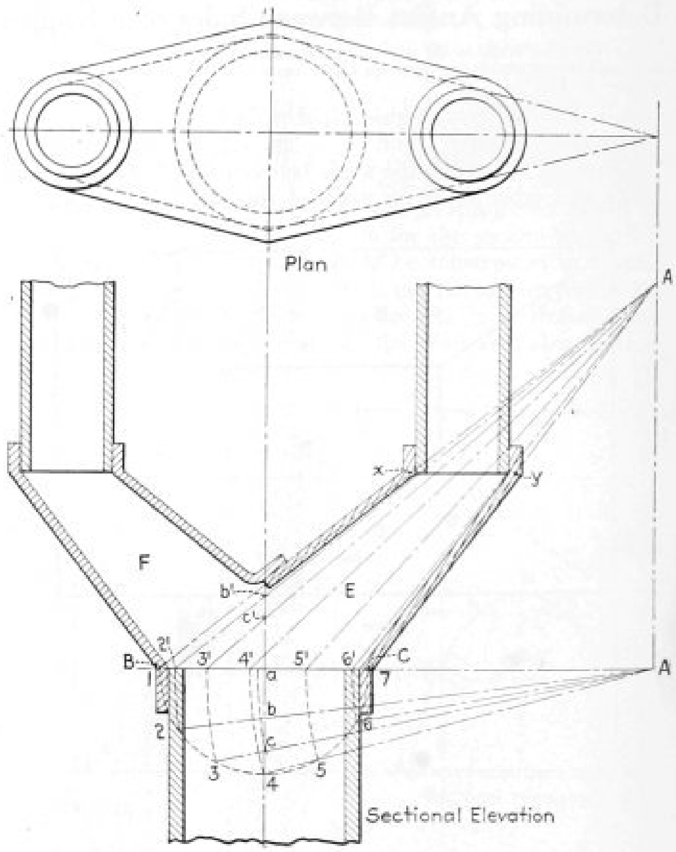
Tests of this kind are made to locate imperfections in the construction of the boiler and defects in the material used.

10.—The steam dome provides additional steam space. It is also considered as a receptacle for the storage of dry steam. Boilers that prime, with a low water level, should be fitted with either a steam dome or drum.

Tapering Y—Heavy Plate Development

Q.—Very often I am called upon to layout a "Y" connection and it is necessary to use heavy plate. In what respect does this work differ from a "Y" made of light sheet metal Will you give me a simple method to handle jobs of this kind?—O. L. E.

A.—In all layout work where heavy plate is used, it is necessary to take the plate thickness into consideration or otherwise the work will not be of the proper shape and size. A very simple rule to follow is to work and make all calculations from the *neutral layer,* that is, the center of the plate. Referring to the problem in this case, the neutral layer is indicated by the dotted lines *x-1* and *y-7* and the semi circle *1-4-7* is also drawn to the neutral section of the base for the scalene cone of which the branch *E* is a part. The plate thickness is represented for this pipe connection and the elevation shows the object as if it were cut in two along its center. This view is not needed, as only the part taken on the neutral lines would be sufficient. Note that one leg of the "Y" is flanged all around and the other is not as it fits inside along the *miter a'b'c'.*



Y Connection with Heavy Plates

MAKING THE LAYOUT

Having laid off the scalene, commonly called oblique cone in the elevation, as at *A B C* produce next a section of the plan as A'-*1-2-3-4-5-6-7* and draw the radial as indicated. Find their true lengths by projecting these points to the base *B-C* of the cone by using point *A'* as a center and describing arcs *1-1'—2-2'* etc. Draw the radials *A-1'—A-2'* etc. in the elevation. Revolve also the points *a-b-c* to the base *B-C* and project these points to intersect corresponding radials, as for example point *b* is the intersection between the radial *A'-2* and the line *a-4* as indicated in the plan. The line *A'-b* is shown in its true length at *A-b'* in the elevation.

The pattern is shown fully developed for the leg *F* the section below the lap along the line *a-b-c* for the leg *E* would not be added. Use the radial lines of the elevation and the arc length *1-2—2-3* etc., of the plan.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Table for Use in Laying Out Rivet Spacing

The writer has found a table similar to that given below to be very useful and a real time saver in ordering plates and heads for tanks, etc., and in detailing rivet spacing on drawings for steel plate work. He has therefore extended the table somewhat and now passes it on to those of the boiler shop fraternity who may not have worked out anything of the kind for their own use as yet.

The upper part of the table applies principally to flanged heads, either circular or rectangular, for tanks and boilers. The length of arc AB for other values of R than those given in the table may be found by adding or deducting 0.79 inches for each half inch that the new R exceeds or is less than any value of R chosen from the table. R is always measured on the outside of the plate, as shown in Fig. 1.

The lower part of the table is more applicable to bent wrapper sheets for tanks, etc., R_2 being always measured on the inside of the plate, as shown in Fig. 2. An application is illustrated by Fig. 3, in which the rivet spacing is shown laid out on the neutral axis of the outside or wrapper plate, the length of arc being taken from the lower table. The sizes of plates may be readily worked out by taking the various distances from rivet row to rivet row and adding laps and shearing allowance.

In determining the sizes of the end heads to be ordered, the lengths of arcs would be taken from the first column in the upper part of table, unless there was some reason for using a larger radius in the flanging.

Sherbrooke, Que. DONALD M. MCLEAN.

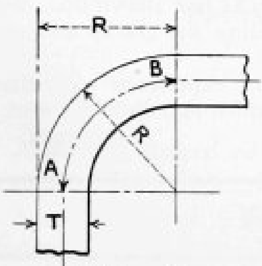


FIG. 1

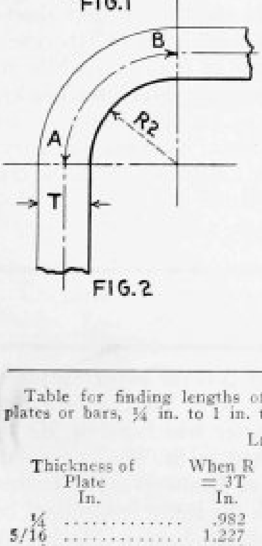


FIG. 2

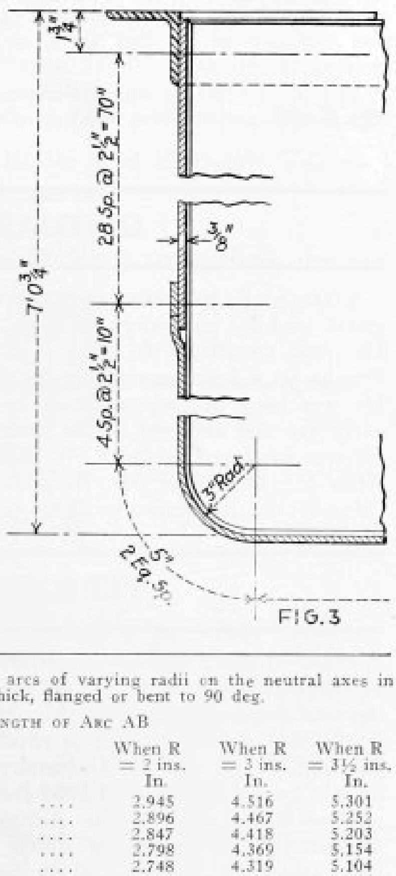


FIG. 3

Table for finding lengths of arcs of varying radii on the neutral axes in plates or bars, ¼ in. to 1 in. thick, flanged or bent to 90 deg.

LENGTH OF ARC AB

Thickness of Plate In.	When R = 3T In.		When R = 2 ins. In.	When R = 3 ins. In.	When R = 3½ ins. In.
¼	.982	....	2.945	4.516	5.301
5/16	1.227	....	2.896	4.467	5.252
⅜	1.472	....	2.847	4.418	5.203
7/16	1.718	....	2.798	4.369	5.154
½	1.963	....	2.748	4.319	5.104
9/16	2.209	....	2.700	4.270	5.055
⅝	2.454	....	2.650	4.221	5.006
11/16	2.700	....	2.601	4.172	4.957
¾	2.945	....	2.552	4.123	4.903
13/16	3.166	....	2.503	4.074	4.859
⅞	3.436	....	2.454	4.025	4.810
15/16	3.681	....	2.406	3.976	4.761
1	3.927	....	2.356	3.927	4.412

Thickness of Plate In.	When R_2 = 3T In.	When R_2 = 1 in. In.	When R_2 = 2 ins. In.	When R_2 = 3 ins. In.	
¼	1.374	1.767	3.338	4.908	....
5/16	1.718	1.816	3.387	4.957	....
⅜	2.061	1.865	3.436	5.006	....
7/16	2.405	1.914	3.485	5.055	....
½	2.749	1.963	3.534	5.104	....
9/16	3.092	2.012	3.583	5.153	....
⅝	3.436	2.061	3.632	5.202	....
11/16	3.779	2.111	3.681	5.251	....
¾	4.123	2.159	3.730	5.300	....
13/16	4.467	2.208	3.779	5.349	....
⅞	4.810	2.258	3.829	5.399	....
15/16	5.154	2.307	3.877	5.447	....
1	5.498	2.356	3.927	5.497	....

Mechanical Locomotive Stokers

A short time ago in company with the road foreman of engines we were passing the main tracks of the road both of us are engaged upon when a passenger train went by at a very high rate of speed. The writer drew the attention of the road foreman of engines to the pretty sight the train made, especially to the engine. "Yes," said the foreman, "the engine is a pretty one and also a good one. But," continued he, "the ideal engine, to my mind, is the United States standard Mikado type; with a good mechanical stoker there is nothing to beat it."

Some years ago when mechanical stokers were first introduced they did not take well either with the companies or the firemen. About the first stokers applied to locomotives were of the hopper type. The hoppers had to be filled by the firemen from the tank, there being no conveyor. From time to time various types of mechanical stokers have been patented, but have never been developed commercially. Many have survived as testified by the various kinds to be found doing duty at the present time.

There is no question about the stoker being a great improvement over the best of hand firing, and it also stands to reason that there must be greater economy by its use, although there are firemen who have made large bonuses by careful firing. These are the exception rather than the rule. The scattering of the small particles of crushed coal evenly over the grates causes quick ignition and almost perfect combustion. Combined with the brick arch and the superheater, the stoker has helped the locomotive a long way towards the ideal.

PRECAUTIONS IN THE CARE OF STOKERS

Mechanical stokers like all other machines at times become troublesome, sometimes from their construction, other times from causes that possibly could be avoided, and no doubt will be in the near future. In coaling engines at coal docks or at the mines very little care is taken to prevent stones, the links and pins and sometimes couplings from mine cars from finding their way into the tank and thence into the conveyor, with the result that when they reach the crushing arrangement in the conveyor they put the machine out of business. There is many an engineer who has been compelled to give up his train on account of stoker engine trouble. It is surprising how bolts, chisels, monkey wrenches, etc., will get into the conveyor and stop the engine. On one occasion we saw a bolt ¾ inch by 18 inches that found its way through the conveyor and into the bottom of the elevator worm before stopping the machine. When such foreign materials find their way into the elevators it means a tremendous amount of work before the obstruction is removed. In the case of the stoker with the elevator inside the firebox, it means the removal of the grates that protect the elevator casing, the drop gates and several shaker grates, and a portion of the ash pan—all this before the elevator casing containing the worm can be reached. With this type of stoker there is another source of trouble not found in any other type, that is the burning out of the protector grates.

In the type of stoker with the elevator in the firebox, the coal is conveyed from the tank, through the conveyor casing directly under the boiler head, and up close to the boiler head to almost a level with the fire door. Around this casing or pot are the heavy protector grates, the object of which, as the name implies, is to protect the inner casing and worm. Sometimes they do, and sometimes they do not, for the writer has seen not only the grates, but the elevator casing burned out entirely, thus putting the locomotive out of service for days. If there are plenty of duplicate grates on hand (four to the set) it is not at all a difficult job to renew the protector grates while the water is being changed in the boiler, but should they become fused together, it means a lot of hard work, and when this burning out takes place, sometimes after an engine has been in service but one day, the cost of protector grates and labor, coupled with the cost of a mighty machine lying idle, so often makes this type of mechanical stoker an expensive and unsatisfactory one.

On the other hand that type of stoker with the double or duplex elevators on the outside of the firebox, although subject in many ways to the same conveyor trouble, is entirely free from the burning out of the various parts simply because there is nothing to burn. The writer has seen distributor tubes removed after one year's service very little the worse for wear, and outside of ordinary engine troubles there were no duplicate parts purchased or applied to the engines referred to in over a year's service.

Another serious matter with regard to the upkeep of mechanical stokers is the care given them at terminal points. Instead of having men who are qualified to examine and determine the trouble, there is usually but one man, and he is generally to be found on the daylight shift, the second and third shifts being supplied with would-be mechanics who are really in their own way and cause more trouble than enough. The writer has seen men fool around a stoker engine for hours at a time going over the various parts that are subject to trouble and finally having to give it up as too much for their ability.

Referring again to our road foreman's remarks about the ideal locomotive, we think that we have with us the ideal mechanical stoker in the "duplex." We are of the opinion that there is nothing like experience to teach what is good and best in all things, and as the above few facts are our experience for some considerable time past, we hope that they may be of interest to the readers of The Boiler Maker.

Wilkinsburg, Pa. Flex Ible.

A. H. Handlan, Jr., vice-president and manager of the Handlan-Buck Manufacturing Company, St. Louis, Mo., has been elected president of the company, succeeding his father, the late A. H. Handlan; E. W. Handlan, vice-president and treasurer, has been made vice-president; E. R. Handlan, secretary, has also been elected to a vice-presidency, and R. D. Teasdale has been appointed secretary.

Repairing a Bagged Boiler

Recently one of our customers had a bagged boiler and the insurance company handling the inspection told them to have a horseshoe patch put on. We recommended against this, suggesting that a three-quarter or full sheet be put in. The owner agreed with us, but due to cost of shutting down his plant, which is a cotton oil mill, he decided to have a patch put on. We told him we would not guarantee the patch, as our experience was that they nearly always gave more or less trouble. The patch was put on about December 15, 1920, and we had to send a man on three occasions to calk it, and after the third attempt he decided to have a three-quarter sheet put in.

With the exception of two small leaks this work held until June 21, 1921, when a small bag appeared about 8 inches in front of second girth seam counting head seam as number one. The bag was 16 inches long and about 22 inches around the boiler. The bag was set up without any trouble and three small fire cracks in center seam were calked which we did not expect to hold for any length of time. They wrote us on July 19 that the center seam was leaking; we went down to see it and found that the three old cracks had opened slightly and that three new small cracks had shown up. We are now cutting out the rivets, welding the cracks and redriving the rivets.

Would appreciate suggestions and experience regarding this trouble and the best manner in which to handle the work.

Subscriber.

OBITUARY

Charles F. Beaman, an expert on sheet-metal and sheet-metal working machinery, died on July 7 at St. Catherine's Hospital, Omaha, Neb., after a stroke of paralysis while in Omaha on a business trip for the Adriance Machine Works. He was born in Independence, Iowa, and left home at an early age and engaged in the sheet metal working industry. He was employed by the E. W. Bliss Company for 32 years. After Mr. Bliss died, Mr. Beaman joined the Adriance Machine Works, remaining until his death, a period of 17 years.

PERSONAL

Isaac Harter has been appointed general superintendent of the Babcock & Wilcox Company, New York, to succeed the late James P. Sneddon. Mr. Harter was born in Mansfield, Ohio, in 1880, and was educated in St. Paul's School, Concord, N. H., and the University of Pennsylvania. Immediately upon graduation in 1901 from the latter institution, he entered the employ of the Aultman & Taylor Machinery Company, a corporation of which his father had previously been president. He began at the bottom in the boiler department as a gang boss on inventories, and was transferred later to the cost department, where he became familiar with the details of each branch of the business. He was elected a director of the company while in this department, and a little later was appointed acting superintendent of the boiler department. In September, 1905, the company sold its boiler business to the Stirling Company, and Mr. Harter joined the staff of E. R. Stettinius, the business head of the latter company, which was absorbed by the Babcock & Wilcox Company in 1907. When L. I. Summers resigned the position of superintendent of the Stirling works at Barberton, Mr. Harter succeeded him, and in 1911 became superintendent of the Bayonne works. He served in this capacity until about a year ago, when he became assistant to the president, at New York, where his office will remain as general superintendent.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

Electrical Products.—Catalogue No. 23 illustrating and describing the products of the Benjamin Manufacturing Company, N. Y., has just been sent out. This catalogue lists such material as sockets, attachment plugs, reflectors and reflector fixtures, signals, portable lamps, panel boards, water and moisture proof fittings and marine panels and cabinets.

Small Tools.—The Greenfield Tap and Die Corporation, Greenfield, Mass., is distributing a new catalogue describing the small tools and pipe tools manufactured at its various plants. The tools described include screw plates, drills, reamers, countersinks, mandrels, tap wrenches, pipe vises and pipe wrenches. Tables that will be found useful to the users and designers of machinery are also included in the book.

Boiler Production.—Two booklets have been sent out by the Bigelow Company, New Haven, Conn.; the first containing a general description of the Bigelow boiler, details of construction, useful tables, specifications and the like, while the second, entitled "Quality" outlines the methods used by the Bigelow Company to insure uniform high quality in all of its products.

Pneumatic Tool Accessories.—A booklet covering all the various accessories used in connection with air tool service has been sent out by the Ingersoll Rand Company, New York, makers of "Little David" pneumatic tools. The booklet describes air hose, hose couplings, hose clamps and menders, air drill chucks, rivet sets and blanks, wire brushes, grinding wheels, rail drilling equipment and the like. Convenient tables of dimensions of all rivet sets and chisels are given.

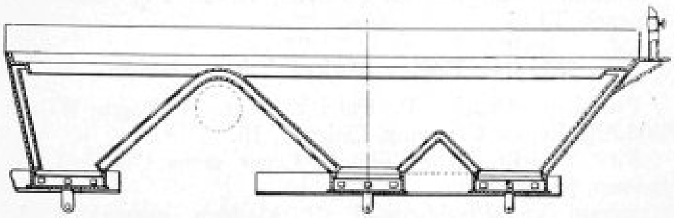
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,348,737. STEAM BOILER ASH PAN. JASPER N. RALSTON, OF FITZGERALD, GEORGIA.

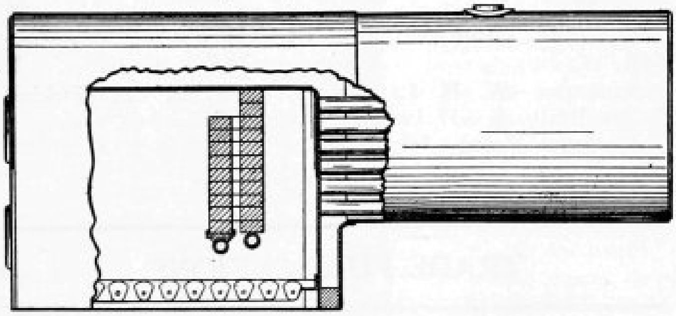
Claim 1.—An ash pan of the class described including side and end walls and bottom sections having interiorly arranged water spaces, the side and



end walls being composed of inner and outer sheets, the inner sheet being spaced from the outer sheet at the top to provide overflow outlets, and a laterally projecting hopper mounted exteriorly of the ash pan at one end thereof and having an inlet opening, the outer sheet of the end wall of the pan being provided with an inlet opening forming an outlet for the hopper. Five claims.

1,346,010. ARCH FOR FURNACES. IRA W. FOLTZ, OF CHICAGO, ILLINOIS.

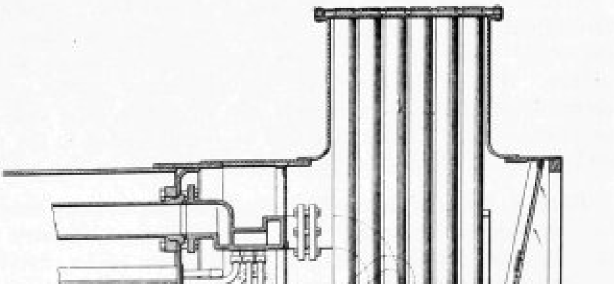
Claim 1.—In a furnace having a firebox and combustion chamber, an arch construction for separating the firebox from the combustion chamber,



comprising a transverse wall extending downwardly from the crown sheet of the firebox toward the grate, a second transverse wall in front of and spaced away from said first-mentioned wall to form a passageway and arranged to provide an open space at its upper end, a boiler pipe extending below one of said walls, and a metallic rider on said pipe in position to support said wall. Three claims.

1,343,144. ECONOMIZER FOR LOCOMOTIVES. WILLIAM F. KIESEL, JR., OF ALTOONA, PENNSYLVANIA.

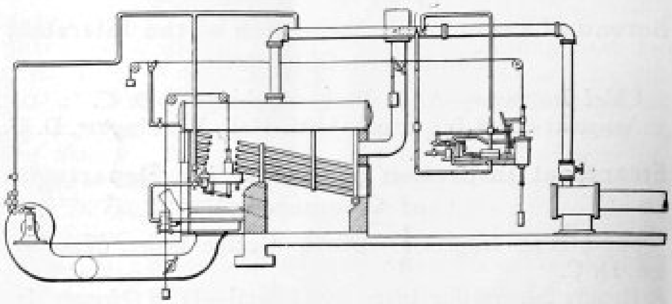
Claim.—In combination with a locomotive boiler having the usual smoke box and stack shell, spaced apart tube sheets arranged at the top of said



shell, similar spaced apart tube sheets arranged below said shell and in the smoke box, a series of inner tubes carried by the end tube sheets, a series of outer tubes surrounding the first series and carried by the inner tube sheets whereby water spaces are formed between the tubes and the tube sheets and the products of combustion are circulated around the outer tubes and up through the inner tubes, an inlet for the space between said upper sheets and outlet for the space between said lower sheets, and means for discharging equal quantities of steam into the lower end of each of the inner tubes. Five claims.

1,338,901. REGULATING COMBUSTION IN FURNACES. FRANCIS H. BROWN, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO JOHN M. HOPWOOD, OF PITTSBURGH, PENNSYLVANIA.

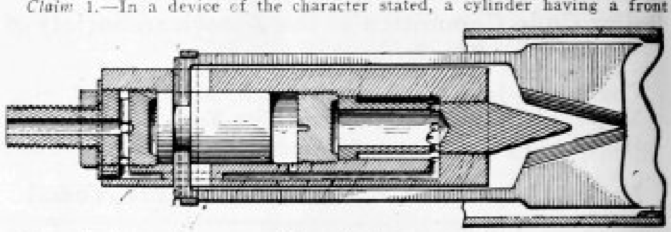
Claim 1.—The method herein described of controlling combustion in furnaces of boilers which consists in changing the rate of discharge of



gases from the furnace by and in accordance with the flow of steam from the boiler, and regulating the feed of fuel and the flow of air into the furnace by and in accordance with variations of pressure in the furnace. Four claims.

1,339,098. DUPLEX ACTING PERCUSSIVE BOILER TUBE CLEANER. WILLIAM BURLINGHAM, OF NEWPORT NEWS, VIRGINIA, ASSIGNOR TO ENGINEERING PRODUCTS CORPORATION, OF NEWPORT NEWS, VIRGINIA, A CORPORATION OF VIRGINIA.

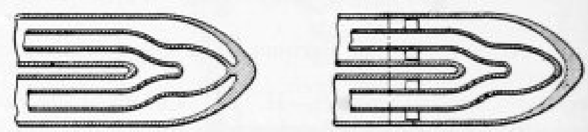
Claim 1.—In a device of the character stated, a cylinder having a front



piston chamber and a rear piston chamber, a partition separating said chambers, a reciprocating carrier-piston located in the rear piston chamber, cutting devices having their inner ends connected with said carrier piston so as to be reciprocated in unison therewith, means for introducing constant live air pressure into both piston chambers, and a hammering piston in the front piston chamber the reciprocation of which occasions the radial vibration of the cutting devices. Six claims.

1,373,465. DOUBLE TUBE RETURN BEND. CHARLES HENDERSON TRUE, OF HAMMOND, INDIANA, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

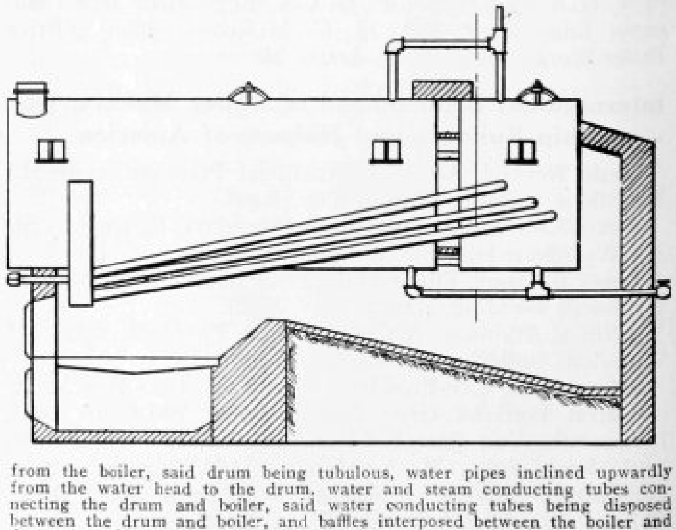
Claim 1.—The process of making double-pipe return bends comprising



the steps of connecting the ends of two pipes by an incomplete return bend, connecting the ends of two smaller pipes to form a complete return bend, inserting the latter into the former so that the two are substantially coaxial, and then finishing the incomplete bend. Four claims.

1,342,672. BOILER. WILLIAM W. GILLETTE, OF GLOVERSVILLE, NEW YORK.

Claim 1.—The combination with a tubulous boiler and a water head depending therefrom, of a drum supported beyond one end of and spaced



from the boiler, said drum being tubulous, water pipes inclined upwardly from the water head to the drum, water and steam conducting tubes connecting the drum and boiler, said water conducting tubes being disposed between the drum and boiler, and baffles interposed between the boiler and drum to guide hot products of combustion from the tubes in the drum across the space between said drum and boiler to the tubes within the boiler. Three claims.

THE BOILER MAKER

SEPTEMBER, 1921

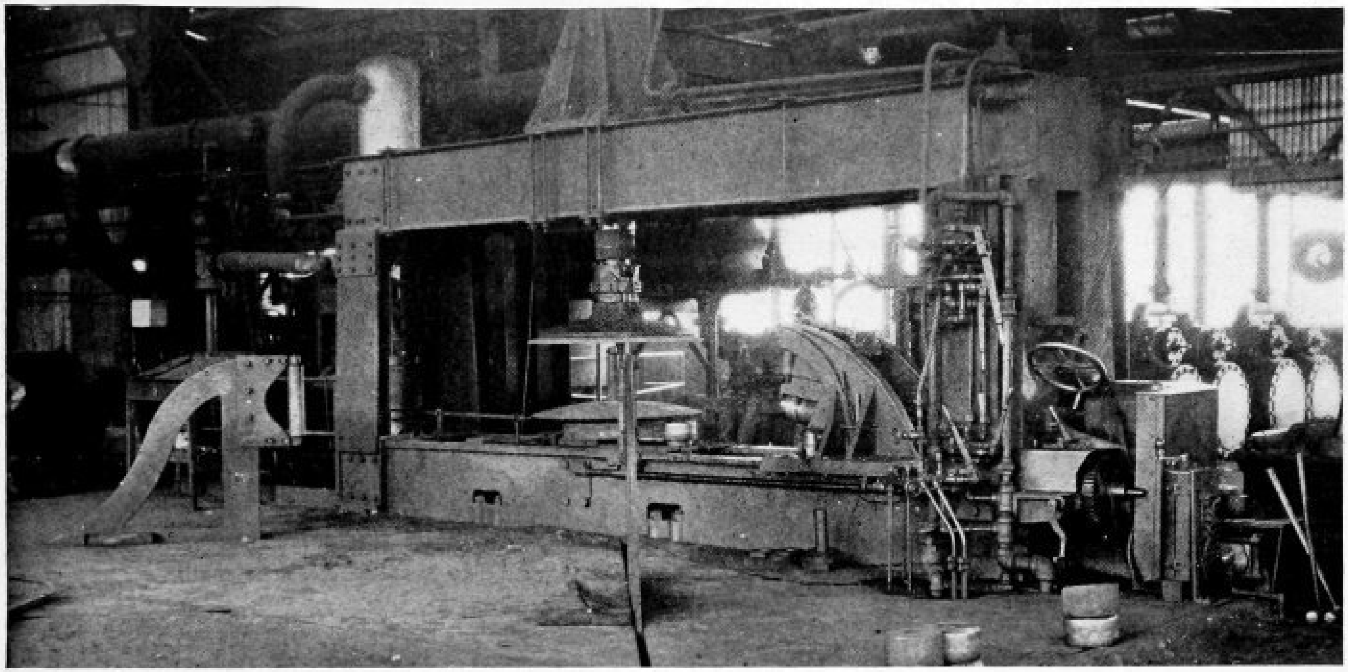


Fig. 1.—Circular Spinning Flanging Machine with Dies in Position for the Dishing Operation

Flanging and Dishing Boiler Heads

By George A. Richardson*

The operations involved in flanging and dishing the heads of steel boilers and tanks require equipment of a special nature which is not included in the machinery of the average size shop. By far the greater proportion of the work therefore falls to the makers of plates, and the following article gives the details of the processes as carried out in a typical plate flanging plant.

FROM the standpoint of variety the field of operations for a plant designed to do flanging and dishing is a rather limited one, although the parts made go into boilers, tanks of all kinds, stills, dryers, and in addition a few jobs of a special nature. The main differences are in the sizes of the materials handled rather than in the shape of the work or the processes involved.

In considering the subject, the logical starting point would be the manufacture of the plates, but as this is really an independent phase of the work, it will be treated in a later issue of the magazine, and the operations will be understood to begin with the receipt of the sheared plates in the flanging shop.

When the material has reached this point, it is presumed to be ready to make up immediately. The steel has been made to either the customer's or to standard specifications, the necessary shearing has been done and the quality of the finished product is consistent with the reputation and practice of the mill under consideration.

Specifications for Laying Out the Work

The question of specifying the proper dimensions is an important one and, properly handled, would eliminate many of the difficulties which can and do arise between the manufacturer and user. As a general rule it is best in every case that the customer or user specify all the dimensions, giving the details on special information blanks similar to those illustrated in Fig. 6. The blank dimensions shown give all the information that is necessary for making the finished pieces correctly. Where such information is not included the manufacturer uses his own judgment and works to those standards commonly in use for the job in hand. It is impossible to lay too much emphasis on the desirability of the customer specifying all the important dimensions required in making up the pieces.

The work of a flanging and dishing plant can be divided into a number of divisions as follows:

(1) Regular work performed on the machines. Under this head may be considered:
- (a) Plain flanging.
- (b) Plain dishing. No flanges called for.
- (c) Plain flanging and dishing.

(2) Specialty jobs made by hand.
Certain types of jobs are not adaptable to being carried out on the machines.

(3) Specialty jobs made on hydraulic sectional flanging presses.
Under this heading come a variety of jobs such as the making of flanged parts for marine boilers, manholes, handholes, flue holes, special shapes, etc.

(4) Minor finishing operations such as trimming the

*Midvale Steel and Ordnance Company, Philadelphia, Pa.

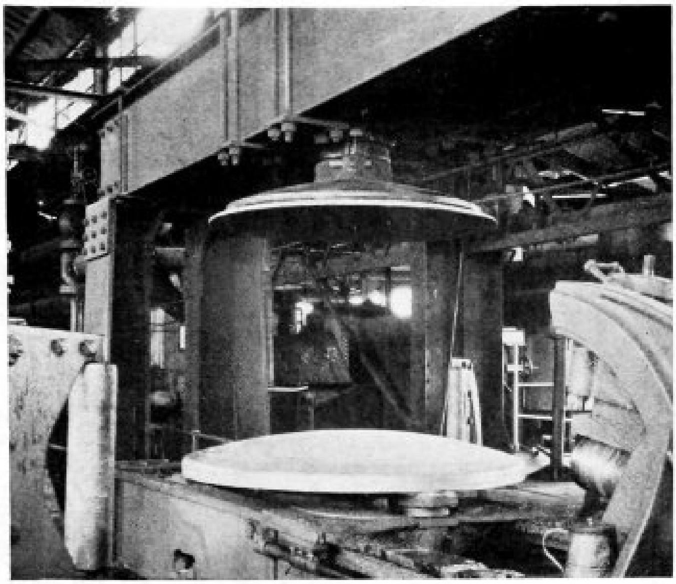


Fig. 2.—Fifty-four-Inch Head Flanged and Dished Ready for Inspection

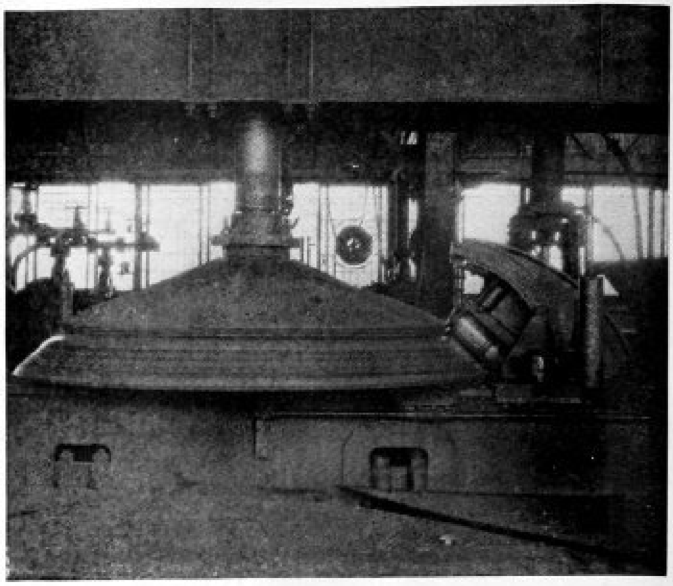


Fig. 4.—End of First Breaking-Down Operation on 108-Inch Flanged and Dished Head

edges of manholes, etc., truing up the ends of manhole yokes and similar work.

In the plant which has been taken as an example for the purposes of illustrating the text of this article, all regular work mentioned under section (1) is performed on a spinning flanging machine. This method of manufacture has several important advantages. The plates must be heated and this is superior to working with the cold metal because all strains are relieved. Then too the job can be done in one operation so far as the final flanging is concerned. Ordinarily it is necessary to heat short sections and turn down only 10 or 15 inches of flange at a time, a method which results in the setting up of uneven strains. These, of course, are eliminated in the spinning flanging process which is used wherever possible.

Operation of Spinning Flanging Machine

The spinning flanging machine, shown in Fig. 1, is one of two which are used for making all heads larger than 12 inches in diameter. Pieces smaller than this are made on the sectional flanging press.

The machine illustrated is the larger one and consists of the following parts, dies for the making of flanged and dished heads being shown in place:

The bottom die is mounted on a water cooled spindle which is driven by a 150 horsepower steam engine. The top die is mounted on the end of an hydraulic ram in such a manner that it is free to rotate. Immediately in front of the bottom die can be seen the radius roll, which is mounted on a "U" frame and can be moved back and forth with the aid of electrically driven worms. The radius roll is mounted on ball bearings and is free to rotate. Means are provided for cooling it between heats. At the right end of the table is the quadrant and it likewise can be moved back and forth along the base by another worm feed driven by the same motor. The quadrant roll can be moved from the position shown to a vertical position with the aid of an hydraulically operated rack and pinion movement. In the front center of the machine are centering pieces used to center the plates on the die. They are moved back and forth in the slots shown by hydraulic power. The rod along the left end of the table is a gage used in measuring the size of the head and all measurements on it have the usual allowance for shrinkage of 1/8 inch per foot. At the right are located the various

Fig. 3.—Ninety-Inch Ladle Bottom, Weighing 3,471 Pounds, Having 5-Inch Straight Flange

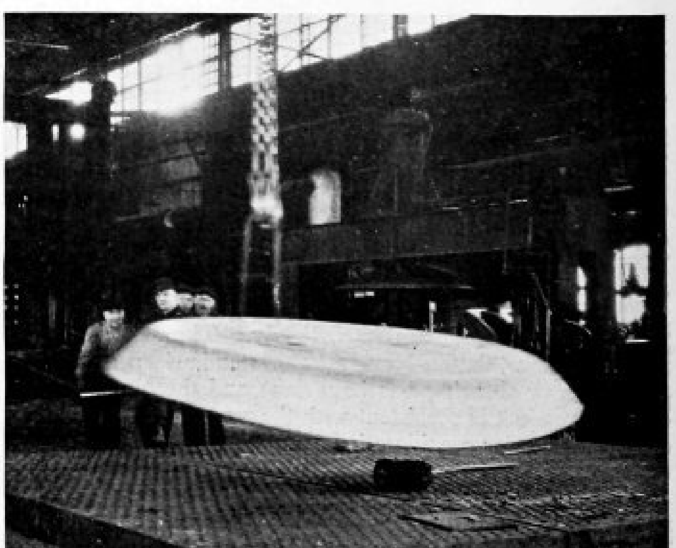


Fig. 5.—Flanged and Dished Head of 87-Inch Diameter, with 4 5/8-Inch Straight Flange. Radius of Dish, 120 Inches

controls such as the valves which operate the hydraulic mechanisms, those that supply the cooling water to the rolls and the controller of the electric motor which is used to move the quadrant and radius rolls. Close-up views of some of the operations described and illustrated later show some of the details of the machine a little more clearly.

The manufacturing operations involved will be taken up in the order mentioned at the beginning of this article and will show just how the spinning flanging machine is used.

Plain Flanging

All standard plain flanges are made in one operation. Flat top and bottom dies are used, the bottom die having a counterbore about ¼ inch deep in the face and a few inches smaller in diameter than that of the die itself. The object of this counterbore is to prevent warping of the plates, there being a tendency to belly up or down when no counterbore is used.

The plates, which have been sheared to size at the plate mill, are placed in the gas fired heating furnaces and brought to the proper temperature. Then one is removed from the furnace and centered on the bottom die with the aid of the centering pieces and the top die is brought down on it. The diameter of the top die is a few inches smaller than that of the bottom die. In the case of flat heads its function is merely to hold the plate in place.

The radius roll is used to give the proper inside radius at the flanging point. It is adjusted to position by eye and in the flanging operation the edge of the plate is bent or worked down over it. Rolls of various radii are kept on hand and changes can be made easily.

Now that the plate is in place between the dies and the radius roll has been set in position, the actual flanging operation can be commenced. First the spindle supporting the lower die is started rotating and the plate and upper die rotate with it. Then the quadrant is moved forward with the quadrant roll in the position shown in Fig. 2, until it touches the edge of the plate. Slowly, as the edge is worked down, the roll is moved towards a perpendicular position and the flange is formed over the radius roll. At the end of the operation the quadrant roll is in a vertical position and pressing up close against the outside of the flange. The head is now completed and all that remains is to remove it from the machine and set it on the cooling bed.

The spinning flanging machine illustrated can manufacture a large range of sizes, being capable of taking plates up to 144 inches in diameter and 1¼ inches in thickness. The range of thickness is from 3/16 inch to 1¼ inches.

Fig. 3 shows an interesting example of heavy flanging, a ladle bottom, having a diameter of 90 inches and made of 1½ inch plate.

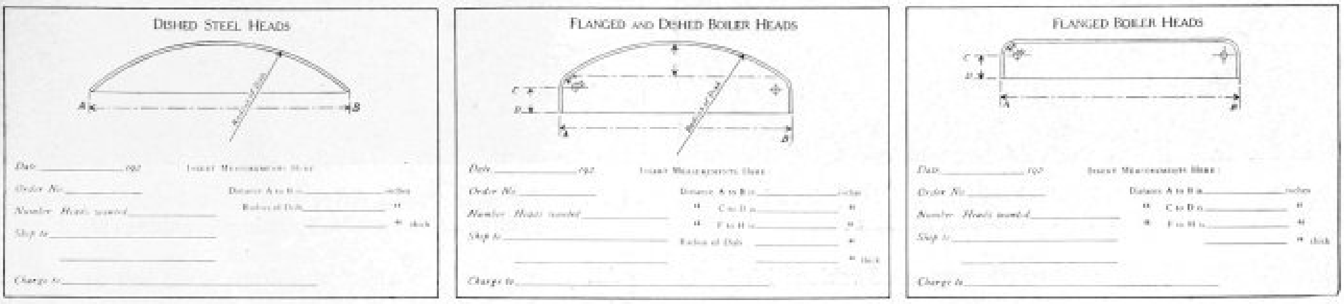


Fig. 6.—Typical Blanks Used in Ordering Flanged and Dished Heads

The small spinning flanging machine is used practically the same as the large one, about the only difference being that a radius roll is not used. The heads are small enough so that the normal bending radius suffices to meet requirements.

A question which frequently arises in the case of spinning jobs such as that mentioned is whether or not the operation tends to reduce the thickness of the plate. The reply to this is that careful measurements show that any variations are so slight as to be negligible for all practical purposes.

In the case of the shop described all heads 12 inches in diameter and over are spun. Under that size it is necessary to press them.

Plain Dishing

The number of plain dishing jobs is limited for as a rule the flange is necessary in order to rivet the pieces in place.

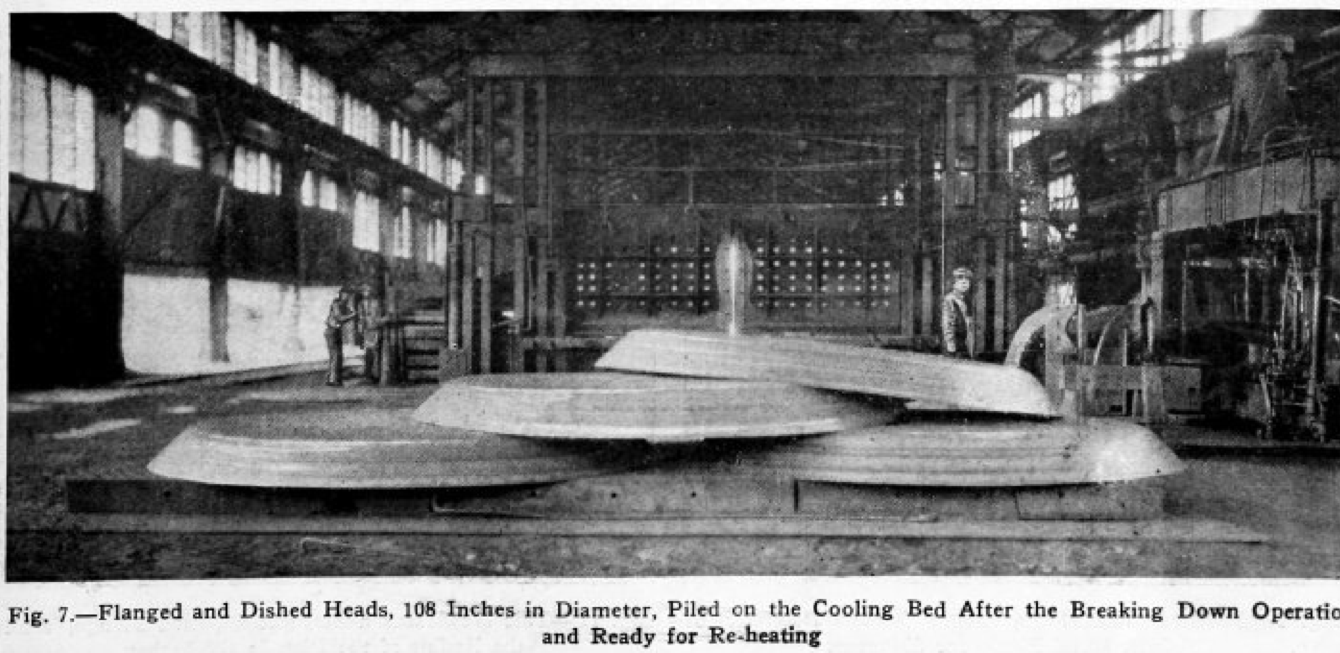


Fig. 7.—Flanged and Dished Heads, 108 Inches in Diameter, Piled on the Cooling Bed After the Breaking Down Operation and Ready for Re-heating

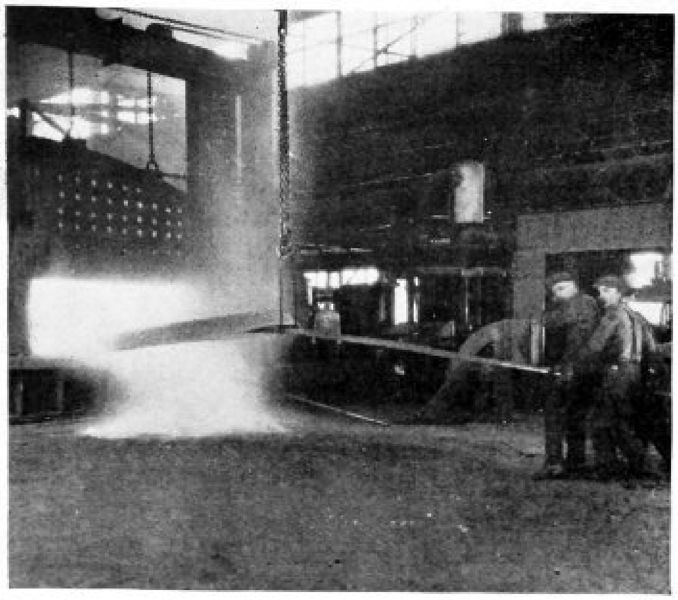


Fig. 8.—One Hundred and Eight-Inch Flanged and Dished Head After the Second Heat

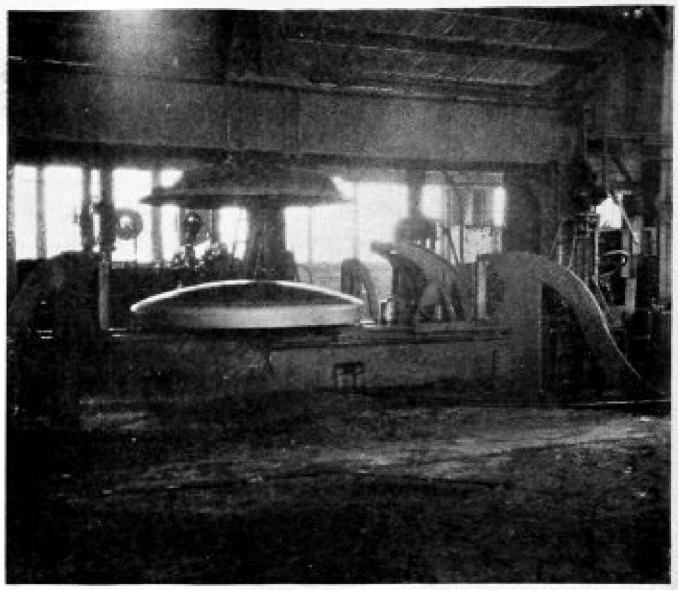


Fig. 10.—Finished Head After the Second or Flanging and Dishing Operation on the Spinning Flanging Machine

Plain dished plates are used for covers of various kinds, in dryers and for other similar purposes.

The making of a plain dished head is merely a pressing operation, the heated plate being placed on the spinning machine and shaped with the aid of special top and bottom dies.

Combined Plain Flanging and Dishing

In making flanged and dished heads two operations are necessary. The first is a breaking down operation. The plate, after heating, is placed in the spinning flanging machine, flat dies being used, and the edge is bent down roughly by the spinning operation. Fig. 4 shows a 108-inch head at the end of the first operation and before removing from the machine. The breaking down has just been completed and the quadrant roll is shown against the edge in the final breaking down position. The object of this operation is to prevent the plate from buckling.

In Fig. 5 is shown a plate removed from the machine after the first operation and about to be placed on the cooling bed.

Several 108-inch heads are shown in Fig. 7 on the cooling bed after the breaking down operation and ready for reheating in the furnace.

All pieces of a given size are done while the dies are in place. Then they are put in the heating furnace again and brought to temperature while the dies are being changed.

The second stage in the making of a flanged and dished head is merely a combination of the plain flanging and plain dishing operations already mentioned. The plate with broken down edge is dished by pressing. Then the quadrant roll is brought up and the flange completed. The result is the finished head.

In all operations of this character the most important thing is to get started right and this is one of the places where the skill of the operators comes in.

There are certain standard practices involved in the making of flanged and dished heads. Ordinarily the radius of the dish is made equal to the outside diameter of the head. Any change from this requires the use of additional forms which of course adds to the cost of making unless it happens that the special forms desired are on hand. The usual dies are made in units increasing 6 inches in radius for each, as for example 54 inches, 60 inches, 66 inches, and the like. While theoretically there would be some variation for an in between radius, there is none from a practical standpoint.

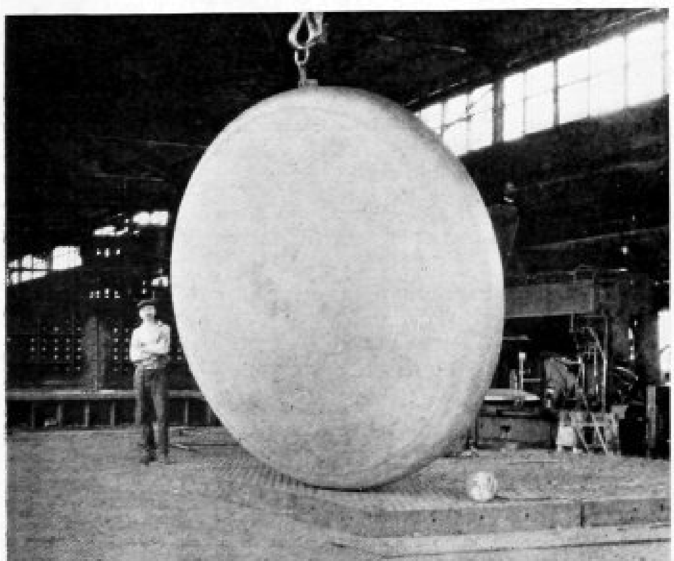


Fig. 9.—Finished Head, 123¼ Inches Outside Diameter, of ⅞-Inch Metal Ready for Shipment

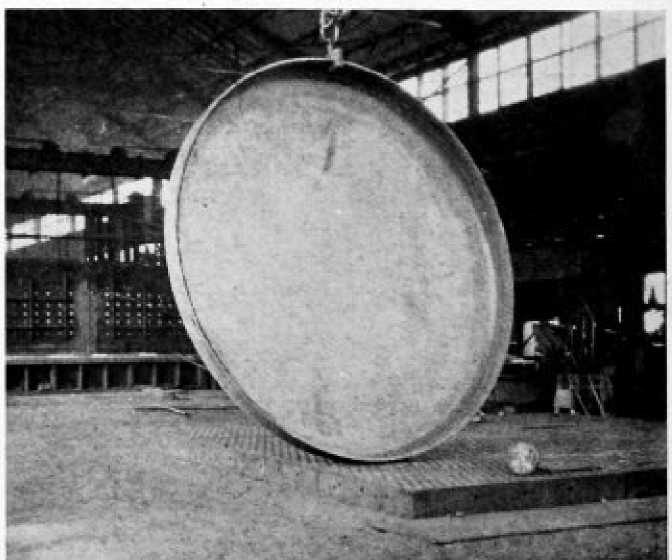


Fig. 11.—This Head Has a Straight 6¼-Inch Flange, While the Radius of the Dish Is 120 Inches

Notes on Locomotive Boiler Tests*

By Lawford H. Fry, M.Inst.C.E.

This article considers the methods to be adopted in analyzing locomotive boiler tests. The purpose of such tests is to study the operation of the boiler through the range of power corresponding to service conditions, the main point of interest being to see how the relation between steam production and fuel consumption varies throughout this range. In other words, to see how the boiler efficiency is affected by the rate of power output. This is a simple matter where only one boiler is in question, but if a comparison of several boilers is to be made it is important to select a proper method for analyzing the test results.

To arrive at a method of analysis for tests on locomotive boilers consider first the three main elements: (1) output measured by the amount and quality of steam produced; (2) input, measured by the amount and heating value of fuel fired; (3) boiler efficiency, measured by the ratio of heat in steam produced to heat in fuel fired.

Output of Boilers

The total output of the boiler is measured by the weight of steam produced and by the heat required to produce each pound of steam from the feed water as supplied. Usually the rate of output is important, and this is conveniently measured in pounds of equivalent evaporation per hour when boilers not producing the same quality of steam are to be compared, or more simply by the pounds of steam produced per hour per square foot of heating surface. For comparisons between different locomotives, it is desirable to express the evaporation in terms of the heating surface. This, in the case of a saturated steam boiler, is readily done on the basis of pounds of steam produced per hour per square foot of boiler heating surface.

In the case of a superheated steam boiler, there is room for a question as to whether the evaporation should be referred to the evaporative heating surface only, or to the evaporative heating surface plus the superheater surface, or to the so-called equivalent heating surface which is found by adding one and one-half times the superheater surface to the evaporative surface. After careful consideration preference is given to the first-named basis of comparison. The reasons for this preference are slight, but are thought to be sufficient to justify the choice. In the first place, the "equivalent heating surface" is ruled out as being a purely arbitrary quantity without any definite meaning so far as the boiler alone is concerned. The choice then lies between the evaporative heating surface, and the total heating surface including superheater, and falls on the former because it permits a more direct comparison between saturated and superheater boilers. For example, if a saturated steam boiler and a superheater boiler having the same outside dimensions be compared it will be found that some of the tubes having been displaced by superheater flues the superheater boiler will have less evaporative heating surface than the saturated steam boiler, and of course will have in addition the superheater surface. If the two boilers are tested under similar conditions it will be found that when burning fuel at the same rate, the weight of steam produced per hour per square foot of evaporative heating surface will be the same for both boilers, therefore the saturated steam boiler having the greater evaporative surface will produce a greater total weight of steam per hour. In the superheater boiler the superheating surface will add additional heat to the steam so that the lesser weight of steam will carry practically the same total quantity of heat. That is to say the total hourly equivalent evaporation of the two boilers will be approximately the same.

Since, however, the evaporative heating surface of the superheater boiler is less, the equivalent evaporation per hour per square foot of evaporative heating surface will be greater for the superheater than for the saturated steam boiler. It can therefore be said that in the case of boilers of the same size operating under similar conditions the weight of steam per square foot of evaporative heating surface will be the same for both, while the equivalent evaporation per hour per square foot of evaporative heating surface will be greater for the superheater than for the saturated steam boiler. A direct comparison of this sort is not possible if the evaporation is measured per square foot of total surface including the superheater.

Determining the Input

The total input is measured by the weight of dry coal fired and by its heating value per pound. In the majority of cases, however, it is sufficient to deal with the rate of firing in pounds of dry coal per hour. For the comparison of different boilers the rate of firing is conveniently measured in pounds of dry coal per square foot of grate area per hour.

Boiler Efficiency

This is the heat in the produced steam, expressed as a percentage of the heating value of the fuel fired. As has been pointed out above, one of the important points in a boiler test is to establish the relationship between the boiler efficiency and the rate of evaporation. This can be done most conveniently by utilizing the fact that the relation between the boiler efficiency and the rate of firing can be represented by a straight line. As an example, Fig. 1 has been plotted from tests made at the Altoona locomotive testing plant on the Pennsylvania Railroad class L 1 s locomotive. It is obvious from the figure that with boiler efficiency plotted against the rate of firing, a straight line fits the test results satisfactorily, and investigation shows that this is the case with any normally-designed locomotive boiler under ordinary working conditions. This fact is of considerable assistance in an analysis of a series of test results, and leads also to other conclusions which are worth being examined and put on record.

In the first place the assumption of a straight line for the relation between boiler efficiency and rate of firing automatically determines the form of the curve which must be used in Fig. 1 to represent the relation between rate of evaporation and rate of firing. This comes from the fact that by fixing the boiler efficiency for a given rate of firing, we necessarily establish the amount of steam produced by the amount of coal fired.

For example, in the tests represented in Fig. 1 the coal had an average heating value of 14,140 British thermal units per pound of dry coal, and the steam being produced at 205 pounds per square inch with approximately 200 degrees of superheat may be taken to require 1,260 British thermal units for the production of each pound from feed water at 70 degrees. It therefore follows that 1 pound of coal used with an efficiency of 100 percent would produce $\frac{14{,}140}{1{,}260}$ =

*From an article in Engineering, London.

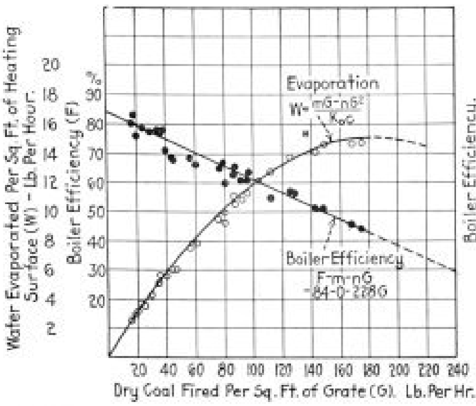


Fig. 1.—Test of Pennsylvania L1s Locomotive Boiler, Showing Efficiency and Evaporation, Against Rate of Firing

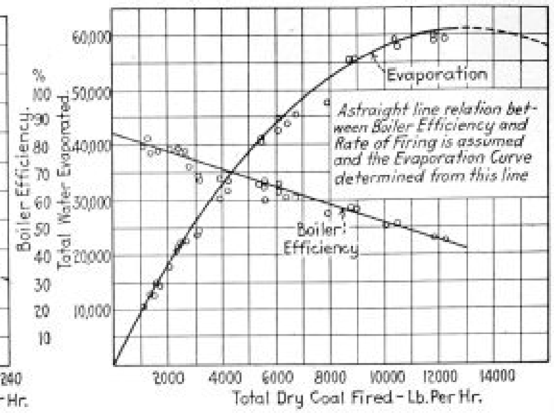


Fig. 2.—Total Rate of Evaporation and Boiler Efficiency Plotted Against Total Dry Coal Fired

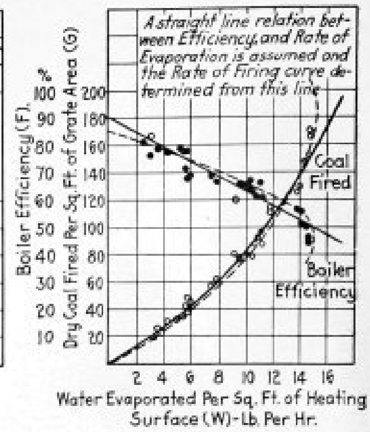


Fig. 3.—Boiler Efficiency and Rate of Firing Plotted Against Rate of Evaporation

11.2 pounds of steam. Now the locomotive has 70 square feet of grate and 4,017 square feet of evaporative heating surface (exclusive of superheater), or 57.5 square feet of heating surface per square foot of grate. Therefore, 1 pound of coal per square foot of grate is equivalent to $\frac{1}{57.5} =$ 0.0174 pound per square foot of heating surface. Consequently, if used with an efficiency of 100 percent, 1 pound of coal per square foot of grate would produce $0.0174 \times 11.2 = 0.195$ pound of steam per square foot of heating surface. From this it is merely a matter of simple proportion to find the actual rate of evaporation corresponding to any given rate of firing and to the boiler efficiency determined by that rate of firing. For example, the straight line relation gives a boiler efficiency of 60.9 percent when 110 pounds of coal are fired per hour per square foot of grate area, which makes the rate of evaporation $0.195 \times 110 \times \frac{60.9}{100} = 13.6$ pounds of steam per square foot of heating surface.

EVAPORATION FOR VARIOUS RATES OF FIRING

Table I shows the evaporation calculated as above for various rates of firing, the boiler efficiency for each rate being taken from the line in Fig. 1 which has the equation $F = 84 - 0.228\ G$, where **F** is the boiler efficiency in percent and **G** the rate of firing in pounds of dry coal per hour per square foot of grate area. The rates of evaporation thus found have been used to draw the smooth evaporation curve in Fig. 1.

For use in the analysis of boiler tests it is convenient to express in general terms the relations explained above. To do this the following symbols are required:

F = Boiler efficiency in percent.
G = Dry coal fired per hour in pounds per square foot of heating surface.
W = Steam produced per hour in pounds per square foot of heating surface.
R = Grate area in square feet.
S = Heating surface in square feet.
C = S/R = Ratio of heating surface to grate area.
K = Heating value of dry coal in British thermal units per pound.
k = Heat in British thermal units required to produce one pound of steam from feed water.

$$K_o = \frac{100\,k}{K}.$$

Assuming the straight line relation between boiler efficiency and rate of firing we have:

$$F = m - nG \qquad (1)$$

where m and n are constants for a given boiler design and a given fuel.

Now the heat in the total coal fired per hour is $G\ R\ K$, and the heat utilized in steam production is $W\ S\ k$.

Therefore

$$F = 100\ \frac{W\,S\,k}{G\,R\,K} \qquad (2)$$

which can be written

$$F = \frac{W}{G} \cdot \frac{100\,C\,k}{K} \qquad (2a)$$

combining this with equation (1) we have

$$\frac{W}{G} \cdot \frac{100\,C\,k}{K} = m - n\,G$$

from which it follows that

$$W = (m\ G - n\ G^2)\ \frac{K}{100\ C\ k} \qquad (3a)$$

To simplify writing it is convenient to write K_o instead of $\frac{100\ k}{K}$ and this gives the equation (3) the form

$$W = \frac{m\ G - n\ G^2}{K_o C} \qquad (3a)$$

Treating this as a quadratic equation for **G** and solving, we have:

$$G = \frac{m \pm \sqrt{m^2 - 4\,K_o\,C\,n\,W}}{2\,n} \qquad (4)$$

From equations (3) and (4) it follows that the curve expressing the relation between rate of evaporation and rate of firing is a parabola, and that with constantly increasing rate of firing the rate of evaporation rises to a maximum and then falls off. The maximum rate of evaporation is reached when $m^2 - 4K_oC\ n\ W = 0$, which gives as a maximum rate of evaporation:

$$W_{max.} = \frac{m^2}{4\,K_o\,C\,n} \qquad (5)$$

If we write $G_{W_{max.}}$ for the rate of firing corresponding to the maximum evaporation, we have:

$$G_{W_{max.}} = \frac{m}{2\,n} \qquad (6)$$

and by combining this with equation (7) it follows that if we write $F_{W_{max.}}$ for the boiler efficiency at the maximum of evaporation:

$$F_{W_{max.}} = \frac{m}{2} \qquad (7)$$

In the foregoing formulæ the rates of evaporation and of firing are measured in terms of steam per square foot of heating surface and coal per square foot of grate area. This is desirable where different locomotives are to be compared, but it is also of value to compare total steam production and total coal consumption. Formulæ for this purpose are readily derived from those already given.

Using the same symbols as before:

WS = Total steam produced in pounds per hour.
RG = Total dry coal fired in pounds per hour.

Then equation (1) can be written:

$$F = m - \frac{n}{R}(GR) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1b)$$

and in equation (3*a*) if for C we write its equivalent S/R and transpose, the equation takes the form:

$$(W\,S) = \frac{m}{K_o}(G\,R) - \frac{n}{K_oR}(G\,R)^2 \quad . \quad . \quad . \quad . \quad (3b)$$

from which it is found by solving for (G R):

$$(G\,R) = R\,\frac{m \pm \sqrt{m^2 - 4\,K_o\,n/R\,(W\,S)}}{2\,n} \quad . \quad . \quad . \quad (4b)$$

The maximum total evaporation $(W\,S)_{max.}$ and the corresponding rate of firing $(G\,R)\,_{W\,max.}$ are readily found from equations (5) and (6) to have the following values:

$$(W\,S)_{max.} = \frac{R\,m^2}{4\,K_on} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5b)$$

$$(GR)\,_{W_{max.}} = \frac{Rm}{2n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6b)\,..$$

If the values given for F and (W S) by equations (1*b*) and (3*b*)are plotted against (G R) as in Fig. 2, it will be seen that the resulting curves are exactly similar to those of Fig. 1, but with a change in scale.

Before leaving the subject it is interesting to see the result of assuming a straight line relation between boiler efficiency and rate of evaporation instead of between boiler efficiency and rate of firing as above.

In Fig. 3 the results of the same tests as in Figs. 1 and 2 are plotted with the rates of evaporation as abscissæ, and the best straight line is drawn to represent the boiler efficiency points.

In the general case this line has the equation:

$$F = p - q\,W \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where p and q are constants.

From which it follows that

$$W = \frac{P}{K_o\,C/G + q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and

$$G = \frac{K_o\,C}{P/W - q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

In the case of the L 1 s locomotive tests plotted in Fig. 1:

$$F = 90.5 - 2.7\ W$$

If these values of p and q are inserted in equation (14) an equation is obtained, from which can be found the rate of firing (G) corresponding to any given rate of evaporation (W). From this equation the values in Table II have been computed. These values have also been plotted as the solid line curves in Fig. 3. To facilitate comparison, the curves for boiler efficiency and rate of firing in Fig. 1 have been transposed and are re-plotted as broken lines in Fig. 3. It will be seen that there is not much to choose between the solid line and the broken line curves until maximum boiler outputs are reached. Here an important difference is found. The broken line indicates a continued increase in evaporation as the rate of firing is increased, while the full line follows the test results in bending sharply after a certain rate of evaporation is reached, indicating a maximum rate of evaporation which cannot be exceeded no matter how much coal is fired. This maximum evaporation is a definite and important characteristic of the locomotive boiler, and the fact that it is indicated by the formulæ based on the straight line relation between boiler efficiency and rate of firing, but not by the formulæ based on a straight line relation between boiler efficiency and rate of evaporation, makes the former set of formulæ the more useful.

APPLICATION OF FORMULÆ TO ACTUAL TEST DATA

Now let us return to the application of this set formulæ to the L 1 s test results plotted in Figs. 1 and 2. In this particular case equation (1) F = m — nG becomes

$$F = 84 - 0.228\ G \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1c)$$

while we also have

$$K_o = \frac{1260 \times 100}{14{,}140} = 8.9 \text{ and } C = 57.5$$

Then inserting these numerical values of the coefficients in equations (5), (6) and (7), we find:

From equation (5) maximum rate of evaporation $= W_{max} =$ 15.1 pounds per hour per square foot of heating surface.

From equation (6), the rate of firing for maximum evaporation

$$G_{W_{max.}} = \frac{m}{2n} = \frac{84}{2 \times 0.228} = 183 \text{ pounds per hour per square foot of}$$

grate,

and from equation (7), boiler efficiency at maximum rate of evaporation

$$F\ _{W_{max.}} = \frac{m}{2} = \frac{84}{2} = 42 \text{ percent.}$$

In the total evaporation and firing plotted in Fig. 2, the maximum evaporation is found from equation (5*b*) to be 60,500 pounds of water per hour, and the corresponding rate of firing is found from equation (6*b*) to be 12,810 pounds of dry coal per hour.

It is worth noting that in every case where a straight line is drawn for the boiler efficiency in relation to the rate of firing, this line, if produced, will cut the vertical for zero rate of firing (G = 0) at a value for the boiler efficiency which is equal to the coefficient m in equation (1), $F = m - n\,G$, and this efficiency is double that obtained at the rate of firing which corresponds to the maximum rate of evaporation. In the L 1 s tests, Fig. 1, we have efficiencies of 84 percent for zero rate of firing and 42 percent at 183 pounds fired per hour per square foot of grate, which gives the maximum evaporation. This enables us to predict the maximum power of a boiler from a series of tests at moderate rates of firing.

METHOD OF PLOTTING

In studying a series of locomotive boiler tests the best method of establishing the relations between the observed quantities is to plot the values of the boiler efficiency against the rates of firing and to draw a straight line through the points thus obtained. This gives values for the coefficients m and n in the equation $F = m - n$ G, and by inserting these values in the equations derived above, relations between evaporation, boiler efficiency and rate of firing are obtained. For convenience the equations are collected below.

Boiler efficiency (F) in terms of rate of firing per square foot of grate area (G):

$$F = m - n\,G \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Evaporation per square foot of heating surface (W) in terms of rate of firing per square foot of grate area (G):

$$W = \frac{m\,G - n\,G^2}{K_o\,C} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

Total evaporation (W S) in terms of total coal fired (G R):

$$(W\,S) = \frac{m}{K_o}(G\,R) - \frac{n}{K_o\,R}(G\,R)^2 \quad . \quad . \quad . \quad (3b)$$

Boiler efficiency (F) in terms of total dry coal fired per hour (G R):

$$F = m - \frac{n}{R} (G\,R) \qquad (1b)$$

MAXIMUM EVAPORATION

The maximum evaporative capacity of the boiler will be reached at a rate of firing:

$$(G\,R)\,w_{max.} = \frac{m\,R}{2\,n} \qquad (6b)$$

the boiler efficiency being $F\,w_{max.} = \frac{m}{2}$

and the maximum evaporation:

$$(W\,S)_{max.} = \frac{R\,m^2}{4\,K_0\,n} \qquad (5b)$$

TABLE I.—BOILER EFFICIENCY AND EVAPORATION IN RELATION TO RATE OF FIRING

The values given in this table correspond to the smooth curves in Figs. 1 and 2, and are derived from the equation F = 84 — 0.228G, which assumes a straight line relation between boiler efficiency and rate of firing. The figures below the dotted lines are for rates of firing greater than 183 pounds of dry coal per square foot of grate per hour, which gives the maximum rate of evaporation.

Dry Coal Fired Per Square Foot Grate G	Boiler Efficiency F	Evaporation Per Square Foot Heating Surface W	Total Dry Coal Fired (G R)	Water Total Evaporated (W S)
Lb. Hr.	*Percent.*	*Lb. Hr.*	*Lb. Hr.*	*Lb. Hr.*
30	77.6	4.6	2,100	18,400
60	70.3	8.3	4,200	33,400
90	63.6	11.2	6,300	45,000
120	56.6	13.2	8,400	53,000
150	49.8	14.7	10,500	59,000
183	42.0	15.1	12,810	60,500
210	37.0	14.7	14,700	59,000
240	30.2	13.9	16,800	56,000

TABLE II.—BOILER EFFICIENCY AND RATE OF FIRING IN RELATION TO RATE OF EVAPORATION

The values in this table correspond to the full line curves in Fig. 3 and are derived from the equation F = 90.5 — 2.7 W, which assumes a straight line relation between boiler efficiency and rate of evaporation. The figures below the dotted lines are for rates of evaporation greater than the observed maximum rate of 15.1 pounds equivalent evaporation per hour per square foot of heating surface.

Evaporation Per Square Foot of Heating Surface W	Boiler Efficiency F	Coal Fired Per Square Foot Grate Area G
Lb. Hr.	*Percent*	*Lb. Hr.*
3	82.4	19
4	79.7	26
5	77.0	33
6	74.3	42
7	71.6	50
8	68.9	59
9	66.2	70
10	63.5	80
11	60.8	93
12	58.1	107
13	55.4	119
14	52.7	134
15	50.0	155
16	47.3	176
17	44.6	197

F. J. O'Brien, vice president of the Globe Seamless Steel Tubes Company, Milwaukee, Wis., in charge of operations and sales, has moved his office from the mill at Milwaukee to Chicago at 1043 Peoples Gas Building.

Hoover Favorable to Revision of Marine Boiler Regulations

THE necessity of revising certain sections of the rules governing the construction of marine boilers has long been understood by those interested in the manufacture and operation of such boilers. In a recent letter to Secretary Hoover, F. W. Dean, secretary of Wheelock, Dean and Bogue, Inc., (power equipment specialists of Boston) asks that action be taken in the matter. His letter and Mr. Hoover's reply are given below:

Hon. Herbert Hoover, July 21, 1921.
Secretary of Commerce,
Washington, D. C.
Dear Sir:

As a mechanical engineer, a member of the American Society of Mechanical Engineers and of the Boiler Code Committee of that society, and also a former member of the boiler department of the Emergency Fleet Corporation, I wish to call your attention to the antiquity and inadequacy of the "General Rules and Regulations Prescribed by the Board of Supervising Inspectors" with reference to the construction of marine boilers.

For many years it has been the ardent wish of all persons concerned with marine boilers that the rules should be modernized. Strong but fruitless efforts have been made to bring this about.

The association for the promotion of the adoption of the boiler rules of the American Society of Mechanical Engineers has made efforts to have the A. S. M. E. rules adopted by the Department of Commerce with no better success.

The rule concerning riveted joints of boilers is such that nobody would think of following it and no marine classification society would permit boilers designed in accordance with it to be used.

As you are an engineer, perhaps an appeal made to you may serve to overcome the inertia that seems to surround all efforts made to have the Rules changed.

Very respectfully yours,
F. W. DEAN.

Mr. F. W. Dean, July 26, 1921.
Wheelock, Dean & Bogue, Inc.,
141 Milk St., Boston, Mass.
Dear Mr. Dean:

1. The Department is in receipt of your letter of the 21st instant, calling attention to what you describe as the antiquity and inadequacy of the "General Rules and Regulations Prescribed by the Board of Supervising Inspectors," with reference to the construction of marine boilers, and stating that for many years it has been the ardent wish of all persons concerned with marine boilers that the rules should be modernized, and that strong but fruitless efforts have been made to bring this about.

2. In reply, I beg to say that the Board of Supervising Inspectors of Steam Vessels realizes the situation and the Supervising Inspector General of Steam Vessels has recommended to the Department that Sections 4433 and 4418, R. S., be amended, and if those sections are amended as proposed by the Supervising Inspector General, then the Board of Supervising Inspectors would have authority to make General Rules and Regulations, so far as boiler construction is concerned, that would make the practice of the Steamboat-Inspection Service absolutely modern and put it abreast of the very best practice of all other societies.

3. You will find inclosed herewith a copy of the Annual Report of the Supervising Inspector General for the fiscal year ended June 30, 1920, your attention being particularly invited to the paragraph "Boiler Pressure," commencing upon page 19.

4. In conclusion, it may be stated that a bill has already been introduced looking to the amendment of the sections in question, and just as soon as Congress takes action and gives the board the proper legislative authority, the board will do its part.

Faithfully yours,
HERBERT HOOVER,
Secretary of Commerce.

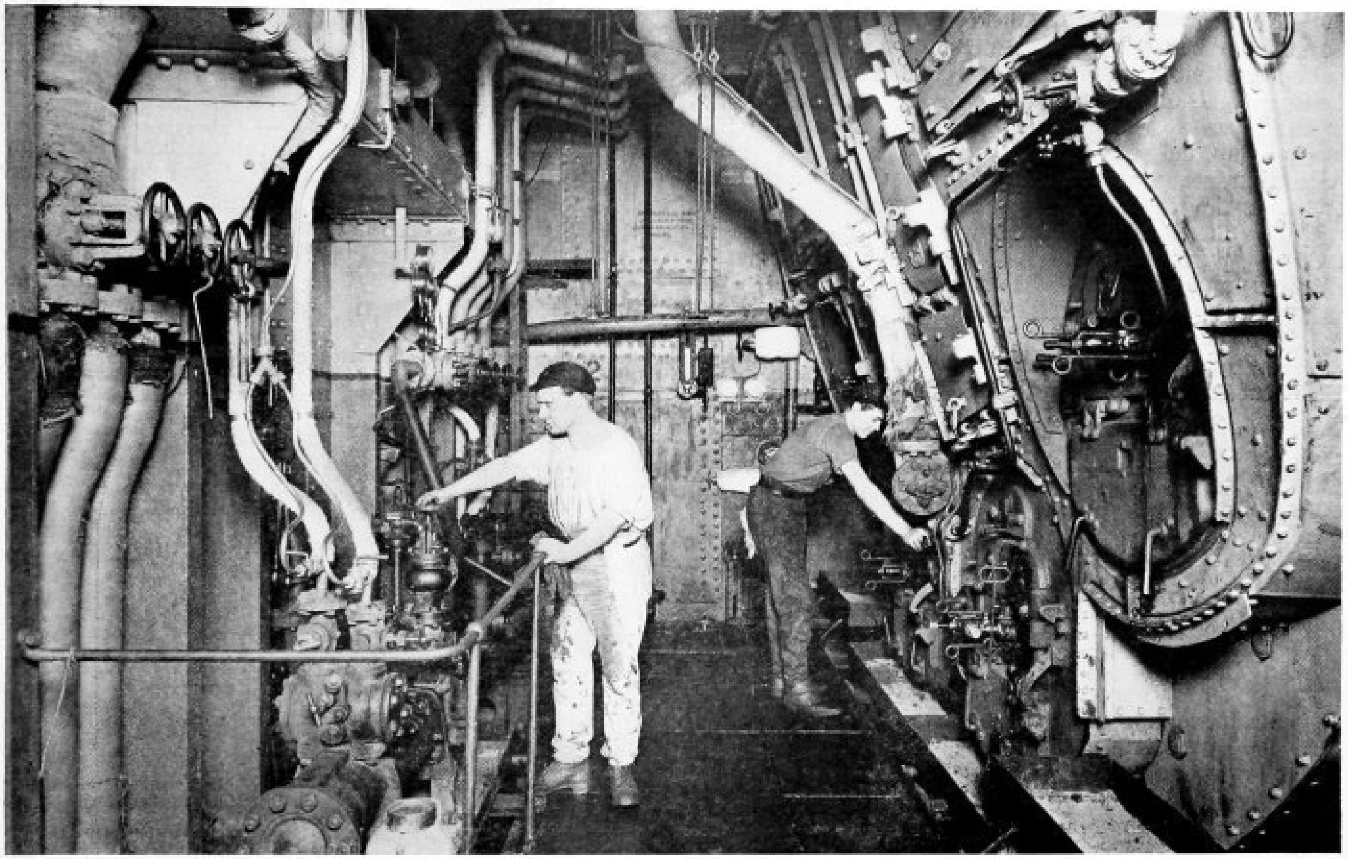
Executive Committee Meeting of the Master Boiler Makers' Association

The executive committee of the Master Boiler Makers' Association will meet at the Sherman Hotel, Chicago, Ill., September 24, to make arrangements for holding the 1922 convention of the Association and to decide where it is to be held.

J. E. Slimp, formerly with the Ohio Brass Company, and recently with the E. T. Chapin Company, Spokane, Wash., as sales manager with office at Chicago, has resigned.

Duties of a Boiler Maker Aboard a Naval Transport

By R. B. Harrison



Corner of the Boiler Room of a Modern Steamship

WHILE American vessels were still operating as transports in the transatlantic service, I was assigned to one of the largest of them (an ex-German liner) which had been converted into a troopship, for duty as a boilermaker, which had been my trade before entering the Navy. Seven other boiler makers besides myself were attached to the ship's company. Two of us and four firemen, acting as helpers, were assigned to each watch in different firerooms.

When sailing orders were posted on the bulletin board all boiler makers went below to their respective firerooms and, while the boilers were being fired up and steam raised, we went over all manhole plates for the purpose of taking up slack. When steam was up to working pressure we would make a final tour of inspection to be sure that all plates were absolutely tight. On this trip we could oftentimes take up half a turn on the nuts. After this inspection, when everything had been made shipshape, we would go on deck and be assigned to our watch, which meant that we worked four hours and then laid off for eight hours.

Our first job when going on watch was to blow the tubes. This was done with compressed air in the following manner: There were two 1-inch pipes on each side of the boilers, one on top and one on the bottom. These pipes ran the entire length of the boiler on the outside of the tubes, and were perforated with 3/16-inch holes about 1 inch apart for their entire length. At the end of each pipe was a connection for the air hose. The air was turned on for about a minute, to dislodge all soot and dirt, which fell on the baffle plates. After all the tubes were blown the side doors were opened and the accumulated soot allowed to run to the deck. We would blow the tubes in the boilers in two firerooms every watch, and the next watch coming on would blow the tubes in the other two firerooms, there being four double firerooms in all.

Ship Fitted with Watertube Boilers

The boilers, some forty-six in number, were of the watertube type and of German manufacture. They were in excellent condition, having been thoroughly overhauled and retubed when the government took the vessel over for transport duty. Therefore our duties were very light, but we always kept our weather eye open for fear of something happening. Should we discover a cracked or broken casting, for example, it was marked for repairs at the earliest moment possible, if serious, otherwise the work would be done on arriving in port.

After having made several round trips on this vessel I was ordered to report on board another transport, a much smaller ship. Here I was given entire charge of the boiler work. This vessel had 16 Scotch boilers (8 single and 4 double enders). These boilers were very old and some of them in a bad state of repair, and we had but few tools aboard to work with. The bulk of the work was done by civilian boiler makers while the ship was in port on either side. Sometimes there were as many as 12 or 15 boiler makers in the gang working on the boilers. On arriving in port the boilers were blown down, manhole plates removed and it was my duty to make a thorough examination of the furnaces, combustion chambers and the interiors of the boilers, taking note of every little defect. I found that cracks developed frequently in the corrugations of the furnaces. Such cracks were always welded with the electric arc. The tubes with bad beads were removed at the end of each trip and new tubes installed.

Leaking tubes would gather a thick crust of salt which had to be cut away with hammer and chisel before the rolls could be put in. The boilers were scaled after each trip, this work being done by a scaling company. In some cases the uptake tubes had left their holes, and the holes were all out of shape, but after being welded they held very well. That it was possible for boilers on a transatlantic liner in the regular passenger service before the war to get into such bad condition passes all understanding. Not a very encouraging state of affairs for a young boilermaker to stack up against on a strange ship, but such were the conditions I found when I dumped my sea bag on board this old liner, and which I had to put up with for the several months she continued in service.

During the Spanish-American war this ship was pressed into the government service as a scout ship or a commerce destroyer, and was at that time a very fast boat, but sailed under a different name. Early in this year while being refitted for the transatlantic passenger service she caught fire and was partly destroyed. Whether her boilers had been taken out and new ones installed I am unable to say, but surely her owners would never have ventured to send this old timer to sea with boilers that had seen so many years service, even if they were retubed. The shells and furnaces were so badly crystallized that they would be unsafe even at a greatly reduced working pressure and from my knowledge of the condition of the boilers, steam pipes and the like, I am of the opinion that the scrap heap would be the best place for her rather than to be put back into the passenger service.

The position of a boiler maker on board a transport is a very responsible one, for although the engineer officers are well posted on boilers they invariably depend upon the practical knowledge and the ability of the man in charge and his word is taken at all times when it comes to a question of what shall be done. Generally the chief comes to know and trust his subordinate. The rating of a boiler maker as a petty officer in the Navy is a rating without much authority, and should be changed to that of a chief petty officer with authority. This would give the boiler maker a better standing in the fireroom.

Standard Requirements for Staying Flat Surfaces

Description of Chart Used for Determining Diameter and Pitch of Stays in Boiler Work

By John S. Watts

THE chart, accompanying this article, will be found useful in working out the pitch, and diameter of stays, for flat surfaces, in boilers built under the rules of any of the following authorities: United States Board of Supervising Inspectors of Steam Vessels; Lloyds Register of Shipping; Provincial Government of Canada for land boilers.

All the above commissions use the following formula, which is the one used in making up this chart.

$$W.P. = \frac{CT^2}{P^2}$$

Where W.P. = working pressure in pounds per square inch.
C = Constants as per table below.
T = thickness of plate in sixteenths of an inch.
P = pitch of stays in inches. Where the pitch of stays is unequal, the mean of the squares of the two pitches is to be taken.

TABLE OF CONSTANTS

Constants U. S.	Lloyds	Canada	Type of Staying
112	90	112	Ends riveted over, plates 7/16 inch thick and under.
120	100 / 110	120	Ends riveted over, plates over 7/16 inch thick. Nutted, plates 7/16 inch thick and under
125	120	125	Nutted plates over 7/16 inch thick and under 9/16 inch.
135	135	135	Nutted plates 9/16 inch thick and over.
160	...	...	Nutted, and washers or strips, at least one-half the thickness of the plate, and in diameter or width one-half the pitch of the stays.
175	175[3]	175	Nutted, inside and out.
200	...	...	Nutted, and doubling plate at least one-half the thickness of the plate and covering full area. T to be taken as 72 percent of the combined thickness required, will therefore be that given by the chart divided by 0.72.
...	185[1 3]	...	Double nuts, and washers one-third of the pitch in diameter and one-half of the thickness of the plate.
...	200[1 3]	...	As above, but washers two-fifths of the pitch in diameter.
...	220[1 3]	...	As above, but washers two-thirds of the pitch in diameter, and the same thickness as the plate.
...	240[1]	...	Double nuts, and strips in width two-thirds of the pitch between the rows of stays, and the same thickness as the plate. The pitch of stays in the rows to be that given by using constant 220.
...	...	160[2]	Double nuts, and washers or strips one-half of the pitch in diameter, and same thickness at plate.
...	...	200[2]	Double nuts, and doubling plate at least same thickness as the plate, and covering the full area to be stayed.

[1]If a doubling plate is fitted of a thickness = t (in sixteenths of an inch) and covering the whole surface, the thickness given by the chart is equal to $T + \frac{t}{2}$, and therefore T = ¾ of that shown in the chart, and t = ½ of the chart. If desired T can be made less by adding double the amount to t. that has been deducted from T.

[2]T in these cases is equal to 75 percent of the combined thickness of the plate and washer, therefore the actual combined thickness will be one-third more than shown by the chart.

[3]If exposed to flame, 175, 185, 200 and 220 become 140, 150, 160 and 175, respectively.

ALLOWABLE STRESSES IN STAYS

The stress per square inch allowed on the stays, by the various authorities, is as follows:

United States Board of Supervising Inspectors of Steam Vessels—

Under 1½ inch diameter at bottom of thread......	6,000 pounds
1¼ inch diameter and not over 2½ inch diameter..	8,000 pounds
Over 2½ inch diameter..........................	9,000 pounds

LLOYD'S REGISTER OF SHIPPING.

1½ inch diameter and under, at bottom of thread..	8,000 pounds
Over 1½ inch diameter, at bottom of thread	9,000 pounds

CANADIAN PROVINCIAL GOVERNMENT

Less than 1½ square inches area at least section..	8,000 pounds
1½ square inches and over area at least section....	9,000 pounds

It will be seen that Lloyds and the Canadian rules agree as to the stress on the stay, as the change in stress allowed takes place in both rules between the 1½ inch and 1⅝ inch diameter (at the top of the thread).

DETERMINING THICKNESS OF A PLATE

To explain the use of the chart, we will take as an example, to determine the thickness of plate, pitch, and diameter of stays for 175 pounds working pressure to the United States rules.

The thickness of plate and pitch of stays being interdependent, it is necessary to assume a dimension for one or the other, to start with.

We will take an 11/16 inch plate, and constant 175; now, through the intersection of the 175 constant vertical, and the 11/16 inch thickness diagonal, draw a horizontal line to the 175 pound vertical where we read the pitch of stays as 11 inches; and the required diameter of stay as 2 inches over the threads.

If this pitch is not desirable, it is only a moment's work

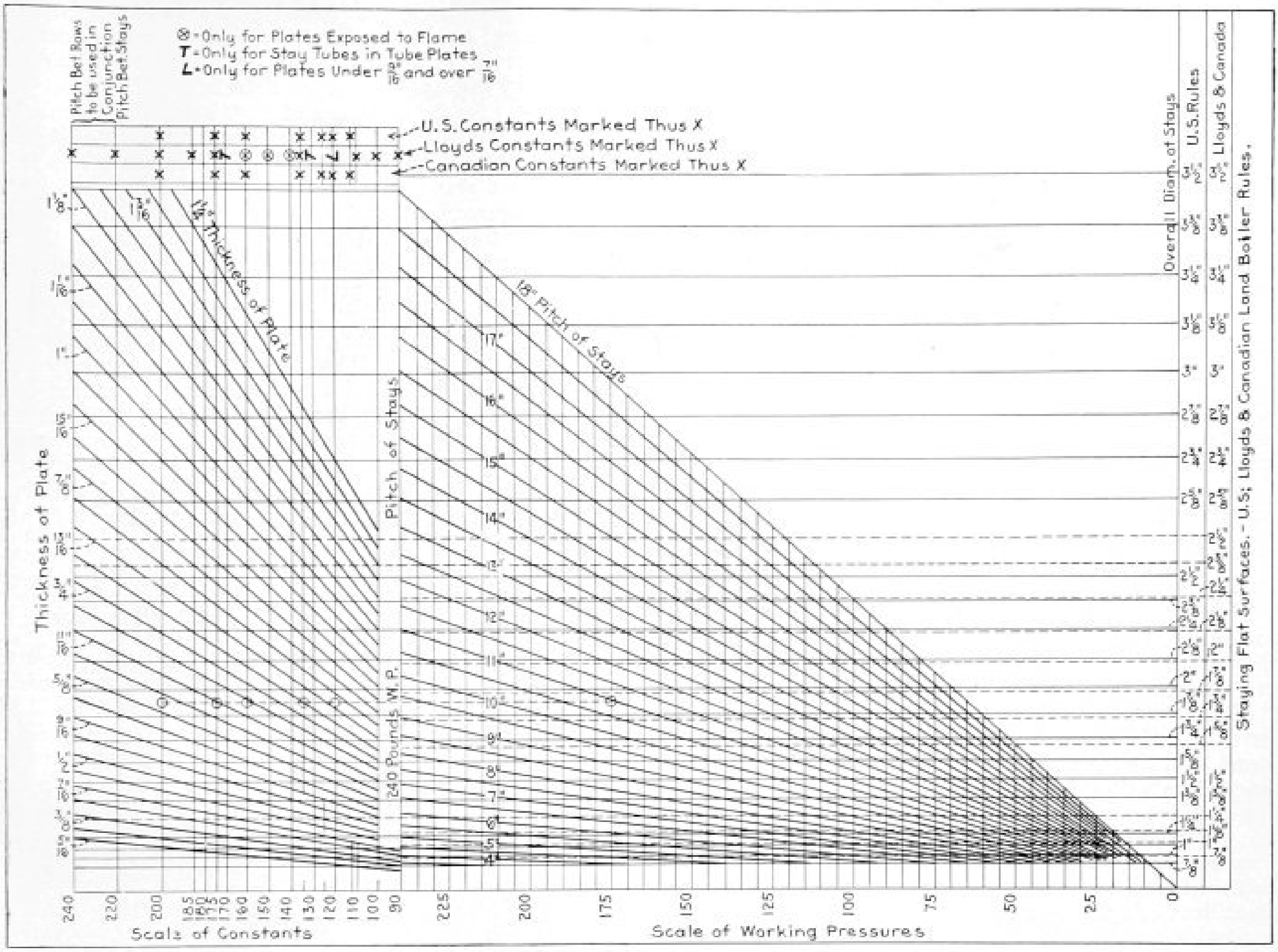


Chart Giving United States and British Constants Used in Computing Stays for Flat Surfaces

to draw another horizontal line at a more suitable pitch, which will show the corresponding thicknesses, etc.

The line just drawn also shows that we have the choice of the following thicknesses of plate, under the United States rules, viz., 21/32 inch, 23/32 inch, 13/16 inch and 22/32 inch; with their respective constants of 200, 160, 135 and 120, so that we have at once all the possible alternatives corresponding to the chosen pitch of stays.

For the constant of 200, as noted in the constant table, the actual combined thickness is obtained by dividing that given by the chart by 72. In the above example, the combined thickness will be 21/32 ÷ 0.72 = 15/16. As the doubling plate must be half the thickness of the plate, the plate will be ⅔ of 15/16 inch = ⅝ inch, and the doubling plate 5/16 inch thick.

The diameter of the stays given in the chart is the diameter over the threads, as this is the dimension to which the stays are manufactured, but, of course, the strength of the stays is calculated from the diameter at the bottom of the thread.

For stays under 2½ inches diameter I have allowed for 12 threads per inch, and for stays 2½ inches diameter and over, 9 threads per inch, the thread in both cases being United States standard thread form.

Constants for Calculating Stay Tube Pitch

In addition to the constants in the above table, the chart carries all the constants used for the pitch of stay tubes as given in the rules issued by Lloyd's Register, these constants being as follows:

One hundred forty where P = mean pitch of stay tubes in the nests of tubes and for the wide water spaces between the nests of tubes. Where P = horizontal distance from center to center of the bounding rows, the constant is:

- 120 where the stay tube is every third tube
- 130 as above, but nutted
- 140 where every alternate tube is a stay tube
- 150 as above, but nutted
- 160 where every tube is a stay tube
- 170 as above, but nutted

In order that, in the event of any change being made in the constants, the user may be able to make new lines to suit, I will explain the method of constructing the chart, and this will also be proof of the accuracy of its construction.

We first lay off the vertical line for the thickness of the plates, and as the formula uses T^2, where T is the thickness in sixteenths of an inch, the heights are made proportional to T^2 to any convenient scale. In this case we have chosen 48 units = 1 inch.

For example, the height to the 1¼ inch line will be 20^2 = 400 units, because there are 20 sixteenths in 1¼ inches. The chart goes down to 5/16 inch plate, as this is the thinnest plate that should be used in stayed surfaces.

Next we lay off the horizontal line for the constants, and as the highest constant is 240, we make this line 240 units in length to any convenient scale. In the chart this cale is 48 units = 1 inch, and the zero point is the point for 180 pounds pressure, on the scale of working pressures. This latter scale overlapping the constant scale for economy of space.

Now join all the thickness points on the 240 constant line to the zero point by diagonal lines. But as 100 is the lowest constant used for plates over 7/16 inch stop at the 100 constant, similarly as 90 is the lowest constant for plates 7/16 inch thick and under, we stop these latter thicknesses at the 90 constant vertical line.

At the top of the constant lines each line is marked to indicate the rules under which it is applicable, and also to indicate when the constant is only applicable to special cases; this in order to prevent taking a constant which is not used by the authority under which the boiler in question is being built.

From the zero point we measure to the left, the lengths corresponding to all the constants to the same scale, and erect perpendiculars at each point.

As the 100 constant refers only to plates over 7/16 inch thick, its vertical is drawn only from the 7/16 inch diagonal upward. And as the 110 and 112 constants refer only to plates 7/16 inch thick and under, these two lines stop at the 7/16 inch diagonal line. The 125 constant likewise refers only to plates between 7/16 inch and 9/16 inch and is only shown between these lines; and the 135 constant starts at the 9/16 inch line because it is used only for plates 9/16 inch and over.

From the law of similar triangles it follows that the height to the intersection of any constant line, and any thickness diagonal is proportional to $C \times T^2$; C and T being the respective thickness and constant at that intersection.

The 90 constant, being the lowest one used, the rest of the constant scale to the right of that constant is not required, so we start the scale of working pressures at the 90 constant line. Now taking this 90 line to represent the highest working pressure we are likely to use, namely 240 pounds, we lay off the scale of working pressures to any convenient scale. In our case we have chosen 32 pounds = 1 inch; and raise vertical lines at every five pounds. The heights of the constant lines being, as already shown, proportional to $C \times T^2$, must also be proportional to P^2 for any one given pressure.

Therefore we can, by calculation, fix the pitch of stays on the 240 pound pressure line corresponding to the various thicknesses and constants.

Taking the thicknesses at the 240 constant and 240 pounds pressure, we find that the corresponding pitches are, from the formula:

$$W.P. = \frac{CT^2}{P^2}$$

$$P^2 = \frac{CT^2}{W.P.}$$

$$P^2 = \frac{240 \times T^2}{240}$$

$P^2 = T^2$; or, the pitch equals the thickness in sixteenths. By producing horizontally across from the thickness points on the 240 constant line to the 240 pound pressure line, we get points representing the pitches of stays, equal to T in sixteenths.

That is, the point produced from the 1⅛ thickness point will represent a pitch of 18 inches, as there are 18 sixteenths in 1⅛ inches. This 18 inches is the highest pitch shown, as this is the limit allowed under the United States rules.

Now join all these pitch points by diagonal lines to the zero point on the scale of working pressures. From the law of similar triangles it is obvious that the height of any pressure line to any pitch diagonal is proportional to $W.P. \times P^2$, which is in turn to equal to $C \times T^2$, as can be seen by transposing the formulae.

$$W.P. = \frac{C \times T^2}{P^2}$$

$$W.P. \times P^2 = C \times T^2,$$

which proves that a horizontal line drawn across the chart will intersect at the left hand side, all those constants and thicknesses corresponding to the pressures and pitches intersected by the same line at the right hand side.

The lines for the diameters of stays are got by calculating the allowed load on each diameter of stay, after deducting from the diameter the double depth of the thread, and from that load the area the stay will support at 240 pounds pressure per square inch, and scaling this area on the pitch of stay line to the scale used before, namely 48 units = 1 inch.

The diameter lines are horizontal because the heights at any pressure line are proportional, as shown above, to $W.P. \times P^2$, which equals the load on the stay.

As the stress per square inch allowed on the stays varies on some sizes with the different authorities, two columns are given, one for the United States Board and one for both Lloyds and the Canadian Provinces, the latter two being the same. Where they differ from the United States requirements dotted lines indicate the changes.

The smallest diameter of stay shown is ⅞ inch diameter over the threads, as this is the smallest size allowed by the Canadian rules, and in any case should not be reduced.

Explosion of Long Seam Boiler

THE long seam boiler again demonstrated its ability to kill people and cause enormous property damage when a boiler of this construction recently exploded at the mill of the McKeithan Lumber Company, Lumber, South Carolina.

The mill had been idle for some time and was about to resume operations, the boiler plant having been fired up for this purpose. Shortly before a force of two hundred men were to report for work, the boiler exploded with terrific violence and if the accident had occurred a little later the

Destruction Caused by Lap Seam Crack Explosion

casualty list would have been a long one. As it was, two men were killed and the mill almost entirely destroyed, the damage being estimated at about $30,000.

The boiler was built with two sheets—one upper and one lower—with two horizontal lap seams running the length of the shell. The explosion, as is usual in this type of construction, was the result of a lap seam crack. Whereas a boiler subject to this type of defect is always treacherous, the long seam gives additional opportunity for an extremely violent explosion because the boiler may rip open from head to head. This is clearly shown in the illustration of the wrecked boiler at the McKeithan mill, shown above. Evidence of the fatal lap seam crack can also be clearly seen.—*The Locomotive.*

Principles of Riveted Joint Design - II

Developments in the Design of Double Shear Joints and Compound Failures of Riveted Plate Sections

By William C. Strott*

BY this time the student has probably begun to wonder why neither the breaking strength nor the crushing strength of the butt straps has been considered in any of the previous formulæ bearing on the efficiencies of double shear joints. With this thought in mind, he should recall what was said earlier in this treatise, that the stress in each butt stra is evidently one-half that in the main plate. Consequently, by employing two straps of equal thickness, the sum of which is somewhat greater than that of the main plate (see Table I), it follows that the strength of the butt straps will be greater than the main plate.

The advantages of double shear joints have long been appreciated, but only within recent years has a design been successfully developed to give the required net plate strength

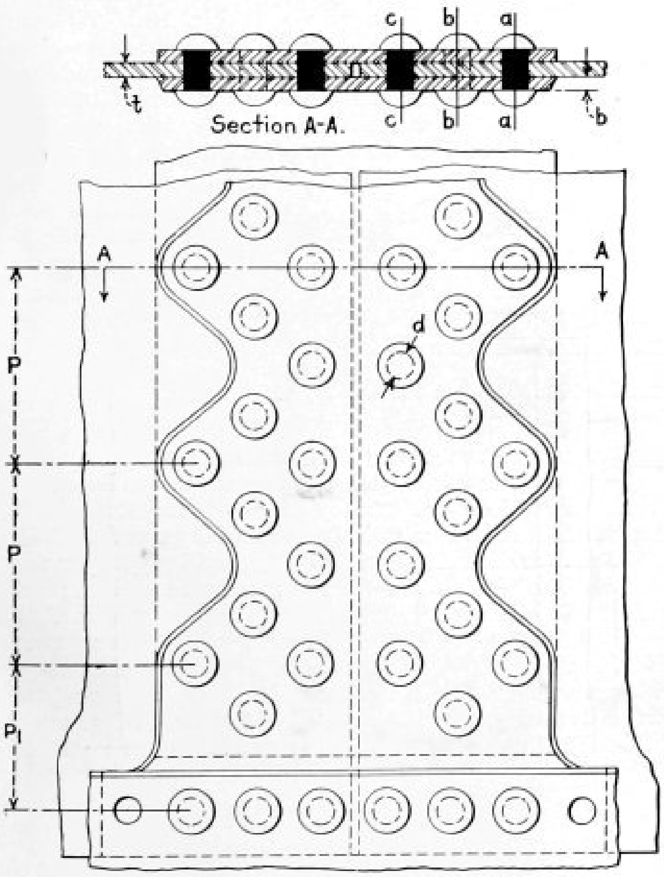


Fig. 14.—"Saw-Tooth" Joint, Triple Riveted

and higher efficiency, while at the same time allowing the edges of the straps to be satisfactorily calked against leakage. This joint is illustrated in Fig. 14, and on account of the serrations on the edges of the outside butt strap, it is commonly known as the "saw tooth" joint.

As unique as it may seem, the saw tooth joint is, nevertheless, simply a development of the type illustrated in Fig. 13, in which it would only be necessary to serrate the edges of the outside strap in order to convert this joint into one of the saw tooth form.

It is evident, therefore, that the same strength equations, T, Sh, Cr, (T + Sh) and (T + Cr), as given in connection with Fig. 13, apply also to the saw tooth joint, whence they need not be repeated.

Saw tooth joints are a costly proposition, owing to the labor involved in cutting, forming and fitting them. Consequently they are never applied to the commercial types of boilers. They are coming into extensive use, however, for the longitudinal seams of scotch marine boilers. These boilers are usually of large diameters, being often as great as 15 feet, and designed for safe working pressures up to 175

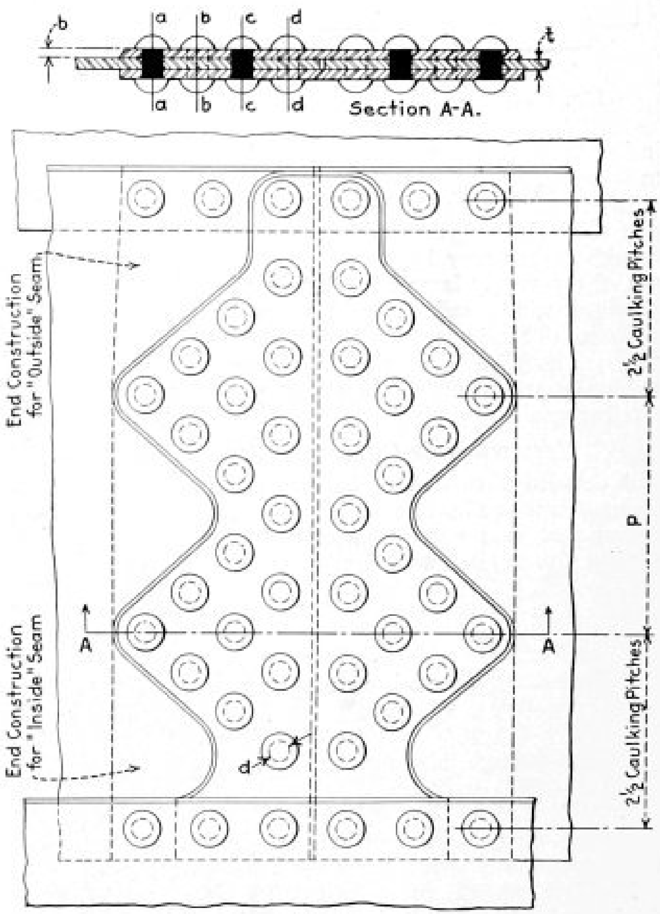


Fig. 15.—"Saw-Tooth" Joint, Quadruple Riveted

pounds per square inch. When constructed of "marine quality" flange steel having an ultimate tensile strength of 60,000 pounds per square inch, the required shell plate thickness for such a boiler (allowing a factor of safety of 6) would be:

$$P_w = \frac{T_s \times t \times E}{f \times R} \text{ or } 175 = \frac{60{,}000 \times t \times 0.93}{6 \times 90} \text{ or } t = 1\tfrac{5}{8} \text{ inches.}$$

This is more than twice the thickness of shell plate allowed in a horizontal return tubular or any other externally fired boiler, because the plates would become overheated and buckle. The reason for this is that water is a poor conductor

* Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer Blaw-Knox Company, Pittsburgh, Pa.; and Union Iron Works, Erie, Pa.

of heat and cannot take the heat out of the plate as rapidly as it is absorbed by the excessive thickness of metal. For internally fired boilers such as Scotch marine and locomotive types where the shell is not exposed to flame or radiant heat, the permissible thickness of shell plate is unlimited, being governed only by the maximum gage that can be rolled by the plate mills.

If the ordinary well known type of double butt strap joint like that previously illustrated in Fig. 6, having inside and outside straps of unequal width, were to be applied to a shell 1⅝ inches thick the rivets would have to be about 2

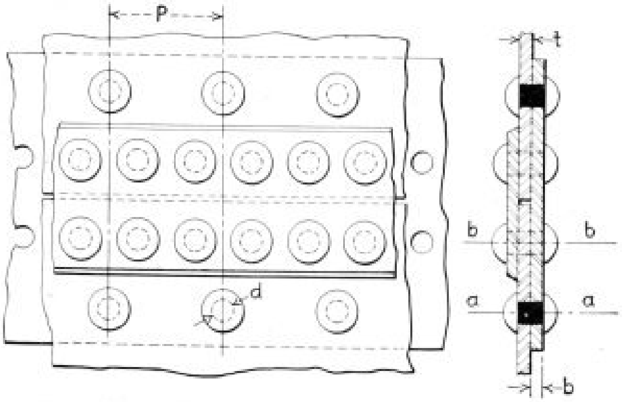


Fig. 16.—Double Riveted, Double Butt Strap Joint

inches in diameter in order to give the necessary resistance to shearing.

Rivets as large as this require specially designed, high powered steam or hydraulic machines for driving them. Even though a shop may be equipped with such a machine, the use of excessively large rivets would result in seams of impractical width, owing to the large back-pitch necessary.

Note: The diameter of the head on a 2 inch button head rivet is about 3½ inches; the minimum back-pitch required would be approximately 4 inches, which for a quadruple riveting would result in a total joint width of almost 3 feet.

Efficiency of Quadruple Riveted Joint

A detailed discussion of the various strength equations in connection with Fig. 15 need not be entered into here for the reason that what was said with regard to Figs. 13 and 14 applies also to quadruple riveted saw tooth joints.

$W = P \times t \times T_s$

$T = (P - d) \times t \times T_s$

$Sh = 9 \times a \times S$

$Cr = 9 \times d \times t \times C$

Failure through second row of rivets:

$(T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times S$

$(T + Cr) = (P - 2d) \times t \times T_s + 1 \times d \times t \times C$

Failure through third row of rivets:

$(T + Sh) = (P - 3d) \times t \times T_s + 3 \times a \times S$

$(T + Cr) = (P - 3d) \times t \times T_s + 3 \times d \times t \times C$

Failure through the fourth or inside row of rivets need not be considered because it is not a reducing section.

Divide T, Sh, Cr, (T + Sh) or (T + Cr), whichever is the least, by W, and the quotient will be the true efficiency of the joint.

It was previously demonstrated, in the case of the joint illustrated in Fig. 13, that by leaving off every alternate rivet in the outer row the net plate ligament would be increased in sectional area, and consequently result in higher joint efficiency. It was also pointed out, in a joint like Fig. 13, the calking pitch on the edge of the upper butt strap is increased to such an extent that satisfactory calking is impossible. That is how the upper strap came to be serrated, and finally resulted in the saw tooth form of Figs. 14 and 15.

Long before the saw tooth joint came into use, however, the difficulty of calking joints like Fig. 13 was overcome by cutting back the upper strap so that the calking edges came adjacent to an inner row of rivets, where a satisfactory calking pitch could be maintained. The width of the inside butt strap was, however, retained in width to suit the required number of rivet rows, resulting in a double butt strap joint having inside and outside straps of unequal width like that illustrated in Fig. 6. The one shown here is quadruple riveted, since it has 4 rows of rivets on each side of the center line of the joint. It should be understood at once that all the rivets in a joint of this type are not in double shear. Only those which pass through both the inside and outside straps are in double shear, while those passing through only the shell and the inside strap are in single shear. The student should readily see that the function of the 2 inner rows of rivets in Fig. 6 is identical with that of a double shear joint, while the 2 outside rows of rivets function identically as in the case of a lap joint.

This type of joint is used exclusively for the longitudinal seams of externally fired steam boilers and pressure vessels, and also for all other cylindrical vessels having plates of medium thickness in which the ordinary commercial rivet diameter may be employed. A complete discussion of these joints will be taken up in detail in a later chapter.

In calculating the efficiency of any riveted joint, we commence by considering the possibility of failure through the first or outer row of rivets, as a-a, in Fig. 16. We then pass on to the possibility of failure through the second row of rivets as indicated by b-b, and so on, until each *reducing* plate ligament has been accounted for. All calculations of course are made for one unit length of the joint only, and efficiencies are based on the solid plate strength.

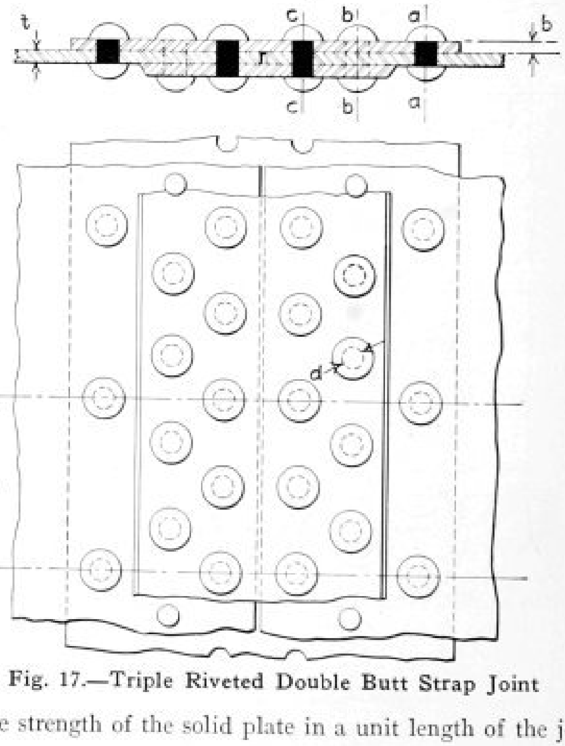


Fig. 17.—Triple Riveted Double Butt Strap Joint

The strength of the solid plate in a unit length of the joint is:

$$W = P \times t \times T_s$$

Through section a-a, failure can only occur by breaking of the plate ligament between the rivet holes. The strength of this section is:

$$T = (P - d) \times t \times T_s$$

Through section b-b, the joint may also fail by breaking of the net plate section, but it is assisted by the shearing value of the rivets in the outer, or first row. Its strength is expressed:

$$(T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times s$$

Another possible method of failure through section b-b is by the tearing of the plate ligament as before, assisted by the crushing strength of the inside strap in front of the rivets in the outer row. Many students will be likely to ask, "Why, in this case, do we figure on the crushing strength of the butt strap and not the main plate?" In reply to this, it may be stated, that since the main plate causes these rivets to bear against the butt strap with a pressure equal to that on the main plate, we must necessarily base the actual available strength on the plate which offers the least resistance. This weaker plate is evidently the butt strap which is only slightly heavier than one half that of the main plate. The strength of the joint in this respect is expressed:

$$(T + Crb) = (P - 2d) \times t \times T_s + 1 \times d \times b \times C$$

(Note: (T + Crb) means "plate tension plus crushing of butt straps.")

There is yet another possible method of compound failure. This may occur by the crushing of the main plate against the inner row of rivets together with the shearing of the rivets in the outer row. Such a failure would occur when very thin plates are employed. Even though the net plate section were then made strong enough by employing large rivet pitches, thereby increasing the length of the plate ligaments, it will be evident that the plate would fail by crushing as we have noted. Hence the strength of a joint in this respect must also be accounted for. It is expressed:

$$(Cr + Sh) = 2 \times d \times t \times C + 1 \times a \times s$$

This makes a total of three compound failures that we have encountered in this joint, but we have yet to consider the total shearing strength and also the total crushing strength of the joint, which of course act independently, in a like manner, to failure by T.

The total shearing value in a unit length of this joint consists of two rivets in double shear in the inner row, plus one rivet in single shear in the outer row. It is expressed:

$$Sh = 2 \times a \times S + 1 \times a \times s$$

The total crushing strength is represented by the bearing value of the main plate in front of the two rivets in the inner row, plus the bearing value of the inside butt strap against one rivet in the outer row. The reason for not figuring the crushing value of the main plate against all three rivets is because the inside butt strap is the thinner of the two and offers the least resistance. The strength of the joint in this respect is expressed:

$$Cr = 2 \times d \times t \times C + 1 \times d \times b \times C$$

This completes the analysis of a double riveted, double butt strapped joint, and in all we have encountered six possible methods of failure.

Failure by Tearing Straps Between Rivets

It might be well, however, to call attention to the fact that the two butt straps may fail by tearing of the ligaments between the rivet holes in the inside row; but this method of failure is not possible when each butt strap is made slightly heavier than half that of the main plate. The combined strength of the butt straps will then be greater than that of the main plate, and it is assumed, therefore, that failure of the main plate will occur before the full breaking strength of the butt straps has been developed.

Nevertheless, when inspecting old boilers, it is sometimes discovered that the butt straps are thinner than the main plate, in which case failure by this method is possible, and must be accounted for. The formula for this failure is:

$$T_b = (P - 2d) \times 2b \times T_s$$

(Note: T_b indicates "tension in butt straps." Failures of this kind will not be referred to again in any of the types of joints to follow.)

Divide T, Sh, Cr, (T + Sh), (T + Crb), (Cr + Sh), or T_b, whichever is the least, by W, and the quotient will be the true efficiency of the joint.

Strength of solid plate:

$$W = P \times t \times T_s$$

Commencing with section a-a, the only possible failure that may occur is by tearing of the net plate ligament, the strength of which is:

$$T = (P - d) \times t \times T_s$$

Through section b-b, we have identically the same condition as exists in the double riveted butt joint of Fig. 15. There are two methods of failure possible in this section of the joint; that is T + Sh and T + Cr, as in the case of the previous joint. It will not be necessary to go into a detailed discussion of these failures, but for convenience their strength equations will again be presented so as to avoid any possibility of confusion.

$$(T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times s$$

$$(T + Crb) = (P - 2d) \times t \times T_s + 1 \times d \times t \times C$$

Failure through section c-c is not probable, since it is not a reducing section with respect to section b-b, hence it need not be considered. The total shearing strength consists of the two inner rows of double shear rivets combined with the outer row of single shear rivets. For a unit length of joint, its strength is expressed:

$$Sh = 4 \times a \times S + 1 \times a \times s$$

The total crushing strength consists of the bearing value of the main plate against the two inner rows of rivets, plus the crushing value of the inside butt strap against the outer row of rivets. For a unit length of this joint, the strength equation is:

$$Cr = 4 \times d \times t \times C + 1 \times d \times b \times C$$

The main plate may also fail by crushing against the two inner rows of rivets combined with the shearing resistance of the rivets in the outer row. It is expressed:

$$(Sh + Cr) = 4 \times t \times d \times C + 1 \times a \times s$$

Divide T, Sh, Cr, T + Sh, T + Crb, or Sh + Cr, whichever is the least, by W, and the quotient will give the true efficiency of the joint.

The riveting arrangement of the joint shown in Fig. 17 is identical with that of Fig. 16, with the exception that the inner butt strap is increased in width to accommodate an additional row of rivets. The pitch of the rivets in the outer row is twice that of a triple riveted joint of equal proportions.

The solid plate strength in a unit length of this joint is:

$$W = P \times t \times T_s$$

Failure through section a-a will occur by breaking of the net plate section, whence

$$T = (P - d) \times t \times T_s$$

The total shearing strength is that offered by eight rivets in the third and fourth rows, which are in double shear plus the three rivets in the first and second rows which are in single shear. The strength equation is:

$$Sh = 8 \times a \times S + 3 \times a \times s$$

The total crushing strength of the joint consists of the bearing value of the main plate against the two inner rows of rivets, plus the bearing value of the inside butt strap against the two outer rows of rivets, which is expressed thus:

$$Cr = 8 \times d \times t \times C + 3 \times d \times b \times C$$

Through section b-b, the joint will fail by breaking of the net plate section, but is assisted by the shearing strength of the rivets in the outer row. The strength equation is:

$$(T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times s$$

Failure through section b-b may also occur by breaking of the net plate section, but in this case assisted by the crushing strength of the inside butt strap against the rivets in the outer row. The strength equation is:

$$(T + Crb) = (P - 2d) \times t \times T_s + 1 \times d \times b \times C$$

Failure through section c-c may occur by breaking of the net plate section, but will be assisted in resisting such failure by the shearing strength of the rivets in both the first and second rows. The strength equation is:

$$(T + Sh) = (P - 4d) \times t \times T_s + 3 \times a \times s$$

Failure through section c-c may also occur by breaking of the net plate section, but will be assisted in resisting such

(Continued on page 262)

Fifty Years as a Boiler Maker

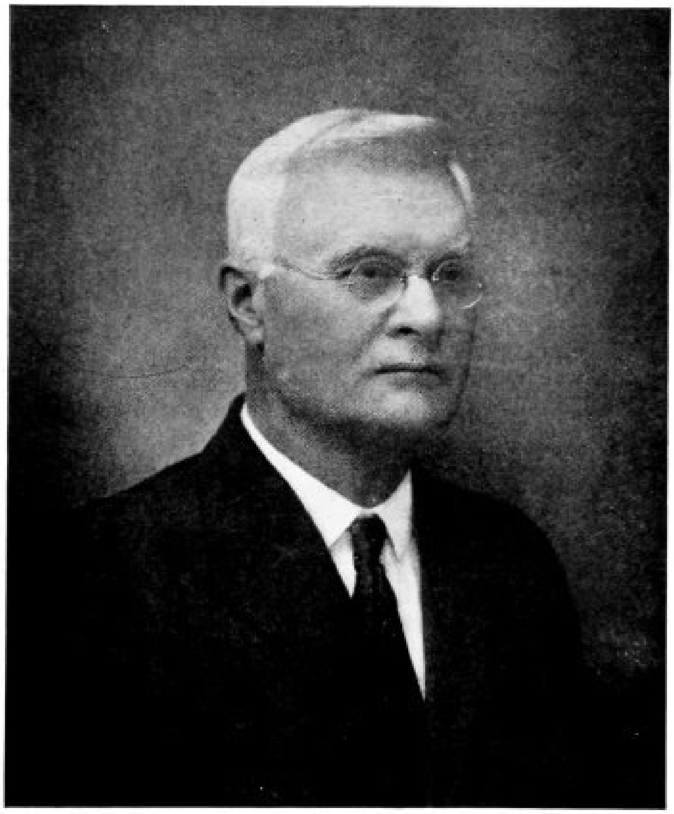
As I look back over the fifty years I have spent in the boiler industry the impression I have gained and the one I would pass on to the young man starting out is that boiler making is a good business and one in which the future holds excellent prospects for any young fellow who is willing to work hard in the shop and study. If he goes into the trade with the intention of making good, of avoiding mistakes wherever possible, taking the blame when he is at fault and not otherwise, and endeavoring to improve his failures, he will succeed.—E. W. ROGERS.

ALTHOUGH there are older living boiler foremen in this country, E. W. Rogers, general foreman of the boiler department of the American Locomotive Works at Schenectady, N. Y., has the distinction of being the oldest foreman actively engaged in the construction of boilers at the present time. His work has taken him to all parts of the United States and several times abroad in locomotive and contract boiler shops, and his experiences during his years of service make an extremely interesting story.

His early history can be passed over briefly with the statement that he was born in Laporte, Indiana, August 29, 1856, and moved to Amboy, Ill., in 1862, where he received his education in grammar and high school, later amplifying this with such studies as mechanical drawing, shop arithmetic, and geometry that would apply to the trade he had decided to follow. The story of his work as a boiler maker begins about 1869 when his parents moved to Boone, Ia., and the following account of his experiences from then on is given as he told it to us:

In May 1870, I went into the boiler department of the Chicago & Northwestern Railway as an apprentice and served my time under M. A. Butler, master mechanic of the division with headquarters at Boone.

This was at the time that coal as a fuel for locomotives was adopted. Previous to this engines were all wood burners and several of these were on the Iowa division of the C. & N. W. railway. One of them the "Spitfire," I remember quite well. She was an old hook motion affair and when the engine stopped on center, the crew had to pinch bar her off, the engineer in the meantime using what the boys called a jostling bar to move the valves or reverse her. The boiler was an upright, at the back or firebox end of the engine with the dome, whistle and a pressure gage on top. The barrel part of the boiler was projected onto the upright part principally to carry off the smoke. The stack was of the bonnet type, as full of seams as an old man's face, and with a screen over the top. In fact the stack was the biggest thing on the whole engine, and after getting a good look at it there was very little else to see. I've watched the fireman polish the brass work on the dome while standing on the floor of the round house.



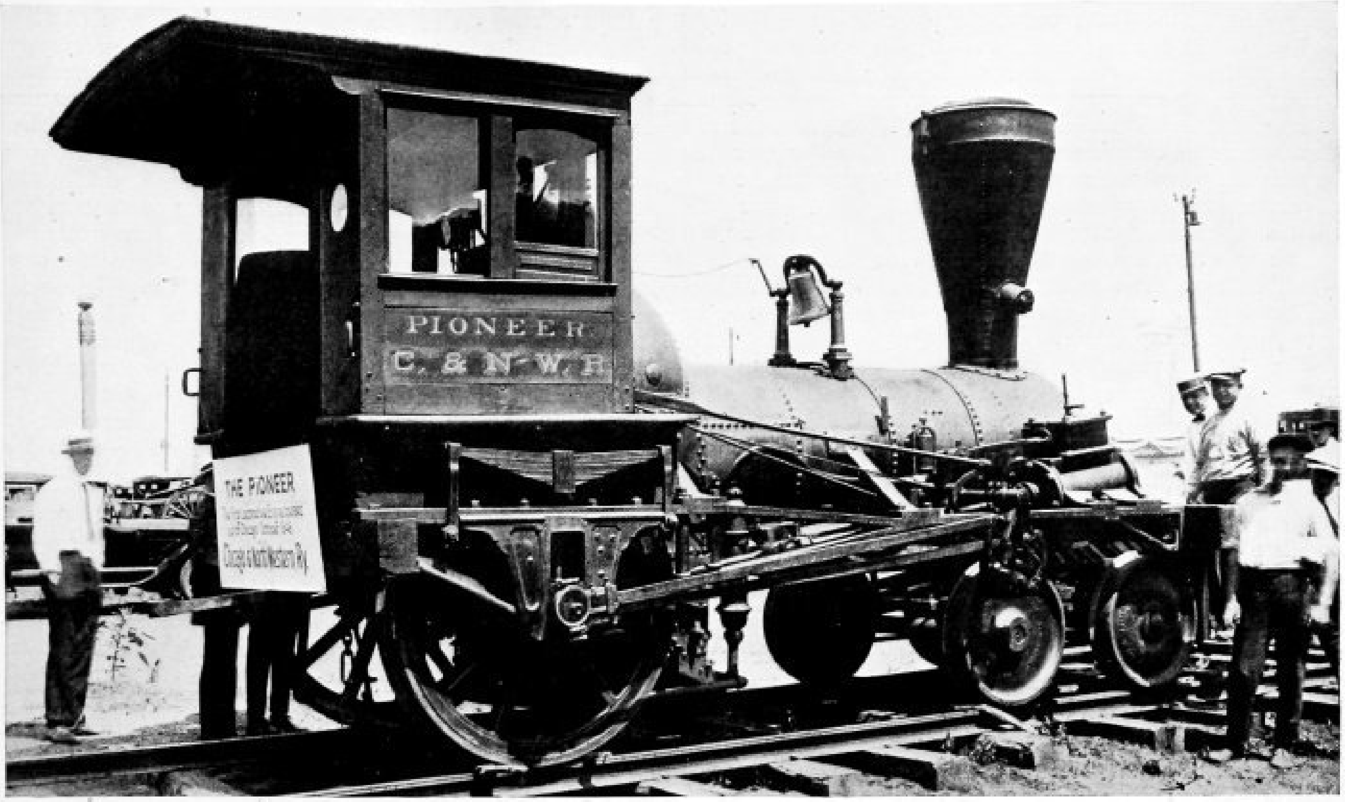
E. W. Rogers

The Iowa division of the Chicago & Northwestern had just been opened up from Clinton to Council Bluffs which was then the outskirts of civilization, or at least seemed so to me. There was no bridge over the Missouri river and we used to ferry across to Omaha. Council Bluffs was then the terminal for several railroads besides the Northwestern, the Rock Island, the Wabash, the Union Pacific and others. Omaha was the first station out on the Union Pacific.

The Chicago & Northwestern had just bought forty new Baldwin engines of the 40 ton, 8 wheel, crown bar type, equipped with coal burners. These locomotives were fitted with copper firebox side sheets, door sheets, and copper staybolts. Back flue sheets, crown sheet and the boiler were of charcoal iron, with iron tubes, a short smoke-box with a long petticoat pipe in it and a diamond stack. These engines were run on the Iowa division for ten years and gave good service. They were numbered from 196 to 235 and also carried a name on the sides of the cab, many of which I can still remember.

Like all young men after serving my time, I thought that I had to see the world, so I started this experience by going to Chicago where I worked in a contract boiler shop on Canal street. However, I soon learned that I was not as good a mechanic as I had imagined, and got some good hard knocks in railway and contract shops in Chicago, Wisconsin and Michigan. I was able to save enough money in this period to get back home, where I got a job as journeyman in Boone and worked there from 1875 to 1881. At this time I went to Grand Junction, Iowa, and worked as a journeyman boiler maker for the Des Moines & Fort Dodge railway, under John Macgrail, master mechanic, and J. Fitzgibbon, general foreman of the road, to whom I owe my first advancement (not at Grand Junction but through their recommendations later in life).

In 1885 I left the Junction going with the Missouri Pacific at St. Louis, Mo., but did not stay there very long for J. O. Chapman, whom I had worked under on the Chicago & Northwestern, was made superintendent of motive power of the road, then known as the Kansas Pacific railway, and wanted me to come with him which I was glad to do.



Photograph by "International"

The "Pioneer," Built by the Baldwin Locomotive Works, Was the First Locomotive to Run Out of Chicago on What Is Now a Part of the Chicago & Northwestern System

I stayed in Kansas City, or rather Armstrong, Kan., until 1888 when Henry Berger, an old Kansas Pacific man, then master mechanic of the Fort Scott, Wichita & Western railway, offered me the position of foreman boiler maker at Fort Scott, Kan., under him, which I accepted very gladly. The next year this road was merged into the Missouri Pacific and J. T. Jones was made master mechanic in place of Henry Berger. I got along very well with J. T. J., and stayed with the road under him until 1892.

My railway experience ended there for soon after this I went to Paterson, N. J., to become foreman of the boiler department of the Cooke Locomotive & Machine Company, where I remained for 16 years or until 1908. From the Cooke works I went to the Rogers Works of the American Locomotive Company as foreman of the boiler department and stayed at this plant until 1912, when I was transferred to Schenectady, N. Y., and appointed general foreman of the boiler department of the Schenectady works of the American Locomotive Company, where I am at present.

In going to Paterson to take up the building end of the boiler business right out of the railway shop, where very often we had to do flanging over a rail, axle or any other thing that happened handy, one might think I had "landed on easy street," but I soon found I had a long, hard road even though we had all the modern tools of the day.

We know now that the greatest improvement made on the locomotive was between the years 1895 and 1915, and most of the developments were made in the boiler. My employers were energetic and ambitious to build the best and I was anxious to help. About this time (1895) the Master Mechanics' Association appointed H. H. Hibbard, professor of mechanics at Cornell University, to investigate the methods of boiler construction in the different locomotive building plants to find out what equipment was being used and whatever other information could be found in order to reduce boiler seams, and increase the size of plates to provide larger and more efficient boilers. In the meantime, the plate manufacturers had agreed and were equipped to furnish larger plates if the builders could handle them. At this time boilers were being built with the barrel made of plates about 4 feet wide and 7/16 inch to ½-inch thick, with the gusset or taper course in two pieces and in some cases four pieces, the roof and sides and crown and sides being in three pieces. We altered this by making the roof and sides in one piece. The taper course was a puzzle as we thought it could not be rolled in one piece, but a little later we built a special boiler for the Oregon Short Line railway with the gusset in one piece. When this boiler was received at Eagle Rock, Idaho, J. F. Dunn, superintendent of motive power wrote back a most complimentary letter about it, congratulating the boiler maker. The credit was entirely due, however, to Professor Hibbard and Mr. Hewat, one of our leading draftsmen, as these two men had supervised and encouraged the men carrying out the work in the shop.

After this, we adopted the system on all boilers when plates large enough could be obtained.

Professor Hibbard then began to talk of making a firebox wrapper sheet in one piece but this to our minds seemed altogether too much to ask as the firebox usually has a rise in the top towards the front of from 3 inches to 6 inches in addition to gradually widening out from the back to the front. He argued that it was the same proposition as that overcome in the case of the taper course and because this was a success the wrapper sheet should be also. I told him it was a very difficult plate to develop, not to mention roll, and was dubious of the job going through at all. He replied, "If you will agree to try and roll it I will undertake to develop it," and, of course, I agreed. We did have a lot of trouble rolling it but when the job was finally finished it was a great success.

The professor, as well as all hands, was highly gratified and as he had spent about three months with us (in the shop most of the time) concluded to write up our efforts and results in his report. He required me to blue pencil and edit the report so that the terms and names used would be accurate. This report was finally submitted to the Master Mechanics' Association as well as to the New York Railroad Club, New York City, and he made sure that I was present at the club when his report was read. Up to the time of his death, which, by the way, was a great loss to the mechanical world, he never came to New York City that he did not 'phone or wire me to come over and visit him. He was a wonderful man, one whom it was an education to meet, forceful but kindly, willing and anxious to give of his store of knowledge and experience.

The Cooke Locomotive & Machine Company about this time installed a 4-stage 125-ton, 17-foot gap hydraulic riveter which was in addition to an 80-ton, 10-foot gap hydraulic and one 6-foot gap steam bull riveter. They also installed a new 4-post hydraulic flanging press and electric traveling cranes for handling material about the shop.

Air tools were becoming a great success very fast and out in the shop we had to hustle to keep up with the procession. Personally, I had one advantage that, even if I did not know much about the new tools, neither did the other fellow, so we exchanged experiences and ideas. Incidentally, more of this feeling of interchanging experiences would be helpful at present. Another advantage was that the tool manufacturers always sent a demonstrator with the tools and these men I have always found to be gentlemanly and painstaking. Sometimes in the early days the trials of the demonstrators were a trifle painful for we knew what we wanted and would not accept tools that failed to give the service required of them. However, we did not expect the impossible. I recall one case in particular. William Duntley (afterwards president of the Chicago Pneumatic Tool Company) came to the shop as a young salesman with a chipping hammer which he claimed could do the work of four hand chippers. We accepted his challenge and I put four of the best hand chippers that we had against him, setting up four back tube sheets, two of which he was supposed to trim, and the hand chippers the other two. Well, Bill was game (I really do not believe he expected to be called on) so he rolled up his sleeves and started. It was a great race and the hand men won by a small margin. Bill was covered with sweat and blood. We bought his tools all right, but to this day I do not believe he ever forgave me nor will he ever forget it as he often spoke of it to me afterwards. He said he was in bed for four days after the test but, nevertheless, he made good.

Electro-Percussive Welding

PRODUCTION of large quantities of duplicate parts which require welding has been found to be expedited by the electro-percussive process of welding. The apparatus consists essentially of a device for producing a percussion of the parts to be welded simultaneously with a discharge of electrical energy, the energy being taken from a condenser or a magnetic field. Use is made of electrolytic condensers charged by direct current of low value, or an arrangement is used, utilizing the energy stored in a magnetic field and discharged through the parts to be welded at the moment of weld. The discharge takes place between the points to be welded with explosive violence, and at that instant the hammer forges the parts together into a perfect union. The time of fusion and union of the parts is only approximately 0.0095 second. The time sequence of events shown in an oscillogram taken during a weld between 3/8-inch copper and steel rods indicated a peak current of 2,600 amperes, an arc voltage of 30, a maximum power of 60 kilowatts and an energy consumption of 0.00077 kilowatt hours. The time of the complete operation was 0.094 second.

The advantages of this process are as follows: At least three-fourths of the power consumption is saved as compared with butt welding; the speed of the process is very great and thus production depends almost entirely on the time required to handle the pieces; unusual welds may be accomplished, such as welding of small rods to heavy plates or blocks, without previous treatment or preparation of the surface; the energy is consumed in a very small amount of material and does not heat up the rest of the stock, and it may therefore be used where excessive temperatures of the whole stock would cause a loss of temper; unlike metals may be welded as readily as metals of like kind; the character of the welds realized after a proper adjustment of the apparatus is made is independent of the skill of the operator, thereby reducing labor cost, and the percussive process produces a much smaller fin or flash than butt-welding. The reduced fin results in a decreased cost for finishing the parts.—*Electrical World.*

Marine Equipment Exposition to Be Held in New York

THE annual Marine Exposition for the purpose of promoting interest in American shipping affairs will be held at the Central Mercantile Building, Sixth avenue, 18th to 19th streets, New York, during the week of November 14, under the direction of the Marine Equipment Association of America, 233 Broadway, New York, of which Colonel E. A. Simmons is president and K. L. Ames, Jr., McCormick Building, Chicago, is secretary.

The future welfare of our foreign trade in which the boiler industry, as well as every other industry of the country is greatly interested, depends on the ability of the nation to efficiently maintain our Merchant Marine in this period of business depression through which we are passing, so that later when the tonnage is required it will be available. The method of giving annual expositions relating to shipbuilding and shipping matters has proven successful, and it is hoped that the general interest created in shipping affairs this year will be more far-reaching than ever.

Principles of Riveted Joint Design

(*Continued from page 259*)

failure by the crushing strength of the inside butt strap against the rivets in both the first and second rows. The strength equation is:

$$(T + Crb) = (P - 4d) \times t \times T_s + 3 \times d \times b \times C$$

Failure through section d-d need not be considered because the section is not reduced below that of section c-c.

The very simplicity of the manner in which compound failures are determined, should by this time have become apparent. Notice how identical are the two compound failures through section b-b with the two compound failures through c-c.

Through b-b we have only the outside row of rivets to provide added shearing and crushing strength, whereas through section c-c we account for two rows of rivets; otherwise the calculations are exactly the same.

The final compound failure to be considered is the crushing of the main plate against the two inner rows of rivets, coupled with the shearing resistance of the rivets in the two outer rows. The strength equation is:

$$(Cr + Sh) = 8 \times d \times t \times C + 3 \times a \times s$$

Because the fourth or innermost row of rivets does not represent a reducing section, failure at this point is, theoretically, impossible. Therefore it need not be considered.

Divide either of the above eight values, whichever is the least, by W, and the quotient will be the true efficiency of the joint. (*To be continued*)

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

Edward A. Simmons, *President* Roy V. Wright, *Secretary*
Henry Lee, *Vice-President and Treasurer*
6 East 39th Street and Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1,
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $3.00; foreign, $5.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,600 copies were printed; that of these 4,600 copies 4,051 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 71 were mailed to advertisers, 34 were mailed to employees and correspondents, and 428 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 43,600, an average of 4,844 copies a month.

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

GENERAL: PAGE.
Flanging and Dishing Boiler Heads 245
Notes on Locomotive Boiler Tests 249
Hoover Favorable to Revision of Marine Boiler Regulations 252
Executive Committee Meeting of the Master Boiler Makers' Association 252
Duties of a Boiler Maker Aboard a Naval Transport 253
Standard Requirements for Staying Flat Surfaces 254
Explosion of Long Seam Boiler 256
Principles of Riveted Joint Design—III 257
Fifty Years as a Boiler Maker 261
Electro Percussive Welding 262
Marine Equipment Exposition to Be Held in New York 262

EDITORIAL COMMENT 263

ENGINEERING SPECIALTIES FOR BOILER MAKING 264

QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Spiral Chute Development 266
Stack Collar Layout 267
Re-staying Wet Bottom Boiler 268
Conical Tank Development 268

OBITUARY 268

PERSONALS 268

LETTERS FROM PRACTICAL BOILER MAKERS:
A Welded Locomotive Tender Tank 269
The Cost of Boiler Scale 270
An Unusual Boiler Shop Service Record 270
Straightening a Tank Frame 270

BUSINESS NOTES 270

ASSOCIATIONS 271

TRADE PUBLICATIONS 271

SELECTED BOILER PATENTS 272

Where boiler and plate shops are not equipped to handle the dishing and flanging of large steel heads or heads for special purposes, the steel mills are in a position to do this work. Hand flanging and machine flanging methods practiced in the average shop are familiar to members of the boiler industry, but the details of the quantity production of heads in the specially arranged flanging departments of the steel mills are not generally known. For this reason, designers and manufacturers of boilers and tanks, as well as the men in the boiler shops, will find the feature article of this month's issue of The Boiler Maker of special interest, as many of the methods can be applied to the operations in smaller shops. Further details of hand flanging will appear in a later issue of the magazine.

The Ohio Board of Boiler Rules has recently decided to permit the acceptance in Ohio of boilers stamped according to the requirements of the by-laws of the National Board of Boiler and Pressure Vessel Inspectors. This official recognition of the National Board definitely places it on the basis of a functioning body with the same authority given its inspectors outside the state as under the laws within Ohio.

With Ohio strongly supporting the work of the Board, other states accepting the American Society of Mechanical Engineers' Boiler Code as a standard will be influenced to modify their requirements to a similar end. It is only through the voluntary action of the state legislatures in granting authority to members of the Board that the principal aim of this organization—to have boilers built in any one of the Code states, and inspected by a member of the Board, equally acceptable in all other states governed by the Code.

The National Board includes in its membership the heads of the boiler inspection departments of Code states and cities and since the adoption of the constitution and by-laws in February, 1921, these men have been attempting to bring about the support of the organization's work in their several states. They have been greatly handicapped by their inability to meet frequently together and especially by the reluctance of state legislatures in general to give attention to new proposals at this time.

The action Ohio has taken in the matter will serve as a precedent to the legislatures of other states and it is hoped that all states enforcing the A. S. M. E. Boiler Code will come to the support of the National Board, so that it may the sooner serve the interests of the boiler industry as originally intended.

Continued explosions of portable boilers in the state of New York have caused the Industrial Commissioner of the State Department of Labor to place the report of a recent boiler explosion investigation at Genoa, N. Y., in which three people were killed, in the hands of the district attorney of Cayuga County to determine the responsibility for the accident.

The requirements in New York State based on the Boiler Code for yearly inspections are rigidly enforced, yet some users of boilers, especially of the portable type, fail to comply with the law that their power equipment be examined by either the state inspectors or those of duly authorized insurance companies regularly. The same condition prevails in many other states and to even a greater degree in some, where the law is either not so strict as in New York or where no law at all exists for the regulation of steam boilers.

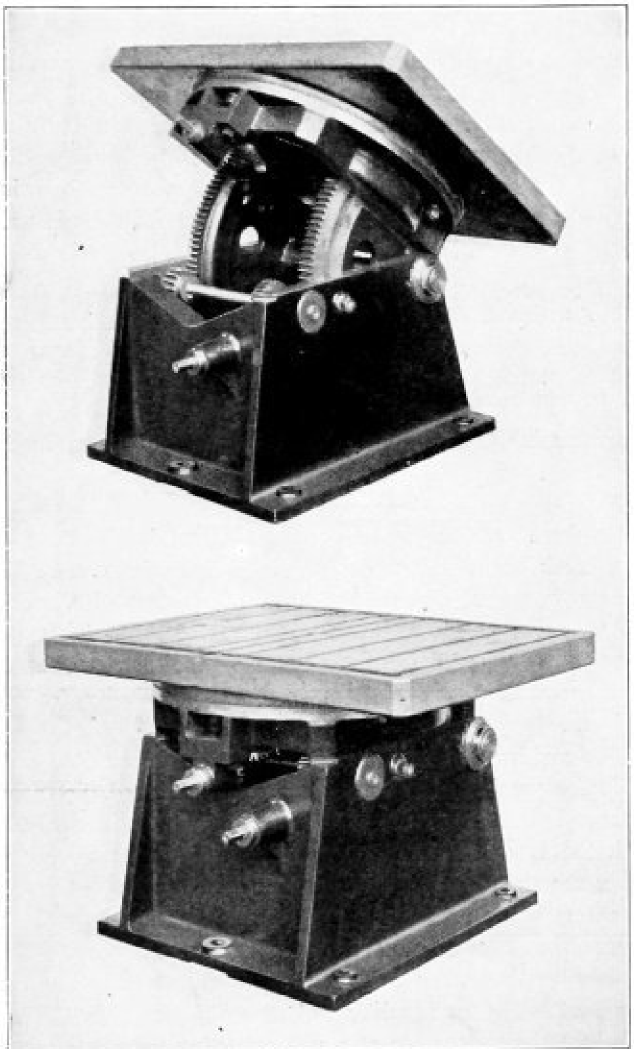
Where boilers operate at a pressure of fifteen pounds per square inch or less, no provisions have been made for their inspection and the danger of fatal accidents from them is slight. No argument, however, should be necessary to convince the owners and users of higher powered boilers that laws governing their inspection and maintenance should be enforced not alone for the interest and safety of the community at large, but also for their own personal interest. This latter is especially true if, as in the case of the explosion now under investigation, the fixing of responsibility for such disasters is to be handled by the district attorney's office of the section in which such explosions may occur.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Tilting and Rotary Table for Use with Boring and Drilling Machines

As a means of speeding up work and reducing machine shop costs a new work table for use with floor type boring, drilling and milling machines, known as the Universal tilting and rotary table has recently been put on the market by the Pawling & Harnischfeger Company, Milwaukee, Wis. This accessory makes it possible to carry out machining operations on five sides of a piece and at any angle with but one set up. The table has an elevation of 90 degrees and can be revolved through 360 degrees in any position, flat or elevated.



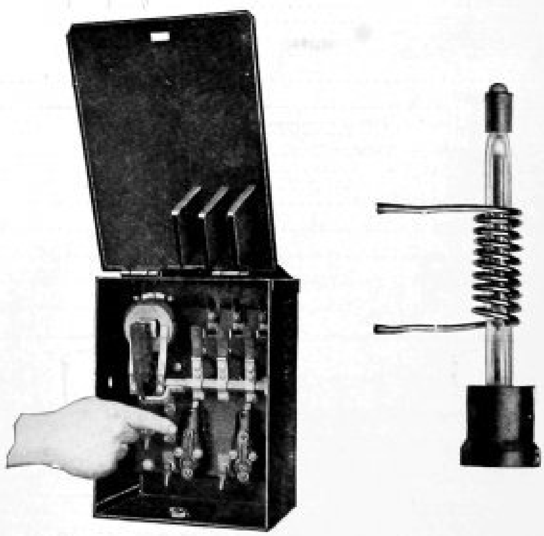
Universal Tilting and Rotary Milling Table in Closed and Open Positions

There is a graduated dial placed in a convenient position so that the operator may locate the work accurately. The table top is elevated by means of two coarse pitch spur gear segments driven by means of a worm and pinions; and it is revolved independently by a bevel gear and pinion. One revolution of the ratchet handle turns the table 30 degrees and one revolution of the elevating handle elevates the top 2½ degrees.

Automatic Starter for Squirrel Cage Motors

A new automatic starter for small squirrel cage motors which allows a large starting current for several seconds but at the same time gives protection against burnout troubles has been developed by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Two mercury overload relays mounted below the contact fingers, shown in the illustration, take the place of fuses and allow momentary overloads and overloads as high as 25 percent for a limited period without injury to the motor.

The overload relay consists of a glass tube carrying a mercury column which forms a part of the pilot circuit of the magnetic switch coil. A portion of this column is surrounded by a heating coil or thermal element. This element is in series with the motor circuit and is heated in the same proportion as the motor windings. Excessive current passing for too long a period heats the coil, causes the mercury to boil and the vapor to pass up into a chamber at the top of the tube. This action breaks the liquid mercury column and opens the circuit of the magnet coil. As this coil is de-energized, the contact fingers drop away and disconnect the motor from the line. After such an interruption, the mercury cools down, becomes liquid again, drops back into the tube so that the pilot circuit to the magnet coil is complete when the control button is depressed.



Automatic Starter and Mercury Overload Relay

As the functioning of these overload relays depends upon the temperature at which mercury will boil, it is evident that the current required to operate the relay increases with the decrease in the temperature of the surrounding air. In other words, if the motor and the starter are installed in a cool location, the relay permits a greater starting current or a higher overload than if the temperature of the surrounding air were higher. Likewise, if the motor and starter are located in an unduly hot place, the mercury relays will act in the place of a thermo-couple.

Duration Time Watch for Studying Efficiency

For the purpose of facilitating the timing of industrial operations, the Mortimer J. Silberberg Company, 122 South Michigan Avenue, Chicago, Ill., has perfected an instrument designed to handle the timing of from one to ten production motions, up to five minutes in duration.

New Type Time Study Watch

The instrument has three circles on the face of the dial, the outer circle being in red, the center circle in black and the inner circle in blue. The large hand makes a total revolution of 100 seconds, and the small hand in the center moves over a red, black and blue sector, thereby showing in which circle the large hand is operating.

All of the figures on the face of the dial denote production per hour, based on the timing of 10 operations. For example if 10 operations were observed to have elapsed in 20 seconds the figure under the large hand in the red circle would show 1,800 operations per hour, based on 10 operations having been completed in 20 seconds. If instead of 10 operations, one operation is observed to have lasted 20 seconds, then instead of 1,800 it would be necessary to point off one figure with a decimal, and the result would be 180 operations per hour, based on one operation being completed in 20 seconds.

If an operation is timed and its duration is 130 seconds, it will be noted that the large hand will have made one total revolution, and thirty seconds additional, and the small hand in the center of the dial will have passed the first sector, and show in the second sector, which is the black, and which denotes that the operation must be read in the black circle; and reading under the 30-second mark in the black circle the figure 277 will be noted. However, this figure being based on the observation of 10 operations, and only one operation having been timed in that period, it is necessary to point off one figure, and the result is then 27.7 operations per hour, based on one operation timed in 130 seconds.

New Combustion Recorder Maintains Double Analysis of Flue Gases

A recent development in combustion control is embodied in the new type instrument known as the Duplex Mono recorder which maintains a continuous record of the carbon dioxide content and also the percentage of combustible gases present in flue gas. To obtain the highest efficiency from the operation of a furnace, the firing must be so adjusted that a proper balance between these two factors is maintained. The boiler from which the analysis shown in Fig. 1 was taken was operating at about its most efficient point as is evidenced by the high carbon dioxide content indicated by the white area and the low percentage of the combustible gases present represented by the light shaded area between the white and dark portions of the chart.

The instrument itself shown in Fig. 2 does not make use of any mechanical means to force the gas through the apparatus, mercury being used, instead, which also performs

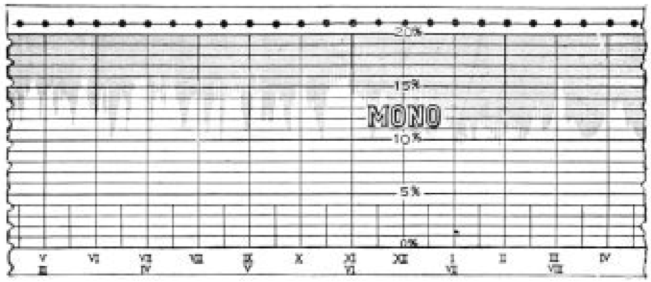


Fig. 1.—Chart Showing Proper Combustion in Boiler

the function of valves. The samples analyzed for carbon dioxide and combustible gases combined are passed through an electric furnace where the combustible gases, carbon monoxide, methane (CH_4) and hydrogen are converted into carbon dioxide and water. When there is not sufficient oxygen in the flue gases to oxidize the combustible gases, the necessary oxygen is supplied by copper oxide placed in the electric furnace for that purpose. Ordinarily, however, the necessary oxygen is taken from the flue gases, which almost invariably contain sufficient free oxygen, the copper oxide acting merely as a catalytic agent.

The carbon dioxide originally in all samples as well as that formed by the oxidation of carbon monoxide and methane (CH_4) in the alternate samples which pass through the electric furnace is removed by passing the gas through a caustic potash solution. Water formed in the electric furnace through the oxidation of hydrogen and methane in alternate samples is condensed. The analyses for carbon dioxide alone are accurate within 1/10 of one percent. The indications for combustible gases not being intended for accurate measuring purposes are exaggerated on the chart as is desirable in a danger signal.

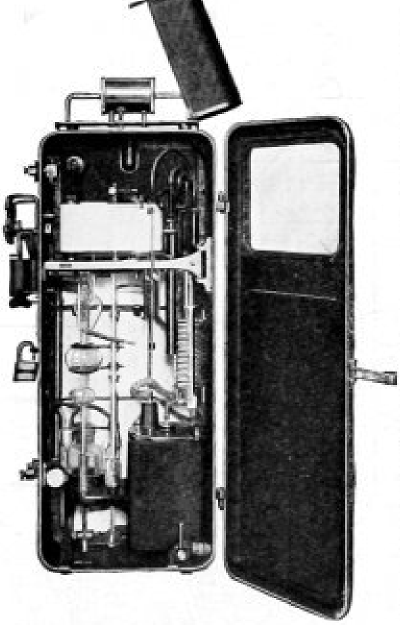


Fig. 2.—Duplex Mono Recorder

The records thus made by the instrument make clear to the firemen and to the plant executive the heat and combustible gas losses at any period during the operation of the boiler. No limit should be placed on how high the carbon dioxide should be kept by the fireman provided that he avoids combustible gases in the flue. However, the best balance to be maintained is shown in Fig. 1. In any case where the combustible gases appeared at high or low percentages of carbon dioxide, the chart shows that they were promptly detected and eliminated.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, 6 *East 39th Street, New York City.*

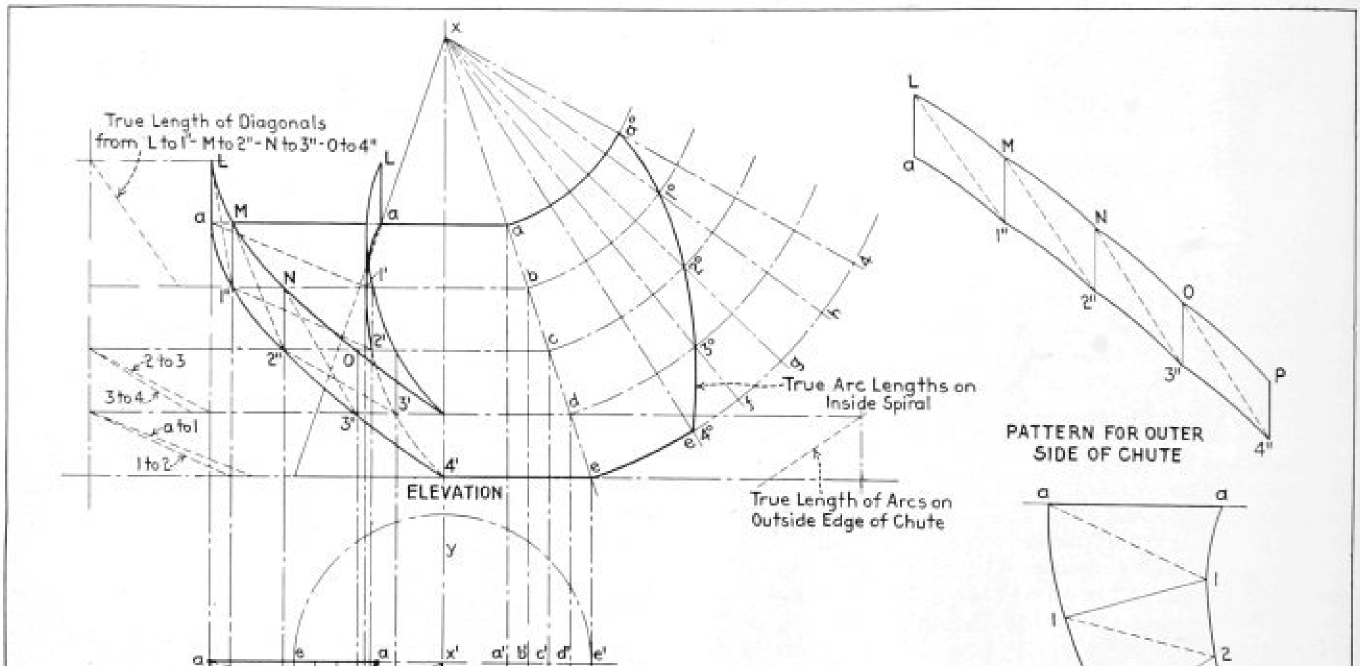
Spiral Chute Development

Q.—Kindly illustrate the way to lay off the views and patterns of a spiral chute as it would appear intersecting a cone. This problem has given me considerable trouble.—F. B.

A.—From your explanation we understand that your problem is similar to the conditions shown in the plan and elevation of the drawing we submit as the solution to the example.

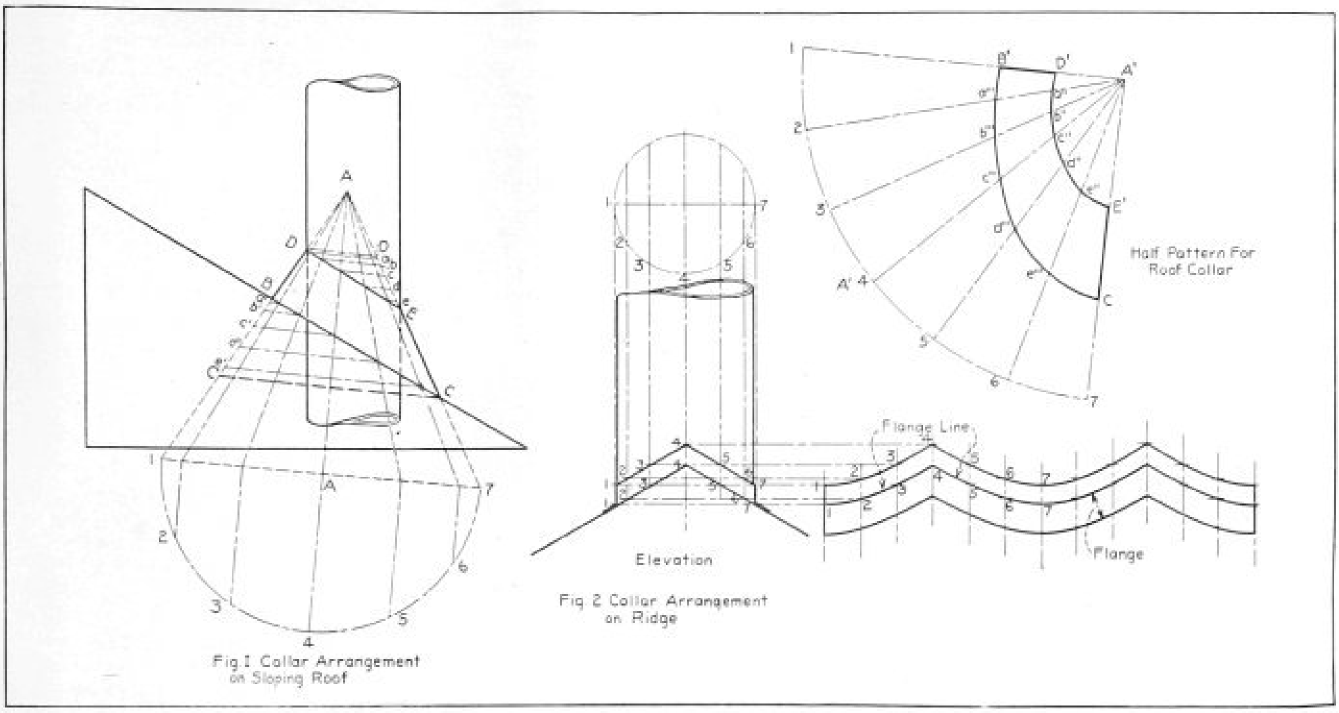
First consider the construction of the spiral along the cone. Pass a number of horizontal planes equally spaced through the cone. In the plan, the sections on the cutting planes are circles. Space one-quarter of the circle, which represents the base of the cone, into the same number of equal parts as there are sections in the elevation of the cone. Draw the radial lines as *f*—*x*′, *g*—*x*′, *h*—*x*′ in the plan. Points 1—2—3 and 4 are on the spiral curve and are shown projected to a—1′—2′—3′—4′ in the elevation. The outer curve can be laid off in the same manner. The side of the chute equals a—*L* and is of the same width both on the inside and outside of the object. A complete projection of the chute is made in the two views, plan and elevation, and by following the construction lines it will be seen how the method should be applied.

By the methods of triangulation the bottom of the chute is developed. Note the arrangement of these triangulation lines and how their true lengths are established, also how the arc lengths on the inside and outside of the spiral are found.



Plan and Elevation of Spiral Chute

For the arc lengths on the inside edge of the chute, a development is made by first considering the surface of the cone to be rolled out flat, and on the surface are projected the true arc lengths. The drawing indicates fully how this is accomplished.



Arrangement of Stack Collar on a Sloping Roof and on a Ridge

There are a number of interesting problems in this example and it would be well for beginners to make a thorough study of them, as for example the use of cutting planes, development of a spiral, laying off the pattern for the frustum of a cone, to show the path of the spiral in the pattern, to find the true lengths of oblique lines, the use of triangulation in developing warped surfaces, that is, surfaces having a compound curvature.

Stack Collar Layout

Q.—In cases where stacks pass through the sloping side of a roof and also directly through the ridge or peak, how do you make the patterns required to fit around the stack and fit the roof? E. F. C.

A.—Figs. 1 and 2 show, respectively, the arrangement of collars on a sloping roof and on a ridge. It will be noted in Fig. 1 that the collar is a frustum of a cone, and its pattern can be laid off by the radial method. Before this can be done, extend first the sides *B-D* and *E-C* of the frustum to intersect in point *A*. Complete the cone *A*-1-7 and draw the semi-circle representing one-half of its base. Divide the semi-circle into a number of equal parts and from the points 2-3-4-5, etc., draw lines at right angles to the base line 1-A-7. From the points located on the base, draw the radial lines intersecting in point *A*. The true lengths of lines on the elevation of the frustum must be found, which may be done by drawing lines from the line representing the roof and the intersecting radial lines. These lines are drawn at right angles to the center line *A-A* and intersect the outer element of the cone at *a-b-c-d*, etc., and at *a′-b′-c′-d′*, etc.

The pattern can now be laid off as shown, constructed in the view for a one-half pattern. With A-1 of the elevation of the cone as a radius describe an arc; make its length equal to the circumference of the base of the cone. Divide it into the same number of equal parts as the base profile is divided into. Draw in the radials as A′-1, A′-2, A′-3 shown in the pattern. From the elevation transfer the radial lengths A-a, A-b, A-c, etc., and A-b′, A′-c′ and A-d′, etc., to the pattern, thus locating points as a″-b″-c″-d″, etc., for the top of the pattern and a‴-b‴-c‴ for the bottom. Make allowance for lap and flange material.

The development of Fig. 2 is made by projection. The collar is laid off in an elevation, as would be seen looking directly at the intersection between the sloping sides of the roof. Draw a circle to the outside diameter of the stack and divide this profile into a number of equal divisions. Project them in the elevation to intersect the roof line. The pattern is laid off at right angles to the elevation as follows: Lay off on a horizontal line the circumference of the collar, and divide this distance into the same number of parts as in the circular profile. From the elevation project the lengths 1-1, 2-2, 3-3, etc. locating them in this relative position in the pattern. Allow for material for the flange that is attached to the roof.

Re-Staying Wet Bottom Boiler

Q.—I have a 25-horsepower wet bottom boiler. The staybolts in the bottom sheet of the firebox are fitted around and some were leaking. I took a few out and found that the sheet was thicker back from them a little. If the holes were reamed out to 1½ inches, the plate would be thick enough for two or three threads back from them; still further it is nearly as thick as new while the above sheet, or bottom of the firebox, is as good as new. I was thinking about reaming out and fitting in 1½-inch staybolts. What is your suggestion on this? Would that much reaming cut make the sheets particularly weak? I think it would make a fairly satisfactory and simple job. The balance of the boiler is good. Original staybolts were ⅞ inch. C. G. G.

A.—Where pressure parts of a steam boiler have been found to be worn thin from corrosion and pitting, the boiler may be operated at a lower pressure than what it was built for. If the original pressure must be carried then the boiler inspector handling the district under which the boiler is operated must prescribe the means of making such repairs. Where the boiler plate has deteriorated to the extent that it is thin in several spots, either repair the damaged plate or reduce the pressure to that which the weakened or weakest part will carry.

As an example to show how the allowable working pressure may be determined in cases of this kind, the following is given:

A boiler shell plate ½-inch thick, originally was allowed a working pressure of 160 pounds per square inch; from corrosion the plate had been reduced to a thickness of 5/16 inch. What should be the allowable pressure on the boiler?

The regular rules used in boiler designing can be applied in determining the allowable working pressure or it may be found by the rules of proportion. As in the example given, "the strength of the boiler shell varies directly as the thickness of the plate," hence:

$$\frac{160 \times 5/16}{3/8} = 133\tfrac{1}{3} \text{ pounds per square inch, allowable}$$

working pressure.

In the case of flat stayed sections the strength of the boiler parts does not vary directly as the plate thickness or its area, because the method of staying enters into the problem. The respective rules governing staying of flat plate sections give a constant having a different value for different methods of staying.

According to the A. S. M. E. rules on staying flat surfaces, the following formula is given:

$$P = C \times \frac{t^2}{p^2}$$

where P = maximum allowable working pressure in pounds per square inch.

t = thickness of plate in *sixteenths* of an inch.

p = pitch of staybolts.

C = constant, being a value for the different methods of staying.

The formula shows that for a given constant the strength of the plate varies directly as the square of the plate thickness. Therefore, if a plate 9/16 inch thick is allowed a maximum working pressure of 200 pounds per square inch and has deteriorated to a thickness of 7/16 inch the allowable pressure would be

$$\frac{200 \times 7/16}{9/16} = 121 \text{ pounds per square inch.}$$

The method you have in mind of re-staying the surface with larger stays would not overcome the weakened condition of the plate. Staybolts are threaded, 12 threads per inch, and you state that the plate is thick enough for at least 2 threads, which would mean a plate thickness of 2/12 inch, or expressed decimally, of 0.1666, which is under 3/16 inch. This is too thin. The plate should be repaired by removing the damaged sections and applying either oval or round patches; if there are a large number of thin spots, apply a new section to the side sheet or bottom sheet.

If the plate has deteriorated only around the stays, ream out the staybolt holes to remove the damaged plate and install larger stays.

Conical Tank Devlopment

Q.—I am writing to you for information as to how to lay out a conical tank. You will find sketch accompanying. Please show me how to proceed to make layout. A. McC.

A.—From your statement of the problem we have assumed that the tank is of the shape shown in the perspective, Fig. 1.

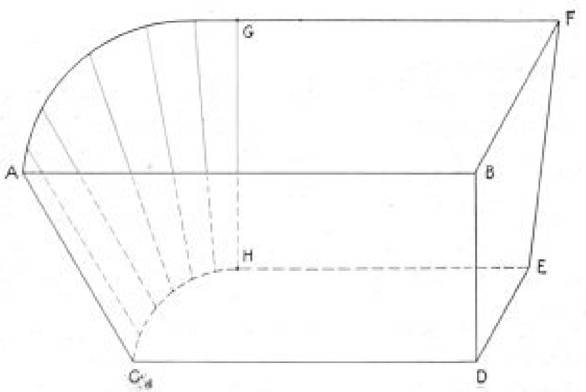


Fig. 1.—Perspective View of Conical Tank

The front of the tank is a straight side *A-B-C-D*, the end is also a quadrilateral *F-B-D-E*, the top and bottom are similar in shape, tapering from the top *A-G-F-B* to the bottom *C-H-E-D*.

The pattern for the conical section is laid off by first constructing a section of the cone of which this section is a part. This is done as shown in Fig. 2. The side *A′-C′* is extended

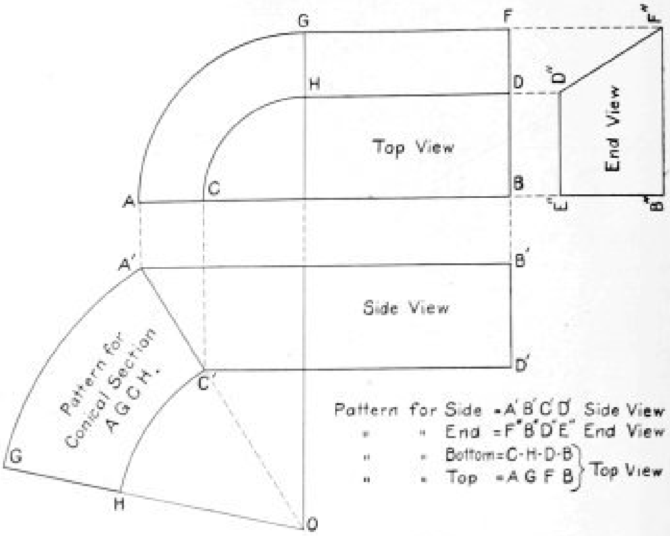


Fig. 2.—Pattern for Sections of Conical Tank

to meet the vertical center line *O-G* in the point *O*. With *O* as a center draw an arc, and make the length *A′G* equal to the arc length *A-G* of the top view. Connect *G-O* with a straight line and *A′-C′-H-G* is the required pattern.

It is necessary to make the tank of several sections. However, two adjoining sides can be laid off and bent to the required form. The shape of the patterns for the sides, top and bottom will be of the same form as their profile view shown in the top, side and end views, and the patterns may be laid off directly from these views.

To illustrate, the pattern for the front side will be of the form shown in the side view as *A′-B′-C′-D′* the end section of the form *F″-B″-D″-E″* of the end view, the top of the form indicated in the top view at *A-G F-B* and the bottom as at *C-H-E-D* shown also in the top or plan view.

OBITUARY

Francis Burke Allen, for over 48 years associated with the Hartford Steam Boiler Inspection and Insurance Co., died recently in his eighty-first year at his Hartford home. His good work in the Hartford Company had brought him up to the position of vice president, which he held at the time of his death.

PERSONALS

A. Clarke Morre has resigned as assistant to president of the Globe Seamless Steel Tubes Company, Milwaukee, Wis., with which he has been connected since November, 1919.

William J. Shriver, of the steam boiler and engine inspection department of the Fidelity & Casualty Co., was transferred recently from the Milwaukee office to the Chicago office, and now has charge of inspection work in the Chicago territory.

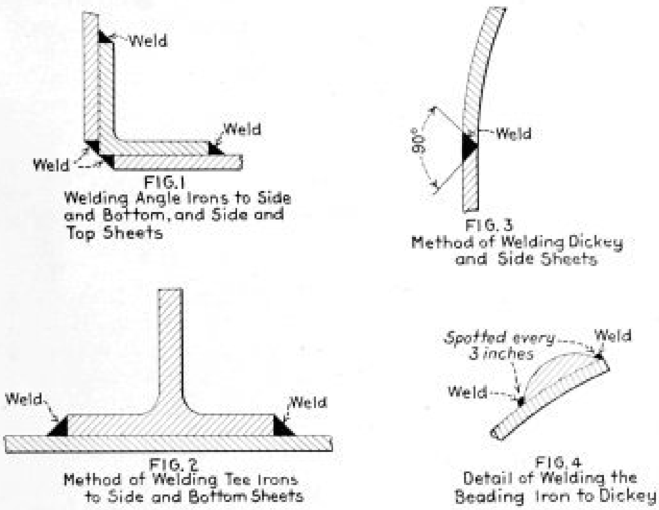
In a fire which damaged the Erie Railroad's roundhouse at Pavonia avenue, Jersey City, N. J., September 11, eighteen heavy passenger locomotives were completely destroyed. The total loss is estimated at $350,000. Engines from other terminals are being used to maintain the traffic service from Jersey City.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

A Welded Locomotive Tender Tank

During the past seven or eight years the art of autogenous welding has made rapid progress and the introduction of electric arc welding and oxy-acetylene welding into railroad shops has brought about results which were not possible of attainment by old methods. It frequently happens that parts which would be difficult to repair by welding in a blacksmith's forge can be readily repaired by autogenous welding.



Details of Welded Sections of Tender Tank

The work has been simplified and it is now possible to repair broken or damaged parts without the necessity of dismantling other sections of a locomotive, and this means a large saving in time and reduces the cost of repairs. Oxy-acetylene welding can be used successfully in many kinds of repair work, but it is difficult to weld steel plates or sheets by this process on account of buckling and bulging produced by heat. In this work the electric arc process can be applied to advantage.

It is recognized that welded joints are strong and reliable and in the case of tank work there is the added advantage of freedom from leakage. In the case of a riveted joint considerable time is required for laying out and punching rivet holes and in calking; and this work is not necessary in the case of electrically welded joints.

Construction of Tank

We have had considerable experience with electric welding in the Boston and Albany shops, particularly in boiler work, and in view of the successful results obtained and the adaptability of this process for welding seams of tanks, the railroad decided to construct a tender tank by joining the different parts together by means of the electric arc welding process.

Details of the Tank

The tender tank is of 8,000 gallons capacity and was built at the West Springfield shop. So far as known, this is the first departure from the customary riveted type construction for tender tanks.

The manner in which the sheets are welded to the tank angles is shown by Fig. 1. This is a satisfactory method, as the welding can be done readily at reasonable cost and the strength of the joint is in excess of that usually obtained by the riveted type of construction. The side plates are butt-welded, and the tank braces and splash plates are securely welded to the sheets and the whole construction results in a watertight tank of good appearance.

Safety appliances and tank lugs are riveted on. The tender tank is 26 feet long, 10 feet wide and 5 feet 2 inches high, having a capacity of 8,000 gallons of water and 12 tons of coal; and is used with a Pacific type locomotive in passenger service. The tender is equipped with a Commonwealth cast steel underframe, equalized trucks, 5½ inch by 10 inch axles, Miner friction draft gear and radial buffer.

In assembling the various parts of the tank, approximately 1,200 linear feet of welding was done, and the following tabulation showing the welding work may be of interest.

	Feet
Butt-welded seams ¼ in. plate	85
Eight 3½ in. by 3½ in. by ⅜ in. reinforcing tees	550
Ten 2½ in. by 2½ in. by 5/16 in. tank angles	410
Twenty-three 3½ in. by 3½ in. by ⅜ in. side tees	120
Beading at dickey	25
Total linear feet of welding	1,200

The welded method of construction eliminates the necessity of punching rivet holes in sheets, tees and angles and there appears to be less likelihood of leaks, and it is expected that cost of maintenance will be reduced.

The photograph, Fig. 5, shows the completed tank and the absence of rivet heads is particularly noticeable.

The tender tank has been in service for more than five months, and no defects of any kind have developed; and we

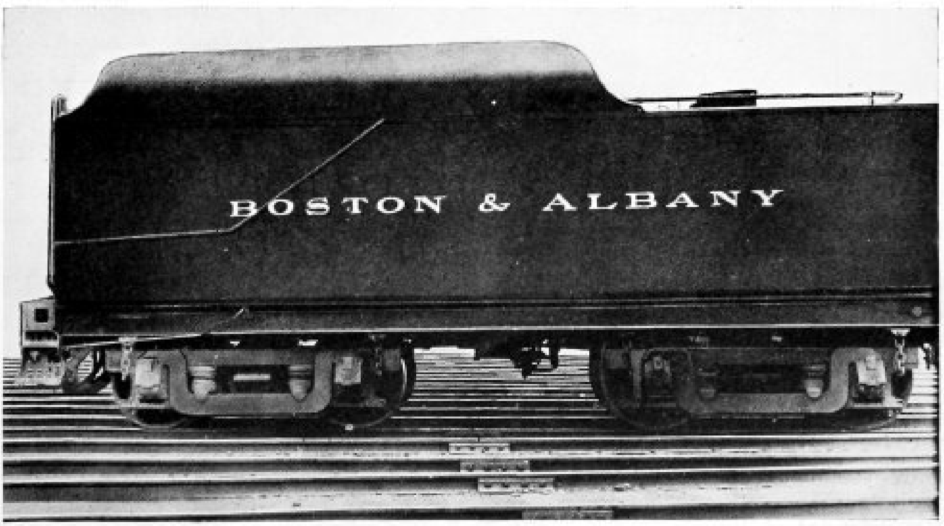


Fig. 5.—Eight Thousand Gallon All Welded Locomotive Tender Tank.

are confident that the welded type tender tank will gradually supplant the old riveted type of construction.

West Springfield Shops, Boston and Albany Railroad. J. W. MURPHY, General foreman.

The Cost of Boiler Scale

No one disputes the statement that scale is a bad thing, that it has caused and is causing serious losses. The actual money loss due to a definite thickness of scale is a variable quantity, for much depends upon the kind of scale, whether carbonate or sulphate, hard or soft, etc.

The most commonly used rule for determining the money loss is that given in Sames' Mechanical Engineering Handbook as follows: "Scale of 1/16 inch thickness will reduce boiler efficiency 1/8; and the reduction of efficiency increases as the square of the thickness of scale."

The chart shown herewith is based upon the above rule.

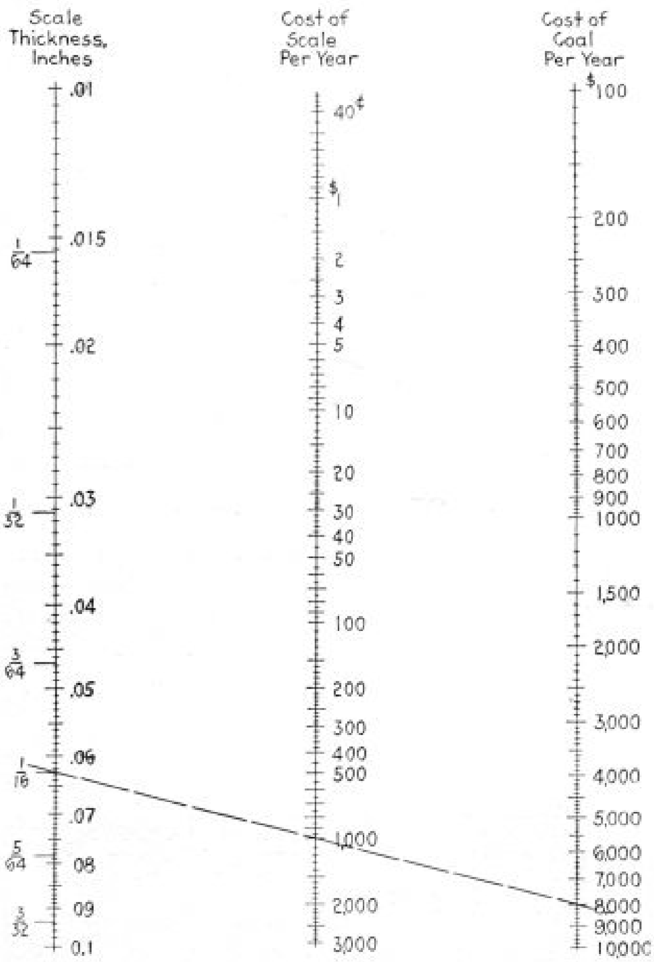


Chart for Determining Loss Due to Scale

It covers all scale thicknesses from .01 inch to 0.1 inch and for convenience shows thicknesses in fractions as well as in decimals of an inch. The dotted line indicates that where $8,000 is spent per year for coal, $1,000 per year is lost due to a scale 1/16 inch thick.

Whatever the thickness of scale and whatever the coal costs per year (up to $10,000), this chart shows the money loss in strict accordance with the given rule. It may help to indicate where the installation of a water treating device would save money or it may show how often boilers should be thoroughly cleaned.

Newark, N. J. W. F. SCHAPHORST.

An Unusual Boiler Shop Service Record

It is sixty-nine years since my father signed my indentures to the Niagara Dock Company to serve five years as an apprentice in the boiler making trade and I have been at it ever since. I can hardly say I am working at boiler making now, still I am working in a boiler shop clearing up, sweeping and picking up bolts, washers, nuts and rivets. I do not think there is another man in the country who has worked in a boiler shop as long as I have. What do you say?

As an apprentice, while heating rivets, I wanted to be a chipper and calker and every chance I got I had the hammer and chisel in hand. When I was able to use the chipping and calking tools, I was not content until I got the riveting hammer, and then nothing would do until I got the flange fire. When I could flange, I laid out all my work and from that picked up the laying out. On my travels when I was looking for work I always inquired if a riveter was wanted. (It did not matter if they wanted a right or left hand riveter, I was "there.") The same in calking. I very seldom asked for a flanger's job and never for a layerout job without knowing there was one wanted, and I am proud to say I always had good luck with all my work.

I would like to know what readers of THE BOILER MAKER think of my record for length of time at working in a boiler shop, and whether any of them can look back over a longer period of shop service than I?

Springfield, Ill. JOHN COOK.

Straightening a Tank Frame

Recently I had to straighten a heavy cast steel tank under frame that was bent down 4½ inches on the front end. I removed this frame from the trucks and blocked it up on the floor, making the blocks (at the point where the frame was too high) the original height of the tank. Then I took a six driver light shifting engine that was on the blocks with the wheels out and blocked it up on the under frame, blocking it just as it was on the floor, i. e., on the pedestal caps. Using a ½ inch pipe burner that took in the full width of the frame, and the fuel oil tank that we use for heating tires, and covering the blocks with tin and asbestos lagging, we started a heat on the frame at 12:30 P. M. We then filled the boiler with water as the engine itself would not bring the frame down. With the boiler full of water the frame came down to the blocks in fine shape, thus straightening the frame to its original height. The frame was back on the trucks at 2:30 P. M.

Conway, Pa. C. J. CASBOURNE.

BUSINESS NOTES

The Whitlock Coil Pipe Co. is now manufacturing an all-steel steam superheater, constructed with heavy open-hearth steel headers and heavy-gage seamless steel tubing, the heating elements being expanded into the steel headers. The openings opposite the expanded tube terminals are closed by means of patented gasketless removable steel caps.

The Dodge Sales and Engineering Company of Mishawaka, Ind., announces that the excavation for its new $1,000,000 building in New York City at 49 Park Place is practically completed. The basement of the building and part of the first three floors when completed will be used by the Dodge Sales and Engineering Company as a warehouse, and for the sales and distribution of Dodge, Oneida and Keystone products for the mechanical transmission of power, covering both domestic and export needs.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 95 Liberty street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

Locomotive Terminals.—Dwight P. Robinson & Company has recently prepared a booklet describing some of the terminal work which the company has done for railroads. The major part of the booklet is devoted to illustrations and brief descriptions of several of this company's more prominent projects which have been carried out for seven railroads, while the last few pages of the book are devoted to the listing of work done on several additional railroads.

Man Power Multiplied.—Locomotives and trackless tractor cranes having moderate lifting capacities and considerable speed of lift are described in a booklet issued by the Brown Hoisting Machinery Company, Cleveland, Ohio. It is stated that these cranes can go wherever required and do practically any kind of handling work. Applications of different types are shown, and additional and more complete descriptions are given in catalogue K, sent out by this company.

Coal and Ash Handling Systems.—Catalogue No. 40, illustrated and descriptive of various types of coal and ash handling systems for boiler houses, has been issued by the R. H. Beaumont Company, Philadelphia, Pa. The text of this booklet is descriptive of the various classes of material handling machinery which this company installs, such as skip hoists, crushers, cable drag scrapers, ash cars, hoppers, larries, bunkers, conveyors. The illustrations show many actual installations as well as plan drawings of the different units and sketches of typical systems.

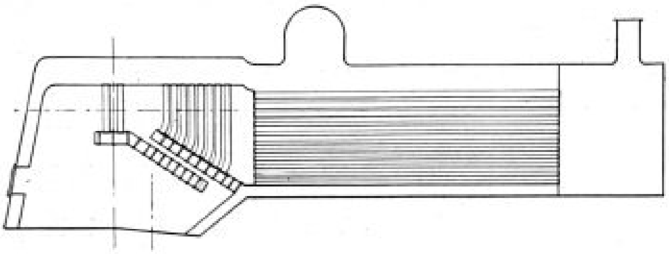
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,346,769. STEAM-BOILER FURNACE. ROBERT G. SEAMAN, OF SUMMERHILL, PENNSYLVANIA.

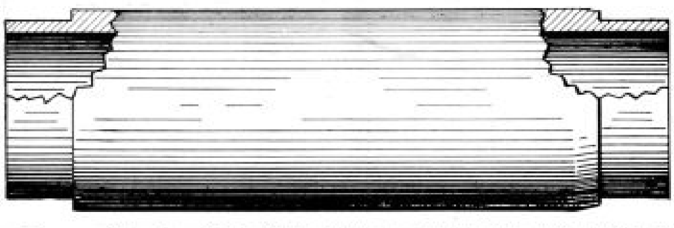
Claim.—A boiler furnace having water legs at the sides thereof, a downwardly and forwardly inclined water arch extending between and communicating with the water legs and communicating at its lower forward



end with the lower portion of the water space of the boiler, a second water arch communicating with the water legs and arranged below and to the rear of the first-named water arch in spaced relation thereto and also in spaced relation to the front wall and the rear wall of the furnace, upright tubes establishing communication between the first-named water arch and the crown of the boiler, and upright tubes communicating with the second-named arch and the crown of the boiler; the said arches forming between them a flue.

1,339,739. BOILER TUBE END SECTION. CHARLES S. COLEMAN, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO THE COLEMAN BOILER APPLIANCE COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF DELAWARE.

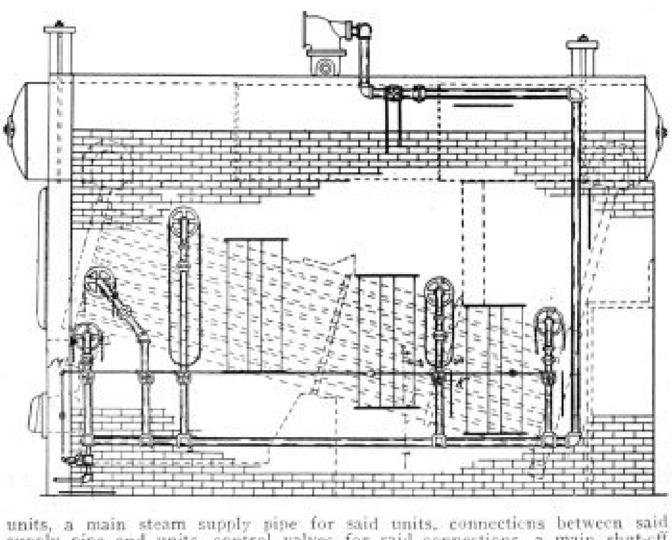
Claim 1.—The combination of a boiler tube, and a tube end section comprising an integral cylindrical tube having an intermediate wall portion of



a thickness greater than that of the boiler tube and having an end portion of reduced outside diameter said end portions being of equal diameter and wall thickness throughout and inserted in the end of the boiler tube and on which the tube is shrunk and welded. Four claims.

1,343,654. BOILER CLEANER. LEWIS BEEBEE AND FRANK BOWERS, OF DETROIT, MICHIGAN, ASSIGNORS, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICHIGAN, A COPARTNERSHIP COMPOSED OF RAPHAEL HERMAN AND SAMUEL J. HERMAN.

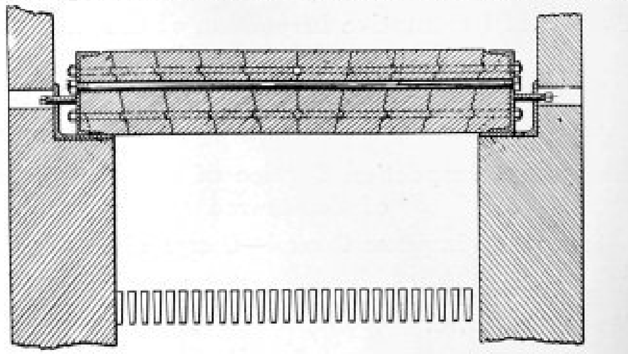
Claim 1.—In a boiler cleaner, the combination with a plurality of blower



units, a main steam supply pipe for said units, connections between said supply pipe and units, control valves for said connections, a main shut-off valve for said steam supply pipe and means controlled by the operation of said valves for automatically indicating when the main supply valve is left open and the valves in the branch connections closed. Five claims.

1,339,615. FLAT ARCH FOR FURNACES. OTTO WUNDRACK, OF MAYWOOD, ILLINOIS.

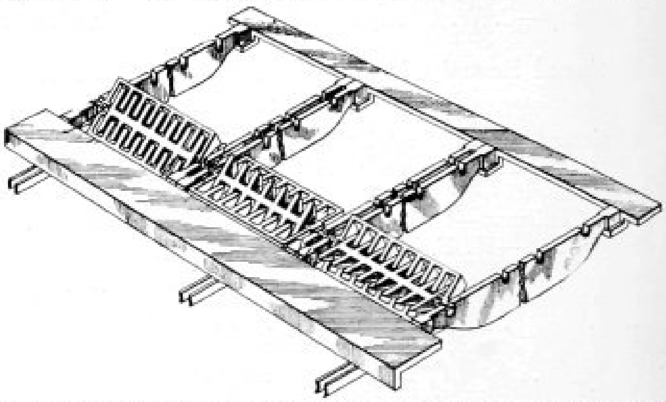
Claim 1.—An arch for furnaces comprising several courses each consisting of springer-tiles, arch-tiles and key-tiles, the contacting longitudinal sides of which are, excepting the meeting longitudinal surfaces of the key-tiles, inclined downward toward the transverse center of the furnace, each tile



of each course having longitudinal tongues projecting from one inclined side thereof and longitudinal grooves in the opposite inclined side thereof, the longitudinal tongues of each tile entering the longitudinal grooves in the contacting inclined side of the next tile, and each tile of each course being provided with transverse tongues in one end and transverse grooves in the opposite end, the transverse tongues of the tiles of each course entering the transverse grooves in the contacting ends of the tiles of the next course, metal abutments for said springer-tiles, and means for regulating the lateral position thereof. Two claims.

1,369,553. GRATE FOR BOILER-FURNACES. CHARLES H. SCHRODER, OF BURLINGTON, IOWA.

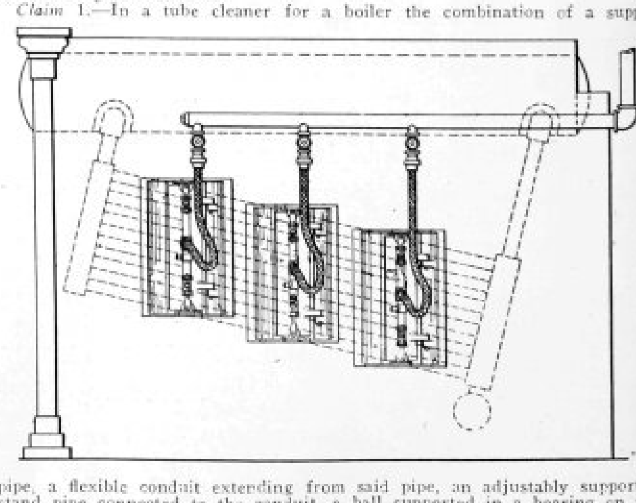
Claim 1.—A grate bar composed of inner and outer sections the outer one of which consists of a rectangular frame having inwardly projecting fingers integral with its side members and provided centrally at its ends



with trunnions and also provided centrally with recessed seats open at the top, and the inner section having trunnions journaled in the recessed seats in the outer section, the said inner section also provided with integral fingers which intermesh with the fingers on the side members of the outer section the said sections each having an integral depending arm located centrally at one end of the grate bar for connection with rocker bars, whereby the grate bar as a whole can be rocked in either direction, or either section thereof rocked in either direction independently of the other. Two claims.

1,348,542. TUBE-CLEANER. CHARLES T. COE, OF KEARNEY, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICHIGAN, A COPARTNERSHIP COMPOSED OF RAPHAEL HERMAN AND SAMUEL J. HERMAN.

Claim 1.—In a tube cleaner for a boiler the combination of a supply



pipe, a flexible conduit extending from said pipe, an adjustably supported stand pipe connected to the conduit, a ball supported in a bearing on the side of the boiler and an outlet nipple extending from the said stand pipe through said ball, said stand pipe being adapted in its movement to impart longitudinal as well as lateral movement to the outlet nipple. Five claims.

The Boiler Maker

OCTOBER, 1921

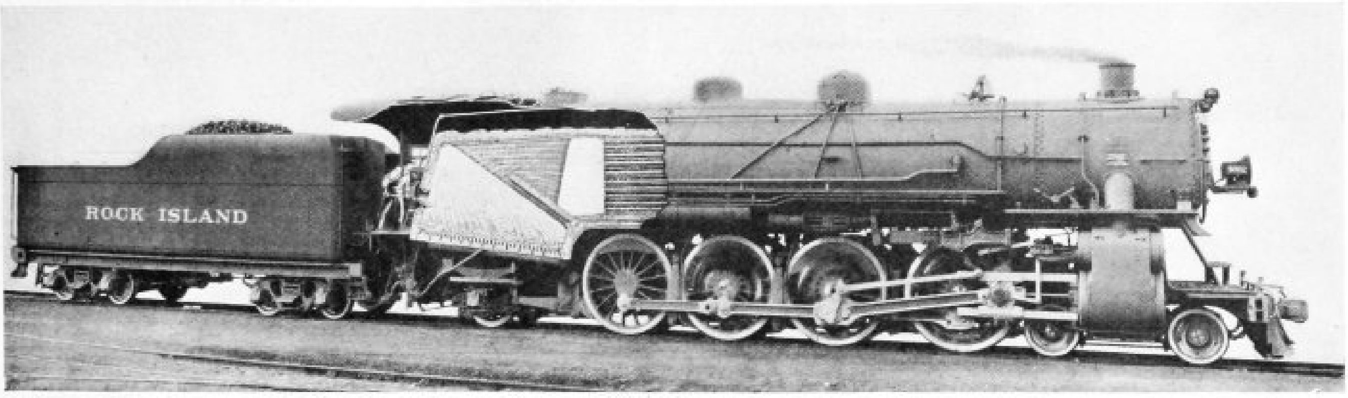


Fig. 1.—Sectional View of Firebox of Mountain Type Locomotive Equipped with Thermic Syphons

The Installation and Operation of Thermic Syphons

Construction and maintenance costs combined with the necessity for fuel economy have brought about the invention and application of various efficiency promoting devices on modern locomotives. The limit of firebox size has practically been reached and to further enlarge the capacity of a locomotive in this direction the Nicholson Thermic Syphon has proven one of the most advantageous methods of increasing heating surface. Although this device has been in actual operation less than three years, it is already in active service on twelve prominent railroads in the United States and Europe, and is now being installed on fourteen other roads in this country.

FROM the mechanical point of view the construction of the thermic syphon and its installation lie wholly within the duties of the boilermaker. It is built of materials with which he is familiar and by methods which are common to his every day practice. Each syphon takes the place of an arch tube but is larger in diameter and extends up into the crown sheet in the form of a triangular water leg, as shown in Fig. 2. Syphons can be applied to the firebox of any old or new locomotive.

The syphon is ordinarily made from a single sheet of 3/8-inch firebox steel which is first cut to shape and punched for staybolts and then folded over a mandrel and pressed between large dies. This operation also forms the neck which is 6 1/4 inches diameter inside, and at the same time brings the side walls parallel to one another and 3 1/4 inches apart. The other dimensions of the syphon vary more or less according to the class of engine to which the syphon is applied; these two dimensions, however, are always constant.

After the folding operation has been completed, the top flange is formed and the front end of the syphon is brought together and welded by either the gas or electric process. The staybolt holes are then reamed and tapped, the bolts put in place, then headed over and tell-taled. The staybolts are one inch in diameter and are spaced according to flat surface practice.

Accompanying each syphon is a plate known as the diaphragm or breathing plate, see Fig. 3. This plate is drawn from 3/8-inch firebox steel and is corrugated and punched to receive the neck of the syphon, to which it is attached just before being installed in the firebox.

Syphons are designed by the Locomotive Firebox Company to fit any locomotive firebox, the railroad sending a boiler print and receiving the syphon finished and ready for installation. Where desired the staybolting and welding may be done by the railroad.

How Syphons Are Installed

Upon installing a syphon the crown and flue sheets are first marked, as indicated by the drawing Fig. 4, which is furnished with the syphons. On old locomotives the radials and throat stays are removed from the areas as marked and the holes are cut in the crown sheet and flue sheet for the admission of the syphon and the diaphragm plate respectively. The edges of these cuts are then chipped for welding.

Before proceeding further, the intake channel for each syphon is tacked into place along the belly of the boiler. These channels are inverted U-shaped sections formed from light sheet stock and extend along the floor of the boiler from points near the front flue sheet. The location of these channels is illustrated in Fig. 5 as well as the character of the connection with the syphon proper. These channels are of such length that they can be inserted through the firebox end of the boiler, and are of a height which permits them to pass under the lowest line of flues.

The next step in the installation is to cut the diaphragm plate to fit the hole cut in the flue sheet. The patch cut out for the diaphragm plate varies in size for different jobs, and for this reason the plate is shipped to the railroad in rectangular shape, and cut to the exact size in the railway shop. After the diaphragm plate has been shaped, it is placed on the neck of the syphon, which has in the meantime been cut to the proper length. The plate is then welded to the neck from what is to be the water side; this being done before the syphon is placed in the firebox and while the operator has ample room in which to carry on the work.

The syphon and plate are then beveled for welding and the whole job raised into the firebox and clamped in place. When this is done, the job resolves itself into a matter of good welding and careful staybolting.

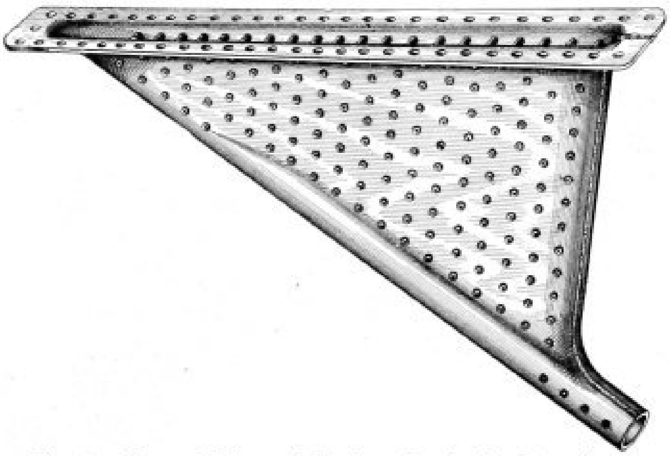


Fig. 2.—General View of Syphon Ready for Installation

The method of making the crown sheet connection is illustrated in Fig. 6. In this view it will be observed that one row of radial stays is made fast in each flange of the syphon itself and that the welds come between these rows and the next rows of radials which are in the body of the crown sheet. In this manner all of the actual weight of suspension is removed from the weld and it is thus freed from any undesirable stresses.

and in line with the syphon at both the throat sheet and the back head. These plugs, Fig. 8, are so located as to facilitate inspection of any part of the interior of the syphon and afford ample opportunity to wash them thoroughly. One or more plugs are also placed in the roof sheet directly above

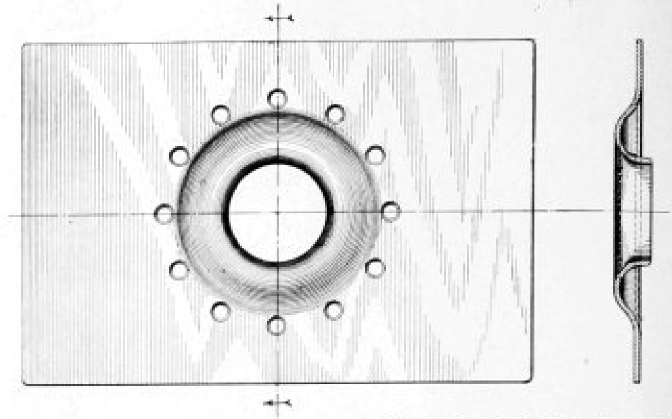


Fig. 3.—Diaphragm Plate to Which Neck of Syphon Is Attached

the opening of the syphon and offer additional means for inspection and washing.

Arch Application and Number of Syphons Installed

The brick arches are laid on the bulges of the syphons and against the side sheets, as shown in Figs. 6, 9, 10, and 11. The design of the syphons is such that any desired form of arch may be applied to the locomotive; and the

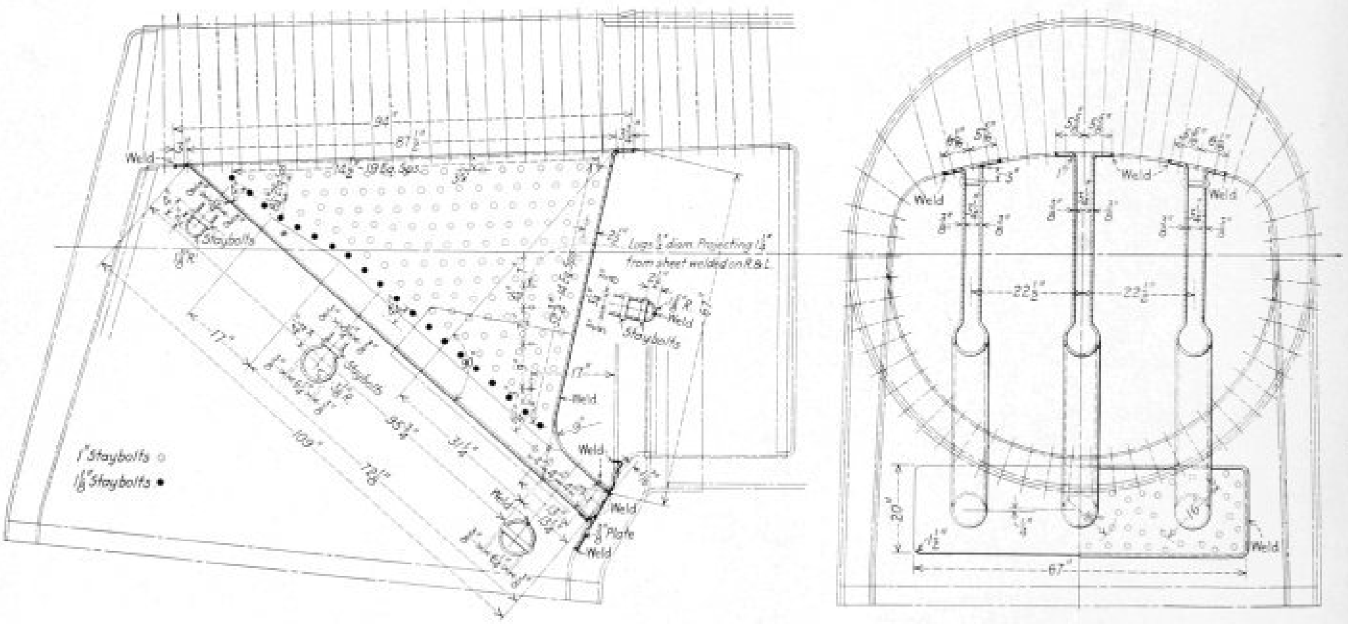


Fig. 4.—Typical Three-Syphon Installation, Showing Longitudinal and Vertical Sections of Firebox and Method of Connecting Syphon Neck at Throat Sheet and Crown Sheet

The same practice is followed in making the flue sheet connection with the exception that the stays in the area surrounding the diaphragm plate are flexible. These flexible stays combined with the flexibility of the corrugations in the diaphragm plate, allow a freedom of movement to the sheet in breathing, Fig. 7, and relieve the rigidity of the firebox and syphons.

Syphons Easily Inspected and Maintained

Provision for washing and inspecting the syphon is provided in the form of washout plugs located directly opposite

strong and rigid support which they afford an arch eliminates the frequent occurrence of bricks dropping from the arch.

The number of syphons which can be installed in a locomotive firebox is dependent entirely upon the dimensions of the box. The only rule which regulates this matter is that there shall always be ample room for a man to work around and between syphons and that there shall be sufficient space left between the front of the syphons and the flue sheet for a man to get in ahead of the syphon and work the flues. Figs. 5 and 9 show the location of syphons and the construc-

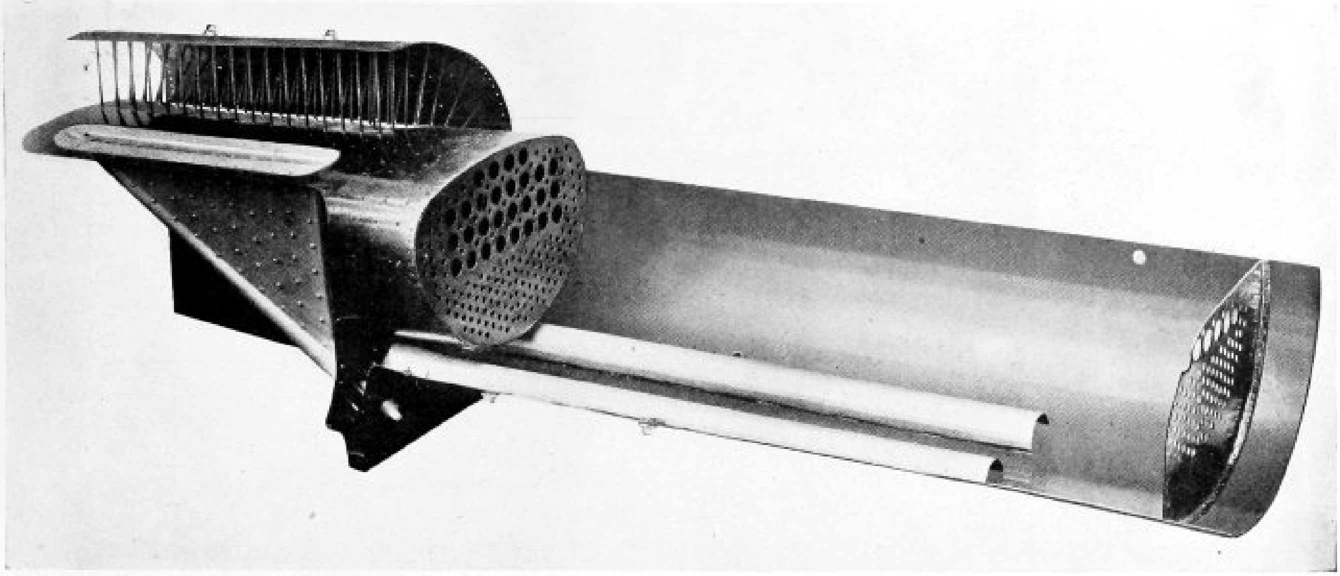


Fig. 5.—General Arrangement of Intake Channels and Syphons

tion employed in a two-syphon installation. These views show the syphons and intake channels in white and indicate how the syphon is adapted to the locomotive boiler; looking

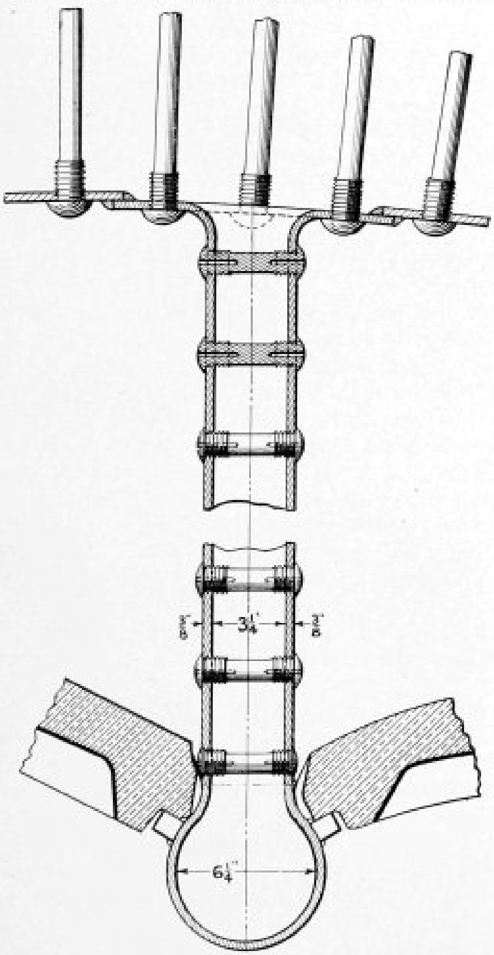


Fig. 6.—Section Through Syphon, Showing Method of Making Crown Sheet Connection; the Support of Syphon by Radial Stays; the Staying Through the Body of the Syphon and the Support of the Brick Arch

at the syphon from the door of the firebox, its appearance is as natural as that of an arch supported by tubes.

The primary object of the thermic syphon is to improve the efficiency and capacity of the locomotive boiler, since it is these two factors that mainly determine the efficiency and capacity of the locomotive. The syphon promotes the efficiency by aiding the circulation of water in the boiler and by increasing the heating surface of the firebox. By the addition of syphons the firebox heating surface can be increased by an amount ranging from 15 percent to 45 percent, depending upon the size of the box. As is well known,

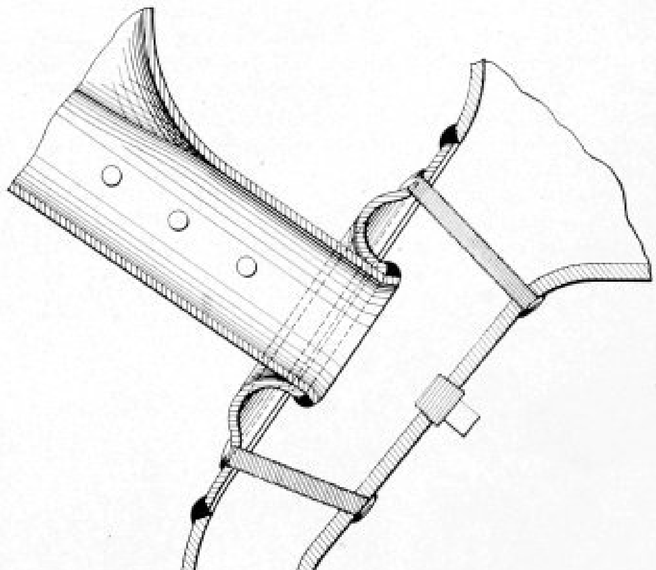


Fig. 7.—Method of Securing the Syphon at the Throat Sheet

every square foot of firebox heating surface will evaporate as much water into steam in a given time as 5½ square feet of flue surface. This fact was demonstrated several years ago by Professor Goss in the Coatesville boiler tests.

The syphon is virtually a large, valveless pump which sets up a positive circulation from the front end of the boiler to the rear. This circulation is induced in the following manner: The water, in the syphon which lies in the direct path of the hottest flames in the firebox, heats quickly and steam is generated in the syphon itself. This heating of the water and the generation of steam cause the water in the syphon to become lighter than the water in the forward

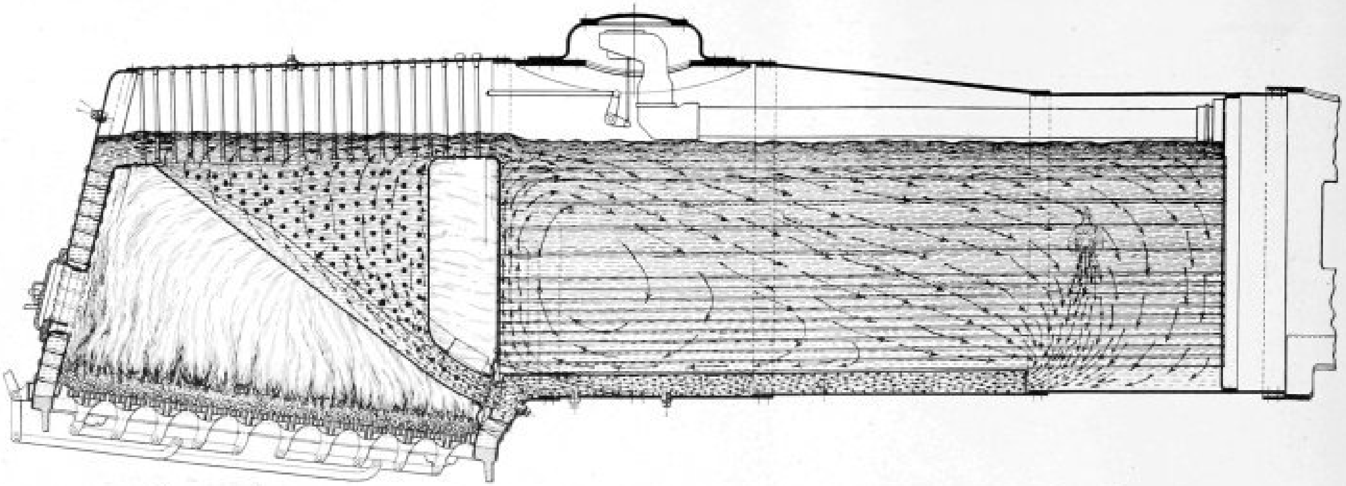


Fig. 8.—Diagram of Water Circulation in a Boiler Equipped with Syphons and Intake Channels

part of the boiler and this lightening of the water soon causes the hotter mixture of water and steam in the syphon to be replaced by the relatively colder and heavier water which is drawn in through the intake channel. The flow of water through the smallest part of the syphon, the neck, is estimated to be approximately four feet per second.

Overheating Prevented by Installation of Syphons

The extent to which this pumping action is carried is best illustrated by the recent case of a locomotive in which the water was allowed to drop 6 inches below the top of the crown sheet. Ordinarily this would have caused the crown sheet to become heated to such an extent that it would probably have dropped, causing a serious and fatal boiler explosion. However, in the case of this locomotive, the water boiling up through the syphons was sufficient to spread over the crown sheet and keep it from overheating except for a short distance midway between the syphons, so that none of the stays on either side of the syphons pulled out. The heating of the crown sheet was thus confined to a small area some distance from the syphons and when several stays loosened in this section the result was no more severe than that of a burst flue.

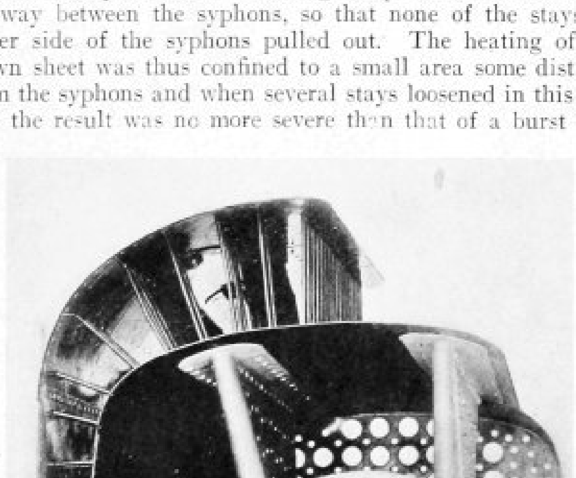


Fig. 9.—Section of Firebox, Showing Method of Attaching Syphons to Sheets and Supporting Firebrick Arch

Improved Circulation Essential to Efficiency as Well as Capacity

Positive circulation of water in a boiler acts in many ways to increase the efficiency. In the case of the syphon the water rising through it sweeps all accumulations of steam from the walls carrying them upwards, thus freeing the surface and allowing a close contact at all times between the water and the heated sheet. Steam accumulations which might lead to blisters and scale are thus prevented from forming. The rapid movement of water in a boiler also carries any sediment in suspension and prevents a deposit of mud from forming against the front flue sheet. In locomotives equipped with syphons the mud deposit collects in the rear water leg from which it can readily be removed.

From tests to determine the rate of circulation of water in syphon-equipped locomotives it has been estimated that the entire contents of a boiler will pass through the syphons in about ten minutes.

The intake channels receive water from the coolest part of the boiler a foot or so behind the boiler check and carry it directly to the syphons where it is subjected to the intense radiant heat of the fire. With this action going on continuously it can be seen that a greater uniformity of temperature is obtained throughout the boiler than is ordinarily the case. This uniformity of temperature tends to a great extent to minimize the cracks and strains occasioned by sharp differences of temperature which are present in a boiler where the circulation is at all obstructed.

The flames as they come from the grates are divided into several bodies by the syphons and are caused to travel a longer path, thus permitting a more complete combination of the air and gases in the firebox and promoting more efficient combustion.

Constant and vigorous circulation of water in a boiler is an element of safety in its operation in cases of low water. Fig. 12 shows the crown sheet of a locomotive on a western road which at the time of failure had stopped on a meet order.

At that time the crew noticed with alarm that the water in the glass was out of sight. Both injectors were immediately started and a period of two minutes elapsed before water again showed in the lower gage cock. Steam broke into the firebox, but there was no explosion. Subsequent investigation showed that the water was six inches below the highest part of the crown sheet, but that only one radial stay had pulled entirely away from the sheet although several of them were leaking badly. What would have happened in an ordinary boiler not equipped with syphons had the water reached the low point registered on the flue and crown sheets can well be imagined, and this incident proves beyond a doubt that even in the event of low water the syphons continue to pump water from the bottom of the boiler up onto the

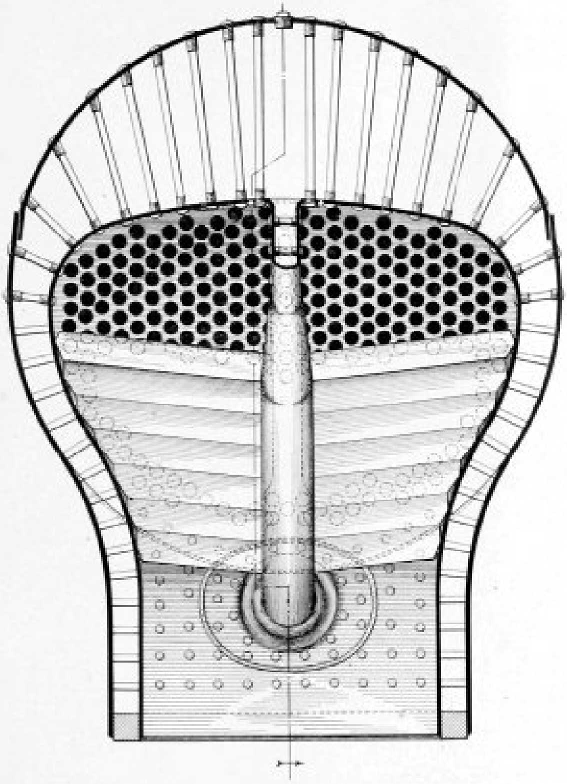


Fig. 10.—Single Syphon Applied to Narrow Firebox, Forming Substantial Arch Support

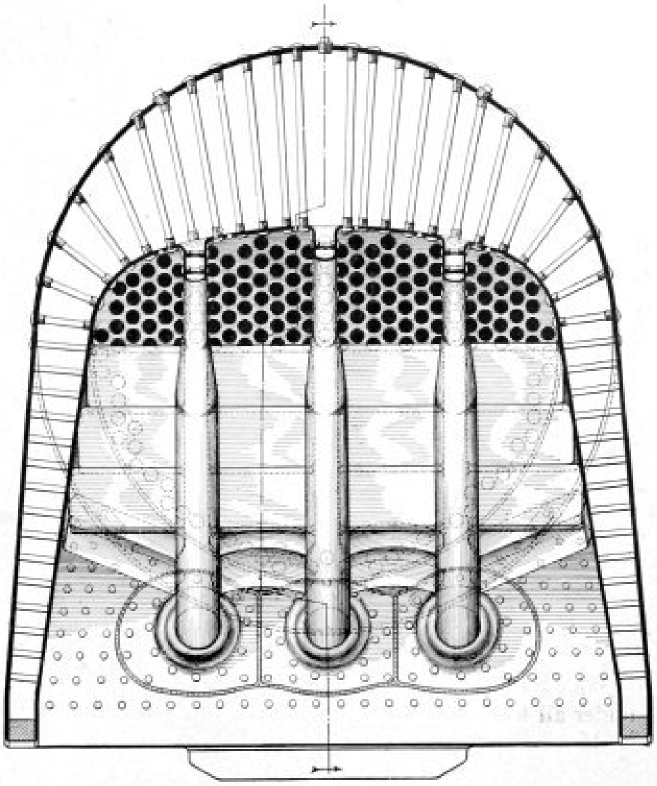


Fig. 11.—Typical Three Syphon Installation, Showing Arrangement of Arch in a Wide Firebox

crown sheet in sufficient volume to prevent its ripping and causing a disastrous explosion.

Syphons Improve Locomotive Service with Low Maintenance Cost

The reports of railroads operating locomotives equipped with syphons indicate that on superheated steam locomotives fuel savings ranging from 12 percent upward have been experienced while on engines using saturated steam 20 percent savings have been obtained. Syphon equipped locomotives have proved to be free steamers and easy to operate and fire.

In the roundhouse and in the repair shop syphons have given little trouble in maintenance. Mud accumulations are not found in the syphons and the flues have shown little tendency to pit. The syphons are practically self-cleaning and ordinarily all that is necessary in cleaning them is to lightly "bob" the sheets to free them of scale. By means of numerous washout holes thorough inspections can be made at any time a locomotive is in the roundhouse and the boiler and syphon thoroughly washed out.

None of the roads using syphon equipped locomotives have reported indications of weakness in the body or neck of the syphon itself. Even when as in two cases the water had fallen several inches below the top of the crown sheet, there has been no evidence of a weakening of the welds along the top flanges or down the front of the syphon.

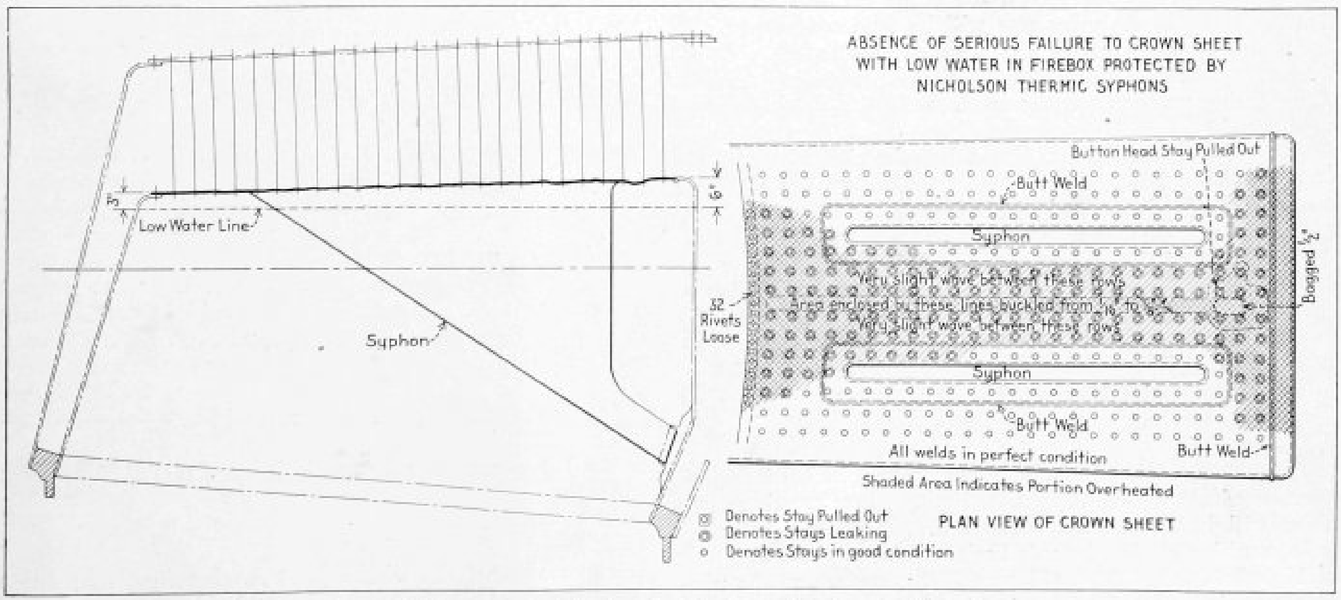


Fig. 12.—Diagram of Crown Sheet of Locomotive Equipped with Two Syphons Which Prevented a Disastrous Explosion Caused by Low Water

A Criticism of High Efficiency Riveted Joints

Calculations Indicate That the Use of Multiple Riveted Joints Does Not Increase Seam Efficiencies

By John S. Watts

I HAVE often felt that the calculated efficiency of triple and quadruple riveted butt joints was not the actual efficiency, but not being in a position to test an actual joint to destruction, and having been unable to find that any such test has been made, I have carried through calculations, which prove that the efficiencies often assumed to be 90 percent and over are actually much less.

Referring to the joint shown in Fig. 1, which is a quadruple riveted butt joint for ½-inch plate, the tensile strength of the plate is assumed to be 55,000 pounds, and a factor of safety 5, the pull on the strip of plate between lines *a* and *b* will be 11,000 × 14 11/16 × ½ = 80,781 pounds.

Now as the strain is transmitted from the shell plate to the butt straps, it is clear that both plate and strap must stretch an equal amount between lines *c* and *d*, if the strap is to fulfill its function.

We know that steel elongates practically at a constant rate, under all loads, up to the elastic limit; and, as the butt strap is ¾ of the thickness of the plate, the pull necessary to elongate the strap an amount equal to the elongation of the plate, will be ¾ of the pull on the plate.

In other words, as the strap and plate must stretch equally to preserve the strength of the joint, the strain on the strap must be ¾ of that on the plate.

The total pull of 80,781 pounds between lines *c* and *d* is to be distributed between the plate and strap in the proportion of 4 to 3. Therefore the pull on the strap is

$$\frac{80{,}781 \times 3}{7} = 34{,}620 \text{ pounds.}$$

There is in the joint only one 15/16-inch diameter rivet, in single shear, to transmit this 34,620 pounds to the strap. As the ultimate shearing strength of one 15/16-inch rivet is only 28,993 pounds a stress of 42,000 pounds per square inch will evidently cause the rivet on line *c* to give way by partial shearing, or crushing an amount sufficient to allow the plate to stretch more than the strap. It follows, then, that the rivets in the outer row will be rendered useless.

The rivet will give way by crushing, too, as the area of the bearing surface is 0.938 × 0.375 = 0.351 square inches. The bearing pressure per square inch on the rivet is therefore $\frac{34{,}620}{0.351}$ = 98,866 pounds, and as the ultimate crushing strength of the plate is only 95,000 pounds per square inch, the plate is stressed to its ultimate strength and must crush.

The result of this failure at line *c*, will be to transfer the total load to the plate at line *d*, where the load will be distributed between the plate and strap, in the same proportion as found for line *c*. On this line we have two rivets to transmit the load, and each rivet will have to carry $\frac{34{,}620}{2}$ = 17,310 pounds.

This gives a shearing stress per square inch of 25,000 pounds, which is over the elastic limit. Therefore these two rivets will be permanently deformed.

In crushing strain, the safe limit will be reached at a pull of 19,000 × 0.938 × 0.375 = 6,680 pounds, and the ultimate crushing strength of the rivet is 95,000 × 0.938 × 0.375 = 33,400 pounds, so the pull of 17,310 pounds is far above the safe limit, and equals the elastic limit. The rivets on line *d* will fail as did those on line *c*, both in shearing and compression.

The total load will now fall on the plate at line *e*, and be distributed between the plate and straps through the rivets on this line as follows:

We have two ⅜-inch butt straps which must elongate the same amount as the plate. The strain on each strap must therefore be ¾ of that on the plate, and as the total of the strains on the two straps and the plate must be equal to the total load, the strain on the plate between lines *e* and *f* must be $\frac{80{,}781 \times 4}{10}$, and the strain on each strap $\frac{80{,}781 \times 3}{10}$.

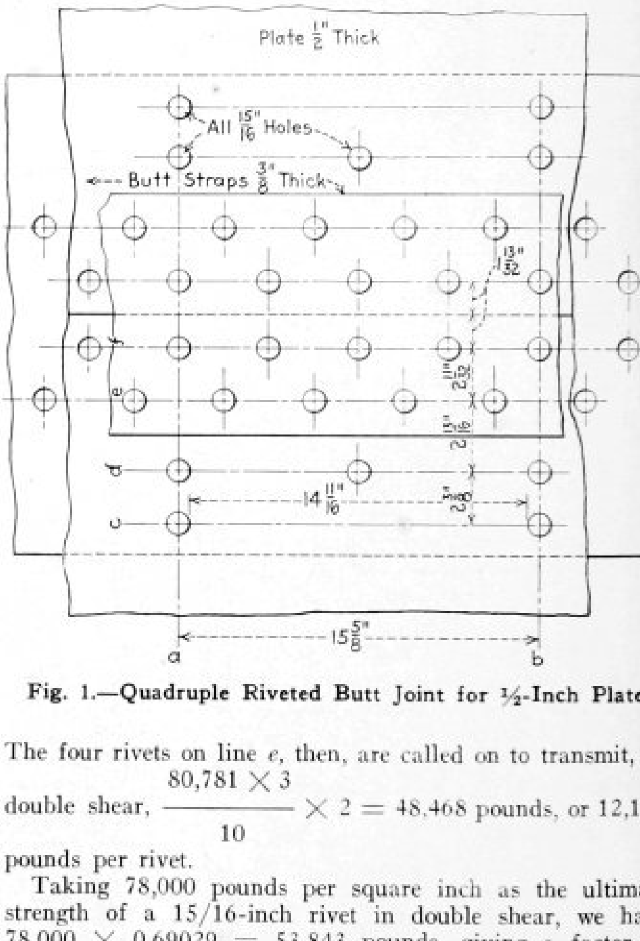


Fig. 1.—Quadruple Riveted Butt Joint for ½-Inch Plate

The four rivets on line *e*, then, are called on to transmit, in double shear, $\frac{80{,}781 \times 3}{10} \times 2$ = 48,468 pounds, or 12,117 pounds per rivet.

Taking 78,000 pounds per square inch as the ultimate strength of a 15/16-inch rivet in double shear, we have 78,000 × 0.69029 = 53,843 pounds, giving a factor of safety of 4.4.

In crushing on the plate, the stress will be $\frac{80{,}781 \times 0.4}{4 \times 15/16 \times 1/2}$ = 17,233 pounds per square inch, or a factor of safety of $\frac{95{,}000}{17{,}233}$ = 5.5.

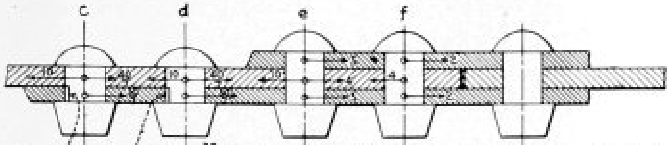
The real efficiency of the joint is, therefore, that due to the strength of the plate on line *e* which is

$$\frac{[15\tfrac{5}{8} - (4 \times 15/16)] \times \tfrac{1}{2}}{15\tfrac{5}{8} \times \tfrac{1}{2}} = 76 \text{ percent}$$

instead of the 94 percent as calculated by the usual methods. Therefore instead of a factor of safety of 5, we have actually only a factor of safety of $\frac{5}{94} \times 76 = 4$.

Distribution of Stresses

The distribution of the strain through the joint may be more clearly understood by referring to Fig. 2, where the total pull is taken as 10 for clearness, and the various reactions given in proportion to this figure. The thickness of the butt strap is taken as ¾ of the thickness of the plate.



Rivets Fail to Carry Load of $\frac{30}{7}$; so Full Load is Transferred from Line c to d and Finally to e.

Fig. 2.—Demonstration of Strain Distribution in Riveted Joint

It will be noticed that the rivets on line *f* are called on to carry only ⅔ of the load carried by the rivets on line *e*, while the rivets are the same number and size on both lines. The stresses in the rivets on line *f* are therefore only 2/3 of the stresses as calculated above for line *e*.

To sum up then, we can say that if this joint were tested to destruction, it would fail in detail; that is, the rivets at *c* would give way, then the rivets at *d*, and finally tear the plate along line *e*.

The writer's opinion is that the wide inside butt strap should be abolished, and the same rule be used as that enforced by the British Board of Trade, and the Dominion and Provincial Governments of Canada, which limit the maximum pitch allowed to that found by the following formula:

$$(C \times T) + 1\tfrac{5}{8} = P,$$

Where: C = Constant applicable from following table.
T = Thickness of plate in inches.
P = Maximum pitch of rivets in inches, provided it does not exceed ten inches.

Number of Rivets in one pitch	Constants for Lap Joints	Constants for Double Butt Strap Joints
1	1.31	1.75
2	2.62	3.50
3	3.47	4.63
4	4.14	5.52
5	....	6.00

This rule, by limiting the pitch, eliminates the wide butt strap.

These rules, however, call for the butt straps to be at least ⅝ of the thickness of the plate, which causes the outer

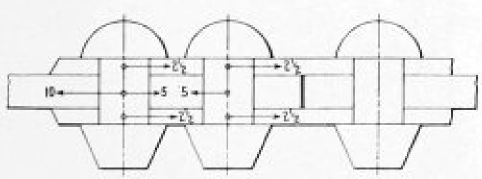


Fig. 3.—Diagram of Reactions on Rivets and Plate Between Rivets

row of rivets to carry 56 percent of the load, the inner row taking the remaining 44 percent. This could be improved by making the butt straps one-half the thickness of the plate, when the load would be equally divided between both rows of rivets, as may be seen by following out the reasoning given above in discussing the quadruple riveted joint. As the two butt straps together would equal the thickness of the plate, and therefore be the same strength as the plate, there is no reason why they should be made thicker, so long as only two rows of rivets both equal in pitch are used.

From the previous discussion it follows that, as the butt straps in order to elongate equally with the plate between the rows of rivets must carry on the outer row of rivets at least one-half of the total pull, there is no gain in strength in fitting more than the two rows of rivets.

This may be more clearly understood by referring to Fig. 3. If we take the total pull to be ten, and the strains on the straps and plate, as already proved, proportional to their thickness, because the elongation must be equal and the plate twice the thickness of the strap, the reaction in the plate between the rows of rivets will be 5. The reaction in each strap will be 2½. The inner row of rivets will give another 2½, making 5 for each strap, and 10 for the two straps.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the code is requested to communicate with the secretary of the committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of the society for approval after which it is issued to the inquirer and published.

Below are given the interpretations of the committee in cases Nos. 351 to 356 inclusive, as formulated at the meeting of May 12, 1921, and approved by the council. In accordance with the committee's practice, the names of inquirers have been omitted.

Case No. 351

Inquiry: Is it necessary, under paragraph 2 of the boiler code, that welded or seamless circular furnaces or flues in boilers up to 18 inches in diameter as specified in paragraph 241, must conform to the requirements for firebox plate material when exposed to the products of combustion?

Reply: It is not necessary that welded or seamless circular furnaces or flues up to 18 inches in diameter meet the specifications for boiler plate material. It is the opinion of the committee that such boiler parts should be constructed from material fulfilling the requirements for lap-welded and seamless boiler tubes given in paragraph 165 of the boiler code.

Case No. 352

Inquiry: Is it not permissible to construct boilers of the locomotive, economic or other portable types as coming under the classification of traction or portable boilers, as regards the attachment of lugs or brackets for which paragraph 325 of the boiler code permits the use of studs with pipe threads? It is found impossible to properly rivet the lugs on certain designs of locomotive-type boilers where the lugs are to be located near the bottom of the waterleg of the firebox.

Reply: It is the opinion of the committee that where the boilers of the portable type are to be fitted with lugs or brackets, the practice specified in the last sentence of paragraph 325, of using studs, is permissible.

Case No. 353

Inquiry: Is it permissible, under the requirements of paragraph 218 of the boiler code, to use stay tubes in place of through stays for supporting the surfaces around the manhole in the heads of horizontal return tubular boilers?

Reply: Stay tubes are not permissible for supporting the surfaces around the manhole in the heads of horizontal return tubular boilers.

CASE No. 354

Inquiry: What are the requirements of the heating boiler section of the code, relative to the staying of flat surfaces of steel heating boilers designed to operate at a pressure not to exceed 15 pounds per square inch?

Reply: Paragraph 372 of the code specifies a shop test of 60 pounds per square inch hydrostatic pressure shall be applied to steel or cast-iron boilers used exclusively for low-pressure steam heating. It is the opinion of the committee that in staybolting a boiler of this sort, the stresses in the material should not exceed those allowable in power boiler practice which would necessitate computing the staybolts and their spacing for a working pressure of at least 40 pounds per square inch, or two-thirds of the test pressure.

CASE No. 356

Inquiry: Is a boiler constructed as shown in the prints and described, safer under the boiler code rules than other forms of similar boilers?

Reply: The boiler code committee does not express opinions upon the relative merits of different designs of boilers. This is in accordance with the constitution of the society, C56, which reads as follows:

C56—The society shall not endorse any commercial enterprise. It shall not allow its imprint or name to be used in any commercial work or business.

An interpretation of the boiler code is a proper action of the boiler code committee and will always be given upon request.

Water Cooled Furnace Door

IN visiting a large number of locomotive shops in recent months I have noted that in many cases the old, old trouble, due to rapidly burning out furnace doors of furnaces used for heavy work in the blacksmith shops is still very much in evidence.

It seems to me to be a very short sighted policy to cling to old methods and practices because they have always been used, when there are much more efficient ways that cost but little more for the first application and are much more economical in the long run.

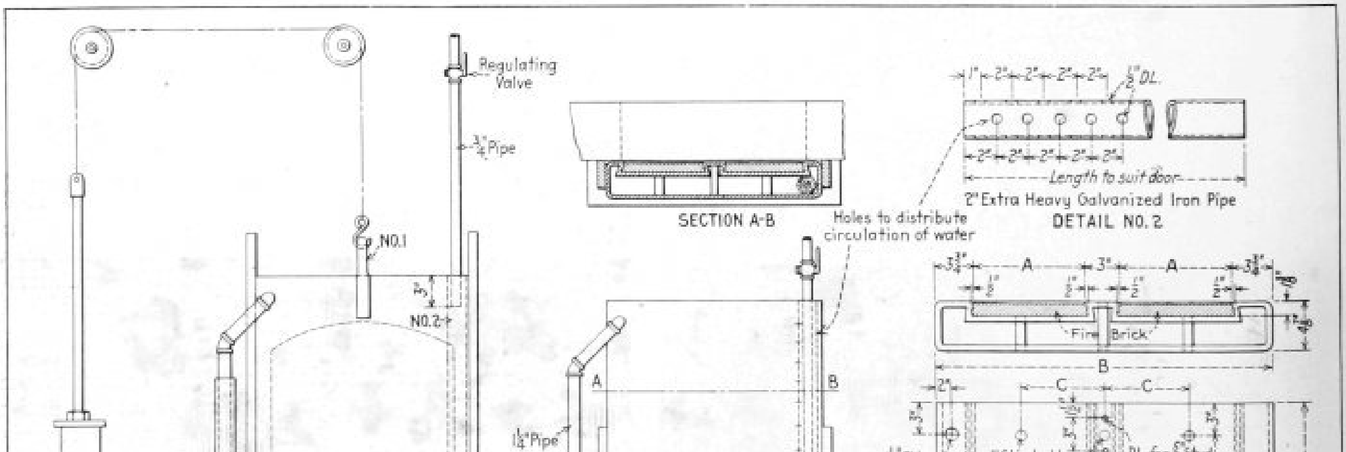
The attached sketch of a water jacketed furnace door is one in use at the Trenton shops of the Pennsylvania Railroad, furnished me by the courtesy of the master mechanic, and I judge it to be an economical and efficient arrangement inasmuch as there is one furnace that has operated three years with the same door and which is still in good condition. Having seen the same (or nearly the same) arrangement at several other shops and being impressed with its value, I am submitting it for the benefit of those who care to adopt it.

C. E. LESTER.

Safety Code for Compressed Air Machinery

THE American Society of Safety Engineers has been designated as sponsor for a safety code for compressed air machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization of apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

This work is being undertaken as part of a comprehensive program of safety codes in process of formulation under the auspices and rules of procedure of the American Engineering Standards Committee. The American Society of Safety Engineers was appointed sponsor for the code for compressed air machinery on the recommendation of the National Safety Code Committee.



Type of Water-cooled Furnace Door Used with Success in Shops of the Pennsylvania System

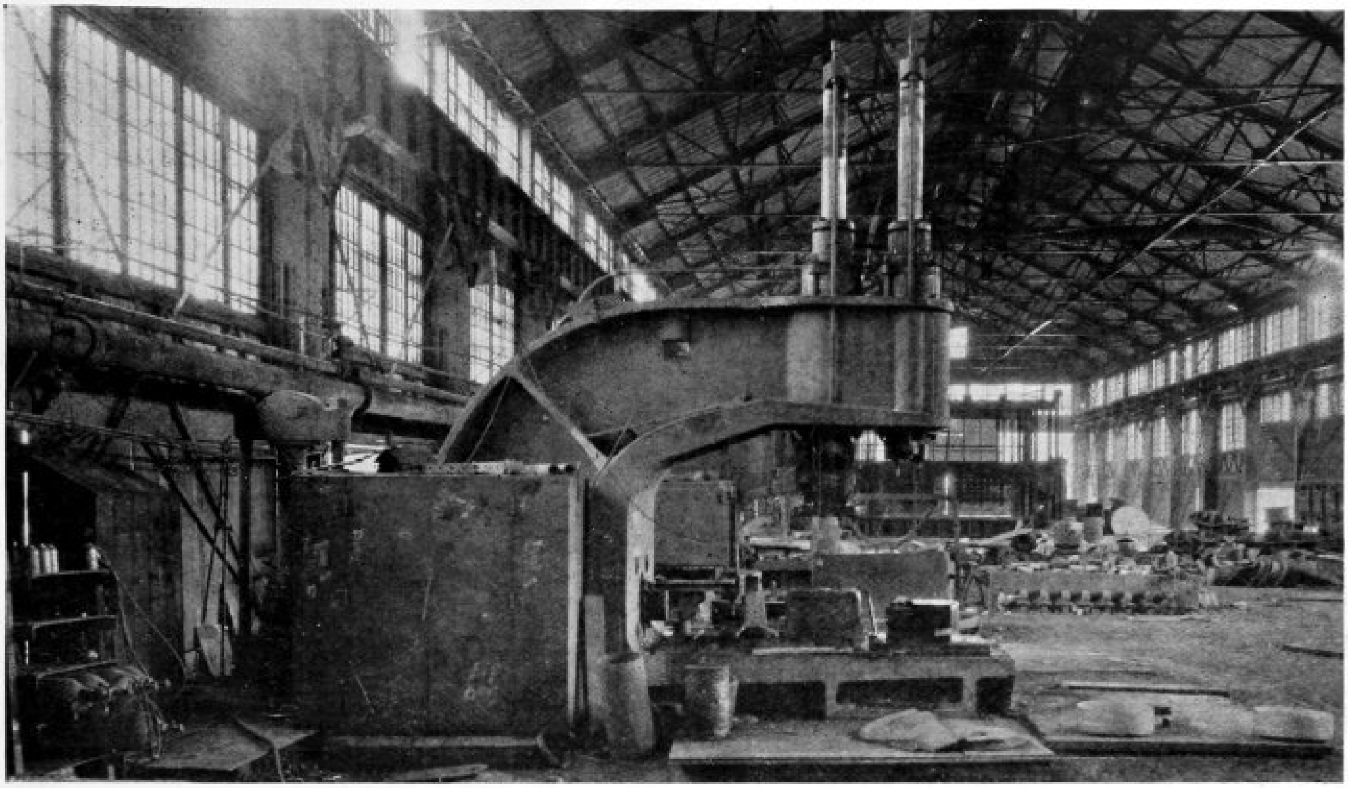


Fig. 1.—Flanging Shop with 250-Ton Hydraulic Sectional Flanging Press in Foreground

Special Methods of Boiler Flanging*

Hand Flanging and Sectional Presses Used for Irregular Shapes in Boiler and Tank Fabrication

By George A. Richardson†

THERE are certain types of flanging jobs which cannot be made to advantage on any machine and must be worked out over forms by hammering with large wooden mallets after the part to be bent has been heated in a forge. Usually it becomes necessary to reheat these a number of times, depending on the area to be bent.

Two typical jobs which must be handled in this way are illustrated. Fig. 2 is an interesting example of this. The head, which is to be part of the tank of an oil burning locomotive, was flanged and dished in the usual manner to an

Fig. 2.—Head for Tank of Oil Burning Locomotive

Fig. 3.—Fifty-four Inch Dome Sheet for Tank Car

*Continuation of the article "Flanging and Dishing Boiler Heads," which began on page 245 of the September issue of THE BOILER MAKER.

†Midvale Steel and Ordnance Company, Philadelphia, Pa.

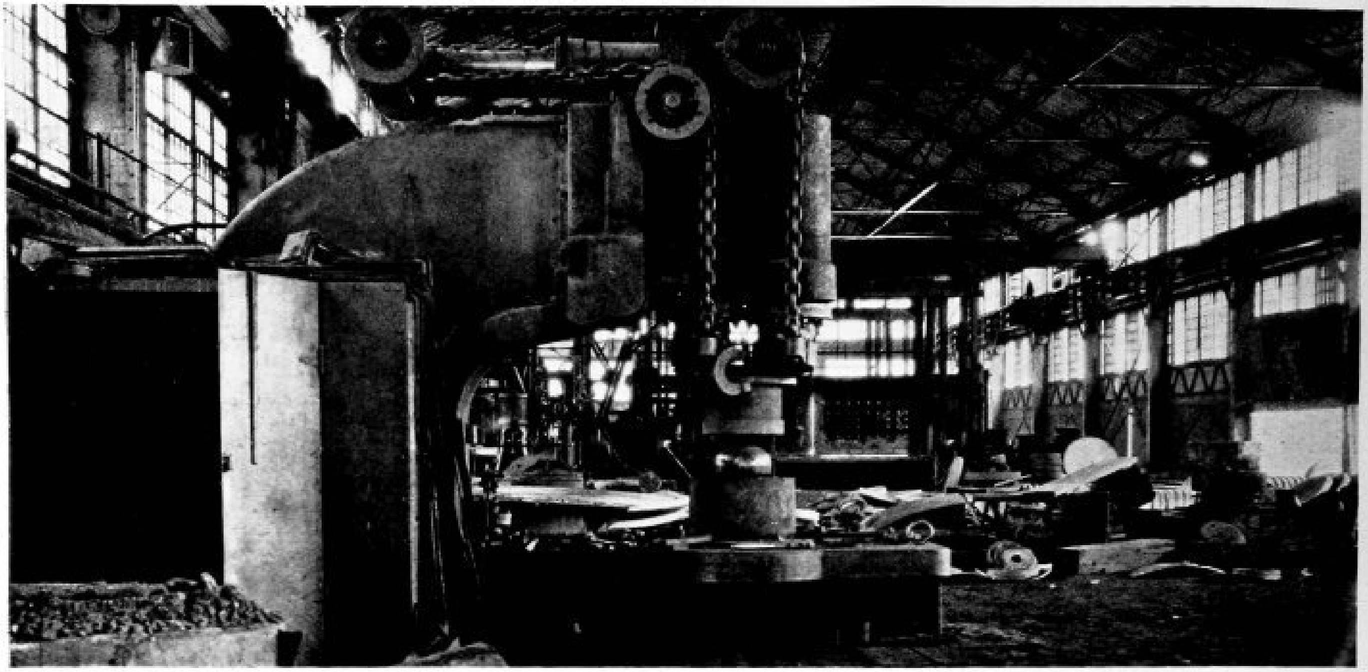


Fig. 4.—Hydraulic Sectional Flanging Press of 200 Tons Capacity with Dies in Position for Flanging Manholes

outside diameter of 113 inches. The 22-inch throat indenture was put in by hand. A 54-inch dome sheet for a standard oil tank car is shown in Fig. 3. The flange was made by heating in sections and hammering down over forms. In all work of this character the heating in sections tends to set up uneven strains, and hence it is customary to anneal the pieces after they are flanged.

SECTIONAL FLANGING MACHINE JOBS

The sectional flanging machines are the handy men, the job machines of the flanging plant, for any work that cannot be handled on the spinning flangers and can be made by machine operations come to these machines. Flue holes, manholes, handholes, flanged parts for marine boilers, irregular flanging, manhole and handhole yolks, brake drums and special shapes are all successfully handled.

A typical machine of this kind is illustrated in Fig. 1. This machine is especially interesting because it is the largest sectional hydraulic flanging press of this type in the country, being rated at 250 tons. The width of opening is 6 feet and the depth of opening 5 feet.

This press was originally built for 132-inch heads with a manhole in the center. Large heads, such as Scotch marine boiler heads, are usually made in two sections, the individual sections being flanged on this press. In this way the capacity is much increased. The adaptability of the press lies in the fact that so many different sizes and types of dies can be mounted on the bed. In addition to the two top rams which can be used together or independently, there is a bottom ram which makes it possible to use complicated dies and work from both sides at the same time. There is also a ram in a horizontal position in the throat which is available when needed.

Fig. 4 shows a 200-ton hydraulic sectional flanging press with dies in place for flanging a manhole.

The best way to get an idea of the capabilities of presses

Fig. 5.—Scotch Marine Boiler Head Flanged on Spinning Flanger and Flue Hole Made on Sectional Flanging Machine

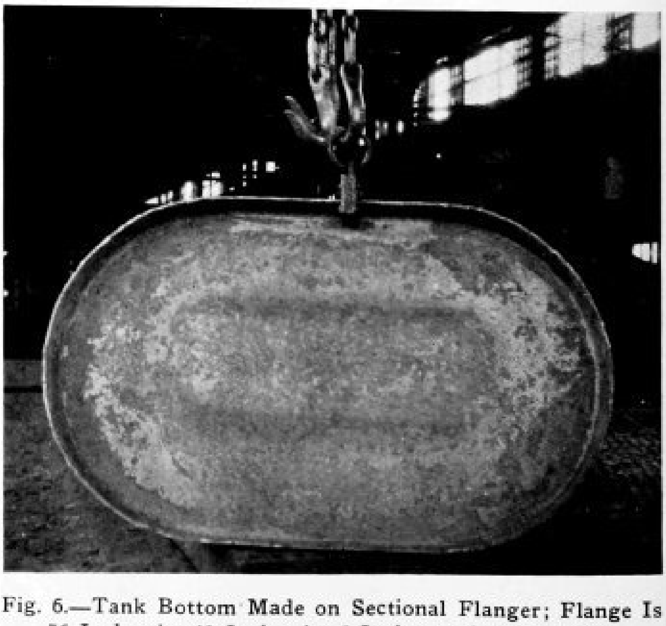


Fig. 6.—Tank Bottom Made on Sectional Flanger; Flange Is 76 Inches by 49 Inches by 6 Inches and Countersink Is 53 Inches by 22 Inches by 1¼ Inches

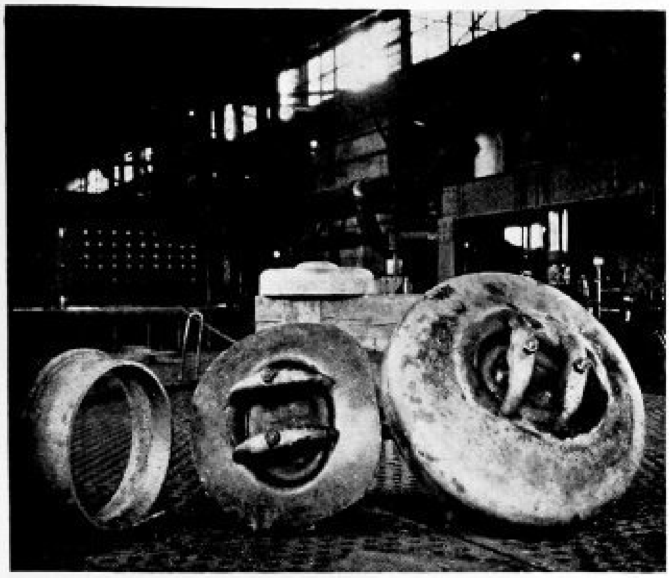


Fig. 7.—Standard Manhole Plates and Fittings, and Flanged and Dished Heads

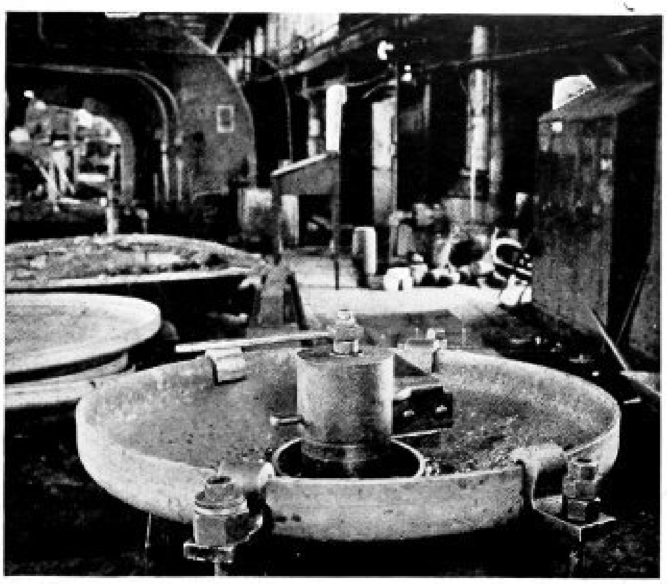


Fig. 8.—Trimming Machine Used for Truing Up Edges of Manholes, Handholes and the Like

of this character is to examine some typical pieces of work produced on them.

All manholes, handholes and flue holes are made on the sectional flangers. Fig. 5 shows a head for a marine boiler. This head, 78⅞ inches in diameter, was made on the spinning flanging machine. Then the hole for the flue was cut out with the aid of a torch and the flue hole flanged, as shown on the sectional flanger.

Manhole and handhole covers and yolks are likewise made on the sectional flanger. This statement of course excludes the drop forged bolts and eyes. As a rule these plates are made in two operations. In the first a rectangular piece of plate is taken and the corrugations are pressed in it. Then it is trimmed to shape and the holes for the eyes are countersunk on the press.

The tank bottom, Fig. 6, is another example of the range of work that is performed on the hydraulic sectional flanging presses. Both the countersinking and the flanging were done on the large press.

A recent development has been the making of high carbon steel automobile and truck brake drums on these presses. This, however, is a specialty that cannot be discussed within the limits of this paper.

All pieces that enter into the construction of boilers, tanks and the like and steel buckle plates that are used in bridge floors and for similar purposes are also among the specialties that can be made.

It is important to remember that all pieces made on the sectional flanger for boilers and related purposes are annealed after flanging. This, as previously mentioned, relieves all strains and makes a far more satisfactory finished job. These few examples show very clearly the capabilities of sectional flangers and their very great adaptability.

Minor Finishing Operations

There are a few finishing operations involved in the turning out of such jobs as those that have been mentioned. The edges of the flanges for manholes and handholes must be trued up to insure a tight joint and this is accomplished with the aid of the trimming machine which is a very simple affair, Fig. 8. This machine consists of a vertical post or spindle, motor driven, in which a high speed steel cutter blade is placed. The head is clamped on the bed with the spindle projecting up through the hole as shown and the cutting tool is fed down by hand until the desired cutting has been accomplished.

Another minor operation is the finishing of the yolks. As they come from the press the bottoms of the ends are rough and irregular. In order to make them set flat on the head it is necessary to true them up, and this is done by sawing them in a circular saw.

Thorough and careful inspection cannot be classed as a minor operation, but it is done after the pieces are made and just before shipment, so it seems proper to mention it at this point. When the pieces go forward from the mill, regardless of their character or the purpose for which intended, it is with the assurance that they meet the customers' specifications in every way.

The illustrations which accompany this article have been chosen with the three-fold view of featuring the types of equipment used, the character of the operations performed and the variety and range of work done by a modern plant well equipped to do flanging and dishing. In conclusion the fact should be emphasized once more that the greatest difficulty that the manufacturer has to contend with is not that of producing but that of getting the necessary and correct information from the customer to make it possible to produce.

State Board of Boiler Inspectors Proposed for Pennsylvania

Commissioner Connelly of the Department of Labor and Industry of Pennsylvania is making an effort at the present time to bring about the formation of a Board of Boiler and Pressure Vessel Inspectors for that state. Although the object of this organization will be similar to that of the National Board of Boiler and Pressure Vessel Inspectors—that of promoting co-operation between the various boiler inspectors of the state, as the National Board promotes co-operation between various states—it will, however, have no connection with the National Board.

Over 800 approved boiler inspectors in Pennsylvania, including those of insurance and casualty companies, have received letters and questionnaires which are intended to determine the sentiment in connection with the matter. The response from these men has been favorable and it is expected that an organization meeting will be held October 24 in connection with the proposed Industrial Relations Conference.

If the State Board is actually organized there will undoubtedly be a working agreement made with the National Board of Boiler and Pressure Vessel Inspectors to cooperate as far as possible since the work of both organizations has a common object.

Principles of Riveted Joint Design—IV

Laying Out Complicated Seams and Studying the Effect of Failures on Various Type Joints

By William C. Strott*

A FURTHER development of the quadruple riveted joint is illustrated in Fig. 19. It has five rows of rivets on each side of the centerline from which it gets its name "quintuple" riveting. The maximum pitch P is twice what it would be for a quadruple-riveted butt joint, and four times that for a triple-riveted butt joint of equal proportions. In other words, the maximum pitch P is equal to eight times the calking pitch.

There are ten possible ways in which a quintuple riveted joint like Fig. 19 can fail. Three of these are by the three methods T, Sh and Cr, each acting independently; the remaining seven methods are compound failures. In short, the calculations are so very similar to those outlined in connection with the double, triple and quadruple riveted joints that no further discussion of them will be entered into here. The strength equations for the different methods of failure will, however, be given.

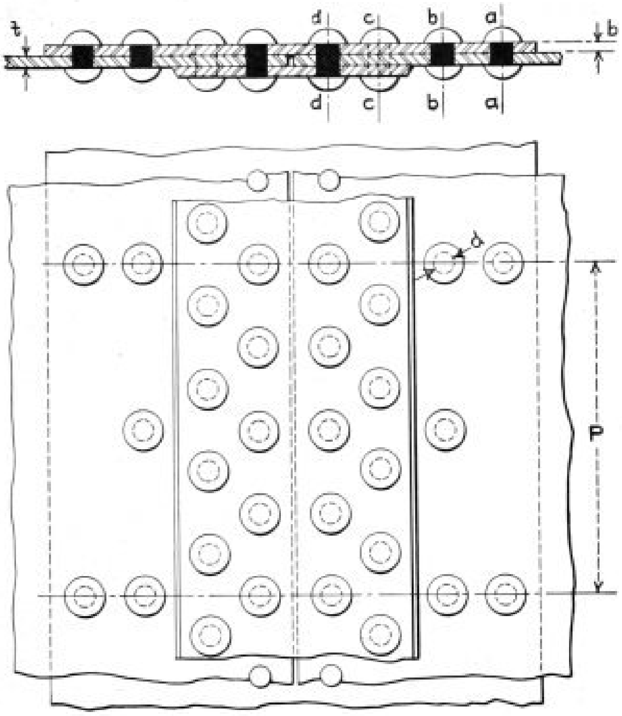


Fig. 18.—Quadruple Riveted Double Butt Strap Joint

Strength of solid plate .... $= W = P \times t \times T_s$

Available net plate strength through section a-a .... $= T = (P - d) \times t \times T_s$

Total rivet shearing strength $= Sh = 16 \times a \times S + 7 \times a \times s$

Total crushing strength $= Cr. = 16 \times d \times t \times C + 7 \times d \times b \times C$

Combined shear and crushing........... $= ShCr = 16 \times d \times t \times C + 7 \times a \times s$

Through section b-b $\begin{cases} (T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times s \\ (T - Crb) = (P - d) \times t \times T_s + 1 \times d \times b \times C \end{cases}$

Through section c-c $\begin{cases} (T + Sh) = (P - 4d) \times t \times T_s + 3 \times a \times s \\ (T + Crb) = (P - 4d) \times t \times T_s + 3 \times d \times b \times C \end{cases}$

Through section d-d $\begin{cases} (T + Sh) = (P - 8d) \times t \times T_s + 7 \times a \times s \\ (T + Crb) = (P - 8d) \times t \times T_s + 7 \times d \times b \times C \end{cases}$

Divide the least of these ten values by W and the quotient will be the true efficiency of the joint.

It is evident that this process of widening the inside butt straps and adding rows of rivets along the outside might be continued indefinitely, producing sextuple (six rows) and even higher combinations. Due to their extreme width, however, longitudinal joints above quadruple riveting are practically unknown in even the largest commercial boilers. Quintuple riveted joints, however, are extensively employed in very large tanks and standpipes, where on account of their increased efficiency material may be saved by reducing the thickness of the shell plate.

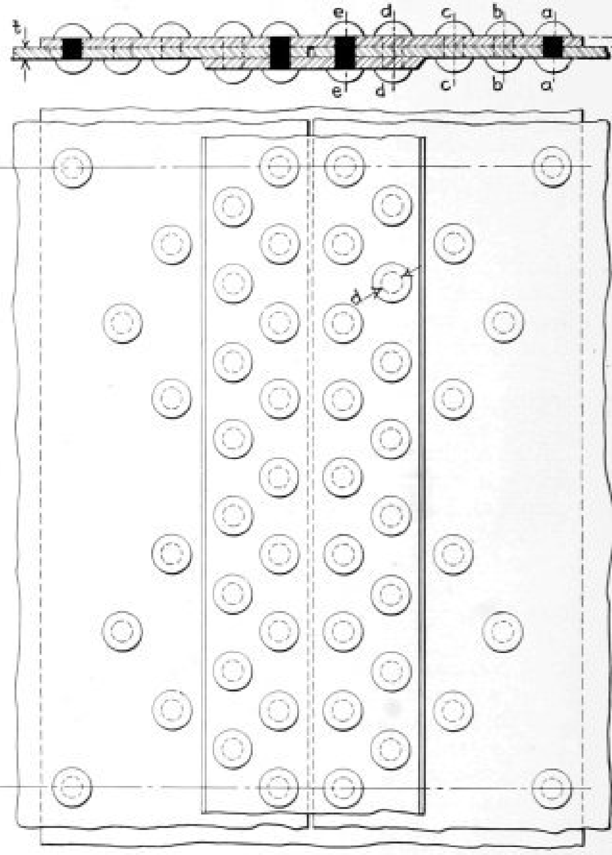


Fig. 19.—Quintuple Riveted Double Butt Strap Joint

Fig. 20 shows an interesting type of riveted joint, though very little used on new work at the present time. It received its name because at one time it was very extensively used in locomotive practice. The joint is simply a double riveted lap, having an inside cover plate. It may seem strange, but the efficiency of this joint is identical with that of a triple riveted double butt strapped joint, Fig. 17, of equal proportions. This may be easily proven by comparing the strengths of these two types through their corresponding sections. The locomotive joint is peculiarly adapted for strengthening an old lap joint where it is found to be weak for the pressure desired.

Strength of solid plate,.................... $W = P \times t \times T_s$

Strength of net plate section through a-a.. $T = (P - d) \times t \times T_s$

*Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer Blaw-Knox Company, Pittsburgh, Pa.; and Union Iron Works, Erie, Pa.

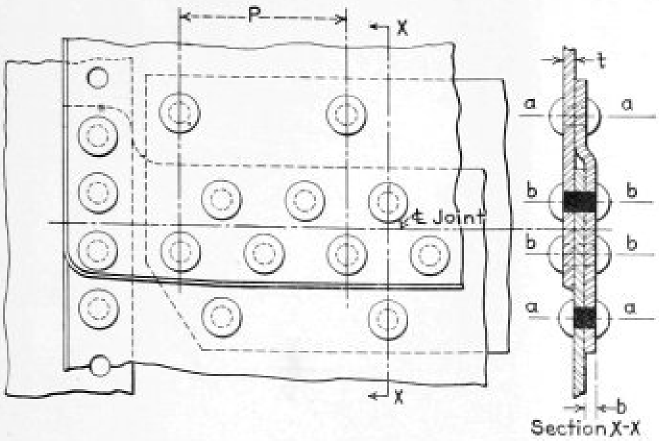


Fig. 20.—The "Locomotive" Type Joint

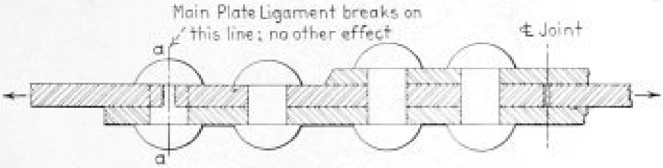


Fig. 21.—Illustrating Failure of Double Butt Strap Joint Through First Row of Rivets; Failure (T)

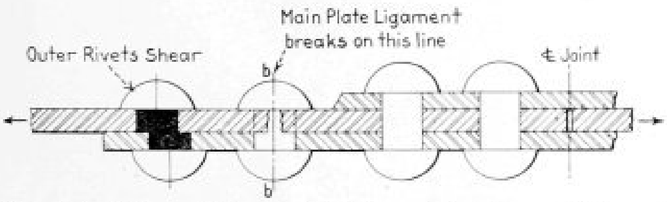


Fig. 22.—Failure of Double Butt Strap Joint Through Second Second Row of Rivets; Failure (T + Sh)

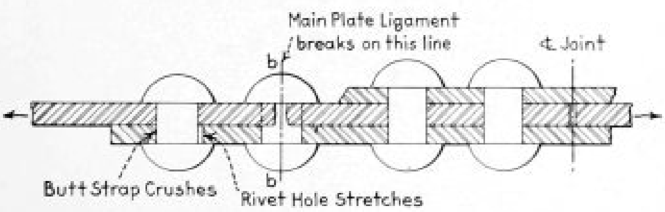


Fig. 23.—Failure of Double Butt Strap Joint Through Second Row of Rivets; Failure (T + Crb)

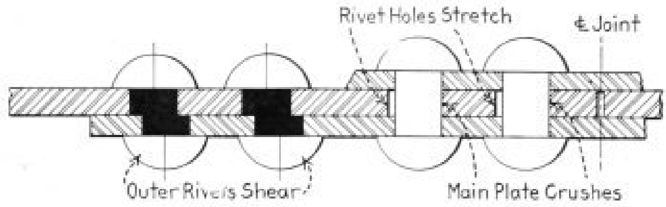


Fig. 24.—Failure of Double Butt Strap Joint Through Third Row of Rivets; Failure (T + Sh)

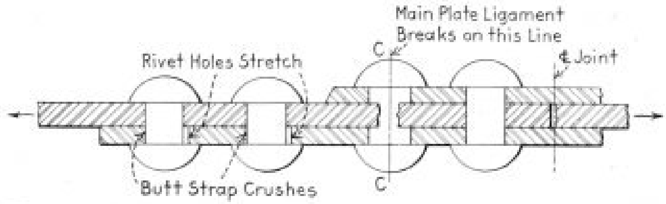


Fig. 25.—Failure of Double Butt Strap Joint Through Third Row of Rivets; Failure (T + Crb)

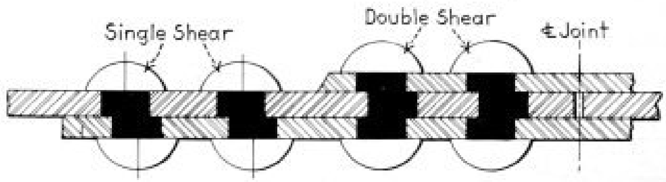


Fig. 26.—Failure of Double Butt Strap Joint by Rivet Shear; Failure (Sh)

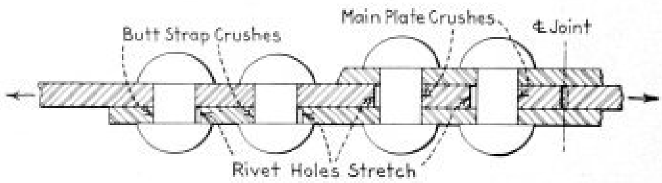


Fig. 27.—Failure of Double Butt Strap Joint by Crushing; Failure (Cr)

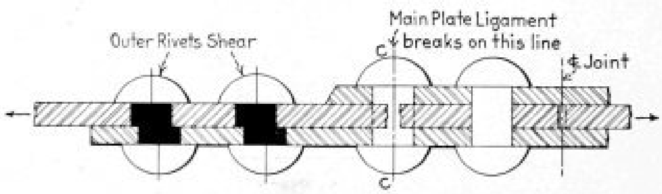


Fig. 28.—Failure of Double Butt Strap Joint by Combined Shear and Crushing; Failure (Sh + Cr)

Total shearing strength........ $Sh = 2 \times a \times S + 1 \times a \times s$
Total crushing strength.. $Cr = 2 \times t \times d \times C + 1 \times d \times b \times C$
Through section b-b $\begin{cases} (T + Sh) = (P - 2d) \times t \times T_s + 1 \times a \times s \\ (T + Crb) = (P - 2d) \times t \times T_s + 1 \times b \times d \times C \end{cases}$
Combined crushing and shear...... $(Cr + Sh) = 2 \times d \times t \times C + 1 \times a \times s$

Divide either of the above values, whichever is the least, by W, and the quotient will be the true efficiency of the joint.

Actual Illustrations Showing the Various Methods of Riveted Joint Failure

The author believes that the following set of illustrations presents a novel method of indicating riveted joint failures. In order for anyone to clearly understand how failure, by any of the methods previously discussed, can occur in a riveted joint, let him simply imagine the joint to be stressed in the direction of the arrows as indicated in the illustrations, commencing with the first or outermost row of rivets as section a-a of Fig. 21.

It may be seen that the only method of failure possible at that point is the breaking of the net plate section between the rivet holes in that row. Since there are no rivets outside of this row, the plate ligament receives no assistance, but takes the full load independent of any other source.

Through section b-b, Fig. 22, it is quite plain that in order for the plate ligament to break, the rivets in the outer row must shear with it.

Fig. 23 likewise shows a plate failure through the second row of rivets, but in this case we add to it, the crushing resistance of the butt strap against the rivets in the outer row.

In Fig. 24, we find a condition identical with that shown in Fig. 22. Although the net plate section through the third row of rivets is less than that in the second row it should be clear that considerable more shearing strength is available—this being represented by two instead of only one row of rivets as was the case shown in Fig. 22.

In Fig. 25, we also have the joint failing through the third row of rivets, but here we have the crushing resistance of the inside butt strap against the two outer rows of rivets. In fact this method of failure is identical with that illustrated in Fig. 23.

This method of failure is quite simple and should require no further explanation, except that a careful distinction should be made between the rivets which are in single shear and those which are in double shear.

In Fig. 27, it may be difficult to understand immediately the reason for not considering the crushing value of *all* the plates against the rivets. Assume a load to be applied to the above joint; then the two outer rows of rivets transmit this pressure at once to the lower butt strap. Therefore, since the butt strap is thinner than the main plate, the strap would crush first. Now, proceeding to the two inner rows of rivets, we know that this same force also acts against these rivets, which in turn transmit the load to *both* upper and lower butt straps. Since the pressure on each strap will then be only one-half that on the main plate, it follows that the main plate will crush *before* the butt straps.

Fig. 28, illustrates a method of failure very similar to that shown in Fig. 24, except that in the present case we have the crushing strength of the main plate against the two inner rows of rivets, acting in conjunction with the shearing resistance of the two outer rows of rivets.

In order to simplify the work as much as possible for practical use, the author has arranged the following reference table which will give the efficiency of any part of a riveted joint, directly. It is only necessary to substitute figures for letters in the formulæ and solve as indicated. The least of the several values determined for any type of joint will of course be its true efficiency.

Reference Table for Calculating the Efficiency of Riveted Joints.

Single Riveted Lap Joint.

$$T = \frac{P - d}{P} \qquad Sh = \frac{a \times s}{P \times t \times T_s}$$

$$Cr = \frac{d \times c}{P \times T_s}$$

Double Riveted Lap Joint.

$$T = \frac{P - d}{P}$$

$$Sh = \frac{2 \times a \times s}{P \times t \times T_s}$$

$$Cr = \frac{2 \times d \times C}{P \times T_s}$$

Triple Riveted Lap Joint.

$$T = \frac{P - d}{P}$$

$$Sh = \frac{3 \times a \times s}{P \times t \times T_s}$$

$$Cr = \frac{3 \times d \times C}{P \times T_s}$$

Double riveted double butt strapped joint, (straps of unequal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{5 \times s \times a}{P \times t \times T_s}$$

$$Cr = \frac{2 \times d \times t \times C + d \times b \times C}{P \times t \times T_s}$$

Failure through second row of rivets:

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T + Crb) = \frac{(P - 2d) \times t \times T_s + d \times b \times C}{P \times t \times T_s}$$

$$(Sh + Cr) = \frac{2 \times d \times t \times C + a \times s}{P \times t \times T_s}$$

Triple riveted double butt strap (unequal width) joints.

$$T = \frac{P - d}{P}$$

$$Sh = \frac{9 \times s \times a}{P \times t \times T_s}$$

$$Cr = \frac{4 \times d \times t \times C + d \times b \times C}{P \times t \times T_s}$$

Failure through second row of rivets:

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + s \times a}{P \times t \times T_s}$$

$$(T + Cr) = \frac{(P - 2d) \times t \times T_s + d \times b \times C}{P \times t \times T_s}$$

$$(Sh + Cr) = \frac{4 \times d \times t \times C + a \times s}{P \times t \times T_s}$$

Quadruple riveted double butt strapped joints, (straps of unequal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{19 \times a \times s}{P \times t \times T_s}$$

$$Cr = \frac{8 \times d \times t \times C + 3 \times d \times b \times C}{P \times t \times T_s}$$

Failure through second row of rivets:

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T - Crb) = \frac{(P - 2d) \times t \times T_s + 3 \times d \times b \times C}{P \times t \times T_s}$$

Failure through third row of rivets:

$$(T + Sh) = \frac{(P - 4d) \times t \times T_s + 3 \times a \times s}{P \times t \times T_s}$$

$$(T - Crb) = \frac{(P - 4d) \times t \times T_s + 3 \times d \times t \times C}{P \times t \times T_s}$$

$$(Sh + Cr) = \frac{8 \times d \times t \times C + 3 \times a \times s}{P \times t \times T_s}$$

Quintuple riveted double butt strapped joint, (straps of unequal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{39 \times a \times s}{P \times t \times T_s}$$

$$Cr = \frac{16 \times d \times t \times C + 6 \times d \times b \times C}{P \times t \times T_s}$$

Failure through second row of rivets:

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T + Crb) = \frac{(P - 2d) \times t \times T_s + d \times b \times C}{P \times t \times T_s}$$

Failure through third row of rivets:

$$(T + Sh) = \frac{(P - 4d) \times t \times T_s + 3 \times a \times s}{P \times t \times T_s}$$

$$(T + Crb) = \frac{(P - 4d) \times t \times T_s + 3 \times d \times b \times C}{P \times t \times T_s}$$

Failure through fourth row of rivets:

$$(T + Sh) = \frac{(P - 8d) \times t \times T_s + 7 \times a \times s}{P \times t \times T_s}$$

$$(T + Crb) = \frac{(P - 8d) \times t \times T_s + 7 \times d \times b \times C}{P \times t \times T_s}$$

$$(Sh + Cr) = \frac{16 \times d \times t \times C + 7 \times b \times C}{P \times t \times T_s}$$

Single riveted double butt strapped joint (straps of equal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{a \times S}{P \times t \times T_s}$$

$$Cr = \frac{d \times C}{P \times T_s}$$

Double riveted double butt strapped joint, (straps of equal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{2 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{2 \times d \times C}{P \times T_s}$$

Triple riveted double butt strapped joint, (straps of equal width).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{3 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{3 \times d \times C}{P \times T_s}$$

Triple riveted double butt strapped joint, (straps of equal width, but every alternate rivet in the outside rows omitted, Fig. 12.)

$$T = \frac{P - d}{P}$$

$$Sh = \frac{5 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{5 \times d \times C}{P \times T_s}$$

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T + Cr) = \frac{(P - 2d) \times t \times T_s + d \times t \times C}{P \times t \times T_s}$$

Failure through second row of rivets.

"Saw-Tooth" Joint, Triple Riveted.

$$T = \frac{P - d}{P}$$

$$Sh = \frac{5 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{5 \times d \times T_s}{P \times T_s}$$

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T + Cr) = \frac{(P - 2d) \times t \times T_s + a \times t \times C}{P \times t \times T_s}$$

Failure through second row of rivets.

"Saw-Tooth" Joint, Quadruple Riveted.

$$T = \frac{P - d}{P}$$

$$Sh = \frac{10 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{10 \times d \times C}{P \times T_s}$$

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times S}{P \times t \times T_s}$$

$$(T + Cr) = \frac{(P - 2d) \times t \times T_s + d \times t \times C}{P \times t \times T_s}$$

Failure through second row of rivets.

$$(T + Sh) = \frac{(P - 3d) \times t \times T_s + 3 \times a \times S}{P \times t \times T_s}$$

$$(T + Cr) = \frac{(P - 3d) \times t \times T_s + 3 \times d \times C}{P \times t \times T_s}$$

Failure through third row of rivets.

The "Locomotive Joint"

(Double riveted lap seam with inside cover plate. Fig. 18).

$$T = \frac{P - d}{P}$$

$$Sh = \frac{3 \times a \times S}{P \times t \times T_s}$$

$$Cr = \frac{3 \times d \times C}{P \times T_s}$$

$$(T + Sh) = \frac{(P - 2d) \times t \times T_s + a \times s}{P \times t \times T_s}$$

$$(T - Crb) = \frac{(P - 2d) \times t \times T_s + d \times b \times C}{P \times t \times T_s}$$

Failure through second row of rivets.

$$(Cr + Sh) = \frac{2 \times d \times t \times C + a \times s}{P \times t \times T_s}$$

(To be continued)

Inclining the Torch When Cutting

STRAIGHTAWAY cutting with the hand torch is facilitated by inclining the head of the torch backward after the cut is well started. The degree of inclination will vary somewhat with the thickness of the metal and other conditions. A fairly conservative figure is 65 to 75 degrees angle from the plate behind the torch to the torch head. The effect of inclining the torch is to speed up cutting considerably. The gases directed at an angle preheat the thin edge of undercut metal ahead of the igniting temperature more rapidly than when the tip is held squarely with the plate. The gases and products of combustion turn backward, passing through an arc of, say, approximately 90 degrees and shooting down and back. Often the drag or lag of the cut will be as much as one-half or even three-quarters inch on half-inch steel. When cutting with the torch inclined, it should be uprighted just before finishing the cut in order to sever the metal at the end. Otherwise a wedge of uncut metal will be left due to the oxygen shooting by the corner as the torch reaches the end of the cut. The "drag" part of the cut will be left untouched. Uprighting of the torch cuts this portion off cleanly.

Expert hand cutters are able to cut one-half-inch steel plate with a very narrow kerf and low oxygen pressure, often working at speeds up to 24 inches per minute and sometimes faster. The experienced cutter learns to follow the cut with great precision, going no faster than permissible, but still following the combustion rate so closely that there is little or no loss of cutting efficiency. This is very important. The cutter who tries to work too fast "loses the cut" and makes a mess of things. The cutter who works too slow wastes gas and time, while the one who knows just how fast to cut approximates 100 percent efficiency in time and gas.—*Autogenous Welding.*

Special and Topical Committee Reports of the Master Boiler Makers' Association

Methods of Autogenous Welding in Principal Railroad Shops Investigated and Firebox Problems Considered

THROUGH the courtesy of The Master Boiler Makers' Association we are able to present the committee reports prepared for the 1921 convention and which will be presented at the convention in 1922, to be held at the Hotel Sherman, Chicago, May 23 to 26. Several reports not appearing in this number of the magazine will be published in the November issue.

STATEMENT OF THE EXECUTIVE COMMITTEE

Financial stress and serious business conditions on the railroads having for obvious reasons made it desirable to cancel the convention which was to have been held at St. Louis on May 23 to 26, 1921, the executive committee has authorized this publication of the reports of committees on subjects prepared and filed for the occasion, in place of the official proceedings which would otherwise have been issued.

The object is to afford members ample opportunity to study the reports and be prepared to discuss them at the next convention.

Also to make any recommendations suggested to their minds that will be of assistance to the chairmen in the event that they deem it desirable to revise or amplify their reports for the 1922 convention.

Such recommendations should be sent in writing to the chairman of each committee whose address is shown with each report.

CHARLES P. PATRICK, President.
JOHN F. RAPS, Chairman, Executive Board.
HARRY D. VOUGHT, Secretary.

Report on Investigation of Autogenous Welding

The purpose of this special committee was to investigate autogenous welding by personal observation owing to conflicting reports by different members on the floor of our 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.

Your committee is satisfied that welds 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 the principal causes of failures in autogenous welding. It is now a recognized fact that welders cannot 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 oxyacetylene 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 percent, 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.

The idea of doing anything or everything 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 percent 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 sheet 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.

Thomas F. Powers, system general foreman, Chicago and Northwestern Railroad, 1129 South Clarence Ave., Oak Park, Ill., chairman. Members of committee: John Harthill, John F. Raps, H. J. Wandberg, C. E. Elkins, W. J. Murphy.

Methods of Welding Safe Ends on Locomotive Tubes

In submitting report on the above subject, and as chairman of this committee, in making composite report, I have therein embodied the substance of individual reports by the other committeemen, as well as information gathered by the chairman during the year in visiting the large railroad shops throughout the country and his past personal experiences.

Standard Safe End Practice

We will first take up the welding of safe ends in the regular way which is in vogue in most of the large railroad shops, viz.: the oil furnace, roller and hammer welders. It seems to be the consensus of opinion of the committee that no difficulty is experienced in welding iron to iron, steel to steel, iron to steel, or vice versa. In this connection I wish to say, however, that where steel is being welded to iron, it is good practice to give the iron somewhat of a lead in the heat, as steel will weld very readily up from 2500 degrees to 2600 degrees F., and iron fuses nicely at about 2800 degrees to 3000 degrees. This can be very readily done when heating the tube and opening it to receive the safe end; then return to furnace immediately and it will have about the required lead in heat over the steel. If the tube should be placed in the fire with both iron and steel cold, I believe it to be good practice to set the material in the furnace so as to give the iron the benefit of the heat. With this practice there should be no trouble in welding steel to iron, or vice versa.

The committee seems to be somewhat divided on the scarfing of safe ends. A large number of shops are welding safe ends onto tubes without scarfing, with very good results. The committee, however, recommends that the sharp burr be taken off the outer edge of the safe end before inserting it into tube; otherwise when being rolled down in welding the sharp edge cuts in and thereby weakens the wall of the tube, causing the tube in some cases to break off. It is my opinion that the scarfed safe end makes the smoother weld, providing the scarf is properly made; about ½ inch in length and at the thinnest end to be not less than 1/16 inch thick, instead of scarfing them down, as we find in a good many cases, to a feather edge.

It is the further opinion of the committee that it is not necessary to use flux in welding, the reason being that in a good many cases dirt and foreign matter become mixed with the flux, and when it is applied to the metal prevents cohesion, and the result is a defective weld. If the flux can be kept perfectly clean there seems to be no objection in the use of it. A very fine sand is being used in some places, and, it is claimed with very good results. If, however, the welding qualities of the material are right, and the furnace constructed so that it will properly heat the material, there should be no trouble in welding without the flux.

Causes for Poor Welds on Safe Ends

Investigating complaints of trouble experienced in the welding of safe ends, we find that this can be attributed mostly to one or two things, or both—improper construction of the furnace and the roller welding machine not being speeded up to the revolutions necessary to make a quick and sound weld. The roller welding machine should have a speed of not less than 450 revolutions at the fly wheel. The material being of a light wall, it cools very rapidly, and therefore must have quick action for fusing. In our opinion, some of the trouble complained of is due to the oil burners being set so that they play directly upon the material to be heated; especially is this a fact in short furnaces. Where the oil is of a good grade and light there seems to be no trouble in properly heating the material, but when the oil is dirty and of a heavy grade proper combustion will not take place in the short distance. The results are that where specks of this oil strike the metal along the line of the weld the material will not amalgamate; the result is a defective weld. The burner should be placed so that it will not blow directly upon the material; better at right angles, either top or bottom. In some cases I have found that they mixed heavy crude with kerosene oil; this brought about better combustion and better results were obtained from the furnace. The heavy oil clogging the burner causes the temperature to fluctuate, and the material is wasted in the furnace without being given the proper degree of heat for welding. The temperature of the furnace should be kept above the welding heat; if possible, 300 degrees to 400 degrees F., and it is the opinion of the committee that it is necessary to use a pyrometer only in cases where the desire is to establish the proper heat for welding. This, however, is not necessary with an experienced flue welder, as his eye will readily detect the proper degree of heat for welding, and the pyrometer should only be used as a matter of education.

Use of the Spot Welding Machine

Welding safe ends by the electrical spot welding machine, in the opinion of the committee, will eventually supersede the present method. Mr. John Doarnberger, a member of this committee, for the benefit of the Association, has made a number of tests, both as to cost, quality of material, and strength of welds. He states that the average consumption of current is about 20,000 watts, or in other words, 20 kilowatts. In considering the cost the current is one cent per kilowatt hour delivered to the machine, and would cost about 20 cents per hour for current. Mr. Doarnberger claims that he can turn out about 85 flues per hour, which would make the cost per flue about ¼ cent for current. To operate this machine, however, it is necessary to have available alternating current, 60 cycle, with 110 or 120 volts. They will not operate on direct current. These machines will operate very satisfactorily, however, over a wide range of voltage. The present machine at the Roanoke, Virginia, shop, Mr. Doarnberger states, has a minimum of 170 and a maximum voltage of 300, and under these conditions it is commercially possible to put them on any lighting or power circuit that may be available, providing the current is generated in a standard apparatus, or purchased from any ordinary lighting company operating under conditions as found in the average town.

The Norfolk & Western Railroad now has in service approximately 280,960 tubes welded by this method, 152,000 being welded in 1919, and no failures are reported. The Union Pacific Railroad is welding about 60 tubes per hour. It claims to have over 700,000 in service, and only two service failures out of this number, those that failed being in service more than three years.

Chamfering Safe Ends

In connection with the electrical spot welder, I find tubes and safe ends being chamfered to about 30 degrees at the Omaha shop and when the safe end is inserted there is a lap of about 3/16 inch, and this, in my opinion, is the better method; or, I would prefer it over the butt-welded, because if the material carbonized and broke off at the weld, after going into service, it would drop into the boiler. On the other hand, if it is lapped there is less liability of the tube breaking off from the safe end completely, and in this way would cause less damage.

At the Atchison, Topeka & Santa Fe shops I found the most up-to-date electrical spot welding machine, which has a roller attachment on the machine, the tube being heated and rolled down without moving from the machine to the roller, as is the practice in other shops where the spot welder has no roller attachment. These people, however, are using the machine mostly for reclaiming, welding from six inch to 10 inch and about 35 or 40 tubes per hour.

Following is the strength of new $2\frac{1}{4}$-inch tubes without a weld:

37,820 pounds 37,770 pounds 38,030 pounds 38,030 pounds 38,030 pounds 37,800 pounds	Average 37,921 2/3 pounds.

Coke Welded

31,130 pounds 36,380 pounds 28,370 pounds 37,060 pounds 32,550 pounds 33,930 pounds	Average 33,236 2/3 pounds. Efficiency 87 2/3 percent.

Electrically Buttwelded

31,290 pounds 37,240 pounds 33,020 pounds 38,770 pounds 33,450 pounds 30,350 pounds	Average 34,020 pounds. Efficiency 90.6 percent.

The chairman of the committee has also conducted a test with 12 electrically spot welded two inch tubes which proved to have an efficiency of over 90 percent.

In conclusion, I wish to say that in most large shops—with the present method of furnace, roller and hammer welding—two men are employed in the welding, one piecing up and the other welding. In this way the tube is not allowed to cool off and it takes less time to heat; you might say this brings about continuous welding. I find that in most up-to-date shops they claim to weld about 50 tubes per hour, some places, however, are doing even better than that.

P. J. Conrath, boiler tube expert, National Tube Company, 4414 Michigan Ave., Chicago, Ill., chairman. Members of committee: J. A. Doanberger, Alfred R. Stiglmeier.

Best Type Crown Stays for Various Classes of Locomotives

Up to several years ago, the crown stay generally used on the radial stay fireboxes was of the button head type. The more general use of oil as fuel in fireboxes demonstrated the need of a crown stay without as much bulk and of a smaller head than the button head type. This was due to the large amount of iron used in the head of the button type of bolt becoming overheated and crumbling away, due to the extreme temperature of the fire in an oil burning firebox.

In most cases when the button head bolt was used in oil burning fireboxes, they could not be maintained. The heads on the bolts crumbled and broke away in pieces, leaving the crown bolt in weakened condition.

The riveted head bolt with a taper was then generally adopted on most oil burning fireboxes and was generally a success. Due to the success of the hammered head bolt in oil burners and the fact that it was much easier to apply and maintain, it was then adopted on some roads as a standard for coal burning locomotives as well as those burning oil.

The only objection that can be raised against the use of the hammered head bolt with taper, used as crown stay, is the fact that it is not as strong as the button head bolt. Answering this objection, it may be said, that in the first place, it will have to be admitted that the hammered head bolt with a taper is of ample strength under ordinary working conditions; that is, with water over the crown sheet, as it will stand from 18,000 to 20,000 pounds before pulling through the crown sheet and under ordinary conditions, all the bolt is called upon to stand with 200 pounds pressure with a spacing of 4 by 4 inches is 3,200 pounds. The only time the strength of the bolt can be questioned is when the sheet becomes overheated, and it is well known that the button head type of bolt will not hold up the crown sheet when it becomes overheated. Then the only question to be considered is how much longer will the button head type of bolt hold than the hammered head bolt with a taper when the crown sheet is overheated, bearing in mind that it is questionable whether we want the sheet to hold until the plates are badly overheated and soft, or prefer to have them let go as soon as possible after the water gets below the high point of the crown sheet?

This should bring out some debate in the discussion of this paper, as we have all seen some very bad explosions with both types of bolts.

In order to reduce the amount of iron in the fire, some roads made it a practice on all oil burning locomotives to drill off one-third to one-half the head on the button head radials when they were used in the crown sheet. This was not a success as it still left a large amount of iron and like the full button head bolt, crumbled and left the bolt in a weakened condition. Before adopting the hammered head radial with a taper, the road with which the chairman of this committee is connected, made some tests which in part are as follows:

Test No.	Condition of pull	Where broken	Kind of head	No. pounds	Remarks
1	Cold	Head pulled off	Button head with 1/3 head drilled off	23,750	Plate dished 1/4
15	Cold	Bolt broke 3 ft. from head	Full button head	29,510	Plate dished 3/8
4	Cold	Head pulled through sheet	Hammered head with taper 1½ in. in 12 in.	19,400	Plate dished 1/16
14	Cherry red	Head pulled off	Full button head	7,100	Plate dished 3/16
7	Cherry red	Head pulled off	Button head with 1/3 head drilled off	7,730	Plate dished 3/16
11	Cherry red	Head pulled through sheet	Hammered head with taper 1½ in. in 12 in.	2,900	Plate dished 1/16

All of the above tests, with the exception of those made cold, were made with the heat as near the same temperature as it was possible to get them, that is, about a cherry red. It can be seen that as long as the sheet is cold the hammered head type of bolt is of ample strength and even when the sheet is cherry red, it takes 2,900 pounds to force the plate from the bolt. If, as in most cases, it has been found necessary to adopt the hammered head bolt with a taper on oil burning locomotives (and from all we are able to learn, these are the only bolts which can successfully be maintained in an oil burner), we believe that the whole thing can be summed up in the phrase, "that what is sauce for the goose is sauce for the gander," and that this type of bolt if used in an oil burning locomotive should certainly be a good thing in a coal burner.

We would recommend for the following reasons the adoption of the stay screwed into the crown sheet with the taper and riveted over.

1. That it is of ample strength.
2. It is easier to apply than the button head on account of being tapered.
3. Less work is needed to replace on account of the rank taper in firebox; can be cut free in roof sheet and in firebox, and driven clear of crown sheet, thereby avoiding a lot of extra work cleaning broken ends off of crown sheet, where, in a great many cases, bodies of bolts become fast between braces and cannot be removed.
4. Easier to get tight and does not strip, can be pulled up tight regardless of the angle of the sheet.
5. Gives little or no trouble in service, while the button head type of bolt leaks very easily, and when it does leak it is hard to calk, and if not calked properly is wedged away from the sheet, making it necessary to renew the bolt.
6. Gives a cleaner crown sheet both on the water and fire sides of the sheet, and does not collect dirt and cinders as does the button head, and gives a more even head surface.
7. Can be manufactured at less cost than the button head stay.
8. Gives a saving in tool bills, both in making of bolts and in reaming and tapping, as the one tap and reamer can be made to do for three or four diameters.
9. Can be carried in stock threaded at both ends ready for use.

In applying the hammered head radial with taper, we would suggest that the first five rows of radials in the center of the crown sheet from the back flue sheet be applied without the taper. This weakens the high point of the crown sheet and, in case of low water, probably would let go by bagging and pulling out these few bolts while the rest of the crown sheet with the taper radial stay would hold.

LEWIS NICHOLAS, JR., general boiler inspector, Chicago, Indianapolis and Louisville Railway, Lafayette, Ind., chairman. Members of committee: T. F. POWERS, J. J. MANSFIELD.

Elimination of Firebox Deterioration Behind Grate Bars

The most active agent of corrosion behind grate bars is sulphurous acid gas produced from the sulphur in the coal which is converted into sulphuric acid in the presence of moisture in the coal.

The principal reasons for this condition are poorly constructed grate bars and supports and ash pan hanger sheets, together with leaky mud ring rivets and staybolts, side bars and supports being so constructed that they hold the coal and cinders against the side sheet and the moisture from the leaky staybolts or rivets soon causes the sheet to deteriorate.

To prevent this condition, the grate bars should be constructed to fit up tight against the side sheet on top and should also have the top of bar made at an angle of 45 degrees instead of flat on top. This will have a tendency to keep the coal from going down behind the bars. There should also be all the opening possible between the sheet and bars at bottom to allow any coal or cinders that might work down from firebox to fall on through.

If this practice is carried out and the mud ring rivets and the staybolts are tight, no great amount of trouble will be experienced from deteriorated side sheets. It is also a good plan when the grate bars are removed to have the side sheets thoroughly cleaned and painted with a heavy coat of rust proof paint.

C. E. ELKINS, general foreman boiler maker, Missouri Pacific Railroad, 1212 West 11th St., Little Rock, Ark., chairman. Members of committee: JOHN J. ORR, C. F. PETZINGER.

Cause of Boiler Shell Cracking Through Girth Seam Rivet Holes

Your committee respectfully submits the following for your consideration:

One member of the committee after 45 or 50 years' experience can recall only 10 boilers which failed when the boiler shell cracked circumferentially. Five were locomotive boilers which cracked through the rivet holes at the external lap, two cracked through the rivet holes at internal lap, and one through the main plate at the abutment of the lap. Two return tubular boilers cracked through the rivet holes of the external lap. These boilers all developed cracks ranging in length from three to four feet, extending about equal distances to each side of bottom center line.

The locomotive boilers had double riveted girth seams and the tubular boilers single riveted girth seams. The girth seams in all boilers which cracked did not become defective because of a low factor of safety as they had factors in excess of that prescribed by both the governments of the United States and Canada. Not one of these cracks resulted in the explosion of the boiler.

The other two members of the committee, after making inquiries and observations from numerous railroads, find very few boiler shells cracking through the girth seam rivet holes and what has come to their attention was due to carelessness in preparing the sheets for riveting.

It must be quite clear to all of us that the plates in the steam space on the locomotive boiler must expand to a greater extent than the water space of the shell of the boiler, and the difference in the expansion between the top and bottom of shell in the locomotive type of boiler is dependent on the temperature of the steam at the top and the water below.

At first it would be thought that the top of the boiler would fail in advance of the bottom, but this is not so, because expansion is occurring equally and normally over every unit of its length, whereas the lower shell is subjected to a higher tension of stress brought about by the expansion of the top, which stress the bottom cannot equal because of its low temperature. This, in our opinion, causes the cracking of the shellplate through the girth seam rivet hole and the shell of the boiler, usually starting at the bottom.

It is our opinion that the rivet hole should be drilled in the girth seam and sheets properly prepared for riveting, and other improvements, which would quicken circulation such as applications of feed water with top checks located at the top of the boiler and at a distance from the fire; feed water heaters to raise the temperature of the feed water; automatic feed water regulation with regulators which would supply and keep the water as near as possible at a normal working level under all conditions. Also keep the expansion pads that secure the boiler to the frame free. Allowing the boiler to breathe and move freely in the frame will often prolong the rupture.

In our opinion with such improvements in general use on boilers the differential between the expansion of top and bottom of the shell would become more normal, with a reduction in the number of failures and the cracking of rivet holes in the girth seam, and the time of rupture be prolonged.

ANDREW S. GREENE, general foreman boiler maker, Big Four System, 3209 East 16th St., Indianapolis, Ind., chairman. Members of committee, WILLIAM A. MCKEOWN, T. W. LOWE.

Best Type of Side Sheet to Be Applied to Narrow and Wide Fireboxes of Locomotives

This matter was taken up with all members of the committee on July 13, 1920. J. P. Malley has covered the subject thoroughly on every point and in accord with my views and consideration in the following:

Depressed, corrugated, vertical or longitudinal side sheets have been manufactured to overcome short life of sheets, cracks and defective and leaky staybolts without success; therefore, we recommend that straight side sheets be maintained wherever possible and in following this practice, locomotives be equipped with side sheet in the same manner as when received from the mill, free from all strains to which the sheet would be subject in the manufacture of the others referred to above, as well as having a locomotive boiler that can be washed clean.

This report was prepared by a committee consisting of C. R. BENNETT, chairman; J. P. MALLEY and WILLIAM FANTOM.

Oxy-Acetylene Welding

We are 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 for his boiler welding, and at no time was a welder. Put in a firebox to do welding that had not been tried and tested out on several test pieces, made of boiler iron, and had them 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 wish to call attention to an article from THE BOILER MAKER and the *Railway Mechanical Engineer* entitled "The Status of Autogenous Welding." "Tests on Welded Pipe" appeared in the August, 1920, issue and "The Status of Autogenous Welding" in the July issue. These tests were made since our last meeting in May, 1920.

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

This report was prepared by a committee consisting of D. A. LUCAS, chairman; H. J. WANDBERG and THOMAS LEWIS.

Copper vs. Steel for Boiler Tubes

WHILE it has been the general practice in the United States for half a century to fit steel tubes in locomotive boilers, this does not appear to have been the case in Europe. Copper boiler tubes are said to have been coming into use to a large and increasing extent in England, Australia and South America, while brass tubes on the Continent of Europe are very largely used.

With a life stated to be three times that of steel tubes, the first cost of the copper tubes is put at only about twice that of the former; and it has been estimated that during a period of 12 years the cost of a ton of copper tubes, plus interest on the investment and minus the scrap value of old tubes, would figure out at £186. This contrasts with an estimate of £293 for steel.

Attention is called also to possible fuel economies through using the tube of greater heat conductivity than is inherent in steel, and to the savings both in expenses and in locomotive operating time from the less frequent renewing of tubes. —*Iron Age.*

Annual Convention of the Master Boiler Makers' Association

AT a meeting of the executive committee of the Master Boiler Makers' Association, held in Chicago September 24, it was decided to hold the thirteenth annual convention of the association at the Hotel Sherman, Chicago, May 23 to 26, 1922. Registry of members and guests will begin on May 22 at the Hotel Sherman, which will be headquarters during the convention. The secretary urges members to make hotel reservations early to insure satisfactory accommodations and to send applications directly to the Hotel Sherman.

Very valuable reports have been prepared by the committees on topics and by a special committee on welding for this convention which have been published in book form and distributed to members in good standing. The office of the secretary, Harry D. Vought, is now at Room 315, 26 Cortlandt Street, New York city.

Boiler Inspection Regulations in California

AS a result of the repeal of Chapter 202 of the Laws of 1917 boiler users in California have had difficulty in understanding certain of the safety provisions of the law. According to a statement recently made by H. M. Wolflin, superintendent of safety, the enactment of Chapter 904 of the statutes of 1921, formerly known as Assembly Bill 1300, automatically repealed the former chapter.

The Workmen's Compensation Insurance and Safety Act, according to Mr. Wolflin, requires that places of employment in California shall be made reasonably safe and calls upon the Industrial Accident Commission to see that the safety provisions of this law are carried out. The Boiler Safety Orders adopted in accordance with the act required the annual inspection of steam boilers operated in all places of employment. Chapter 202, which was repealed, was originally intended to permit the Commission to charge fees for inspecting boilers, to make boiler repairs without a permit illegal and to impose certain requirements on the certification of boiler inspectors. The repeal of this chapter has no effect upon the Boiler Safety Orders which will continue in force. Although amendments to the Orders are being considered, it is probable that few important changes will be made and quite certain that the annual inspection requirements will remain unchanged.

Because of lack of funds for safety work, it is doubtful if the commission's inspectors will be able to inspect all boilers annually. This fact, together with the repeal of Chapter 202, might possibly cause certain boiler users in the state to feel justified in disregarding the safety provisions of the law. In connection with this point, Mr. Wolflin states emphatically that if an explosion should occur in a boiler which has not been inspected within a year, the owners would still be liable to suit for endangering their employees and the general public.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-President and Treasurer*
Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1,
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $2.00; foreign, $3.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,500 copies were printed; that of these 4,500 copies 3,989 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 71 were mailed to advertisers, 34 were mailed to employees and correspondents, and 390 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 48,100, an average of 4,810 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

GENERAL: PAGE.

The Installation and Operation of Thermic Syphons 273
A Criticism of High Efficiency Joints 278
Work of the A. S. M. E. Boiler Code Committee 279
Water Cooled Furnace Door 280
Safety Code for Compressed Air Machinery 280
Special Methods of Boiler Flanging 281
State Board of Boiler Inspectors Proposed for Pennsylvania 283
Principles of Riveted Joint Design—IV 284
Inclining the Torch When Cutting 287
Special and Topical Committee Reports of the Master Boiler Makers' Association 288
Report on Investigation of Autogenous Welding 288
Methods of Welding Safe Ends on Locomotive Tubes 289
Best Type Crown Stays for Various Classes of Locomotives 290
Elimination of Firebox Deterioration Behind Grate Bars 291
Cause of Boiler Shell Cracking Through Girth Seam Rivet Holes 291
Best Type Side Sheets to Be Applied to Narrow and Wide Fireboxes of Locomotives 292
Oxy-Acetylene Welding 292
Annual Convention of Master Boiler Makers' Association 292
Boiler Inspection Regulation in California 292

EDITORIAL COMMENT 293

ENGINEERING SPECIALTIES FOR BOILER MAKING 294

QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Layout of Cowl Ventilators 296
Oblique Transition Piece Development and Hopper Angles 297

BUSINESS NOTES 297

OBITUARY 297

LETTERS FROM PRACTICAL BOILER MAKERS:
Crown Sheet Failure on Oil Fired Locomotive 298
Another Record of Boiler Shop Service 298

ASSOCIATIONS 299

TRADE PUBLICATIONS 299

SELECTED BOILER PATENTS 300

Copies of the annual index of THE BOILER MAKER for the year 1921 will be mailed on January 1, 1922, to all our subscribers who send us a request for them on or before December 1, 1921. As the edition of the index will be limited to the number ordered up to December 1, all readers desiring a copy should send in their orders promptly.

Although the annual convention of the Master Boiler Makers' Association was not held in St. Louis last May, the reports which were prepared for this convention have been published and distributed by the Association so that members will have ample opportunity between now and the next meeting to study the findings of the committees carefully and prepare to make the discussions at the 13th convention at the Hotel Sherman, Chicago, Ill., May 23 to 26, 1922, of real practical value. Many suggestions from all the reports, but especially from the one on autogenous welding, may well be applied to operations in every railroad shop in the country, for they were made by a committee which after studying the work of the most progressive railroads in the United States made a selection of the best methods developed and compiled them in the form presented to the Association. A very complete report on electric welding will appear in the November issue of THE BOILER MAKER.

The action of Ohio in accepting as official the boiler inspection stamp of the National Board of Boiler and Pressure Vessel Inspectors last month started a movement which apparently will not stop until all states recognizing the American Society of Mechanical Engineers' Boiler Code as a standard of construction have agreed to accept the Board's stamp. The secretary-treasurer of the Board reports that nine states—California, Indiana, New Jersey, New York, Oklahoma, Ohio, Oregon, Rhode Island and Wisconsin—will now accept the Board's stamp on boilers as of equal authority with the recognized stamps of their own inspection departments.

This announcement indicates that the object of the Board to standardize boiler inspection throughout the country has met with success. Only about eight states and municipalities where the American Society of Mechanical Engineers' Code is in effect have so far failed to approve the National Board's stamp, and every effort is being made to induce these states to take the action necessary to make the Board's work fully effective.

As a result of the recent national conference on unemployment held in Washington, certain specific measures were recommended that will require the support of industries throughout the country in order to relieve the acute unemployment situation. Those recommendations which apply particularly to manufacturers follow:

"(a) Part-time work, through reduced time or rotation of jobs. (b) As far as possible manufacturing for stock. (c) Taking advantage of the present opportunity to do as much plant construction, repairs and cleaning up as is possible, with the consequent transfer of many employees to other than their regular work. (d) Reduction of the number of hours of labor per day. (e) The reduction of the work week to a lower number of days during the present period of industrial depression. (f) That employees and employers cooperate in putting these recommendations into effect. A number of employers have already, in whole or in part, inaugurated the recommendations herein set forth, and for this they are to be commended, and it is earnestly urged upon those employers who have not done so to put them into use, wherever practicable, at the earliest possible opportunity. (g) Specific methods for solution of our economic problems will be effective only in so far as they are applied in a spirit of patriotic patience on the part of all our people."

The discussion on this subject at the June meeting of the American Boiler Manufacturers' Association brought out the fact that boiler manufacturing companies have been doing everything possible to maintain their organizations intact. Certain of the recommendations made at the national conference may, however, suggest to the boiler making industry additional methods of helping in the relief of the unemployment situation.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Turret Rotary Shear for Cutting Metal Without Swinging the Stock

For cutting various shapes from sheet metal without turning the sheet or plate during the cut, the Southwark Foundry and Machine Company, Philadelphia, Pa., has produced a turret rotary shear, which cuts an opening up to double the throat depth at any distance from the end of the sheets or plates regardless of their length. Four sizes of this machine are available, having capacities up to ⅜-inch gage metal, but larger sizes are also built having shearing capacities up to 1-inch plate. The No. 3 Southwark-Gray

No. 3 Southwark-Gray Double Turret Rotary Shear

shear illustrated is of special interest because of the double turret with which it is equipped.

As stock is fed through the machine, the line to be cut is followed by means of the turret which may be revolved by guide wheels on either side of the machine. Cuts are made with minimum radii, equal to the radius of the cutters in stock not heavier than half the capacity of the machine, while on heavier stock than this the minimum radii will be slightly larger than the radius of the cutters. On the double turret machine for material ⅜-inch thick and heavier, both the upper and lower cutters are at an angle, which is unchanged in whatever position the turret may be turned by the hand wheel. When the position of the cutters is changed, the direction of the feed is correspondingly changed, insuring automatic feeding of materials at all times. Foot treads are provided on each side of the machine which control the cutters, so that when difficult cuts are being made, the cutters may be started or stopped within a fraction of an inch.

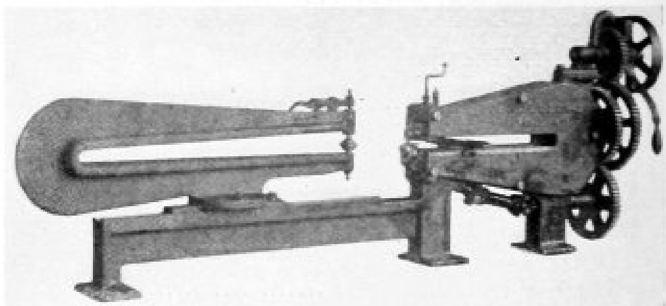
In starting an inside cut, sufficient pressure is provided to force the cutters through the sheet or plate before the cut is commenced. Horizontal and vertical adjustments are provided to insure correct alinement of the cutting edges without the cutters coming together and jamming.

In general sheet metal work the shear may be used to advantage cutting elbows, tees, boiler and tank work.

Ring and Circle Shear

A deep-throat ring and circle shear, designated as the No. 13-B, for light material, has been placed upon the market by the Niagara Machine & Tool Works, Buffalo, N. Y.

The machine is shown in the accompanying illustration and is regularly furnished for bench use, although high legs can be furnished if desired. Owing to the inclined position of the lower shaft and cutter internal circles or holes as well



Deep Throat Ring and Circle Shear

as outside circles can be cut. It is also suitable for cutting reverse curves within certain limits.

Cutters are 1⅝ inches in diameter, of tool steel, ground and hardened, and adjustment is provided for taking up wear and for thickness of material to be cut. The upper cutter can be raised and lowered to penetrate the stock so that the cut can be started in the sheet, and not only on the edge. The slitting gage applied to the cutting head is accurate and readily adjustable for strips of various widths. The circle arm can be conveniently moved and fastened to proper distance from the cutters, according to the diameter to be cut. A scale graduated in 1/16 inch is marked on the circle arm support, and the proper position of the blank between the clamping disks is determined by a swinging gage and the cutters. An eccentric device is used for clamping. The clutch is actuated by a hand lever.

The machine will cut No. 20 gage soft steel and will circle from a square blank 3½ to 42 inches. The distance from throat of cutting head to frame is 18 inches, and to the gage, 9 inches. The throat of circle arm is 30 inches. The weight is 430 pounds.

Belt-Driven Air Compressor

A new type air compressor, having plate valves for both the air intake and discharge and a 5-step clearance control for regulating the output has been developed by the Ingersoll-Rand Company, New York. The plate valves used in this type of compressor are supported throughout their entire operation in correct alinement without any form of wearing guide which insures a long life to the valves. The clearance control was originally developed for use on the larger direct connected, motor driven compressors built by the same company, which have been installed in plants where more than 600 cubic feet of free air per minute is required. With the clearance control the compressor is automatically loaded or unloaded in five successive steps, obtained by the reduction or addition of clearance space to the air cylinders. Under this system a compressor will operate at full, three-quarters, half, one-quarter and no load and the control is so designed as to secure efficient operation at any step in this range.

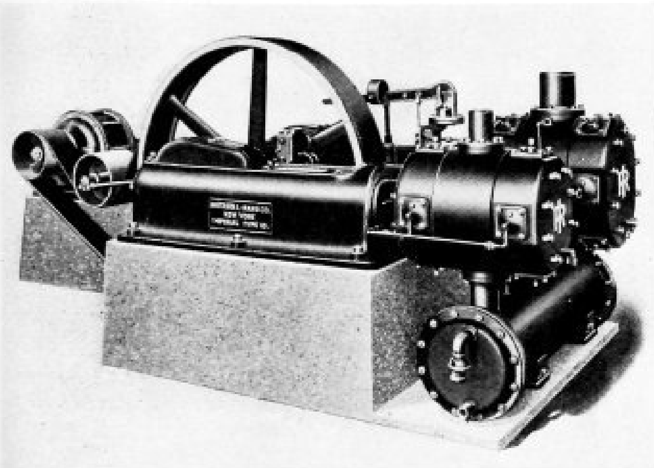


Fig. 1.—Short Belt, Motor Drive "Imperial" Air Compressor

A feature of the control is the fact that the clearance pockets are integral parts of the compressor cylinder and the entire regulation is obtained by the control of the volume of air taken in and compressed. The clearance pockets in the cylinder are automatically thrown in communication with the ends of each cylinder in proper succession, the process being controlled by a pre-determined variation in receiver pressure. With the compressor operating at partial capacity a portion of the air is compressed into an added clearance space instead of passing through the discharge valves. On the return stroke this air expands giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure, at which point the inlet valves are opened automatically and free air is drawn into the cylinder for the remainder of the return stroke.

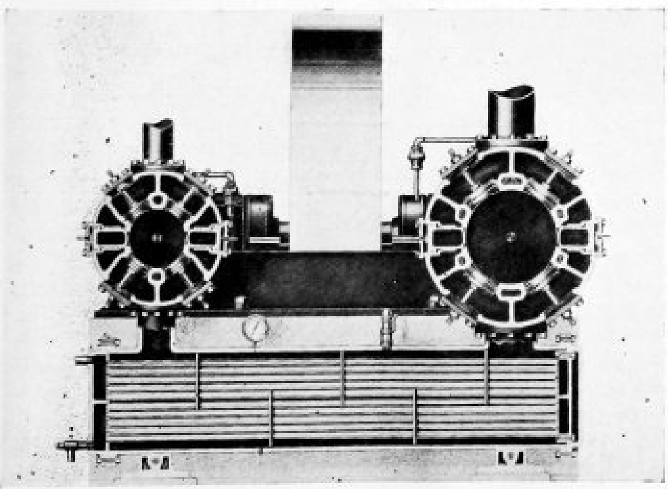
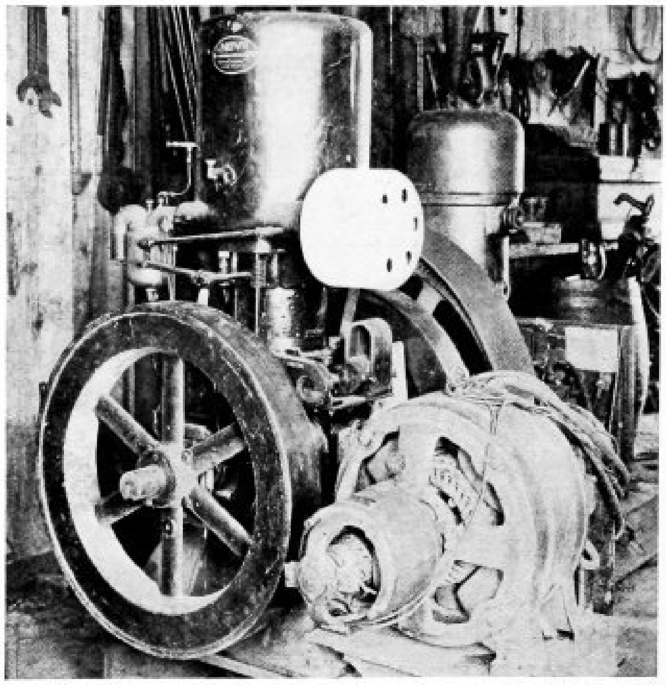


Fig. 2.—Section Through Cylinders of "Imperial" Compressor Showing Clearance Valves and Pockets

On a two-stage compressor, clearance space in proper proportion is added simultaneously for both high and low cylinders giving a constant ratio of compression and maintaining a high compression efficiency throughout the entire load range. All the mechanism for regulating the compressor is independent of the compressor running gear. The new type of belt driven compressor equipped with clearance control is furnished in single stage for low pressures and two stage for higher discharge pressure. The piston displacement capacity for 100 pounds discharge pressure ranges from 610 to 1,505 cubic feet of free air per minute. This new type machine is described in complete detail in Bulletin No. 3042 sent out by the Ingersoll-Rand Company.

Portable Welding Set Operated by Ten Horsepower Novo Engine

A portable welding set, consisting of a generator and a 10 horsepower Novo engine, made by the Novo Engine Company, Lansing, Mich., has been developed for emergency repair work. This unit can be mounted on a motor truck and used within a radius of 50 miles of the home plant.



Novo Engine Driven Generator for Welding Repair Service

A unit operated by the Western Welding and Equipment Company, Chicago, is used in this manner for firebox and boiler repairs in plants where no facilities are available for welding. A great deal of the work on boilers and other machinery in which this equipment is utilized is the calking of plate edges, welding flues, welding combustion chambers, repairing machine castings and the like.

The engine and generator are connected by a belt drive. The fuel consumption is about a gallon and a quarter of gasoline per hour. The speed at which the engine operates gives gives the generator a capacity of 150 amperes at 20 volts, which is a good average current for welding. A throttling governor is arranged on the Novo engine so that it maintains a fixed speed whether the generator load is on or off.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, *Woolworth Building, New York City.*

Layout of Cowl Ventilators

Q.—Please give me information as to how to lay out a cowl ventilator. C. T.

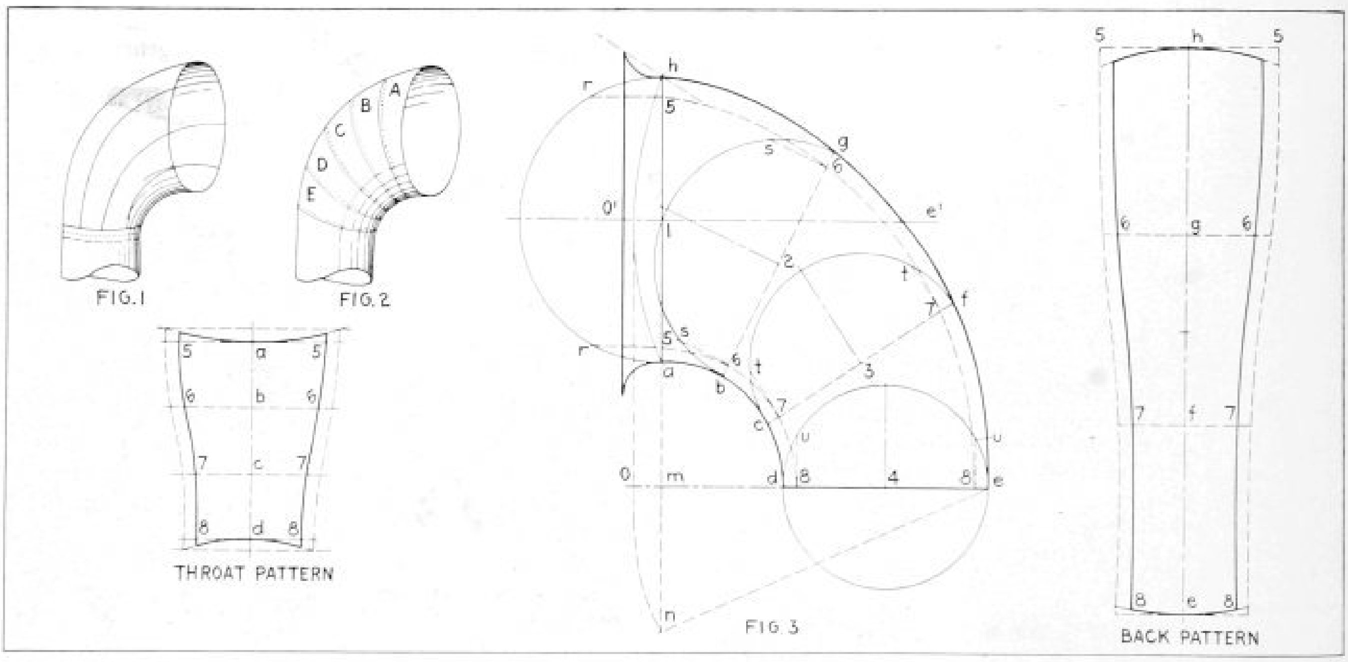
A.—Ventilators are made in many shapes and sizes, and usually of steel or sheet iron, but occasionally of sheet copper or brass. Figs. 1 and 2 show the forms usually employed, the development of the patterns for these ventilators being fully described in the April, 1917, issue of The Boiler Maker. Ventilators made in the form of Fig. 3 are produced by hammering them to the required shape. In work of this character, owing to the stretching of the metal during the forming process, it is practically impossible to lay off patterns that will work up to the exact shape. The best that can be expected is close approximation, making due allowances of metal to take care of the stretching and contracting of the metal. The opening of the ventilator is of the bell-mouthed shape and the body is made in four parts, a back sheet, throat and two side sheets, commonly called cheeks. In large cowls the bell mouth would be made in several sections.

The construction shown in Fig. 3 gives the data for laying off the patterns for the throat and back sheets. The side sheet patterns are laid off to the form shown in the elevation.

Preliminary to the laying off of the patterns, draw first an elevation of the cowl and indicate the seam line between the cheeks, throat and back sheet as indicated in the elevation by the dotted lines. Divide the arcs *e-h* and *a-d* into equal parts. Draw the lines *b-g*, *c-f*. Bisect the lines *a-h*, *b-g*, *c-f* and *d-e* locating points *1-2-3-4*. With these points as centers draw semi-circles. From the point of intersection of the semi-circle and its center line for each of the constructions shown, set off the respective radii, thus locating points *r*, *s*, *t*, and *u*. Perpendicular to the lines *a-h*, *b-g*, *c-f* and *d-e* draw lines *r-5*, *s-6*, *t-7* and *u-8* and through the points *5-6-7-8* draw the curved lines for the seam between the cheek, throat and back sheet.

Patterns may now be developed as shown for the throat and back sheet. For the back sheet make the center line *h-e* equal to the arc length *h-g-f-e* of the elevation and through the points *e-f-g-h* draw straight lines at right angles to the center line *h-e*. Arc length *h-5* equals *h-5*, *g-6* equals *g-s*, etc., and these lengths are set off on both sides of the center line *h-e*. Through the points *5-6-7-8* draw in the sides of the pattern and at the ends draw arcs *5-h-5* and *8-e-8*. The center of the pattern will lengthen and the sides contract during the forming process, so allowances must be made for this condition.

The throat pattern is laid off in the same manner, using the arc lengths indicated on the throat in the elevation. In forming the pattern the metal will stretch and contract in the same manner as the back plate, so it is well to make the length on the center line equal to the arcs *a-b-c-d* and to make the curves *a-5-a* and *d-8-d* the reverse of those shown in the back pattern. The amount to allow for stretching and



Types of Cowl Ventilators and Method of Developing Patterns for a Bell Mouth Ventilator contraction of the metal is largely determined by experiment. Have enough metal to be on the safe side and to allow for trimming.

Oblique Transition Piece Development and Hopper Angles

Q.—What solution in drawing can be used to find hopper angles? The opening in the top and bottom are on a different angle. I do not understand geometry very well and need a simple construction or diagram. Also show in THE BOILER MAKER how to lay out a square to round section inclined two ways. F. S.

A.—The principle applied in finding the hopper angles, described in the August issue of THE BOILER MAKER, can be used in finding angles *A* and *B*, Fig. 1 (page 239, August issue). The development of the transition piece is illustrated in Fig. 1 below. The respective steps in the layout are as follows: First construct a complete plan and elevation, showing the relative arrangement of the upper and lower bases. Laying off the plan at right angles to *a-b* will show a full view of the square base; the circular top appears elliptical in the plan. Its shape is found by drawing the profiles in the plan and elevation. Divide them into equal parts. In the elevation, project points from the profile at right angles to line *1-5*, thus locating points *2-3-4*. At right angles to

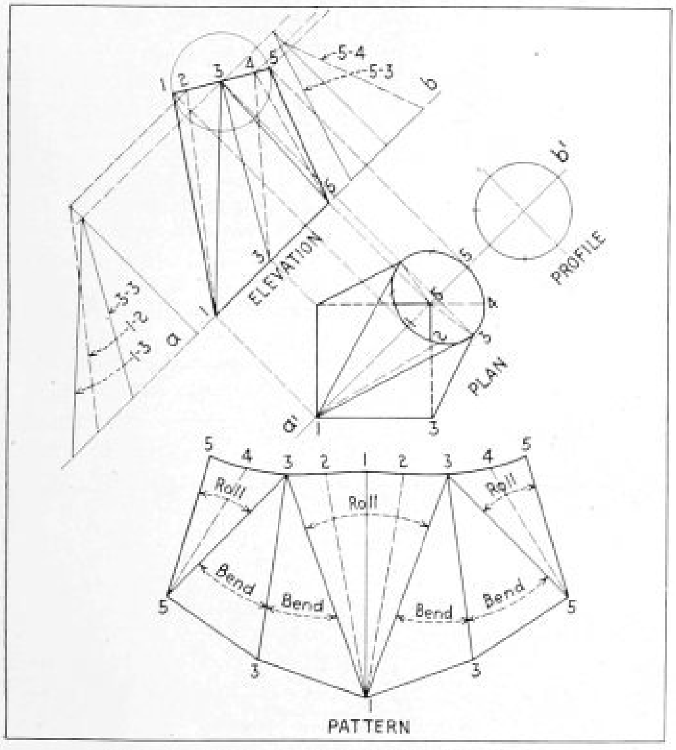


Fig. 1.—Development of Transition Piece

a-b and from points *1-2-3-4-5* project lines to the plan and from the profile in the plan lines are drawn parallel with *a'-b'* intersecting corresponding projectors drawn from the elevation, thus locating points *1-2-3-4-5* on the ellipses in the plan. Draw in the triangulation lines *1-2*, *1-3*, *3-5*, *5-4* in both views. The true lengths of these lines are produced opposite the elevation. The bases of these right angle triangles are numbered to correspond with the lines in the plan transferred from the plan, and as the triangles are numbered to correspond with the lines in the plan and elevation their construction should be easily understood.

A complete pattern is laid off showing the arrangement of the curved and flat surfaces and how they should be formed to make the tapering piece. Observe the lines and numerical notations and how they correspond with those in the two views which will assist you in forming a general idea of the object and its pattern. Make allowances for seams.

BUSINESS NOTES

The Northern Equipment Company, Erie, Pa., has appointed the Ernest E. Lee Company, 115 South Dearborn street, Chicago, as its district representative in the sale of Copes boiler-feed regulators and pump governors.

The Goetze Gasket & Packing Company, New Brunswick, N. J., announces the opening of a branch office at Philadelphia, Pa., in the Drexel Building, 5th and Chestnut streets, under the management of the Sheffler-Gross Company.

Charles S. Crowell, who was for fifteen years district sales manager of the Underfeed Stoker Company of America, Detroit, Mich., and who resigned July 1, has recently accepted a position as general sales manager with Joseph H. Roach & Co., Inc., 225 South Fifteenth Street, Philadelphia.

The Howard Iron Works, Buffalo, N. Y., and the Alberger Heater Company, New York, manufacturers of expansion joints and heaters, now have offices at 1777 Woolworth Building, New York, which are in charge of S. D. Harding and G. S. Whiffen.

The Babcock & Wilcox Company, 85 Liberty Street, New York, manufacturers of watertube boilers for land and marine service, has opened an office in the Guardian Building, Cleveland, Ohio, and will be represented by Mr. John Coleman, who has been connected with the Babcock & Wilcox Company for over twenty years.

OBITUARY

Henry J. Kimman, since 1902 manager of the Cleveland plant of the Chicago Pneumatic Tool Company, died in Cleveland, September 7. He was born in Haarlem, Holland, in 1863 and emigrated to America with his parents and settled in Chicago in 1870. He served with the Adams-Westlake Company and other manufacturing concerns in Chicago and in the west. He designed and, in collaboration with his brother, T. P. Kimman, built the first practicable portable piston air drill known as the "Little Giant." Soon after engaging in the manufacture of air drills, he became associated with H. N. Hurley and together they formed the Standard Pneumatic Tool Company in 1898. In 1901 at the consolidation of pneumatic tool interests by the Chicago Pneumatic Tool Company he became manager of the Cleveland plant and remained in active charge of this plant until his death.

James C. Stewart, senior partner in the Stewart Boiler Works, Worcester, Mass., died September 22 at the Peter Bent Brigham Hospital, Boston, where he was taken following a shock with which he was stricken while traveling from New York to Boston. Mr. Stewart was born in St. John, N. B., in 1857, the son of Charles Stewart a native of Scotland, who had served as an apprentice in the boiler works of John Stevenson, builder of the first locomotive, and who, after coming to this country, established with David F. Dillon in 1866, the plant in which the first horizontal return tubular boiler in the United States was built. Through various partnerships the business developed and in 1878, James Stewart was admitted to the firm which became known as Charles Stewart and Son. In 1889 the shops which are occupied at present by the company were built. After his father's death, James Stewart as senior partner and his brothers, Charles M. Stewart and John C. Stewart, continued the business, until his death. He was active in civic and charitable movements in Worcester and was a member of a number of clubs and societies in that city.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Crown Sheet Failure on Oil Fired Locomotive

The accompanying sketches show a locomotive crown sheet failure which recently occurred on an oil burning 70-ton locomotive of the geared type, working on a logging railroad near Vancouver, B. C. The drawings also show how the repairs to the locomotive were carried out.

The accident was due entirely to low water and the first evidence of trouble was when the engine reached the top of a heavy grade and the engineer heard steam rushing into the firebox. The pressure dropped at once so the injectors could not be used and this no doubt saved a disastrous explosion, as well as loss of life, for there were eight men riding on the locomotive at the time. It will be noted from the sketch that 42 button head stays were broken off short at the shoulder.

The method of repairing this boiler was by cutting out the damaged portion of the crown sheet and putting in a new sheet, approximately 34 inches wide and 6 feet long, and electrically welding the longitudinal seams and riveting the end seams. It will also be seen from the sketch that the old and new plates were beveled approximately 45 degrees to the center. The new sheet was carefully rolled and laid in place and held with just sufficient clamps not to strain it. It was then electrically welded on both sides, the excess metal was chipped off and the boiler subjected to a hydrostatic test of 260 pounds per square inch and found perfectly tight. The machine is now working at 200 pounds steam pressure.

Vancouver, B. C. W. T. Fraser.
Vancouver Machinery Depot, Ltd.

Another Record of Boiler Shop Service

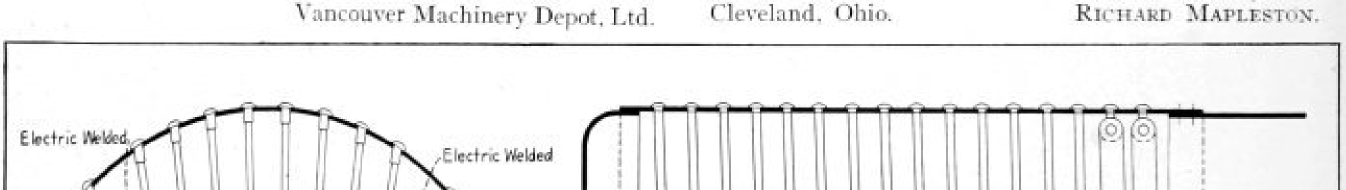
In the September issue of The Boiler Maker, on page 270, is published a letter signed by Mr. John Cook of Springfield, Ill., regarding his 69 years of service in the boiler making trade, and making inquiry as to whether there is any other man in the United States who has been at this particular trade for an equal period of time.

I would be pleased to have you answer Mr. Cook through the journal in October and publish my record as given below: I was born in Limerick, Ireland, on March 15, 1842, and spent my boyhood in the city of Waterford, Ireland. My father signed my indenture of apprenticeship in 1853 for me to learn the boiler making trade with the Neptune Iron Works at Waterford. I remained with this company for 16 years, after which I worked one year in England.

I arrived in America in 1870 at the age of 28, and came to Cleveland where I at once took employment with John and William Connelly, who operated a boiler shop.

At that time a younger brother of the proprietors, Daniel Connelly, was in apprenticeship in the plant, and a large part of his trade training is credited to the writer. In 1875 John and William Connelly sold the business to the younger brother and I continued in his employ for 36 years, until his death in 1911. Since that time I have continued in the employ of his sons, so that I have a continuous record of 69 years at the boiler making trade, as well as a continuous record of 51 years with one concern and one family.

Cleveland, Ohio. Richard Mapleston.



Sketches of Crown Sheet Failure and Method of Carrying Out the Necessary Repairs

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 26 Cortlandt street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

Kinite.—The Kinite Company, Milwaukee, Wis., has published a booklet detailing the use of Kinite for shear blades, re-drawing tools, blanking dies, draw dies and the like. Kinite is explained as an alloy of steel having great resistance to wear, dense structure, and close grain, air hardening quality, and other favorable properties.

Metal Spraying Process.—The process for depositing a coating of metal on nearly all manner of materials known as the Schoop metal spraying process is outlined in a pamphlet issued by the Metals Coating Company of America, 497 North Third street, Philadelphia, Pa. A description of the machines used and the range of application are fully outlined.

Lighting Data.—The Lighting Service Department of the Edison Lamp Works of the General Electric Company has issued a new series of bulletins on the general subject of electric lighting with titles as follows: Reflectors for Incandescent Lamps, Lighting of Printing Plants, Lighting for Outdoor Sports, Ship Lighting, Railway System Lighting, Buildings and Yards and Lighting for Indoor Recreations.

Chain Furnace Screens.—A description of the new chain furnace and oven doors, manufactured by E. J. Codd Company, Baltimore, Md., is contained in a pamphlet recently issued by this company. The screens consist of a number of individual strands of steel chain forming a penetrable, transparent sheet of chain which does not interfere with the view of the interior of the furnace, nor the passage of the charge, yet keeps the heat in. Examples of its application to various types of furnaces are fully explained.

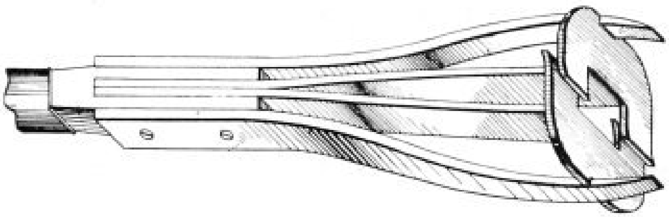
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,379,852. TUBE-CLEANER. CHARLES EDWARD CHESTNUT AND WILLIAM ALBERT HENDERSON, OF CALGARY, ALBERTA, CANADA.

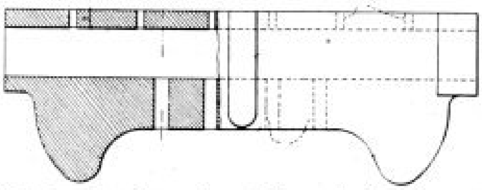
Claim.—A tube cleaner, consisting of a pair of spring members with cutter portions at their outer ends, said cutter portions having overlapping



parts forming substantially sections of a worm; additional spring members bearing against said cutter portions at the outer edges thereof, and a handle or holder to which the inner ends of all the spring members are secured, said additional spring members having scraper edges.

1,379,261. FIRE-BAR FOR FURNACES. JOSEPH ALBERT HILL, OF SHEFFIELD, ENGLAND.

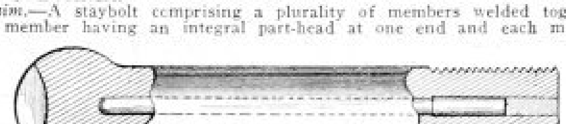
Claim.—A fire-bar for furnaces comprising a body portion of a general wedge-shaped formation in vertical section tapering inward toward the



bottom and having the lower edge of the central portion rounded, the body being provided with a longitudinal bore throughout its length and also provided with a plurality of vertical transverse bores communicating with the longitudinal bore and with the upper and lower surfaces of the bar, and depending end flanges upon said body portion having the lower edges rounded and adapted to fit snugly in a supporting conduit so as to prevent longitudinal movement of the bar.

1,366,725. STAYBOLT FOR BOILERS. JOHN ROGERS FLANNERY AND ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

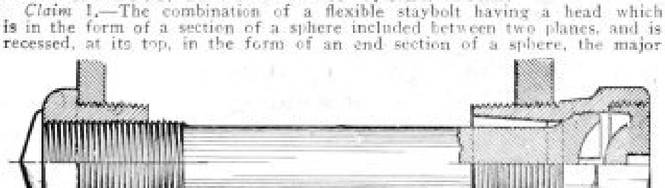
Claim.—A staybolt comprising a plurality of members welded together, each member having an integral part-head at one end and each member



having a groove extending from the unheaded end and into the part head at the other end, the grooves of the members co-operating to form a tell-tale hole open only at the unheaded end of the bolt and said tell-tale hole being slightly tapering at the unheaded end of the bolt with the smaller portion of the taper at the extremity of the bolt, and a removable plug in said tapering portion of the tell-tale hole.

1,348,657. FLEXIBLE STAYBOLT FOR STEAM-BOILERS. ALFRED C. NEGUS, OF SCHENECTADY, NEW YORK.

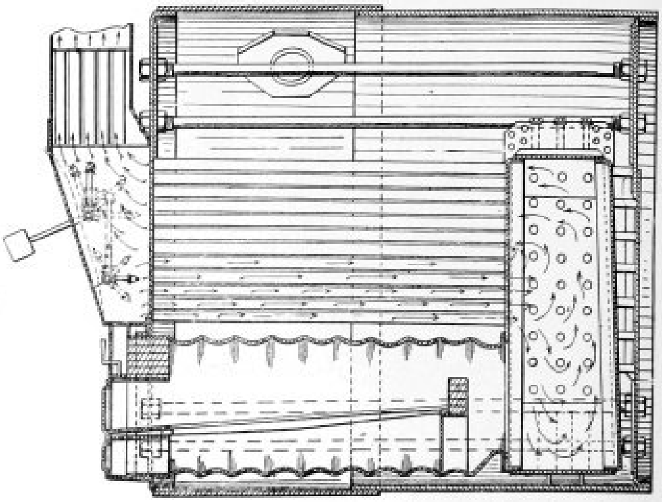
Claim 1.—The combination of a flexible staybolt having a head which is in the form of a section of a sphere included between two planes, and is recessed, at its top, in the form of an end section of a sphere, the major



transverse dimension of which is nearly equal to that of the bolt head; a sleeve in which said head is socketed; and a cap, closing said sleeve and having a projection on its inner side which enters the recess of the head, and depends below the cap only sufficiently far as to admit the interposition of a clear space between it and the bolt head, throughout its entire surface. Three claims

1,340,144. BOILER - TUBE AND COMBUSTION - CHAMBER CLEANER. JAMES BENNETT, OF CLEVELAND, OHIO.

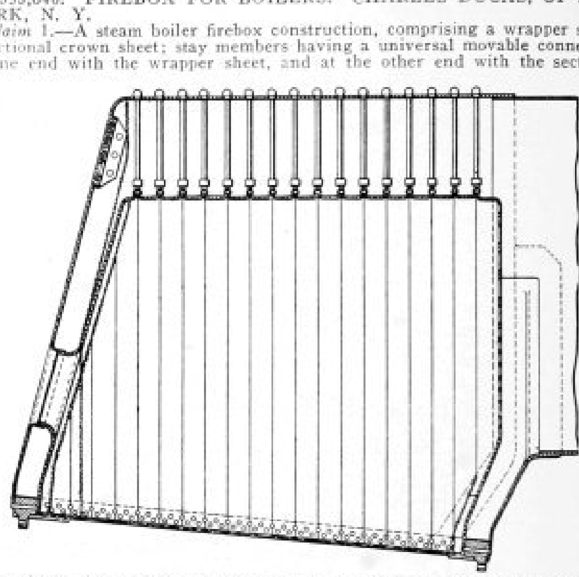
Claim 1.—A device for cleaning the soot and ashes from the combustion chamber and tubes of a horizontal boiler having a smoke box, and for driving them vertically into the smoke stack, comprising upper and lower rows of swinging steam jets, said rows arranged at different elevations in front of said boiler, one row of jets horizontally pivoted to alternately assume vertical and horizontal positions in the upper portion of the smoke box, and the second row, pivoted to alternately assume horizontal and vertical positions in the lower portion of the smoke box, and means for rotating said rows of jets to operate in conjunction to project the steam horizontally through some of the tubes of the boiler against the rear wall



of said combustion chamber, thence through the remaining tubes into the smoke box, and thence vertically into the smoke stack. Five claims.

1,353,640. FIREBOX FOR BOILERS. CHARLES DUCAS, OF NEW YORK, N. Y.

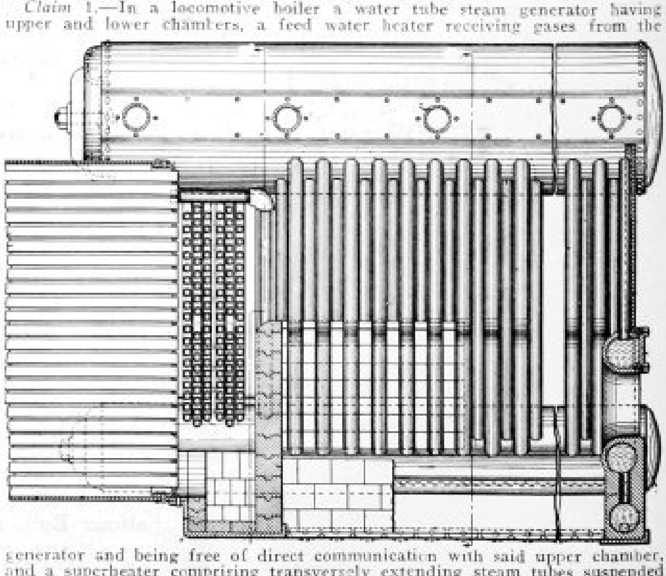
Claim 1.—A steam boiler firebox construction, comprising a wrapper sheet; a sectional crown sheet; stay members having a universal movable connection at one end with the wrapper sheet, and at the other end with the sectional



crown sheet; the sections of the crown sheet being of substantially U-shape in cross-section and having the side walls thereof secured together; and the side walls of the crown sheet sectional members being provided with vertical slots to permit of expansion and contraction, and prevent distortion of such members by reason of the unequal heating of the central and side walls of such sectional members. Thirty-four claims.

1,341,474. BOILER AND FIREBOX CONSTRUCTION. JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS.

Claim 1.—In a locomotive boiler a water tube steam generator having upper and lower chambers, a feed water heater receiving gases from the



generator and being free of direct communication with said upper chamber, and a superheater comprising transversely extending steam tubes suspended between the tubes of said generator and the gas intake end of said water heater. Nine claims.

The Boiler Maker

NOVEMBER, 1921

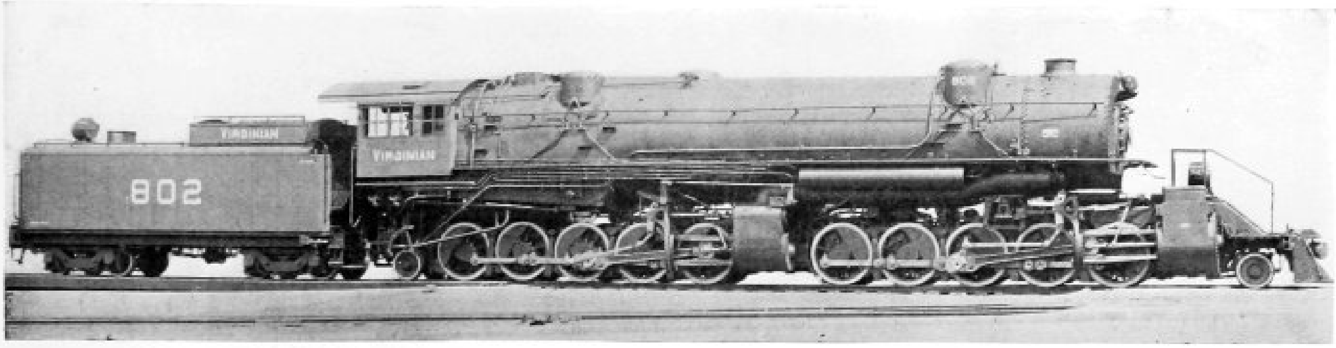


Fig. 1.—Locomotive of the 2-10-10-2 Type Equipped with 70 Superheater Units, Having a Total Heating Surface of 2,120 Square Feet

Superheater Practice in American Locomotives

In the United States, locomotives aggregating over 60,000,000 horsepower are equipped with superheaters. This device has proved to be the most advantageous means of increasing locomotive efficiency, while at the same time it has not required unusual or expert workmanship in its installation and maintenance. To suggest some of the most successful methods developed for handling superheater work, the following article has been prepared which gives the practice of several of the larger railroads and of the Superheater Company of New York.

The subject of superheater practice may logically be treated in two general divisions—the installation of the device and all its accessories and the maintenance of the equipment in service.

Superheaters must above all be installed so that all the parts are readily accessible, since sustained cleanliness of the gas-touched and steam-touched surfaces to a great extent determines the efficiency with which the device will operate. In service, regular inspections are essential and the header, flues, joints, units, damper and the various other parts should be kept tight and in repair. A minimum number of steam joints should be incorporated in the design of the superheater and these located at points of easy access.

All superheaters are designed with a high factor of safety and carefully tested at a pressure far in excess of the service requirements before they are installed. Because of this and the fact that the amount of stored energy in the superheater is small compared with the boiler proper, the possibility of failure of any part is slight.

General Description of Superheater

The type *A* superheater, Fig. 2, which has been found to meet all the requirements of hard service, consists essentially of the superheater header and a series of superheater units, generally arranged in two or more horizontal rows across the top part of the flue sheets.

The superheater header replaces the ordinary tee or nigger-head and, like it, is provided with connections for the dry pipe and steam pipes, but has, in addition, internal walls which prevent the direct flow of steam from the dry pipe to the steam pipes.

The units, shown in Fig. 3, are the type now being installed in all superheated locomotives. These units consist of four seamless steel pipes which are bonded together by machine forged return bends. The return bends are formed integral with the pipes of the unit from the same tubing of which the units are constructed. No acetylene or electric welding is used in this process.

The ball ends on the unit pipes are formed by upsetting. A three-operation die is used in this process in order to prevent folding or creasing of the material which would induce failure. After these ends are forged they are machined, so that the surface which seats in the header and the surface that rests in the clamp washer are true parts of the surface of a 2⅛-inch sphere.

If the joints both in the header and in the ball end of the unit are correctly maintained, the key to tight joints lies in unit clamp bolts. These should have a tensile strength of not less than 100,000 pounds per square inch, and an elastic limit of not less than 75,000 pounds per square inch, and the nuts must be capable of developing the full strength of the bolt.

These units are placed in the superheater flues which will vary from 4 inches to 6 inches outside diameter, depending upon the proportion of the boiler and length of flues. They extend full size from the front flue sheet to within 8 inches of the firebox, where the flue is reduced in diameter by swaging to the proper area.

To prevent the fire damaging the ends of the superheater units, where they come close to the firebox when steam is shut off, a portion of the smokebox including the superheater flues is boxed off. One side of this box is formed by the superheater damper, which is automatically operated, except under special conditions, by the admission of steam to the cylinders.

Setting Flues in Old or New Engines

The holes in both flue sheets, Fig. 4, should be smooth and round. The corners of the sheet around the flue holes in the firebox sheet should be rounded to 1/16-inch radius

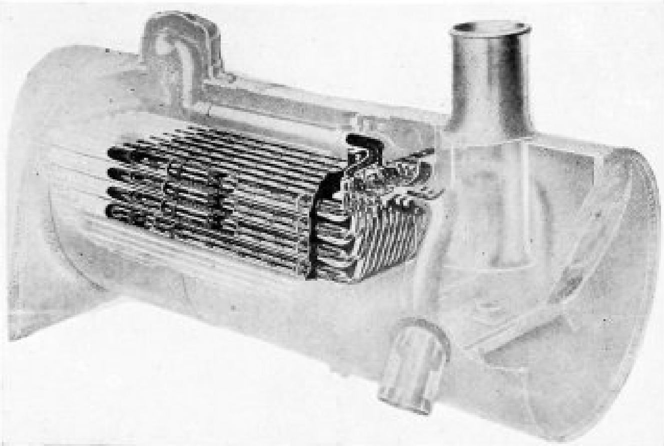


Fig. 2.—Type "A" Top Header Fire Tube Superheater

on both the fire and the water side. The corners of the sheet around the flue holes in the front flue sheet should be rounded to 1/16-inch radius on the smokebox side. In Fig. 4 is shown the best method for setting the copper ferrules.

All dirt and scale should be cleaned from the end of the flue or tube where it rests against the sheet and ferrule. This may be done by filing or grinding.

Sequence of Flue Application

The flues should be placed in the sheets and rolled, beaded at both ends and prossered at the firebox end.

This routine requires the use of but one type of prosser and insures the least abuse and best possible service from the flues and tubes.

The rolls should have not less than five rolls and the prosser not less than twelve sections. Rolls of different diameter are required for use in the front and firebox tube sheets.

Where flues are to be welded, the same practice is recommended preparatory to welding, including the use of a copper ferrule. Care should be taken in placing the ferrule to avoid the possibility of the copper working out under the bead.

Setting the Header in Place

In placing the header in the front end, it should be so set that the face is parallel to the center line of the top row of flues and each end of the face the correct distance above the center lines of the outside flues of the top row.

To check the setting, use long straight edges in each of the upper corner superheater flues and measure the same distance from the straight edges to the face of the header as shown at A and B in Fig. 5.

After the header has been properly located, it is supported in this location by jacks or blocking and the dry pipe studs are securely tightened.

Header Support

The header supports or brackets are designed to carry the header and so relieve the flue sheet and the neck of the header from the weight of the header and units.

With the dry pipe studs properly tightened and the blocking still supporting the header, the header supports are fitted closely to the header and the smokebox. Fasten the fitted supports to the header, with the studs for which holes are provided in the face of the header, and ream the holes for the bolts as shown on the left side of *D*, Fig. 5, fastening the supports to the smokebox. The supports are then secured to the smokebox with at least five ¾-inch turned and fitted bolts in each support, as shown on the right side of *D*, Fig. 5.

Hand holes at least 3 inches in diameter should be provided in each side of the smokebox, slightly below the center of the face of the header and directly opposite each other. These hand holes provide a means of inspection to determine whether the unit joints are leaking without removing the damper or baffle plates.

Superheater Unit Bands

All units should have bands and supports applied as shown in Fig. 8. The band is located 20 inches back from the front return bend.

All styles of units less than 12 feet 4 inches should have one support and this located 42 inches from the back end of the unit.

When units are 12 feet 4 inches or over either with cast steel, or forged return bends, they should have one support, located 42 inches from the back end and others when required spaced at equal distances from each other and the band. The intermediate spacing of supports should in no case exceed 80 inches or be less than 40 inches.

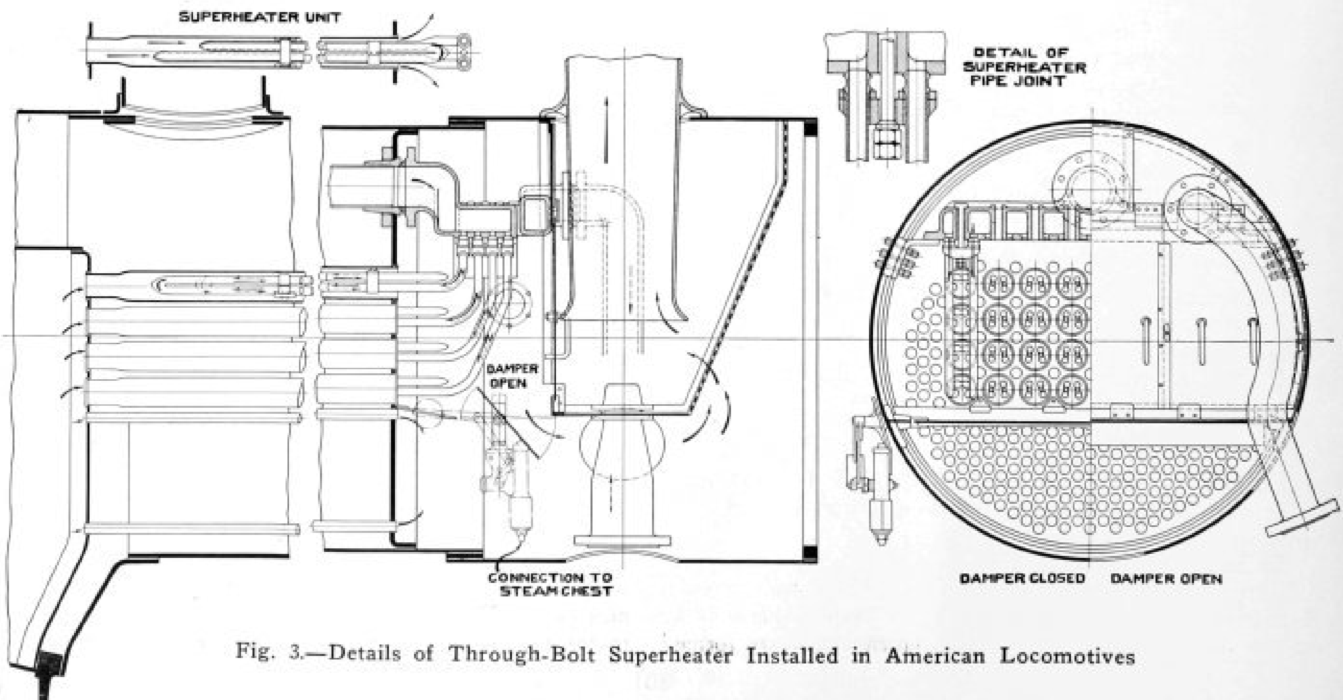


Fig. 3.—Details of Through-Bolt Superheater Installed in American Locomotives

Installation of Units and Placing of Bands and Supports

In all installations the top units should be placed first. With the bands and supports in place, but before the wooden protecting block is removed from the ball joints, slide the unit into the flue.

The unit should slide into the flue freely without twisting, and care should be taken to see that the feet on the supports are resting properly on the flue and in their correct relation to the enclosed pipes, as shown in Fig. 8.

Remove the wooden protecting block upon reaching the header and see that the ball joint end of the unit and the conical seat for it in the header are bright and clean. Then slide the unit into final position, apply the bolt, slide the clamp up into place and tighten the unit joints with the nuts provided. Graphite should be used on these bolts for both nuts.

In tightening units which have been found leaking on test, apply a special wrench over the lock nut and loosen the lock nut one turn; then shove the wrench up over both nuts and tighten. If this does not stop the leaks pull the unit out far enough to regrind the joints.

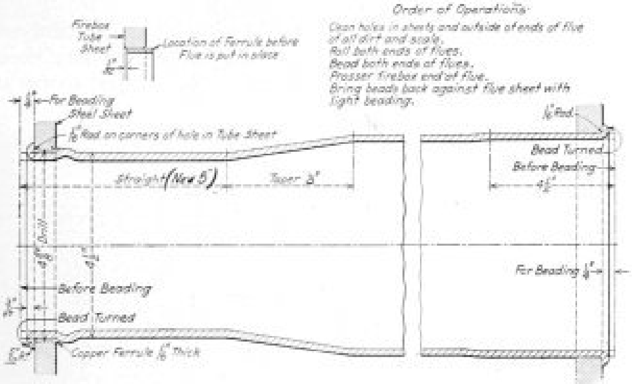


Fig. 4.—Recommended Setting for Superheater Flues

Testing the Superheater

After all the units are in place, but before the second unit bolt nut or the steam pipes are applied, blank the steam pipe connections on the header and apply a water test, with a pressure at or above the working pressure of the boiler. Inspect all ball joint connections, return bends, dry pipe connections and flue sheets, and stop all leaks that may appear. After the boiler has been steamed up, test the superheater with steam and try to tighten all the unit bolt nuts, after which the second nuts may be applied and set up tight.

Fig. 6.—Grinding the Ball Ends on Superheater Units

Maintenance and Repairs

In maintaining the large flues that are not welded, it is essential that the flues fit the flue sheet at both ends closely the whole length of the sheet and in addition at the firebox end the flues should grip the sheet tightly between the bead and the prossering, so as to avoid any longitudinal movement of the flue in the sheet. This movement is sure to occur and means leaky flues, unless provided for as mentioned, because of the greater area of the flue in contact with the front flue sheet, due to its greater diameter.

This condition requires that the rolls be discarded after the flue is first set and that the flue should be maintained or worked with the beading tool and prossers only at the firebox end.

After the prosser is used, the beads should always be worked lightly to make sure that the beads are tight against the sheet. A standard for beading tools, Fig. 9, should be adopted and all beading tools kept to that standard. A beading tool with a radius of 5/32 inch and depth of bead in the tool 13/64 inch has been found satisfactory for superheater flues. In use, the center line of the beading tool should always be kept inside the line of the flue, as shown in Fig. 12. When used in the positions shown in Fig. 11 it tends to loosen the flue in the sheet and cause leaks.

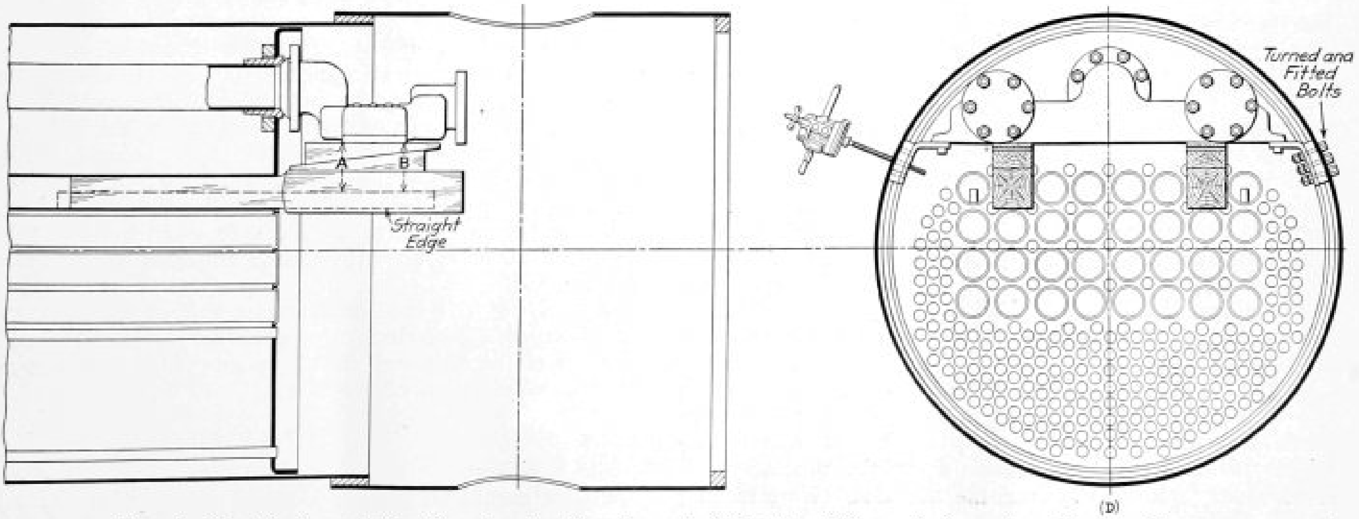


Fig. 5.—Installation of the Superheater Header and Method of Properly Locating Header Supports

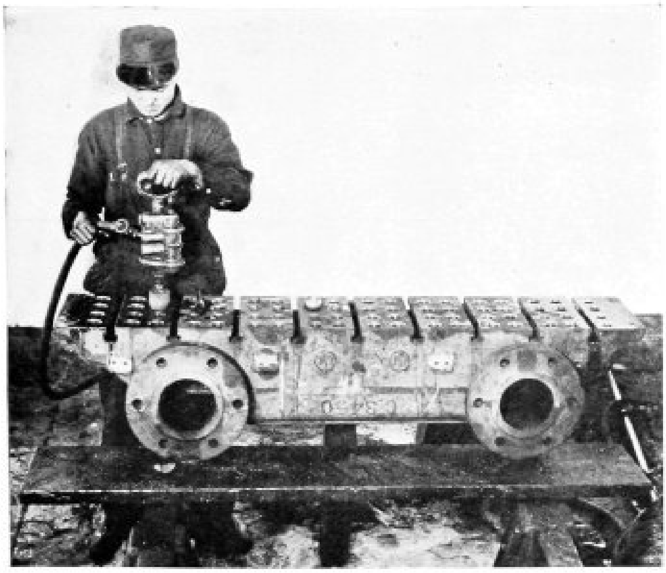


Fig. 7.—Operation of Grinding Unit Seats on Header

Beads should have the fins on the outer edges cut off with a narrow cape chisel when formed. The heel of the beading tool should not be used for cutting off; to do so means that the flue will be loosened in the sheet and eventually the sheet grooved around the edge of the bead.

Cleaning in Roundhouse

The flues and the outside surface of the units should be kept clean and all dirt, cinders and soot removed from the flue. The back end of the return bends should have all clinkers or cinders broken off and removed from the firebox end.

In cleaning the flue, water should be used in preference to air. Washing the flues can be done by the boiler washout gang and with the same tools employed for this work. Special care must be taken to see that the flues are thoroughly cleaned. If the hole in the end of the pipe is reduced to the nominal diameter of the pipe, i. e., ½-inch hole in ½-inch pipe, etc., better results will be obtained.

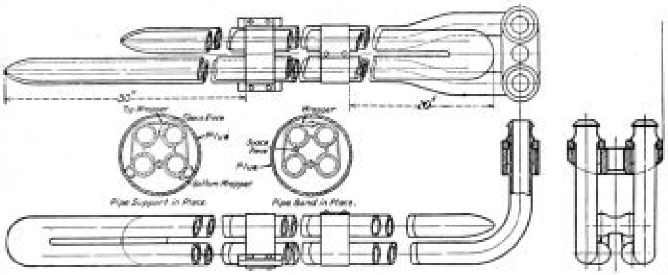


Fig. 8.—Location of Bands and Supports on Return Bend Units

If air is used for cleaning the flues, insert the pipe in the flue, under the unit, for its full length, then open the air valve and gradually draw the pipe back through the flue. This procedure avoids clogging the flue, which would result if the air pipe were worked forward. After the first operation, the air pipe can be worked back and forth until the flue is entirely clean. The superheater damper should always be open when blowing out flues.

A protection from the ejected dirt may be secured by the use of a disk of stiff leather or wood about 9 inches in diameter, with a hole in its center, which is a close sliding fit on the cleaning pipe. Place this on the pipe so as to stand about ½ inch away from the flue sheet before turning on the air.

After the flues are clean they should be inspected from the firebox end while a light is held at the front end to insure that the bottom of the flue is clean. The test of the draft drawing the torch flame into the flue is not satisfactory, as the flame will be drawn into the flue by the draft over the top of the dirt while the whole bottom of the flue may be stopped.

In case water instead of air is used to clean the flues, hot water should be used and the boiler should have steam on so that the flues, units, etc., will dry rapidly and so partially avoid the rust and corrosion following such practice.

Cutting Out Flues

In cutting out superheater flues a single rotation cutting-off tool has been developed which gives satisfaction. It is used with the same motor and a speed reducing rig similar to that used on the smaller flues. In cutting off the flue at the front end, the cut should be made as close to the sheet as seems safe. At the firebox end the cut should be far enough ahead in the flue to cut off the prossered part of the flue, so as to facilitate the application of the safe-end at this end of the flue.

If the flue is cut out in the old method of slitting with the cape chisel, the beads at the front end of the flue should be removed before the flue is placed in the rattler, to prevent breaking or cracking of the large end of the flue, which commonly occurs where the beads are not removed.

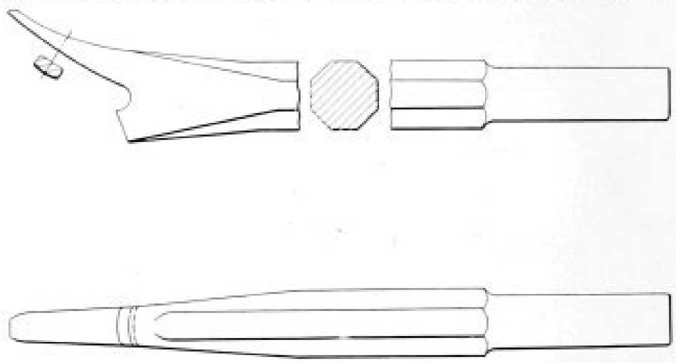


Fig. 9.—Standard Tool for Beading Flues

If the flues should be dented in any manner, straighten out the dents before the flue is replaced in the boiler, to permit the easy insertion of the unit.

Safe Ending Flues

In cutting off the flue, preparatory to safe-ending, the swaged end should be cut off beyond any previous welds that have been made, thereby maintaining only one weld on the swaged end of the flue. When the swaged end has been reduced to its limit by this process, it should be reswaged and sufficient material of standard diameter welded to the large end to provide the necessary length. (This weld should be so made that no obstruction will appear in the inside of the flue.) In applying the safe end to the swaged end of the flue, bell the end of the flue and scarf the safe end about ⅝ inch. In heating for welding watch the inside of the flue to insure the proper heat on the safe end. Better results can be obtained if the safe end is annealed after having been applied.

In applying safe ends to the front end of the flues, the weld should be smooth inside so as not to interfere with insertion of the unit and smooth outside so as not to interfere with application of the flue.

Tests

The superheater, steam and exhaust pipe joints and dry pipe joint should be tested periodically every thirty days if convenient, at the time of the regular washout, with at least

250 pounds of water pressure, preferably hot, if the engine is warm.

The test can be applied through the blow-off or point usually used for filling boilers. The dry pipe joints, steam pipe joints, joints between the units and the header, joints between the exhaust stand and cylinder, the exhaust stand and nozzle tip, and all seams and flues in the front end, should be carefully inspected while under pressure to see that there is no leakage. The return bends at the back end of the unit in the large flue should also be inspected for leaks and any water lying in the bottom of the flue, under the unit ends, should be considered as an indication of unit leakage.

Steam leaks from the flues, flue sheet seams, rivets, units, dry and steam pipe joints are all liable to cut into adjacent parts and cause serious damage, so that the tests should be carried out regularly and thoroughly.

LEAKING UNITS

Leaking unit joints next to the header should be stopped by tightening the clamp bolt nuts, taking care not to stretch the bolts.

Clean the joints and grind with soft metal grinding tools. Use carborundum or other abrasive in these tools and handle the job the same as any other ordinary job for grinding ball joints on injector pipes, etc. A small air motor is satisfactory for this use. The motor should be operated slowly to prevent the grinding tool chattering.

RECONDITIONING BALL JOINTS AND SEATS

It is recommended that both parts of the joints, when finished, be tested with a gage having convex and concave surfaces of 1 1/16-inch radii before placing the unit. Prussian blue should be used for this test, as it is finer than red lead or lamp black ordinarily used and will show the defects in the joint more plainly.

The ball part of the joint should show a continuous blue surface all over the ball when tested with the concave seat in the test gage. The conical seat in the header should show a continuous line when tested with the ball end of the gage.

Ball joints and seats which have been damaged by steam cuts or mechanical injury should be brought back to the standard of new work, i. e., a 45-degree bevel seat in the header, and a spherical surface of 1 1/16-inch radius for the ball end on the unit.

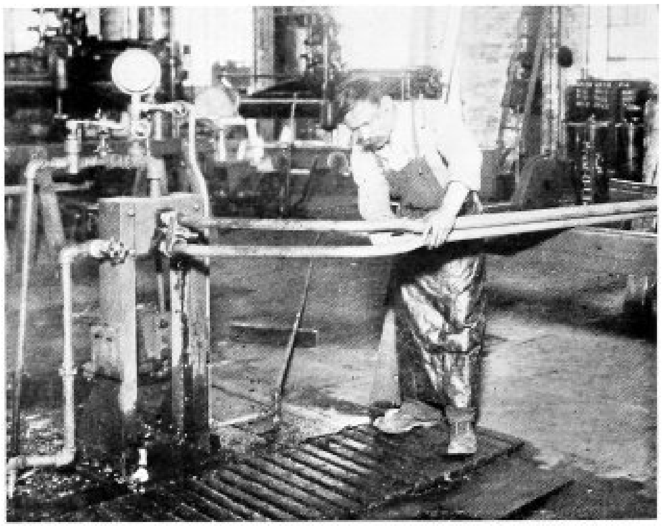


Fig. 10.—Hydraulic Test of Superheater Units

All units are tested to 250 pounds hydrostatic test after assembling and should be retested to that pressure before being installed in the engine, when any work has been done affecting the return bend joints or on any indication of leakage in the unit itself. A test of 500 pounds is applied to units with forged return bends under the same conditions.

This test is best applied by placing the unit on its side, applying water through the lower pipe until it flows from the end of the upper pipe, closing the outlet to the upper pipe and applying pressure through the lower pipe.

This routine will enable the full pressure to be obtained with the application of a very small amount of water and in effect is a rapid means of accomplishing the work. If the test shows the unit to be all right, open the lower end of the unit and blow the water out by air applied to the upper end of the unit.

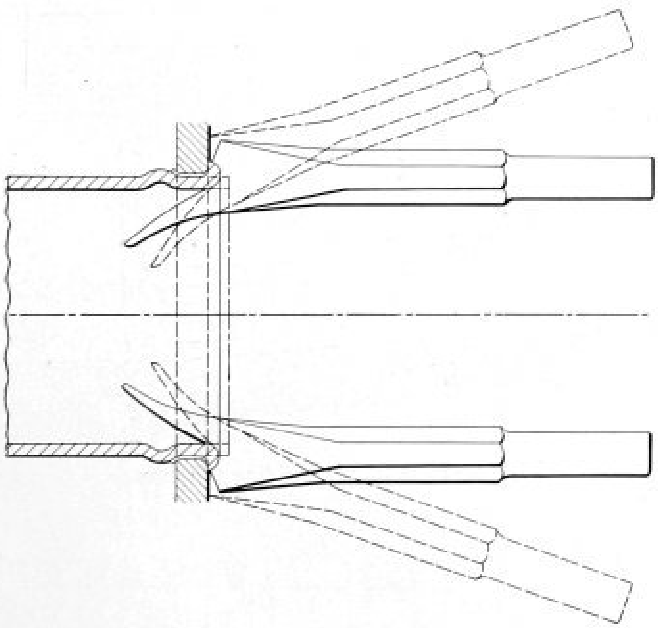


Fig. 11.—Incorrect Method of Beading Flue

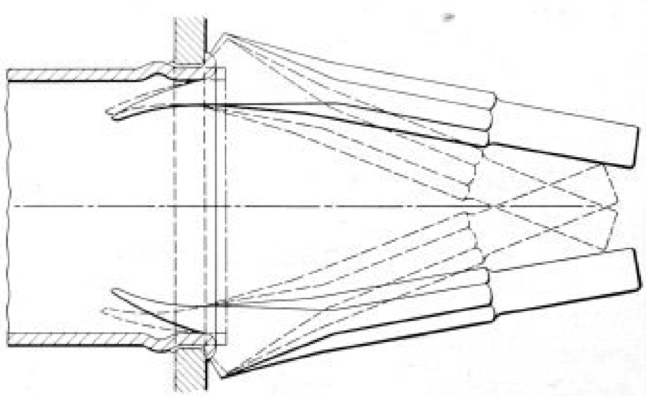


Fig. 12.—Proper Positions of Tool for Beading

The Joseph L. Skeldon Engineering Company, Toledo, Ohio, has bought the McNaul Boiler Manufacturing Company, of Toledo, and will continue the manufacture of the McNaul boiler.

Repairing Locomotive Boilers By Electric Welding*

Special Committee of Master Boiler Makers' Association Reports Best Methods of Reconditioning Boilers

THE responsibilities 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 percent 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.

*This report will be presented at the Master Boiler Makers' Association Convention, which will be held at the Hotel Sherman, Chicago, May 23 to 26, 1922. The report committee consisted of H. H. Service, supervisor of welding, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas, chairman; I. J. Pool and R. W. Clark.

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 sand-blast 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.

The tables (page 308) give an approximate comparison of the cost of labor between applying an electric welded three piece Mikado firebox and riveted box of same type.

For a riveted firebox, the operation is approximately the same as in Table 1 after eliminating the welding and adding the items in Table 2.

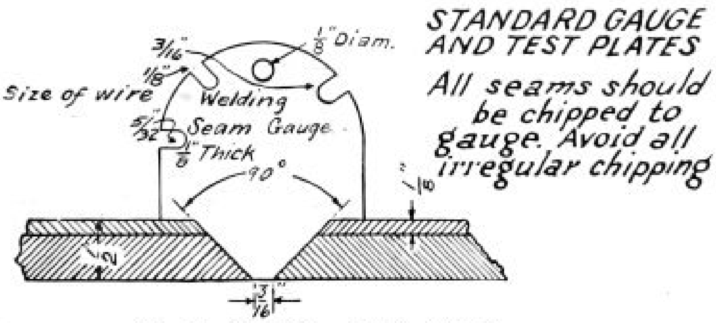


Fig. 1.—Sheet Beveled for Welding

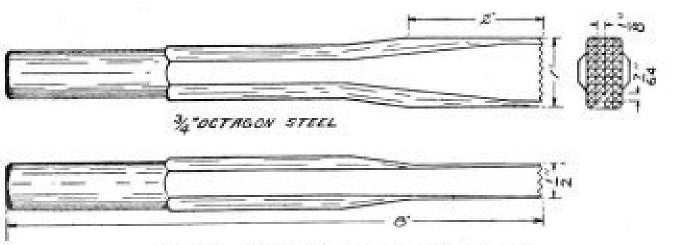


Fig. 2.—Tool for Removing Scale

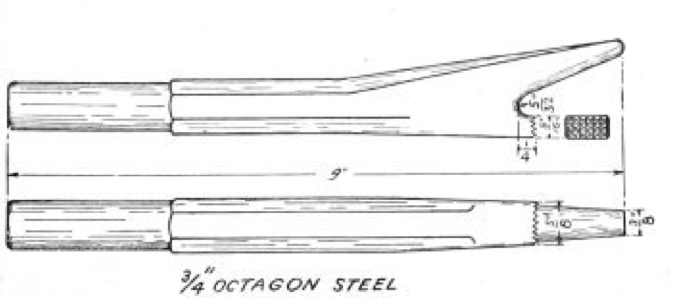


Fig. 3.—Tool to Remove Scale from Around Bead

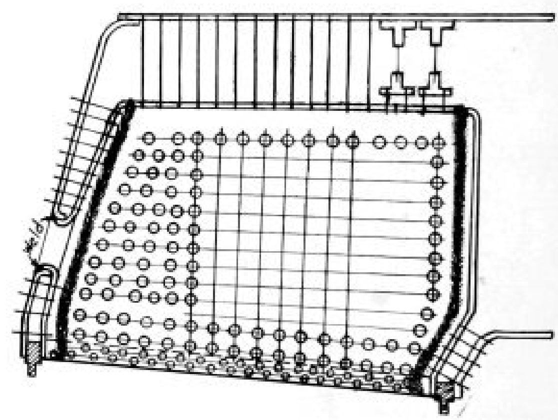


Fig. 4.—Method of Welding Firebox

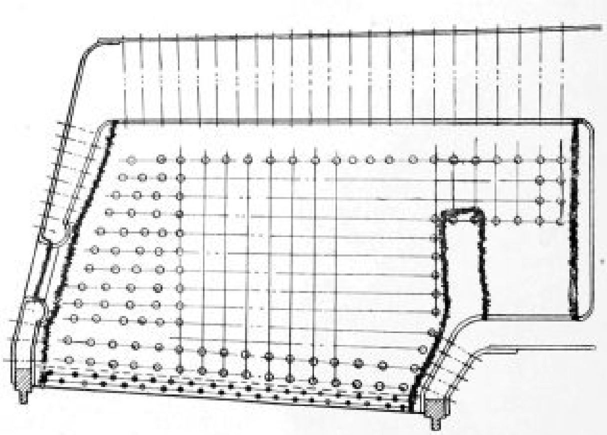


Fig. 5.—Welded Firebox and Combustion Chamber

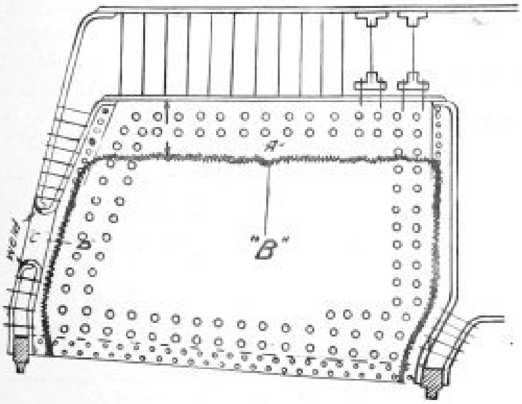


Fig. 6.—Firebox Knuckle Patch

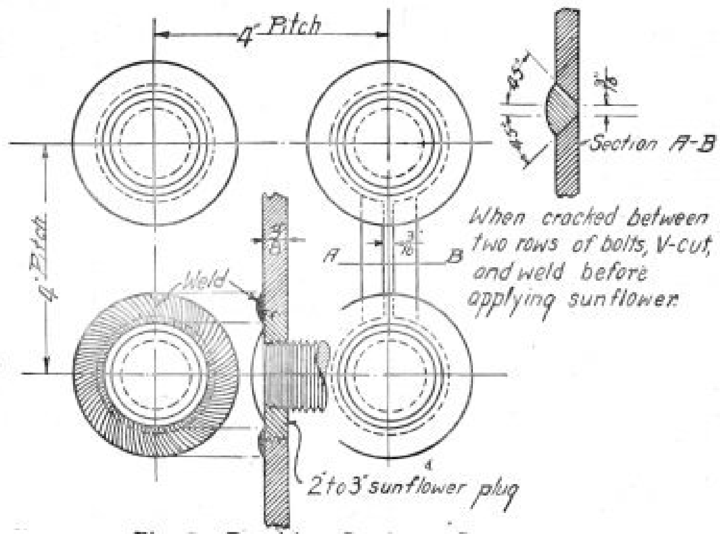


Fig. 7.—Repairing Cracks at Staybolt Holes

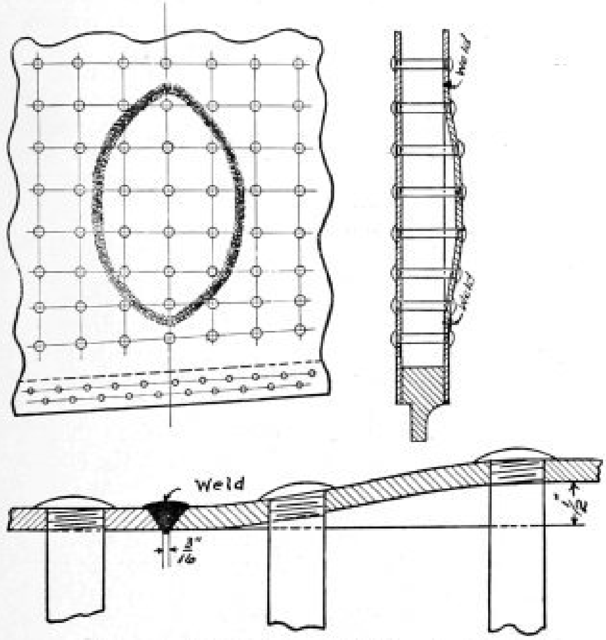


Fig. 8.—Patch Around Defective Staybolts

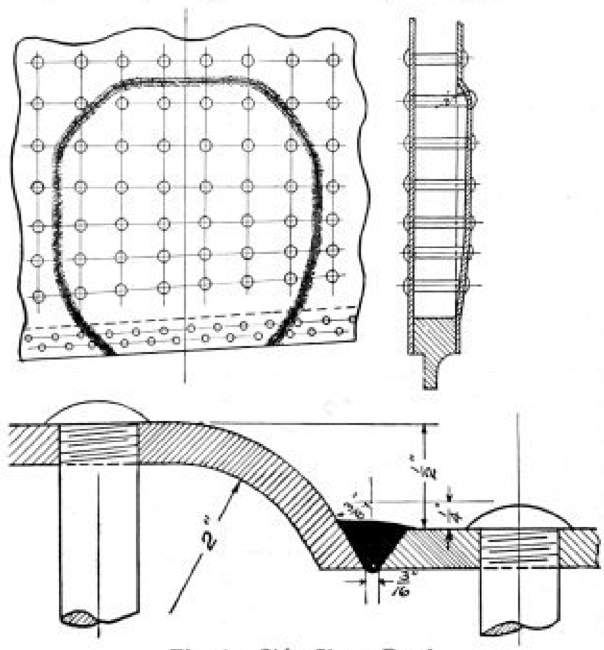


Fig. 9.—Side Sheet Patch

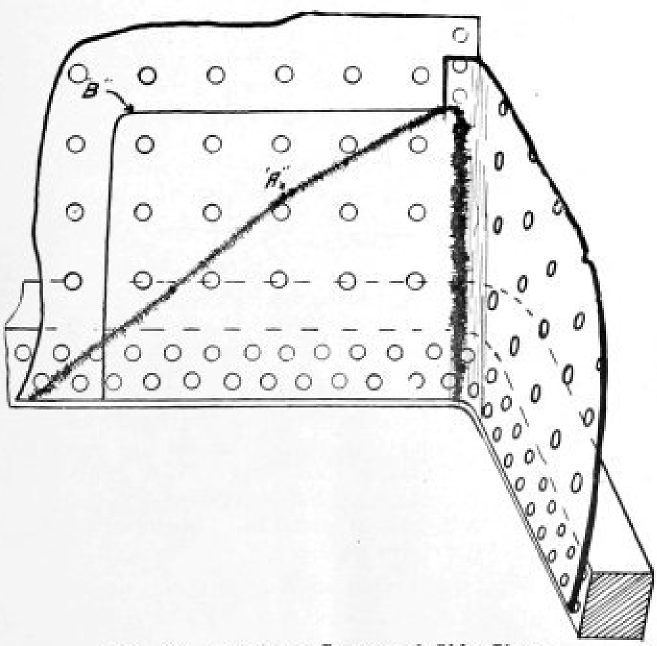


Fig. 10.—Patch at Corner of Side Sheet

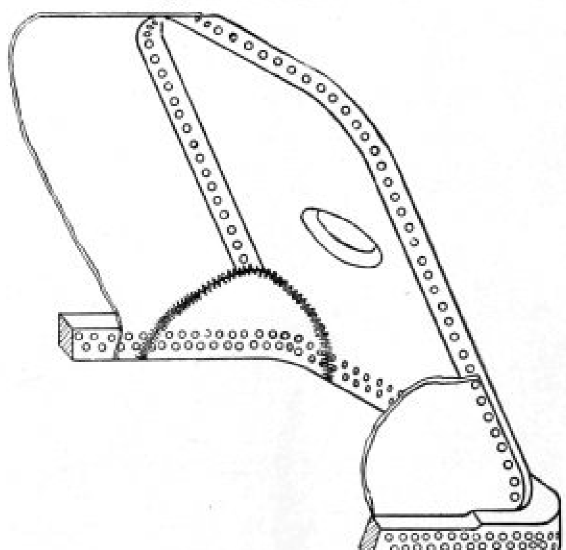


Fig. 11.—Patch at Side and Door Sheet

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 every 12 inches in order to hold the plates in perfect line. The sheet should then be tack welded between each of the clamps, these 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 percent 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 percent, especially on the crown sheet.

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 seams per lineal foot is 90 cents for labor, material and current.

TABLE 1.—ELECTRIC WELDED FIREBOX

	No. of Men	Rate per Hour	No. of Hours	Cost of Labor
Laying out firebox wrapper sheet with template, complete	1	.90	5	$4.50
Punching wrapper sheet	2	.85 .62	9	13.23
Laying out flue sheet, complete	2	.90 .62	7	10.64
Punching flue sheet, complete	2	.85 .62	5	7.35
Punching door sheet, complete	2	.85 .62	3	4.41
Flanging flue sheet under press	4	.90 .67 .67 .67	1	2.91
Flanging door sheet under press and door hole by hand	4	.90 .67 .67 .67	2	5.82
Rolling wrapper sheet	2	.85 .62	3	4.41
Shearing wrapper sheet	2	.85 .62	1	1.47
Shearing flue sheet	2	.85 .62	½	.74
Shearing door sheet	2	.85 .62	½	.74
Burning flange on flue sheet	1	.90	½	.45
Burning flange on door sheet	1	.90	½	.45
Chipping flue sheet for welding	1	.85	3	2.55
Chipping wrapper sheet for welding	1	.85	5	4.25
Chipping door sheet for welding	1	.85	2½	2.13
Fitting firebox for welding	3	.85 .62 .62	4	8.36
Electric welding in door sheet and flue sheet complete	1	.90	28½	25.65
Total	..	..	..	$100.06

TABLE 2.—RIVETED TYPE FIREBOX

	No. of Men	Rate per Hour	No. of Hours	Cost of Labor
Laying out of rivet holes in flue sheet	2	.90 .62	1½	$2.28
Laying out of rivet holes in door sheet	2	.90 .62	1½	2.28
Laying out of rivet holes in wrapper sheet	2	.90 .62	2	3.04
Punching rivet holes in wrapper sheet	2	.85 .62	2	2.94
Punching rivet holes in flue sheet	2	.85 .62	2	2.94
Punching rivet holes in door sheet	2	.85 .62	1½	2.21
Countersinking rivet holes	2	.85 .62	2	2.94
Reaming rivet holes and changing bolts	2	.85 .62	5	7.35
Riveting firebox	4	.85 .85 .62 .62	5	14.70
Calking firebox inside and outside	1	.85	6	5.10
Total	..	..	..	$45.78

Cost of Labor—Riveted firebox $120.19
Cost of Labor—Electric welded firebox 100.06
Saving of welded box over riveted box 20.13

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. After being tacked, start welding at the bottom space and finish at the top space. Current values for successful welding on this operation are the same as for firebox welding described in Fig. 4 and Fig. 5.

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 be removed after the patch is welded 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 ⅜ to ½ inch in the center, the opening at the seam should not be more than ¼ 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 right or left side; then weld this seam 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 become 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.

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 giv-

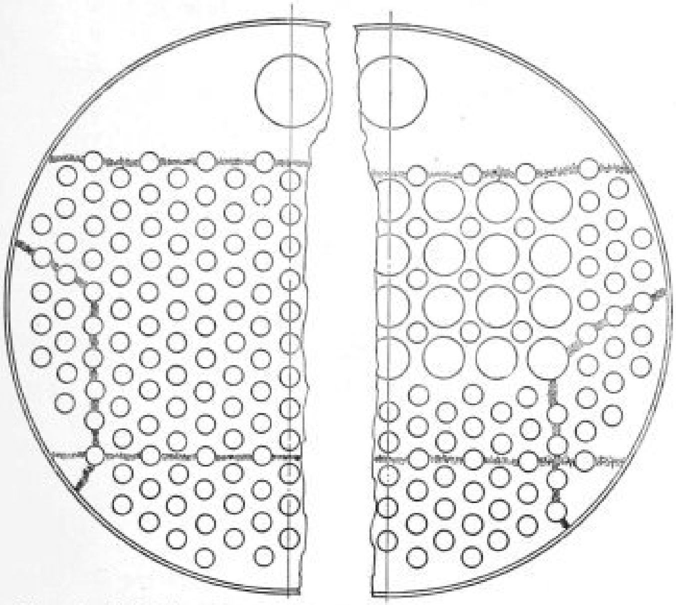


Fig. 12.—Welding Patches in Front and Back Flue Sheets

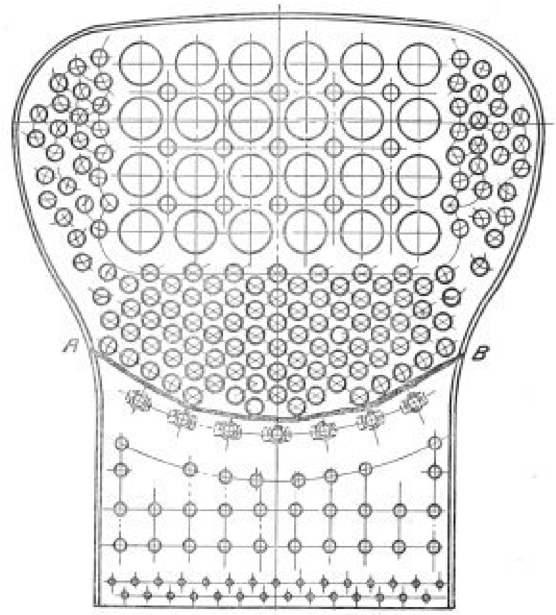


Fig. 13.—New Top Portion of Back Flue Sheet Arranged for Superheater

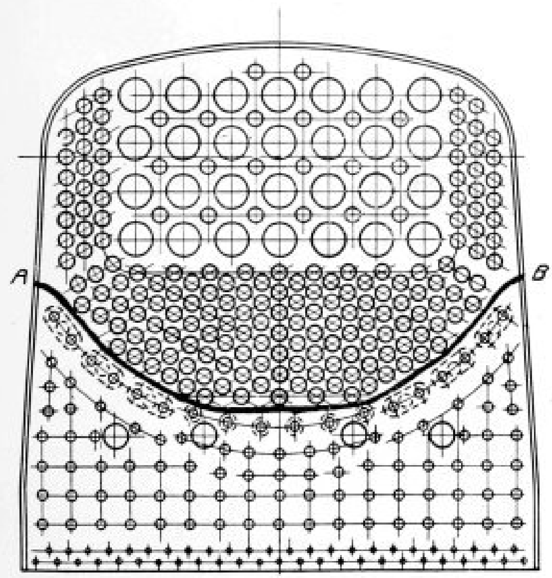


Fig. 14.—Wide Firebox Back Flue Sheet with New Top Portion

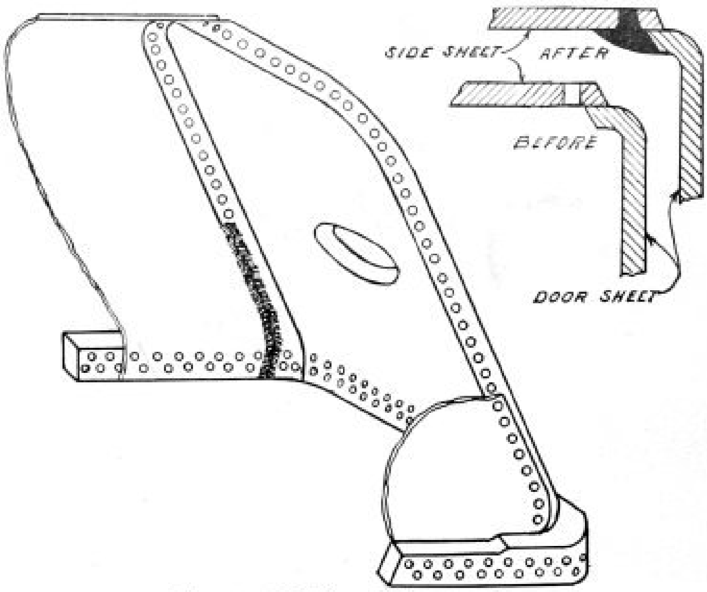


Fig. 15.—Welding Defective Seams

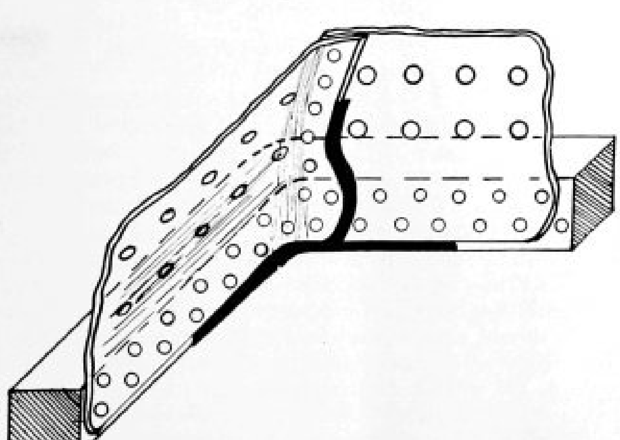


Fig. 16.—Repairing Leaky Mud Ring Corner

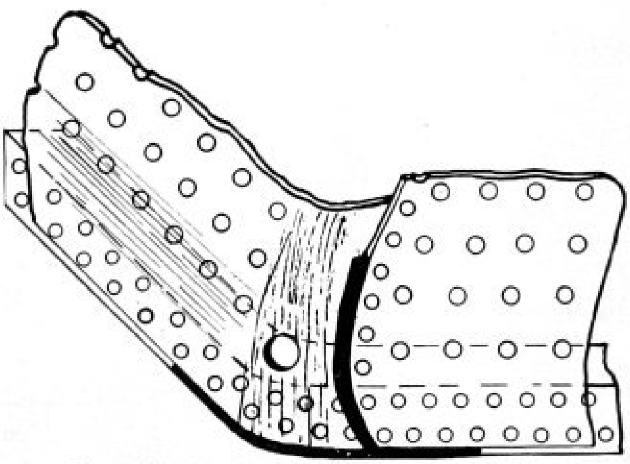


Fig. 16A.—Another Section of the Mud Ring

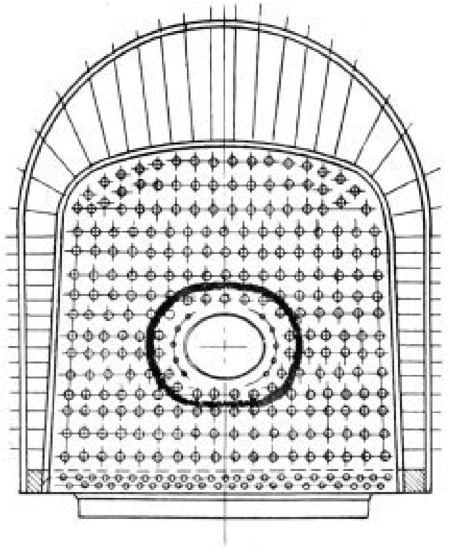


Fig. 17.—Door Collar Patch Weld

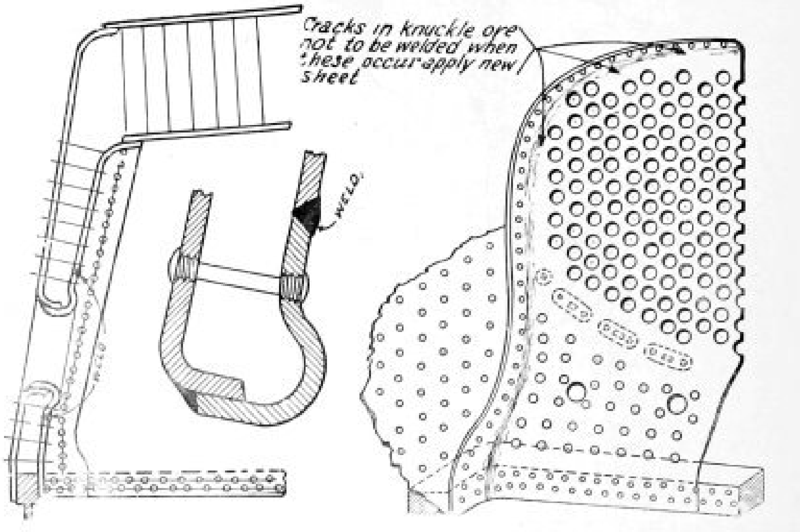


Fig. 18.—Welding Should Never Be Used in Knuckle of Firebox Sheets

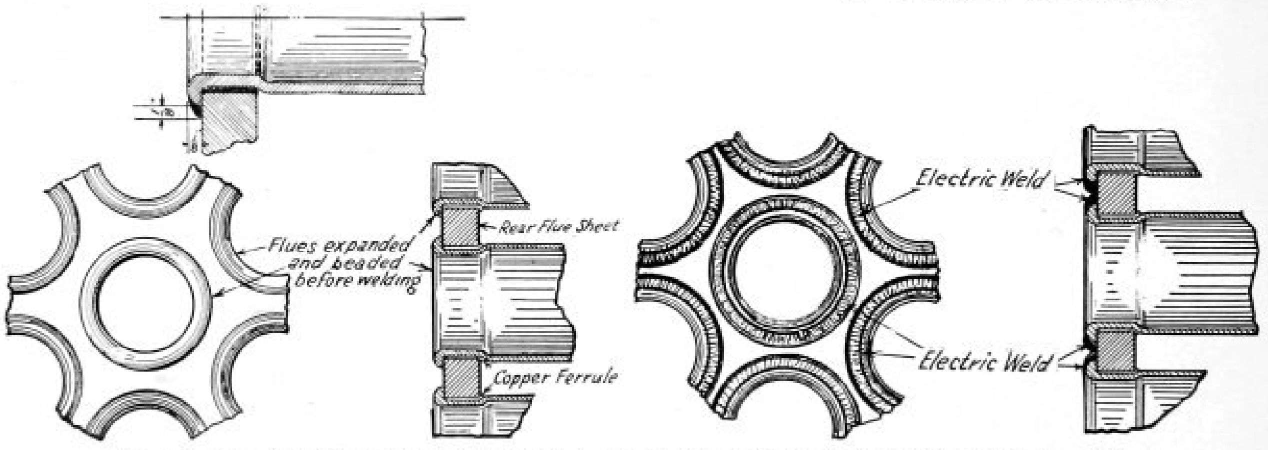


Fig. 19.—Method of Applying Flues in Locomotive Boilers by Means of Electric Arc Process

ing 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.

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.

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.

Principles of Riveted Joint Design—V

Indeterminate Methods of Joint Failure and Design of Staggered Riveting to Resist Shear

By William C. Strott*

IN addition to the foregoing discussion of riveted joints, there are two other possible methods of failure, which, however, cannot be included in the investigations for efficiency for no definite basis upon which to calculate the probability of such failures can be derived.

Fig. 29 illustrates how one of these failures may occur by the rivets pulling out through the edge of the plate before their full shearing strength is developed. Failure from this cause may be produced by either of the two methods shown; (a) being purely a shearing stress, and (b) probably a combined shearing and tensile stress.

It has been demonstrated, however, in tests on riveted joints that, if the distance from the edge of the rivet hole

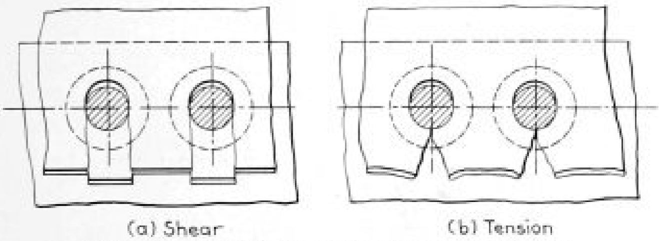


Fig. 29.—Failure of Plate in Front of Rivets

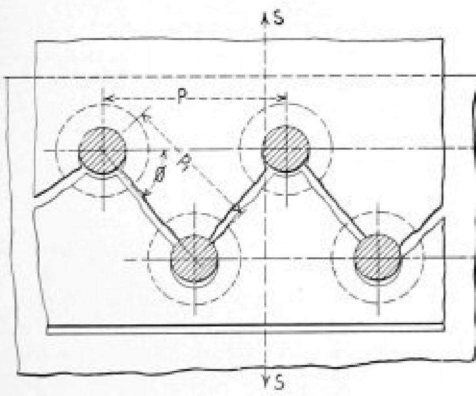


Fig. 30.—Diagram Showing Failure of Diagonal Sections of Plate

to the edge of the plate be not less than the diameter of the rivet hole, failure by the above method is not probable. It was because of the establishment of this standard that the Boiler Code specifies a rivet gage of 1½ times the diameter of the rivet hole.

The student should not confuse this method of failure with the crushing of the plate in front of the rivets. The latter may take place, resulting in enlargement of the rivet holes, regardless of the width of the lap, unless it is much less than 1½d. In this case the plate will break through as in Fig. 29, (a) or (b), before the full crushing strength of the plate is developed.

The second method of joint failure which must be provided against in the design, but for which, through lack of positively accurate analysis, no definite formula can be derived, is indicated in Fig. 30.

*Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

Although Fig. 30 is of a double riveted lap joint, it is used here solely for convenience; the condition exists wherever there is staggered riveting. When stress is applied to the joint in the direction of the arrows S-S, a stress of probably a pure shearing nature occurs diagonally between the rivets. This stress tends to rupture the plate along the line p_1, as is clearly indicated by the broken sections of plate between the rivets.

If steel plate were as strong in shear as it is in tension, then the only requirement necessary to overcome the possibility of joint failure by this method would be to put at

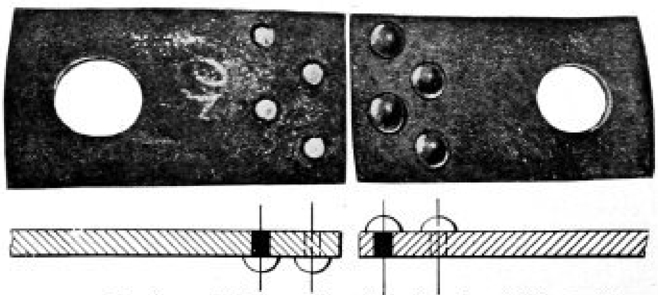


Fig. 31.—Section of Joint, Showing Result of Rivet Shear

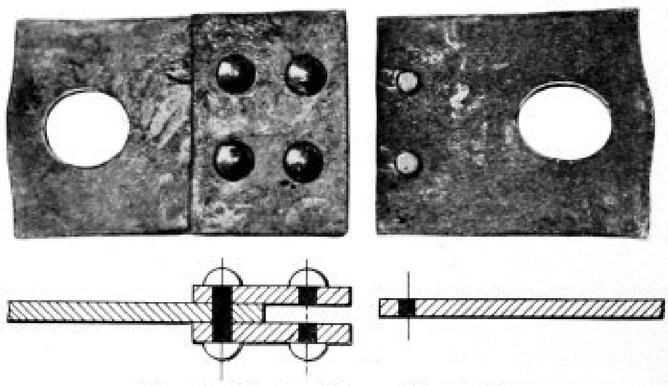


Fig. 32.—Single Shear Joint Failure

least as much metal in the combined diagonals as in the horizontal sections of plate.

However, the unit shearing strength of steel plate has never been definitely determined, it having proven extremely difficult to make tests for this purpose with any degree of accuracy. We know that rivets may be subjected to a safe stress in single shear of 8,500 pounds per square inch, but it should be borne in mind that when a riveted joint is tested for shear the stress acts in a well defined plane and the rivets are often sheared with knife-like precision. Proof of this is established by reference to Figs. 31 and 32.† The sections shown in the illustrations were added to bring the resulting conditions more clearly to the student's mind. Fig. 31 is a double shear joint and Fig. 32 a single shear joint.

When a section of steel plate is placed in a testing machine preparatory to testing the material for shear, an eccentric load must be applied to bring about the condition in

†Courtesy of the Champion Rivet Company, Cleveland, Ohio.

Fig. 33. It is obvious that the ultimate effect of such a load is to bend, and at the same time crumple (crush) the plate. These effects will usually have resulted before the true shearing strength of the material has been determined.

The safe shearing strength of steel plate is given by some authorities at as high as 10,000 pounds per square inch, but this value evidently refers to the usual 60,000 pounds tensile strength material. For boiler plate steel having an ultimate tensile strength of 55,000 pounds per square inch, the safe shearing strength should be taken at not over 7,000 pounds

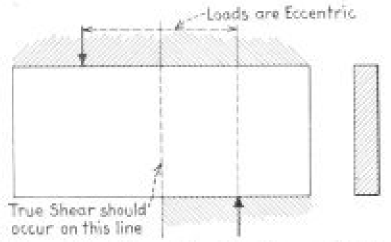


Fig. 33.—Eccentric Load on Plate

per square inch, which is approximately 35 percent less than the safe working tensile strength of steel plate. On this basis we might, for practical purposes, assume that the diagonal sections of plate are in full shear and so provide metal in the diagonal sections at least 35 percent in excess of that in the horizontal sections.

It is evident that as angle α is increased, the diagonals approach the vertical position and are therefore subjected to a more complete shearing stress. Also as the angularity is decreased the diagonals more nearly approach the true tensile effect, in which the material is far stronger than when subjected to shear.

Strength of Diagonal Plate Sections

For the purpose of settling this question concerning the amount of metal necessary in the diagonal sections of plate

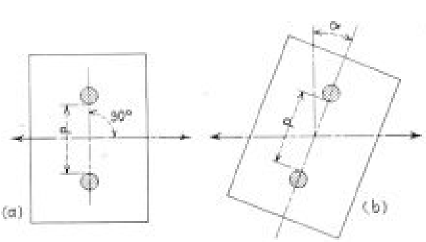


Fig. 34.—Specimens Used in Watertown Arsenal Tests

in riveted joints, extensive tests were conducted at the Watertown Arsenal, in 1915, by Professor J. W. F. McDonald. Plate specimens similar to those illustrated in Fig. 34 were employed for this purpose.

Tests were first applied to the specimens as at (a) with the load placed at right angles to the line of rivet holes as shown. The area of a net section at a load necessary to break the plate was taken as 100 percent; then other specimens of the same thickness and dimensions were tested, but with the line of the rivet hole placed at various angles to the line of application of the load. The excess of metal necessary between the rivet holes, to give the specimen the same breaking strength as in the former case, was noted for each different position. These tests gave the following average results:

When angle α of Fig. 34 (b) was 10 degrees, an excess of 7 percent of metal over that in Fig. 34 (a) was required; for a 20 degree inclination, 13 percent excess; for 30 degrees, 20 percent excess, and for a 40 degree inclination the required excess was 30 percent.

By comparing the above figures it should be noticed that the excess of metal necessary increased in a direct ratio with the angularity, i. e., when the angularity was doubled, the excess of metal required also doubled. For practical purposes we may satisfactorily assume that for each degree inclination of the diagonals with the horizontal, an excess of metal of 0.75 percent over that in the horizontal section is required.

The final solution to the problem, therefore, resolves itself to getting an excess of metal in the diagonal sections of a riveted joint equal to or greater than established by the above tests.

In the earlier editions of the American Society of Mechanical Engineers' Boiler Code, the required excess metal in the diagonals over that in the horizontal sections was fixed at not less than 20 percent in all cases. On the basis of Professor McDonald's tests it would seem that the Code rule was established probably on the assumption that the angularity of the diagonals never exceeded 30 degrees. This is quite true of the outer rows of single shear rivets in double butt strap joints having four or more rows of rivets as in

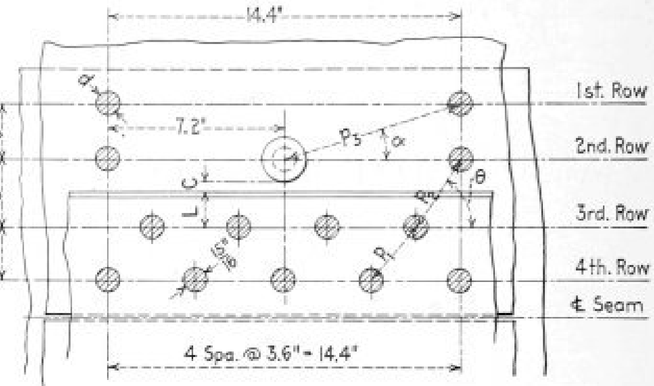


Fig. 35.—Determining Minimum Values for Rivet "Back Pitch"

Figs. 18 and 19, but rarely, if ever, is the angularity less than 40 degrees in the case of uniformly staggered riveting.

All things considered, however, it is almost impossible, when designing a riveted joint, to adhere to any fixed angularity or minimum cross sectional area for these diagonal pitches, for the reason that any alteration of one factor simultaneously affects the other. In view of this difficulty, the American Society of Mechanical Engineers Code, in the 1918 edition, revises its original interpretation on this point and presents the following rule:

The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

(a) If $\frac{P}{d}$ is 4 or less, the minimum value shall be 2d.

(b) If $\frac{P_1}{d}$ is over 4, the minimum value shall be

$$2d+0.1\ (P_1-4d)$$

Where:

P=Pitch of rivets in outer row where a rivet in the adjacent inner row comes midway between two rivets in the outer row.

P_1=Pitch of rivets in the outer row less pitch of rivets in the inner row, when two rivets in the inner row come midway between two rivets in the outer row. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)

d=Diameter of rivet holes.

(*Continued on page* 316)

Fabricating Tanks From Heavy Plate

Air Locomotive Tanks Built for 800 Pounds Pressure Fitted with Special Heads

By C. E. Lester

IN the construction of high pressure air locomotives, the tanks in which the air is compressed are of comparatively large size made from heavy plate. The problems to be solved in fabricating tanks of a type similar to that shown in Fig. 1, in which plate 1 3/32 inches thick was used, are of a nature requiring heavy equipment not found in the average boiler or tank shop. This tank was built by a concern that has been constructing air locomotives for some years and which has developed special machinery and methods for the work.

In the case of the tank, Fig. 1, the heads were of heavier metal than ever before used for the purpose in this shop. With various modifications this vessel was fabricated according to the requirements of one of the Canadian provinces.

The tank is built up of heavy plate 1 3/32-inch thick; the outside longitudinal butt strap is of 7/8-inch steel and the heads of 1 5/16-inch; the inside butt strap is of 3/4-inch plate. The plate which was used for the barrel of the tank is 119 3/4 inches by 108 1/2 inches; the heads were each 53 inches diameter; the outside butt strap 108 inches by 14 inches and the inside strap 96 1/2 inches by 30 1/2 inches. The manhole is 13 1/8 inches in diameter with a depth of flange of 3 3/4 inches. About one hundred and fifty-two 1 1/8-inch diameter rivets, 4 3/8 inches and 5 1/4 inches long, were used, as well as seventy-eight 1 3/8-inch rivets 5 1/8 inches long and thirty 1 5/8-inch rivets 4 1/2 inches long.

The process of rolling the shell from such heavy plate is not particularly difficult only to the extent that the plate must be rolled to a true circle with great exactness and without the slightest twist, as it would be extremely difficult if not impossible to correct any errors in plate of this thickness after forming.

In the fabrication of the shell the plate is first squared and planed and a tack hole drilled in each of the four corners before rolling. Then it is rolled in heavy plate rolls. Due to the stresses set up in working the plate to a small diameter, it is first preheated with an oil burner before rolling and the heat allowed to radiate until equalized throughout the metal at about 150 degrees F. after which the rolling proceeds. This temperature, while low, is apparently sufficient to prevent any weakening of the metal due to cold working. As may be assumed the rolling proceeds very slowly.

Because of a space of about 3 inches between the bottom rolls, a flat surface is left at each side of the formed plate and this has to be taken out on the hydraulic riveter by means of forming dies.

Forming the Heads

The heads are shaped by the formers, matrices and vise plates, shown in Fig. 2, assembled on a four post hydraulic flanger.

The buckling effect usually encountered in turning deep flanges is eliminated here by taking a light cut off the plate about two inches deep around the edges. But little difficulty is encountered in turning the flanges, provided the former is well heated and the former and matrix well "greased."

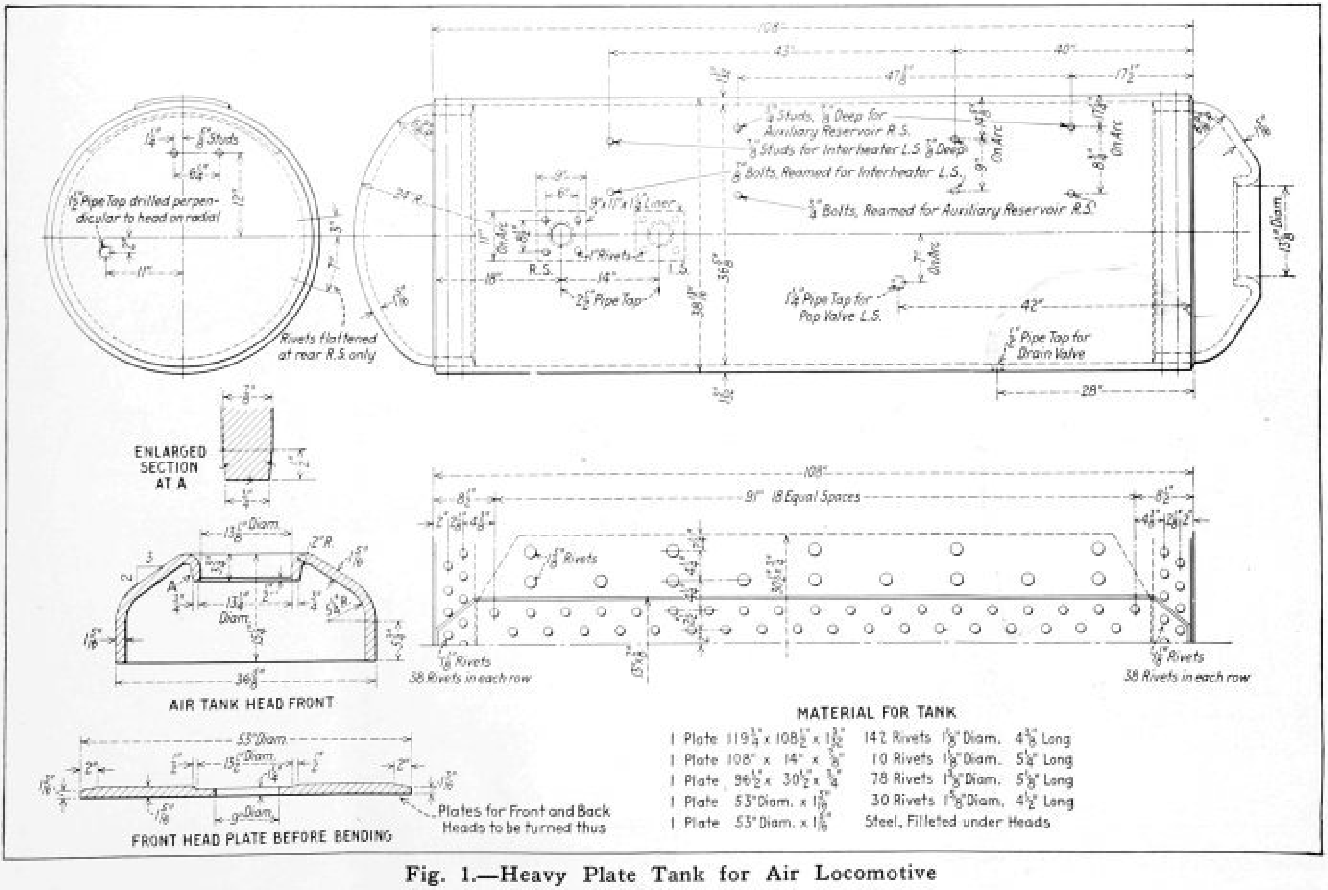


Fig. 1.—Heavy Plate Tank for Air Locomotive

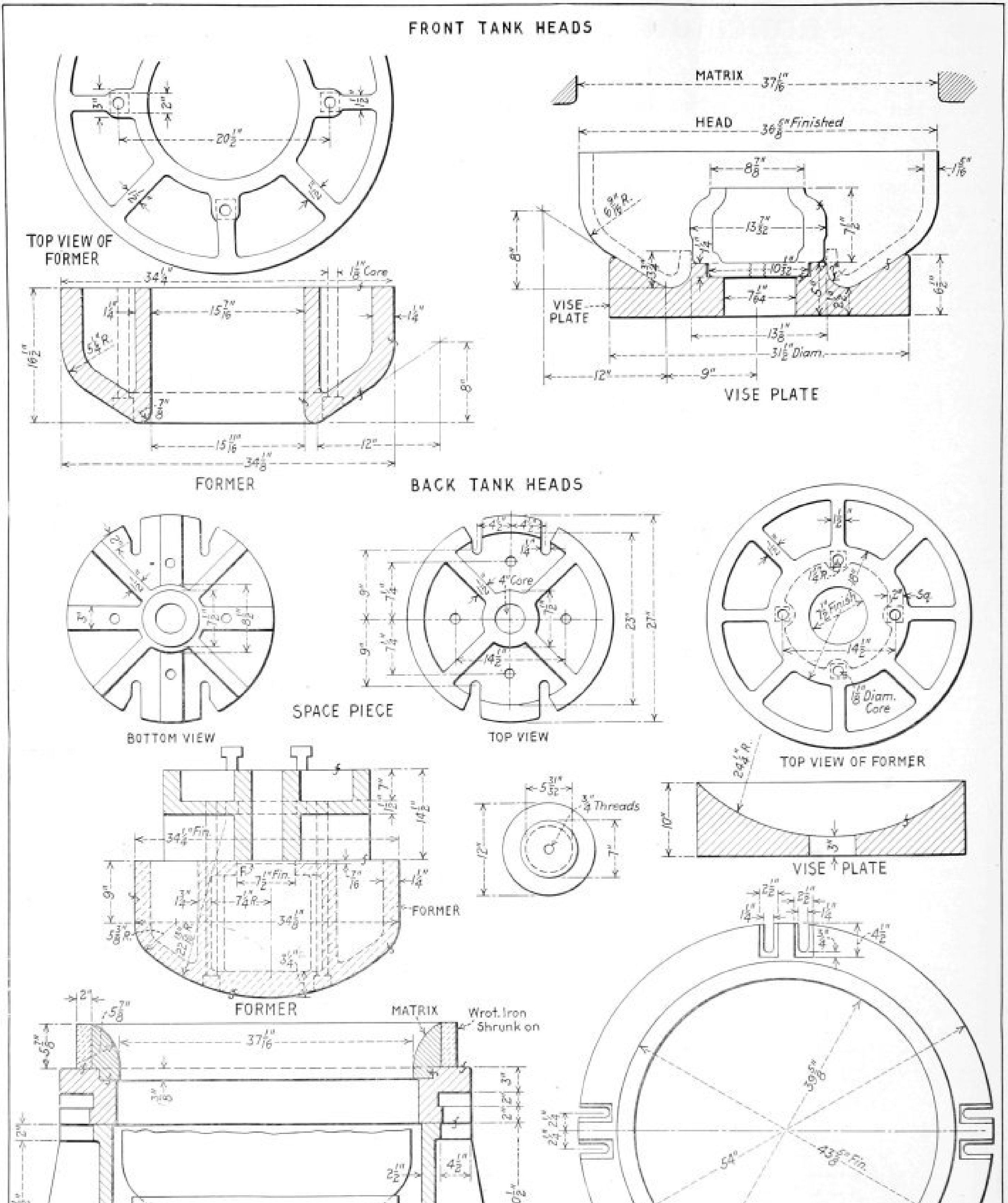


Fig. 2.—Formers, Matrices, and Dies for Turning Out Heads for Air Locomotive Reservoirs

After the complete forming of the plate, welt straps and heads, tack holes are marked and drilled; the plates, welts and heads are assembled and full sized holes are drilled on a two head radial drill press. The front head is then knocked out and the back head is bulled on the hydraulic riveter. The front head is re-applied and driven up on a specially constructed yoke riveter with a yoke that operates through the manhole of the head.

Due to the exceptional accuracy required in the layout, forming, fitting up and riveting, only a moderate amount of calking with a heavy fuller is required and the test is completed with but little effort.

The tank as shown was designed for a working pressure of 800 pounds per square inch, a factor of safety of four and tested out at 1,000 pounds per square inch hydrostatic pressure.

NEED OF REVISING FORMULAS

The writer cannot reconcile himself to many of the formulas in common use for the calculation of allowable working pressures for pressure vessels, particularly where tanks are built of heavy material with welt strap construction. Undoubtedly money is wasted in excess labor and materials in following certain formulas that are manifestly incorrect.

It is a fact that girth seams have a great stiffening effect, therefore short shell courses have not the need for longitudinal seams of the same efficiency that long ones have.

Theoretically the "net section" of the longitudinal seam is usually the governing factor, yet actually, in a short cylindrical course with heavy plate, the stiffness of the plate and the general stiffening effect of a double riveted circumferential seam so strengthen the longitudinal seam that its actual efficiency is increased greatly.

WHAT DO LABORATORY TESTS INDICATE?

In the laboratory, test pieces of metal and riveted sections of joints when stressed to destruction in many cases show a relationship to the present day formulas. However, the conditions of the metal in the case of the test pieces are manifestly different from those in a structure completely assembled, as in a locomotive boiler. Is it not a fact that unlike a chain, a strong member in a boiler helps to carry the load of a weaker one? Is it not fair to assume that the wagon top stayed surface with its double riveted girth seam extends to its neighbor, the back shell course, a definite share of its strength? Is it not also fair to assume that a double riveted girth seam has some value in another direction than to keep a boiler from bursting? What of the double thickness of plate and the grip of the rivets? It is the writer's belief that this seam increases the strength of the shell in its vicinity to a considerable extent.

Practically all seams have points of strength for which no credit is given in efficiency calculations. The practice of designers and calculators of using "unit lengths," while undoubtedly convenient, does not seem to lead toward the development of formulas more nearly corresponding with actual service conditions. Each code becomes more rigid from day to day in its requirements and rightly so along certain lines; however, the writer believes that many code requirements could well be modified by running "working condition tests" and developing new formulas.

Strength of Tubes a Factor In Boiler Design

Boiler Failures May Often Be Due to Lack of Proper Calculation of Tube Sizes

By John S. Watts

IN designing a boiler, the strength of the tubes is often taken for granted and the subsequent strains to which they will be subjected in service not properly considered. The common practice of fitting tubes of standard thickness to any and all boilers, regardless of the working strains involved, is all too common, the assumption evidently being that the regular thickness is good for any pressure. This assumption was more or less safe with the relatively low boiler pressures of a few years ago, but under present conditions the same care should be taken to check the strength of the tubes by calculation, that is taken with all the other parts of the boiler.

CONDITIONS MET IN FIRETUBE BOILERS

Considering first the firetube boiler, that is the boiler having water outside the tubes, we find that the tubes are subjected to an external pressure tending to collapse the tube and also to a compressive stress due to the expansion of the tube which is greater than the expansion of the boiler as a whole.

The pressure that will cause the collapse of a long tube was determined by a series of experiments, details of which were published in bulletin number 5, by the University of Illinois Experimental Station in 1906. Messrs. Carman and Carr who conducted these experiments have embodied the results in the following formula for lap welded steel tubes:

$$P = 83{,}290\frac{t}{d} - 1025$$

Where: P = Collapsing pressure, pounds per square inch.
t = Thickness of tube in inches.
d = External diameter of tube in inches.

This formula is correct for tubes having a length of over twelve times the diameter and a ratio of t/d between 0.03 and 0.07. The standard thicknesses of boiler tubes come within

TABLE 1.—STRENGTH OF BOILER TUBES

External diameter inches	Thickness		Thickness / Diameter	Pressure pounds per square inch	
	B.W.G.	Inches		Collapsing	Safe
1½	13	.095	.0633	4,250	425
1¾	13	.095	.054	3,496	349
2	13	.095	.0475	2,931	293
2¼	13	.095	.042	2,491	249
2½	12	.109	.0436	2,406	240
2¾	12	.109	.0396	2,276	227
3	12	.109	.0363	2,001	200
3¼	11	.120	.037	2,050	205
3½	11	.120	.0343	1,830	183
3½	10	.134	.03829	2,163	216
3¾	11	.120	.032	1,640	164
3¾	10	.134	.0357	1,851	185
3¾	9	.148	.0392	2,262	226
4	10	.134	.0335	1,765	176
4	9	.148	.037	2,056	205
4½	10	.134	.0298	1,455	145
4½	9	.148	.0329	1,936	193
4½	8	.165	.0367	2,028	202
5	9	.148	.0296	1,440	144
5	8	.165	.033	1,723	172
5	7	.180	.036	1,973	197
5	6	.203	.0406	2,356	235
6	8	.165	.0275	1,265	126
6	7	.180	.030	1,473	147
6	6	.203	.0338	1,793	179
6	5	.220	.0367	2,029	202

these limits, as do also their lengths, so that this formula is fully applicable. In order to clear up any uncertainty in the matter, it will be well to state that the above mentioned experiments proved that, for a length of tube of over twelve diameters, the collapsing pressure remained constant for any length.

The accompanying table shows the collapsing pressure for all sizes of tubes from $1\frac{1}{2}$ to 6 inches, calculated by the above formula. The thickness taken is the standard or list thickness. The safe working pressures shown in the table are based on a factor of safety of ten. Where the list thickness is too small to give a safe pressure of 200 pounds, the strength is shown for thicker gages, increasing by single numbers, until the gage required for the 200 pounds pressure is reached.

Reasons for a High Safety Factor

The reason for adopting so high a factor of safety as ten is that a slight variation of the tube from the truly circular form will rapidly reduce the ability of the tube to resist collapse. The possibility of rapid local corrosion of the tube also makes it advisable to use a high factor, especially for marine work.

The compressive stress on the tube due to expansion from the heat is practically indeterminate, depending as it does on the difference in temperature between the tube and the shell of the boiler and also upon the flexibility of the tube sheets. To illustrate what may possibly occur, we will take a 4-inch tube 20 feet long. The temperature of the flame in contact with the tube may be as high as 2,400 degrees F., while the temperature of the water in the boiler and therefore of the boiler shell itself will not be over about 380 degrees. It is not probable however that the tube will reach a temperature of much over say 200 degrees above that of the water in contact with it, unless the tube is thickly covered with scale or oil. Indeed, if the tube did reach a temperature much higher than this, it would collapse in any case through being weakened by overheating.

Difference in Tube and Boiler Expansion

Assuming that the tube is at a temperature of 200 degrees higher than that of the boiler shell and its coefficient of expansion is 0.0000065, the tube will expand $0.0000065 \times 200 \times 240 = 0.312$ inch more than the boiler, or say 5/16 inch. If the tube sheets are sufficiently flexible to permit of this expansion, the strain on the tubes will be only that required to bend the tube sheets each 5/32 inch. If the tube sheets were absolutely rigid, the tube could not expand and would then be subject to a stress equal to $0.0000065 \times 200 \times 30{,}000{,}000 = 39{,}000$ pounds per square inch, taking the modulus of elasticity at 30,000,000 pounds. This stress being over the elastic limit, the tube would soon collapse.

As the tube sheets, however, will never be absolutely rigid, this stress is reduced by whatever amount the tube sheet deflects in the same ratio that the actual deflection bears to the total free expansion of 5/16 inch. The expansion being the same no matter what the thickness of the tube, this stress remains the same for all sizes and thicknesses of tubes, varying only with the temperature difference and the length. The longer the tube the greater will be the total expansion. If the tube sheets of a long boiler are as rigid as those of a short boiler, the stress in the long tubes will be much greater because the tube sheet will only deflect the same amount in both cases, while the expansion varies as the length of the tube.

Sheets Must Be Designed to Allow for Tube Expansion

It follows then that it is useless to make the tubes thicker to provide for expansion, the only relief being to design the tube sheets so that they will permit the tubes to expand an amount sufficient to keep this stress within permissible limits. This point should receive careful attention particularly in long boilers. The strain due to expansion being compressive, it is relieved slightly by the tube having to support the tube sheet against the steam pressure, the latter imposing a tensile stress upon the tube.

The two compressive strains upon the tube, one due to the external pressure tending to collapse the tube and the other due to the expansion, act at right angles to each other and are therefore not cumulative; that is the effect of one is not to be added to that of the other.

Tube Stresses in Watertube Boilers

In watertube boilers the tubes are of course under internal pressure and are able to resist a much higher pressure per square inch than they are when subjected to external pressure. As the formula for calculating the safe working pressure inside a tube is well known, it is unnecessary to enter into it here.

There remains one more strain which may add to the stresses on the tube already enumerated. For fire tubes this is the tendency of the tube acting as an air filled vessel, to float. This load is carried by the tube considered as a beam fixed at each end and subjected to a uniform load equal to the difference between the weight of the tube and the weight of a body of water of the same diameter and length as the tube. The stress that this load will impose upon the walls of the tube can be calculated from the formulae for such beams and should be added to the compressive stress due to the expansion. Except in extreme cases, this additional stress is quite small and only rarely will it be of any importance.

In watertube boilers the load to be carried is equal to the weight of the tube plus the weight of the water contained in the tube, but the tube only carries this load as a beam when the tubes are horizontal or nearly so.

It follows then that the greatest probable stress will be that due to the tubes being too rigidly held to permit sufficient expansion. As is well known, steel under a high stress will corrode much more rapidly than when lightly stressed, so it is of the highest importance to ensure that the tube sheets will breathe sufficiently to allow the tubes to expand.

Principles of Riveted Joint Design

(*Continued from page 312*)

For the purpose of thoroughly explaining the application of the above rule, Fig. 35 is presented. This joint includes both conditions (a) and (b) to which the Boiler Code refers.

Condition (*a*).—It should be very plain that this would refer to the third and fourth rows of rivets in the upper butt strap, in which we find that the rivets in the inner row come midway between two rivets in the adjacent row. Therefore, pitch P, which in this case is 3.6 inches, applies.

$$(a) \quad \frac{P}{d} \text{ or } \frac{3.6}{1} = 3.6$$

Since the quotient is not over 4, then the minimum value for the back pitch x indicated in the illustration would be $2 \times 15/16$ inch or $1\frac{7}{8}$ inch.

Condition (*b*).—This case evidently refers to the back pitch y between the second and third rows of rivets, for it is here apparent that two rivets in the inner row come midway between two rivets in the outer row, whence pitch P_1 applies. From Fig. 34 this is found to equal $(7.2 - 3.6)$ or 3.6 inches. As this value is less than 4, then the minimum distance allowable for back pitch y would be the same as for x. But regardless of how small a back pitch would be permissible for y under the American Society of Mechanical Engineers' rule, it stands to reason that the actual minimum value for this dimension depends entirely on the conditions such as plate lap L, plus clearance C (about $\frac{3}{8}$ inch) plus one-half the rivet head diameter (usually taken as equal to d). For the joint details as in Fig. 35 it should be apparent that the back pitch y would be made:

$$(1.4375 + .375 + .9375) = 2\tfrac{3}{4} \text{ inches.}$$

(*To be continued*)

Inspection of Rendering Tanks Necessary*

Steam Pressure Vessels Used for Cooking Purposes Offer Dangerous Explosive Possibilities

AS the result of a recent rendering tank explosion, in an Indiana city, in which five persons were injured and property was damaged to an amount estimated at $10,000, attention has been called to the need of regulating the maintenance of such equipment by careful and frequent inspections.

Uses of Rendering Tanks

Rendering tanks are used in the process of manufacturing various packing house by-products such as lard, tallow, grease and fertilizer. They are usually built in the form of vertical cylindrical kettles, from four to six feet in diameter and from fourteen to sixteen feet or more in height. They are partially filled with bones, meat scraps and trimmings and various other parts of slaughtered animals. After adding a proper quantity of water the whole is cooked or "rendered" by means of live steam. Under this treatment the stock material yields a considerable quantity of grease, which rises to the surface of the water while the heavier substances sink to the bottom or remain in suspension or solution.

Part of the Wreckage from the Explosion

Some of these tanks are jacketed, and with these the heat necessary for the cooking operation is obtained by admitting steam to the jackets. With others the cooking operation is performed by admitting steam directly into the interior of the tanks containing the stock.

The explosion cited above occurred in a tank of the latter type and the construction of these tanks probably offers the greatest danger from accident due to corrosion.

Causes of Explosion

In this case, and in fact in the case of nearly every rendering tank explosion subsequent examination showed that the metal of which the tank was composed had wasted away until it had become so thin that it could no longer withstand the pressure to which it was subjected. This wasting away or corrosion is caused by the action on the metal of the organic acids which are liberated during the treatment of the material in the tank. Animal oils and fats are compounds of glycerine with the so-called "fatty acids,"—mainly with stearic acid, oleic acid and some few others of similar nature. The heat causes a partial separation of the glycerine and a corresponding liberation of fatty acid. Very possibly other acids are also produced in the complicated mixture in a rendering tank.

Prevention of Corrosion

The corrosion takes place chiefly on the inside of the tank, although under certain conditions the exterior surface may also be affected. External corrosion is comparatively easy to detect and prevent, because it is usually caused by the water which drips down upon the sides of the tank from the charging floor when the floor is washed. A suitable coaming of angle iron secured to the floor about the tank will prevent most of this water from coming in contact with the tank; and if the surface of the tank is also kept clean and properly painted, trouble from external corrosion can be eliminated.

Internal corrosion can usually be detected by an experienced inspector without any special difficulty but it is more difficult to prevent. It should be remembered that corrosion often proceeds with astonishing rapidity after the outer skin of the metal has been penetrated. For this reason inspections are of the greatest importance, and a tank that has become seriously affected should be discarded before the deterioration has advanced to the danger point.

Construction of Tanks

On account of the length of the tanks it is usually necessary to construct them in two or more ring courses. There should be as few seams in them as possible, however, and as the tanks are installed in a vertical position all of the upwardly projecting ends of the courses should be on the outside of the tanks, so as to leave no lodging places for the corrosive material. All the seams should be made with special care, because the acid will in time find its way into every crack and will be likely to cause rapid corrosion and grooving there.

Every rendering tank should have a safety valve of suitable capacity, which should be kept in good working order and tested frequently. These tanks are usually operated at a pressure of about 50 pounds, and pressure reducing valves are therefore required when the boilers which supply steam to them are operated at a higher pressure. The reducing valves should be inspected and tested frequently to make sure that they are in good condition and working properly. In some plants where numerous rendering tanks are used, certain boilers are devoted solely to the purpose of supplying steam to the tanks and are operated at the pressure used in the tanks. This is a good practice when feasible, because reducing valves, although ordinarily reliable and satisfactory, cannot be made absolutely proof against failure in operation. The safety valves on the rendering tanks should never be omitted, even if the tanks are operated at full boiler pressure and there are safety valves on the boilers. Preferably, the safety valves on the tanks should be arranged so as to blow off in the room in which the tanks are situated, so that the attendant may not fail to observe that the ordinary working pressure is being exceeded.

When the covers of the manholes, stock openings and clean out doors are held in place by bolts and nuts, care should be exercised, in tightening up the covers, to avoid overstraining the bolts and nuts. A wrench with a comparatively short handle (not more than 18 inches long) should be used and, if the covers cannot be made tight with the leverage thus afforded, it is probable that new gaskets are needed. The nuts should never be tightened while the tank is under pressure. Many lives have been lost as a consequence of neglecting this precaution.

*Prepared from material published by the engineering and inspection division of the Travelers Insurance and the Travelers Indemnity Company, Hartford, Conn.

Locomotive Boiler Construction Code

American Society of Mechanical Engineers Adopts Rules for Locomotives Not Subject to Federal Inspection

THE Boiler Code Committee of the American Society of Mechanical Engineers, aided by experts on locomotive design and construction, has prepared an additional section of the Boiler Code covering the construction of locomotive boilers, not coming under the supervision of the Bureau of Locomotive Inspection. These rules have been approved by the Council of the Society and published in pamphlet form for distribution. Copies may be obtained from the office of the Secretary, C. W. Obert, 29 West 39th street, New York.

Boiler Code—Part I, Section III

SELECTION OF MATERIALS

L—1. Specifications are given in the rules for power boilers, paragraphs 23 to 178, for the important materials used in the construction of boilers, and where so given, the materials herein mentioned shall conform thereto, except as noted in paragraph L—18.

L—2. Steel plates for any part of a boiler when exposed to the fire or products of combustion and under pressure, excepting front tube sheets, shall be of firebox quality as designated in the Specifications for Boiler Plate Steel.

L—3. Steel plates for any part of a boiler, where firebox quality is not specified, when under pressure, shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—4. Braces, when welded, shall be of wrought iron of the quality designated in the Specifications for Refined Wrought Iron Bars.

L—5. Manhole and handhole covers and other parts subjected to pressure and braces and lugs when made of steel plate shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—6. Steel bars for braces and for other boiler parts, except as otherwise specified herein, shall be of the quality designated in the Specifications for Steel Bars.

L—7. Staybolts shall be of iron of the quality designated in the Specifications for Staybolt Iron.

L—8. Rivets shall be of steel or iron of the quality designated in the Specifications for Boiler Rivet Steel, or in the Specifications for Boiler Rivet Iron.

L—9. Throttle and throttle pipe, dry pipe or dry pipe ring, tee head, superheater header and steam pipes to cylinders may be of cast iron.

L—10. Water-leg and door-frame rings shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

ULTIMATE STRENGTH OF MATERIAL USED IN COMPUTING JOINTS

L—11. In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum of the stipulated range, or 55,000 pounds per square inch for all steel plates, except for special grades having a lower tensile strength.

L—12. The resistance to crushing of steel plate shall be taken at 95,000 pounds per square inch of cross-sectional area.

L—13. In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,000
Iron rivets in double shear	76,000
Steel rivets in single shear	44,000
Steel rivets in double shear	88,000

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

MINIMUM THICKNESS OF PLATES AND TUBES

L—14. The minimum thickness of any boiler plate under pressure shall be 1/4 inch.

L—15. The minimum thickness of shell plates, and dome plates after flanging, shall be as follows:

When the Inside Diameter of Shell is			
36 inch or Under	Over 36 inch to 54 inch	Over 54 inch to 72 inch	Over 72 inch
1/4 inch	5/16 inch	3/8 inch	1/2 inch

L—16. The minimum thickness for butt straps for double strap joints shall be as given in Table L—1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding 1 1/4 inches, the thickness of the butt straps shall not be less than two-thirds of the thickness of the plate.

TABLE L-1—MINIMUM THICKNESS OF BUTT STRAPS

Thickness of Shell Plates, Inches	Minimum Thickness of Butt Straps Inches	Thickness of Shell Plates, Inches	Minimum Thickness of Butt Straps Inches
1/4	1/4	17/32	7/16
9/32	1/4	9/16	7/16
5/16	1/4	5/8	1/2
11/32	1/4	3/4	1/2
3/8	5/16	7/8	5/8
13/32	5/16	1	11/16
7/16	3/8	1 1/8	3/4
15/32	3/8	1 1/4	7/8
1/2	7/16		

L—17. The minimum thickness of tube sheets for locomotive boilers shall be as follows:

When Diameter of Front Tube Sheet is			
25 inch or Under	Over 25 inch to 42 inch	Over 42 inch to 54 inch	Over 54 inch
5/16 inch	3/8 inch	7/16 inch	1/2 inch

L—18. The gage thickness of tubes or flues exposed to the products of combustion on the inside shall not be less than that specified in Table L—2 for the various pressures and outside diameters given.

The gage thickness specified in Table L—2 is that measured by the B. W. gage; the thickness at any section must not vary more than one gage below or one gage above that specified in the case of cold finished tubes, or more than one gage below or two gages above that specified in the case of hot finished tubes. In the case of superheater flues which are expanded, the gage of the expanded end may be 1 1/2 gages lighter and the swaged end two gages heavier than the gage thickness.

TABLE L-2—GAGE THICKNESS OF WALLS OF FIRE TUBES OR FLUES

Outside Diameter, Inches	Maximum Allowable Working Pressure Pounds Per Square Inch				
	160	180	200	225	250
1 1/2	13	13	12	..	..
1 3/4	13	12	12	..	..
2	12	12	12	11	11
2 1/4	12	12	12	11	11
2 1/2	12	12	11	11	11
3	12	11	11	11	10
3 1/2	11	11	11	10	10
4	11	10	10	10	9
4 1/2	10	10	10	9	9
5	10	9	9	9	8
5 1/2	9	9	9	8	8
6	9	9	8	8	7

Note:—Variations in gage thickness permitted in above paragraph and gage thickness of fire tubes specified in Table L-2 are subject to revision in event of uniform tube specification for all boilers being adopted by interests concerned in these rules.

L—19. Brick arch tubes shall be of seamless steel or lap-welded charcoal iron and their minimum thickness shall be determined by the following formula:

$$t = \frac{PD}{16,000} + 1/8\text{-inch.}$$

where: P = allowable boiler pressure, pounds per square inch.
t = thickness of walls, inch.
D = outside diameter, inch.

Construction and Maximum Allowable Working Pressure for Boilers of Locomotives

L—20. The maximum allowable working pressure is determined by employing the factors of safety, stresses and dimensions designated in these rules.

The factor of safety used in design and construction of new boilers shall not be less than 4.5.

The factor of safety used in determining the maximum allowable working pressure calculated on the conditions actually obtaining in service shall not be less than 4.0.

The maximum allowable working pressure determined by conditions obtaining in service shall not exceed that for which the boiler was designed.

No boiler shall be operated at a higher pressure than the maximum allowable working pressure, except when the safety valve or valves are blowing, at which time the maximum allowable working pressure shall not be exceeded by more than 5 percent.

L—21. The maximum allowable working pressure on the shell of a boiler shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in Specifications for Boiler Plate Steel, the efficiency of the longitudinal joint, the inside diameter of the course and the factor of safety.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch.}$$

where;
TS = ultimate tensile strength stamped on shell plates, as provided for in Specification for Boiler Plate Steel, pounds per square inch.
t = minimum thickness of shell plates in weakest course, inch.
E = efficiency of longitudinal joint.
R = inside radius of the weakest course of the shell, inches.
FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress.

Boiler Joints

L—22. The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section considered. (See Appendix, paragraphs 410 to 416, Power Boilers, for detailed methods and examples.)

L—23. The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

(a) If $\frac{p}{d}$ is 4 or less, the minimum value shall be 1.75 d;

(b) If $\frac{p}{d}$ is over 4, the minimum value shall be:

$$1.75\,d + 0.1\,(p - 4\,d)$$

where;
p = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, inches.
p = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between the two rivets in the outer row, inches. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)
d = diameter of the rivet holes, inches.

L—24. On longitudinal joints the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than one and one-third times the diameter of the rivet holes.

L—25. The strength of circumferential joints of boilers shall be at least 50 percent of that required for the longitudinal joints of the same structure.

L—26. The longitudinal joints of a shell which exceeds 36 inches in diameter shall be of butt and double strap construction.

This rule does not apply to the portion of a boiler shell which is stayed to the firebox or combustion chamber.

L—27. With butt and double strap construction, longitudinal joints of any length may be used, provided the tension test specimens are so cut from shell plates and butt strap plates that their lengthwise direction is parallel with the circumferential seams of the boiler and the tests meet the standards prescribed in the specifications for boiler plate steel.

L—28. Butt straps and the ends of shell plates forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

L—29. The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 28,500 pounds per square inch, with steel plates having a range in tensile strength of 45,000 to 55,000 pounds per square inch. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

L—30. The longitudinal joint of a dome 24 inches or over in inside diameter shall be of butt and double strap construction or made without a seam of one piece of steel pressed into shape and its flange shall be double riveted to the boiler shell. In the case of a dome less than 24 inches in diameter, for which the product of the inside diameter and the maximum allowable working pressure does not exceed 4,000 inch pounds, its flange may be single riveted to the boiler shell and the longitudinal joint may be of the lap type provided it is computed with a factor of safety not less than 8.

When boiler shells are cut to apply steam domes or manholes, the net area of metal, after rivet holes are deducted, in flange and liner, if used, must not be less than the area required by these rules for a length of boiler shell equal to the length removed. A height of vertical flange equal to three times the thickness of the flange shall be included in the area of the flange.

Braced and Stayed Surfaces

L—31. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or stays of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where;
P = maximum allowable working pressure, pounds per square inch.
T = thickness of plate in sixteenths of an inch.
p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches.
C = 125 for stays screwed through plates not over 7/16 inch thick with ends riveted over, see Table L—3.
C = 135 for stays screwed through plates over 7/16 inch thick with ends riveted over, see Table L—3.

$C = 150$ for stays screwed through plates and fitted with single nuts outside of plate.

$C = 165$ for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate.

If flat boiler plates not less than 5/16 inch thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than $\frac{2}{3}$ T, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plates, but not more than one and one-half times the thickness of the boiler plate, and the values of C given above may also be increased 15 percent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Where values for screwed stays with ends riveted are required for conditions not given in Table L—3, they may be computed from the formula in Paragraph L—31 and used, provided the pitch does not exceed 8½ inches.

L—32. The ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of solid staybolts other than crown stays 14 inches and less in length, shall be drilled with a hole at least 3/16 inch in diameter, to a depth extending at least ½ inch beyond the inside of the plates, or hollow staybolts may be used. Crown stays and flexible staybolts of either the jointed or ball and socket type need not be drilled.

Staybolts behind permanent brickwork, frame braces, or grate bearers shall have holes 3/16 inch diameter for their entire length, which must be kept open at all times.

L—33. When channel irons or other members are securely riveted to the boiler heads, the stress on such members shall not exceed 12,500 pounds per square inch. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts.

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of those rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

L—34. The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

L—35. (*a*) The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface shall be determined by the formula in Paragraph L—31, using 150 for the value of C.

(*b*) The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Paragraph L—31, using the value of C given for the thickness of plate and type of stay used.

(*c*) The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head shall not exceed p as determined by the formula in Paragraph L—31, using 150 for the value of C, plus the outside radius of the flange.

(*d*) The maximum distance between the inner surface of the shell and the centers of braces of other types shall not exceed p as determined by the formula in Paragraph L—31, using that value of C which applies to the thickness of plate and type of stay as therein specified, plus the outside radius of the flange.

(*e*) In applying these Rules and those in Paragraph L—31 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

L—36. (*a*) When the edge of a stayed plate is flat and is fastened by riveting, the distance from the centerline of the rivets to a line through the centers of the nearest row of stays may be made to equal the pitch of the stays as given in Table L—3 plus twice the thickness of the plate.

(*b*) When the edge of a flat stayed plate is flanged and riveted, the distance from the center of the outermost stays to the inside of the supporting flange shall not exceed the pitch of the stays as given in Table L—3 plus the inside radius of the flange.

TABLE L—3.—MAXIMUM ALLOWABLE PITCH IN INCHES, OF SCREWED STAYS, ENDS RIVETED OVER, FOR FLAT PLATES

Pressure Pounds Per Square Inch	Thickness of Plate, Inch — Maximum Pitch of Staybolts, Inches						
	5/16	3/8	7/16	1/2	9/16	5/8	11/16
100	5.590	6.708	7.826	....	....	....	....
110	5.331	6.396	7.462	....	....	....	....
120	5.103	6.124	7.144	....	....	....	....
125	5.000	6.000	7.000	....	....	....	....
130	4.903	5.883	6.864	....	....	....	....
140	4.725	5.670	6.614	7.586	....	....	....
150	4.564	5.477	6.390	7.590	....	....	....
160	4.419	5.303	6.187	7.349	....	....	....
170	4.287	5.145	6.003	7.129	....	....	....
180	4.167	5.000	5.833	6.928	7.794	....	....
190	4.056	4.867	5.678	6.743	7.587	....	....
200	3.953	4.743	5.534	6.573	7.394	....	....
225	3.727	4.472	5.218	6.197	6.971	7.746	....
250	3.536	4.243	4.950	5.879	6.614	7.349	....
300	3.227	3.873	4.519	5.367	6.037	6.708	7.372

L—37. The distance between the edges of the staybolt holes may be substituted for p for staybolts adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

L—38. The diameter of a screw stay shall be taken at the bottom of the thread, or at the body of the bolt between the threads, whichever is the lesser.

L—39. The least cross-sectional area of the stay shall be taken in calculating the allowable stress, except when the stays are welded and have a larger cross-sectional area at the weld than at some other point, in which case the strength at the weld shall be computed as well as in the solid part and the lower value used.

L—40. Holes for screw stays shall be drilled full size or punched not to exceed ¼ inch less than full diameter of the hole for plates over 5/16 inch in thickness and ⅛ inch less than the full diameter of the hole for plates not exceeding 5/16 inch in thickness and then drilled or reamed to the full diameter. The holes shall be tapped fair and true, with a full thread.

L—41. The ends of steel stays upset for threading shall be thoroughly annealed.

L—42. In curved sheets of a combustion chamber, subject to external pressure, of radius R inches the maximum allowable working pressure shall be calculated by the formula:

$$P = C \frac{T^2}{p^2} + 250 \frac{T}{R}$$

provided p^2 does not exceed 0.008 CTR and in no case shall p exceed $2T$. The stress per square inch in staybolts shall not exceed 7,500 pounds, based on the unit pressure

$$P - 250 \frac{T}{R}$$

(*To be continued*)

The Midvale Steel & Ordnance Company announces the appointment of Herbert H. Moffitt as manager of sales in the Washington district, with headquarters at 1121 Woodward Building, that city. The Washington district embraces the District of Columbia, Virginia and the eastern section of North Carolina.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-President and Treasurer*
Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1,
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $2.00; foreign, $3.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,550 copies were printed; that of these 4,550 copies 4,090 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 69 were mailed to advertisers, 34 were mailed to employees and correspondents, and 341 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 52,650, an average of 4,786 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

GENERAL: PAGE
Superheater Practice in American Locomotives 301
Repairing Locomotive Boilers by Electric Welding 306
Principles of Riveted Joint Design.—V 311
Fabricating Tanks from Heavy Plate 313
Strength of Tubes a Factor in Boiler Design 315
Inspection of Rendering Tanks Necessary 317
Locomotive Boiler Construction Code 318
EDITORIAL COMMENT 321
ENGINEERING SPECIALTIES FOR BOILER MAKING 322
QUESTIONS AND ANSWERS FOR BOILER MAKERS:
Repair to Plain Cylindrical Furnace 324
Leaky Cutting and Welding Hose Connections 324
Transition Piece 325
Placing Cement in Water Leg of Locomotive Boiler 325
BUSINESS NOTES 325
DEATH OF JAMES C. STEWART 325
LETTERS:
Chart for Computing Capacities of Rectangular Tanks 326
Every Day Questions Answered for Apprentices 326
ASSOCIATIONS 327
TRADE PUBLICATIONS 327
SELECTED BOILER PATENTS 328

Those who have been following the work of the committee on rules for the construction of locomotive boilers will no doubt be interested to learn that this difficult undertaking has been completed and the Code is being published in pamphlet form for distribution, independent of the regular edition of the Boiler Code. Through the courtesy of the American Society of Mechanical Engineers this section of the Boiler Code is also being published in THE BOILER MAKER, the first part beginning on page 318 of this issue.

The limited edition being issued by the society will be incorporated in the Code as Section III, upon completion of the 1922 revision. Copies of the Locomotive Code may be obtained from the secretary of the society.

The Boiler Code Committee of the American Society of Mechanical Engineers announces progress in the formulation of the proposed code for air tanks and pressure vessels intended to form Section IV of the Boiler Code. A public hearing will be held in connection with the coming annual meeting of the society in order that all interested in unfired pressure vessels may have an opportunity to discuss the proposed rules.

The hearing will be held in the United Engineering Societies building, 29 West 39th St., New York, on Monday, December 5, at 9:30 A. M.—the opening day of the annual meeting. Everyone interested in the formulation of this code is cordially invited by the committee to attend and participate in the discussion.

A revised draft of this proposed code is now under preparation and every effort will be made by the committee to distribute copies to its mailing list of boiler and tank users and manufacturers well in advance of the hearing. Copies will also be available for distribution at the hearing.

Prevailing business conditions have influenced the executive committee of the American Boiler Manufacturers' Association to omit the customary fall meeting of the Association. It was decided that attendance at any meeting held at the present time would be slight. Every member should make a strong effort, however, to be present at the next meeting which will be held in January or early in February next year.

An excellent program has been arranged for this meeting, which will include a discussion of the adoption of a uniform tensile strength in calculating working pressures of steam boilers; a report by the joint committee of the American Boiler Manufacturers' Association will be given on the setting heights for hand fired horizontal return tubular boilers. Other reports will be given on the progress of the National Board of Boiler and Pressure Vessel Inspectors; a report on inspection by the sub-committee of the Boiler Code Committee, and on the maximum thickness of plates to be used in horizontal return tubular boilers.

Where autogenous welding is concerned, THE BOILER MAKER has always been among the first to recognize the advantages and economies possible in the application of the processes—electric arc and oxy-acetylene—to the industry and to advocate their adoption wherever possible under existing regulations. Probably the greatest field of usefulness claimed for fusion welding is in locomotive boiler repair work.

For a number of years the subject in all its phases has been discussed at meetings of the Master Boiler Makers' Association so, for the purpose of co-ordinating the experiences of the members having control of boiler welding work in railroad shops throughout the country, a sub-committee of the Association has prepared a report outlining the most successful methods so far developed. This report is on the program for the 1922 convention of the Association to be held in Chicago, May 23-26.

Sections of the report on electric arc welding which appear elsewhere in this issue contain details of firebox welding, defective staybolt repairs, flue welding and a number of other applications, all of which have been used with success in the maintenance of locomotives.

The report is a real foundation on which members of the Association may base their welding practice with such additions and revisions from time to time as seem advisable.

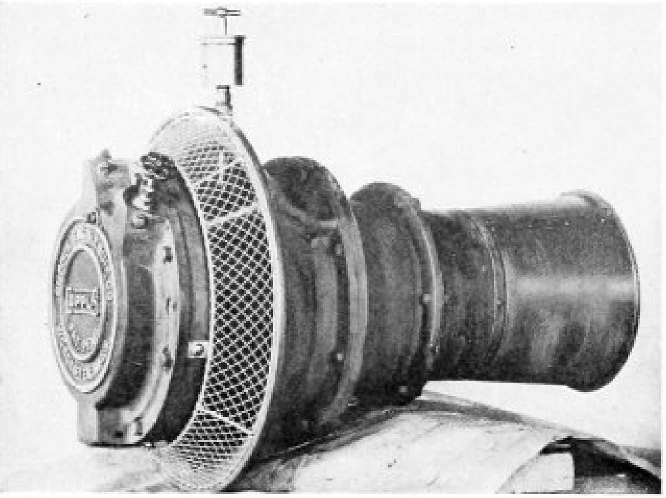
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Blower for Forced Draft or Ventilating Service

Screw blade propeller blowers which deliver air in lines parallel to the axis of the machine have been added to the line of blowers manufactured by the Coppus Engineering and Equipment Company, Worcester, Mass. The Coppus "Vano" blower is designed in two types for turbine and electric drive.

The principal feature of this blower is a stationary guide vane of special design located beyond the propeller. The individual guide vane blades subdivide the air current leaving the propeller radially. These blades, which have a curvature increasing in the direction of rotation of the propeller, concentrate the air current and give it an added acceleration inside the stationary guide vane so that a considerable part of the air pressure is produced in the vane. Much of the end thrust is thus taken up by the stationary guide vane casing.



Turbine Drive Blower

Because of kinetic energy, the streams into which the flow of air has been divided by the guide vane blades rotate slightly and converge towards the axis as they leave the casing, so that the entire air flow is impelled beyond the guide vane.

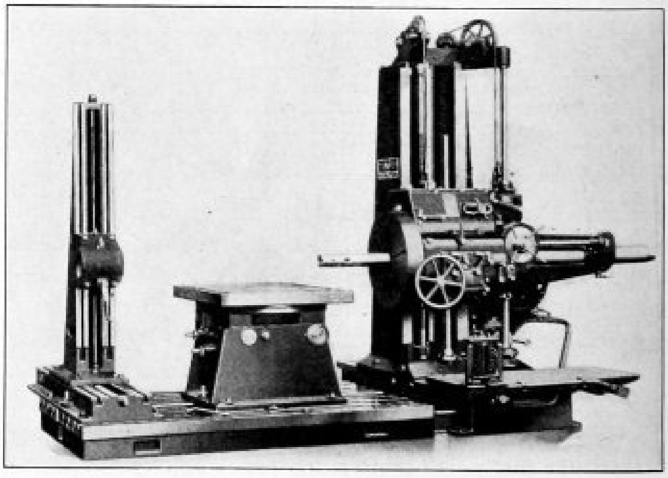
The blowers are used for undergrate or forced draft service in hand fired boilers, induced draft, air heating and drying installations, individual room or tunnel and passageway ventilation of factories and the like.

Horizontal Boring, Drilling and Milling Machines for Heavy Duty

For several years the Pawling and Harnischfeger Company, Milwaukee, Wis., has maintained a special department for the design and construction of horizontal drills distinct from the crane producing section of the organization. This department has developed a line of horizontal boring, drilling and milling machines of which the 4-F size shown is the smallest for heavy work and may be used either as a single purpose machine or for general service.

Among the special features of the machine are narrow guiding surfaces, a saddle fully counterbalanced with weights located inside the column, centralized control, back gears located close to the spindle and automatic stops for the saddle and column in cases where the machines are electrically driven. The spindle-carrying saddle of box section contains the drive for the spindle, the feeding mechanism and the feed distributing mechanism. The saddle is guided upon the column by a narrow guide placed at the front near where the cutting pressure is taken up. The screw for feeding is placed in the center of the guide.

The column is of box section with two sides straight and two sides tapering to a long, wide base and moves along narrow guides placed at the front of the machine. The column can be traversed in either direction on its runway by a hand wheel, power feed or rapid traverse from the saddle. These movements are through a large revolving bronze worm wheel nut, actuated by a quick pitch worm on a steel screw. The driving motor is located at the base of the column. The spindle is a high carbon alloy steel forging ground to a sliding fit in the driving sleeve. Power is applied at the front end while the feed mechanism operates at the rear end through rack and pinion. The spindle is moved through its changes of feed by spur gears and positive clutches, actuated through a frictional worm wheel. The drive may be either by means of a constant speed or variable speed motor or by belt. If a motor is used, 10 horsepower is required and it is mounted at the base of the column. The machine is double back geared and by three levers 18 spindle speeds, reversible, are obtained. A wide range of boring and drilling feeds to the spindle and of milling feeds to the column and saddle are possible.



Type 4-F Drilling Machine

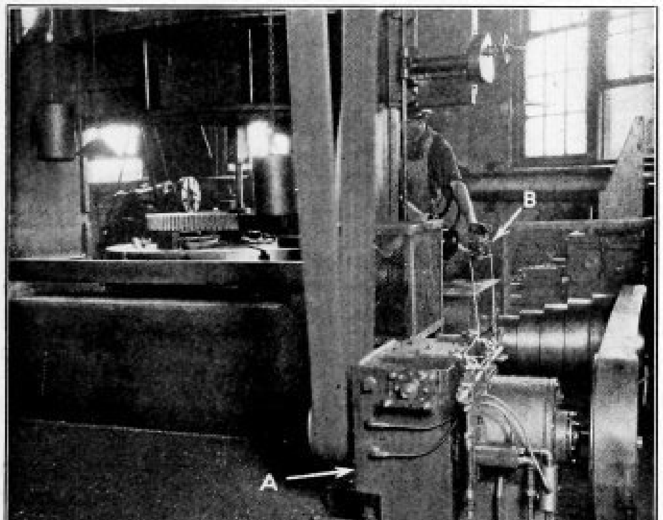
The work bed is provided with planed tee slots running parallel to the spindle travel. Three sides have a planed squaring strip for alining the work. Universal tilting and revolving table or a plain revolving table, with the movement controlled by hand or power can be supplied with the machine.

Oil Pressure Power Transmission Applied to Machine Tool Operation

In applying variable speed, oil pressure, power transmission devices to machine tools the Oilgear Company, Milwaukee, Wis., has developed a feed control and a variable speed drive to eliminate the manual work of controlling medium and heavy machine tools. The feed control system consists essentially of a pump which may be adjusted through a wide range of delivery capacity and a motor driven by the oil received from the pump. The pump is ordinarily driven from the countershaft of the machine tool on which the control is applied and the motor attached to the carriage or ram on which the feed is desired.

Two types of feeding motors are employed: the direct acting pushing cylinder and the rotary motor, the former being used when space conditions permit. For very long machines and frequently for cross feeds where it is necessary to have a screw control of the tool slide, the rotary type of motor is used. A feature of the feed gear is the rapid traverse movement obtainable which enables the operator to move heavy carriages and rams without fatigue. The feed control permits the operator to increase the feed when cuts become lighter, back out the tool for examination of the cutting edge and return it quickly into the cut without disconnecting the friction clutches, etc.

Delivery of fluid from the feed controller, varied in quantity and direction, compels the feeding motor to perform exactly the function desired by the operator. The pressure in the system is large or small according to the resistance offered to the cutting tool, but the feed motor moves at the exact rate of speed called for by the operator without regard to the pressure required to do the work. If this pressure rises above the maximum necessary for feeding, a relief valve opens and permits the feed motor to come to a standstill. This property is made use of in locating shoulders and the like in work to be machined as it is only necessary to set



Rear View of 7-Ft. Boring Mill Equipped with Oilgear Variable Speed Drive

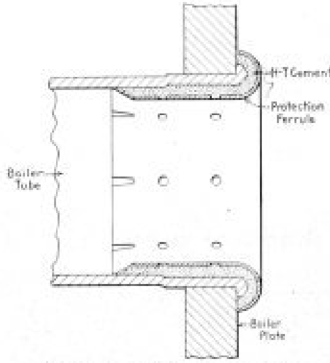
rigid stops and allow the carriage to run against them as desired.

In addition to its use on lathes and the like, the variable delivery pump may be applied to presses and boring mills. An example of this is given in the accompanying illustration, where the device is shown applied to a 7-foot boring mill. This machine is driven by the standard feed controller requiring only a belt drive from a line shaft.

A larger type machine, designed to drive the spindles of machine tools from a line shaft, a constant speed electric motor or a gasoline engine has also been developed by the Oilgear Company. The principle of operation is similar to that of the feed control system, securing for the operator a wide range of speed changes in either direction through the manipulation of a single control handle.

Protecting the Ends of Boiler Tubes

A protection ferrule for boiler tubes, designed to protect the ends of tubes exposed to the fire in the combustion chamber by preventing their burning and leaking, is being produced by the American Boiler Appliances Company, Paterson, N. J. A patent for the device has been applied for.



Sectional View of Tube and Ferrule

For installation of the ferrule, the tubes should be tight and clean for about 3 inches. It is advisable to have the boiler hot and under a head of about 20 pounds of steam. The ferrule is first liberally covered with high temperature cement on the outside. It is then forced into the tube so that the round flange rests against the tube sheet, as shown in the accompanying illustration. The excess cement is cleaned off and the installation of the ferrule is complete. The cement used has been specially developed for this purpose and will withstand a temperature of 3,500 degrees F.

The cement after hardening practically unites the tube and the ferrule into a solid body, giving the end of the tube a greater cross section which, it is claimed, causes the tube and the tube sheet to expand and contract uniformly. Ferrules are available in sizes from 2 inches to 4 inches.

New Type Grease Cup

The Flannery Bolt Company, Pittsburgh, Pa., is manufacturing what is known as the "Realock" grease cup, which is designed to reduce the number of cups lost from engines while on the road. These cups carry a liberal supply of lubricant and may be quickly adjusted to follow up the consumption of grease. It is stated that an entire set of cups can be adjusted during a station stop of two or three minutes. The feature of the cup is that it is positively locked after each adjustment, thereby eliminating the possibility of loss or working out.

Drill Adapted for Bench Use

Certain changes have been made in the new, light ¼-inch drill made by the Black and Decker Manufacturing Company, Baltimore, Md., to adapt it for use as a grinder. For bench work the drill is attached to a special base and the grinding wheel fitted in place. This wheel is not clamped in the chuck drill, but is mounted on the spindle back of the chuck, which screws in position. The drill can also be used on the bench as a small lathe for dressing pins, rods and the like which can be inserted in the drill chuck.

The Bluff City Boiler and Tank Works, formerly of 19 East Broadway, Memphis, Tenn., has moved to 1123-1133 Kentucky street of that city.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *Woolworth Building, New York City.*

Repair to Plain Cylindrical Furnace

Q.—In a repair job to a cylindrical furnace I found the furnace down so bad at the crown that it was impossible to force the plate back into position. The condition is shown in the accompanying sketch, Fig. 1. How should repairs be made? C. D.

A.—The complete removal of the furnace is recommended, but in case the construction of the boiler is such that this would be very expensive and would entail the removal of other boiler parts a repair can be made as shown in Fig. 2.

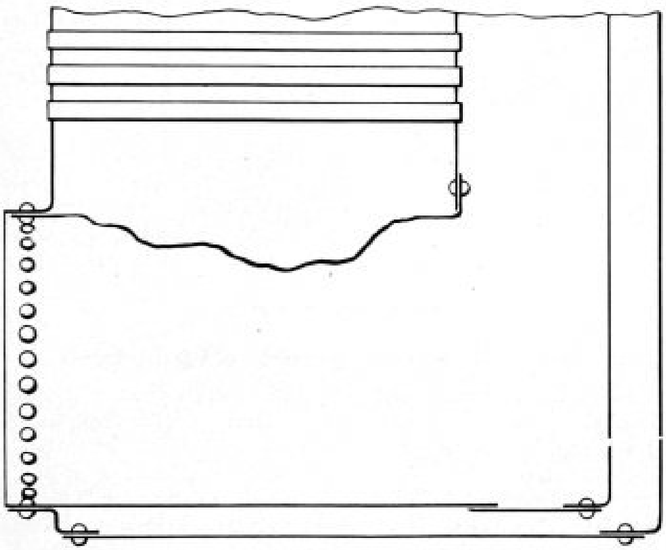


Fig. 1.—Diagram Showing the Failure of a Plain Cylindrical Furnace in Which the Crown Sheet Could Not Be Forced Back Into Position

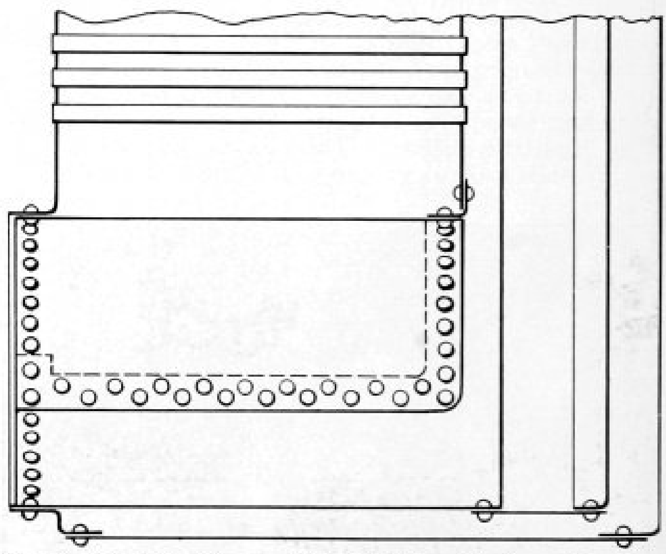


Fig. 2.—Repair to Furnace Was Made by Riveting a Patch to Rear End, Front Head and Along the Furnace Shell as Indicated by Dotted Line

DETAILS OF REPAIR

Cut away the damaged section so as to bring the longitudinal seams below the fire line of the furnace. The new patch is shown by the dotted lines, being riveted to a part of the rear end of the furnace, to the front head of the boiler and by two longitudinal seams along the shell of the furnace. The joint should be made according to the advice of the inspector and to withstand safely the working pressure on the furnace, which, in this case, tends to collapse the furnace shell.

The two circumferential seams are made according to the original design used in attaching the furnace to the front head of the boiler.

For cutting out the damaged plate, use the oxy-acetylene cutting torch, but mark off a line to follow before proceeding with the cutting. Measure the length around the circumference of the section removed and to this length add the material required for the lap seams. Round off the corners, mark off and drill the rivet holes and roll the patch to a radius smaller than the furnace so as to put it through the head opening without trouble, then with a screw jack it can be spread to fit over the furnace. Having placed the patch in position mark off tack holes on the furnace, drill these and bolt the patch in place. Then drill the holes in the furnace for the longitudinal seams and the back girth seam through the holes in the patch. Countersink the rivet holes for the girth seams so as to provide rivets flush with the furnace shell.

Where holes are drilled in place, using the patch plate as a template, it is the practice to remove the patch and then the burrs from the holes. This is necessary to bring the metal close together for riveting. Calk the seams around the patch and apply the hydrostatic test of 1½ times the working pressure.

Leaky Cutting and Welding Hose Connections

Q.—We occasionally find it difficult to make tight hose connections to the oxy-acetylene equipment. What advice can you offer to overcome this? A. L.

A.—A good method is to spread shellac on the nipples before inserting them into the hose. This makes a tight joint. With the use of ordinary wire clamps, wire the nipple and hose together. If this work is properly done you will have no further trouble with leaks around the hose connections.

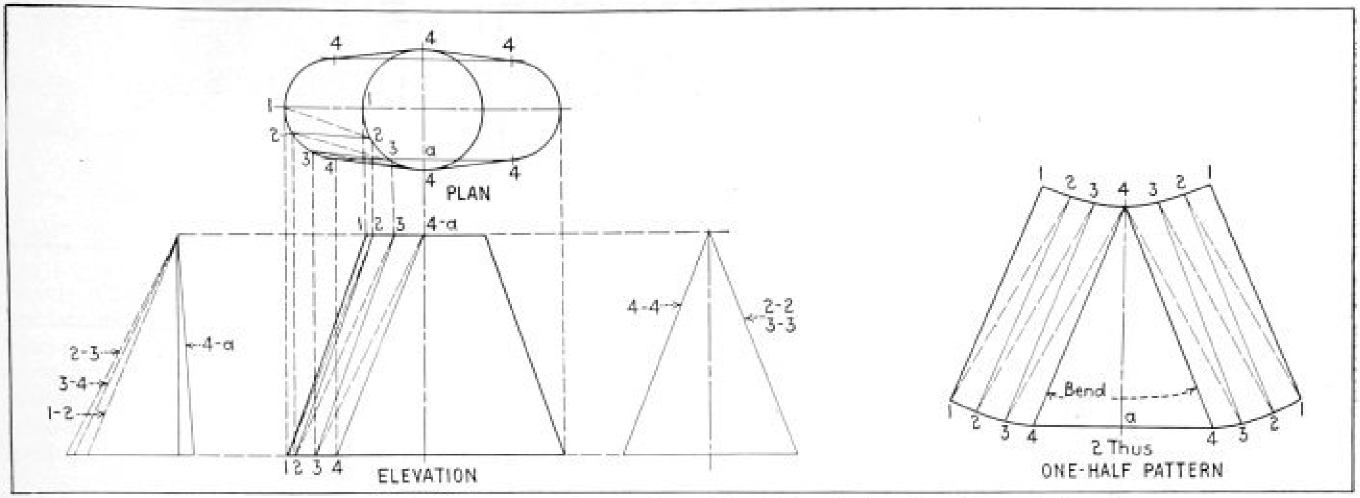


Fig. 1.—General Method of Laying Out a Transition Piece Using the Triangulation Process

Transition Piece

Q.—Please show how to lay out a transition piece as shown in Fig. 1.
A Subscriber.

A.—The general method applied in making developments of this character is illustrated in Fig. 1. Triangulation is employed and if this method is thoroughly understood its application in development of patterns is unlimited.

In this example draw first a plan and elevation and space one-half of the semi-circle of the lower base into a number of equal parts, likewise a quarter of the circle which represents the upper base. Connect points *1-1*, *2-2*, *3-3*, and *4-4* with solid straight lines and points *1-2*, *2-3*, *3-4* with dotted lines as shown in both plan and elevation. Ordinarily this work would be shown only in the plan in cases where the bases are parallel.

The next step is to construct the triangles used to determine the true lengths of the dotted and solid construction lines, as indicated to the right and left of the elevation. From these data the pattern is produced, assembling the true lengths of lines in their relative position and using the arc lengths of the upper and lower bases.

Placing Cement in Water Leg of Locomotive Boiler

Q.—I have a locomotive boiler under my care which will need patching in the corners very soon, which means somewhat of a cost to the owner. Why would it not be all right to put 3 inches to 6 inches of cement in the legs of the boiler and then raise the grates up to that level? By so doing they could get one more year out of the boiler. I have done this on low pressure marine boilers. The boilers that I refer to work under a pressure of 100 pounds. Please answer in your next issue. H. A. A.

A.—As you have not stated fully the exact condition of the plate in the water leg it is difficult for us to advise you definitely. However, the placing of cement in the water leg will not make the plate any stronger; on the other hand it will cause a bending action to take place at the mud ring joint; also it reduces the combustion space in the firebox and the heating surface. At best it is only a temporary arrangement and, as the repairs should be properly made we would recommend that it be done now instead of one year from now. Consult the boiler inspector in your district.

BUSINESS NOTES

The Peerless Machine Company, Racine, Wis., manufacturers of Peerless high speed saws, announces a reduction in the price of the products of this company. Copies of the new price list for the hack saw machines and blades, etc., may be obtained from the company on request.

C. A. Dunn has resigned as general superintendent of the Detroit Seamless Steel Tubes Company, Detroit, Mich., to take a position in the sales department of the Prime Manufacturing Company, Milwaukee, Wis.

The Toronto, Ontario, office of the Independent Pneumatic Tool Company, Chicago, Ill., has been removed from 32 Front street West, to larger quarters at 163 Dufferin street, Toronto. This office will remain in charge of William McCrae.

C. H. Hobbs has been made assistant general manager of sales of the Seamless Steel Tubes Company, Detroit, Mich. For over fourteen years Mr. Hobbs has been with the Lackawanna Steel Company and for the last five years district representative in charge of the department office.

The pulverized fuel department of the Quigley Furnace Specialties Company, Inc., New York, has been acquired by the Hardinge Company, also of New York. The new company states that there will be no change in the method of conducting the business as the organization of the engineering branch of the pulverized fuel department has been taken over practically intact.

Death of James C. Stewart Loss to Boiler Manufacturing Industry

James C. Stewart, senior partner in the Stewart Boiler Works, Worcester, Mass., whose death was announced on page 297 of the October issue of The Boiler Maker, was one of the best known men in the boiler manufacturing industry. He was a leading spirit in the Stewart Boiler Works and was to a great extent responsible for the extensive development of this well known firm, which was established by his father, Charles Stewart. Mr. Stewart devoted over forty-three years of his life to the boiler industry and was known, liked and respected by all the men prominent in the industry in the east and by a host of friends and customers whom he had served for many years.

James C. Stewart

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Chart for Computing Capacities of Rectangular Tanks

Here is a chart that will be found useful for quickly computing the capacities of rectangular tanks or for computing directly the number of gallons of water or the number of pounds of water in such tanks. Or it immediately converts gallons into cubic feet, pounds, or tons of water, or vice versa. All the user of the chart has to do is to lay a straight edge across the chart three times as indicated by the dotted lines drawn on this chart and the problem is solved.

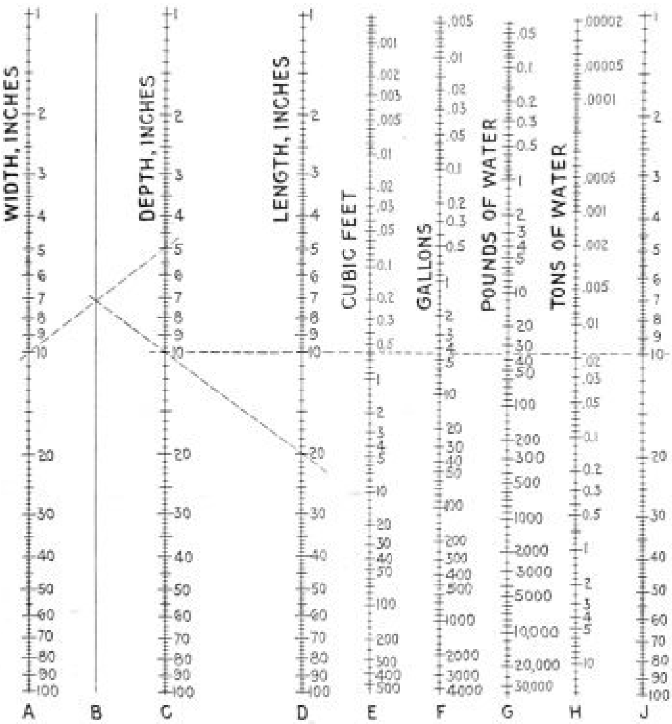


Chart Giving Gallons, Pounds and Tons of Water in Rectangular Tanks

For example, how many pounds of water will a rectangular tank hold whose dimensions are: width, 10 inches; depth, 5 inches; length, 20 inches.

Connect the 10 (Column A) with the 5 (Column C) and locate the intersection with Column B. Then from that located point of intersection run over to the 20 (Column D) and locate the intersection with Column C. Connect that point of intersection with the same point on Column J. Column C and J, it will be noted, are exactly the same. They are made the same in order that the last line (from Column C to J) will be perfectly horizontal. To find the number of pounds of water, now consult Column G. The answer is a trifle over 36 pounds. Roughly we would call it 36 pounds. The same horizontal line, you see, simultaneously gives the number of cubic feet (Column E), the number of gallons (Column F), and the tons of water (Column H) in this selfsame rectangular tank.

In case it is desired to convert gallons into cubic feet, or pounds of water into gallons, etc., it is plain that a simple horizontal line will do the trick. All of the columns are plainly marked so that there can be no misunderstanding, and after reading this over once it will not be necessary to read it again for there is practically nothing to remember.

The range of the chart is wide and easily covers most ordinary conditions. It is based on 231 cubic inches per gallon, 62.5 pounds of water per cubic foot, and 2,000 pounds of water per ton.

To make the chart still more convenient it might be well to point out the fact that digits can be added to the figures in Columns A, C, and D. Thus, if the tank is 100 by 5 by 20 inches the same dotted lines would solve the problem and the answer in Column G would be 360 pounds instead of 36 pounds. Again, if the dimensions are 100 by 50 by 200 inches the answer would be about 36,000 pounds, the number of tons would be about 18, the number of gallons would be about 4,300, and the number of cubic feet would be about 600.

In other words add as many digits or move the decimal point as many places to the right in Columns E, F, G, and H, as are added to the figures in Columns A, B, and D.

Every Day Questions Answered for Apprentices

Q.—Should a boiler be filled with cold water just after it has been blown off?

A.—No boiler should be filled with cold water just after it has been blown off, because the cold water coming in contact with the hot plates will cause sudden and uneven contraction of the plates. Thus the boiler will be subjected to undue stresses caused by this inequality.

Q.—Which is preferable when washing a boiler—hot or cold water?

A.—Luke warm water, always.

Q.—How should staybolts, radial bolts, crown bolts, and braces be placed in regard to the sheets they support?

A.—Staybolts, radial bolts, crown bolts, and braces should be placed so as to be at right angles, or at 90 degrees to the sheets they support. Bolts and braces placed at 90 degrees to the sheets they support are called direct braces, and their holding power is greater than a brace otherwise placed.

Q.—Why can less efficiency be permitted in a girth seam than in a longitudinal seam?

A.—Because the force acting on a girth seam is approximately one-half that acting on the longitudinal seam, and thus the efficiency of the girth seam can be less than the efficiency of the longitudinal seam.

Q.—When should flues be plugged?

A.—Flues should never be plugged whenever it is possible to renew the defective flue. However, circumstances often alter this rule, and it is permissible to plug a flue when an engine is away from its terminal providing the plugs are applied with a tie rod, and made secure on each end. When the engine reaches the home terminal, however, the plugs should be removed and a new flue applied. Under no circumstances apply plugs to flues without tie rods. Flues plugged without tie rods are very dangerous and are liable to blow out on account of a steam pocket being formed between the two plugs.

Canton, Ohio. GEORGE L. PRICE.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.
Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.
Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.
Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.
James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.
William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.
International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.
Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.
Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.
First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.
Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.
Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.
Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.
Secretary—Harry D. Vought, 26 Cortlandt street, New York City.
Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.
Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

Welded Pipe.—The characteristics and uses of hammer weld pipe, a new product of the National Tube Company, Pittsburgh, Pa., are given in a recent bulletin published by this company. The pipe is made by bending a steel plate into tubular form with the edges overlapping and then welding the overlapped edges after they have been heated, by hammer forging them on an anvil block supported on a horn inside the pipe.

Fluid Compressed Products.—The growth and the development of the Sandusky Foundry & Machine Company, Sandusky, Ohio, producers of fluid compressed products in bronze, iron, and special alloys are given in this booklet. These products are used in pulp mills, chemical plants, hydraulic equipment, ship construction, pneumatic tubes and for various other purposes. Shop equipment required for the machining and working of tubular products is described in detail.

Boiler Performance.—A folder giving the result of an official test conducted by George H. Perkins, consulting engineer of Boston, on a 950 horsepower Heine watertube boiler has been sent out by the Heine Boiler Company, St. Louis, Mo. Although this boiler was rated by the builders at 950 horsepower, it actually developed 2,858 horsepower in the test giving a load rating of 300 percent.

Don't Let It Happen to You.—This book gives the story of a business venture that might have been profitable only inadequate equipment caused a loss on certain contracts rather than gains that had been expected. The Williams Tool Corporation, Erie, Pa., uses this story to introduce the proper principles, machinery and dies which should be used for pipe threading, and the necessity of always maintaining an adequate supply of spare dies and machine parts. The book is a complete treatise on pipe threading practice and will be supplied by the company free on request.

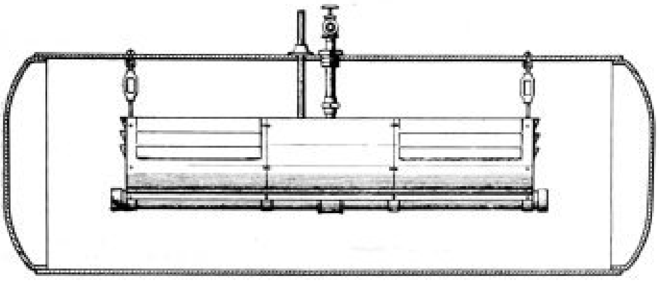
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,392,307. BOILER CLEANER. HARVEY H. DICK, OF LINCOLN, ILLINOIS.

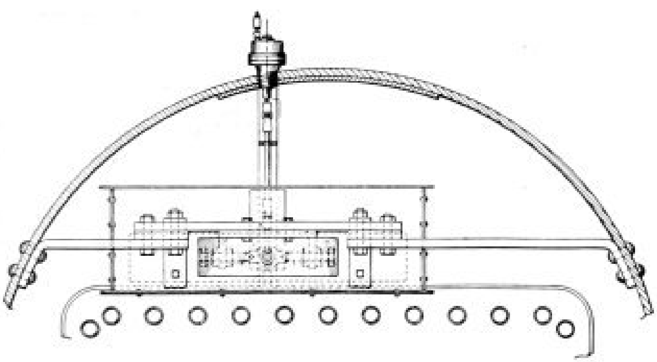
Claim 1.—A device of the class specified comprising a tank or receptacle constructed of a plurality of substantially V-shaped frames and side and end walls secured to the outer edges of said frames, said end walls and



end portions of said side walls being provided with intake orifices at different levels, and a discharge pipe at the angle forming the bottom of said tank or receptacle, said discharge pipe being provided with intake orifices, and a funnel shaped intake member mounted on a pipe supported by said intake pipe, said funnel shaped member having a closed top and side intake orifices. Two claims.

1,392,682. STEAM BOILER LOW WATER SIGNAL. CHARLES E. FULLER, OF OMAHA, NEBRASKA, ASSIGNOR OF ONE-HALF TO ARTHUR H. FETTERS, OF OMAHA, NEBRASKA.

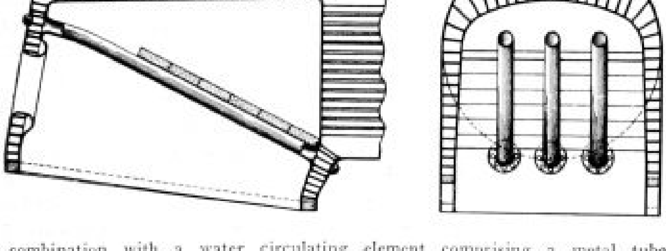
Claim 1.—In a water level signaling apparatus, the combination with a signaling device; of a member subject to scale formation from the water; operative connections between said signaling device and member by which



the signaling device is adapted to be affected in accordance with the position of the members; and means, similarly subject to scale formation from the water arranged to neutralize accumulation of scale deposits on said number. Seven claims.

1,356,307. WATER CIRCULATING TUBE. JOHN L. NICHOLSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE FIREBOX COMPANY, A CORPORATION OF DELAWARE.

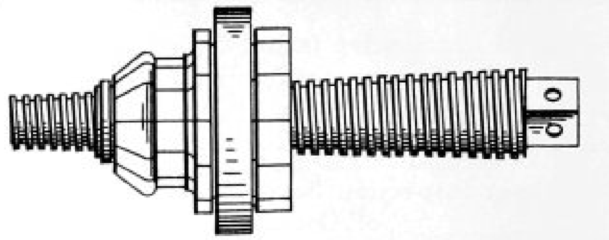
Claim 1.—A locomotive boiler shell and its firebox, the latter having metal walls which contain openings for a water circulating element, in



combination with a water circulating element comprising a metal tube of less diameter than said openings, but having outwardly flaring end flanges which fit said openings, the edges of said flanges being welded to the firebox walls at the edges of respective openings therein, and a plurality of stay bolts secured in each said flange and thereby tying the ends of the tube to the boiler shell. Two claims.

1,393,620. TUBE EXPANDER. PETER GAVIN, OF VANCOUVER, BRITISH COLUMBIA, CANADA.

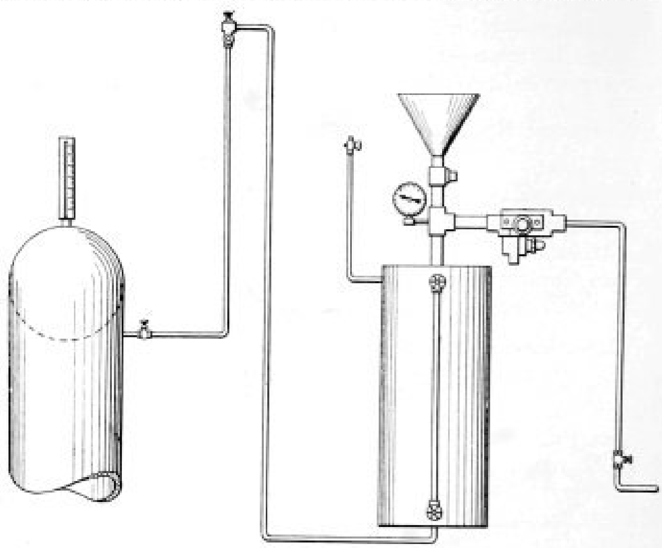
Claim.—A sectional tube expander formed in a large number of sections meeting on planes having some angles to each other, and having a bore



provided with a squared thread extending throughout its length and having projecting flanges at one end, the said sections having a rounded nose at one end adapted to enter the tube to be expanded, and a recessed flange at the opposite end of larger diameter than the nose, a correspondingly threaded and tapered pin fitting said bore and rotatable therein, said pin being so fitted to the bore as to spread the expander sections at all points of its travel therethrough, means formed upon one end of said pin whereby rotation may be imparted thereto, a rubber ring engaging the said recessed flange, and a second rubber ring engaging the projecting flanges of the expander adapted to retain them in operative position on the pin.

1,392,862. STEAM BOILER COMPOUND FEEDER. EDSON H. TUTTLE, JOHN C. MILLER AND TRACY C. BALDWIN, OF CONNEAUT, OHIO.

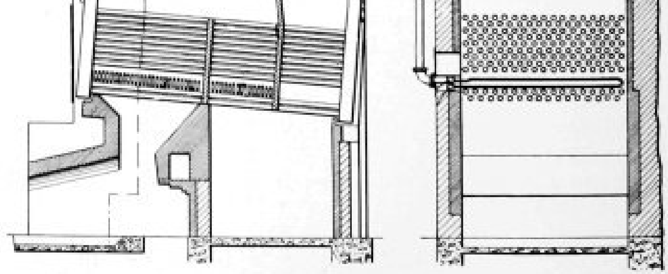
Claim.—Means for feeding a liquid agent to the feed water line of a steam boiler, comprising a supply tank, means for charging said tank, a



sight feed regulator, a pipe intermediate of the supply tank and said regulator, and a pipe leading from the sight feed regulator and adapted to be connected with a conduit in the feed water line; the said charging means and the supply tank being also connected with a pressure regulating valve, and said valve being adapted, in turn, to be connected with a pressure line.

1,387,464. BOILER WITH SUPERHEATER. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

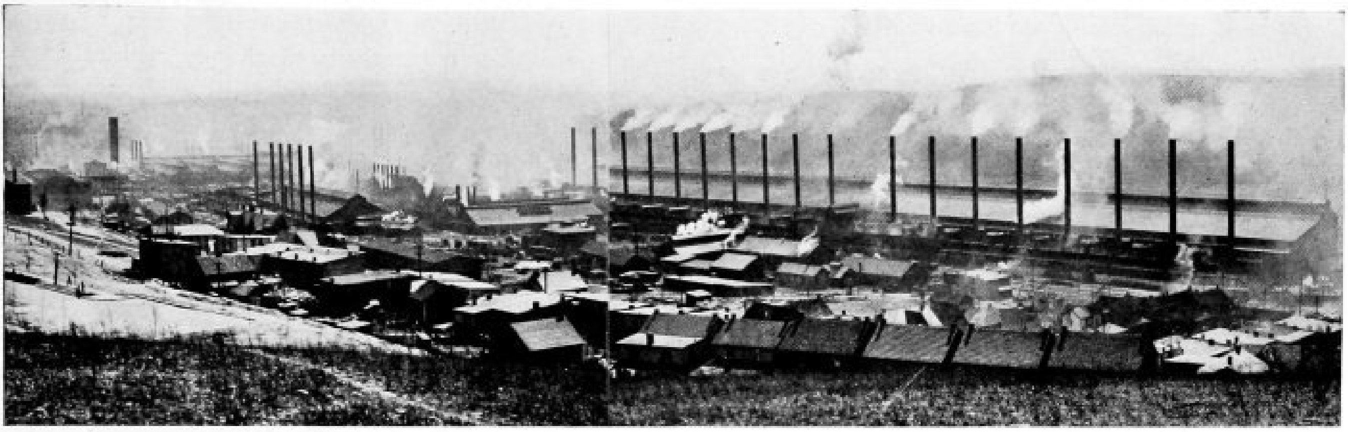
Claim 1.—In a watertube boiler, the combination of two spaced parallel rows of water tubes, and a superheater with alined elements extending



into the space between the rows of water tubes and in a row parallel to them, each element being of greater depth than width, a space being left between the row of superheater elements and one of the adjacent rows of water tubes greater than the width of an element but less than its depth. Three claims.

THE BOILER MAKER

DECEMBER, 1921



Panorama of Midvale Steel and Ordnance Plant at Coatesville, Pa., Showing the Open Hearth Plant, the Rolling Mills and Settlement of Steel Workers

The Manufacture of Boiler Plates

By George A. Richardson*

In order to uphold the high standard required for plates entering into the fabrication of boilers and pressure vessels, the steel mill must maintain the most rigid supervision of materials from the ore pile to the finished plate. In this article a general outline is given of plate production, the machinery used in the various stages of manufacture, the procedure followed in the various shop inspections and the defects for which plates are rejected.

PLATES used in the construction of boilers, locomotive fireboxes and similar work are manufactured to withstand the most severe stresses in service. The production of firebox and flange steel is covered by rigid specifications and requires a plant which has been designed for and specializes in this class of work.

Material of this character calls for expert supervision and an unusual degree of care in every stage of manufacture. Not only this, but there must be rigid inspection and rejection without fear or favor of material that is defective. In no other way can high standards be maintained.

*Midvale Steel & Ordnance Company.

Procedure Followed in a Modern Steel Plant

The first step in the process of manufacturing plates is the production of the pig iron from which the steel is made. For the purpose of demonstrating the processes through which the materials pass, the Coatesville, Pa., plant and equipment

General View of Blast Furnaces and Stock Yard, Showing Method of Handling Materials of the Midvale Steel & Ordnance Company are used as a basis for the descriptions which follow.

In the blast furnace department, every facility is provided to make it complete and capable of turning out large quantities of metal economically and efficiently. The equipment of the plant includes modern ore bridges, a stock house, two 450-ton and one 600-ton blast furnace, a number of gas blower engines, two double strand Heyl and Patterson pig casting machines, a ladle house for ladle cleaning and lining and a 10-ton gantry crane in the stock yard.

The gas blowing engines are of interest because they make for economy in operation by effecting a saving in steam, through the utilization of the waste gases from the blast furnaces. These engines are of large size, each weighing 750 tons and normally developing about 2,100 horsepower though 3,000 horsepower per engine can be attained.

Under normal conditions the general practice at the plant, used to illustrate the processes in this article, is to convey the molten metal direct from the blast furnaces to the open hearth department, where a 400-ton mixer takes care of it until ready to be charged. A certain amount of pig iron is poured into molds on the casting machine for the trade and any surplus is stocked.

Blast Furnace Operation

The most important points to stress in describing the blast furnace operating practice, with reference to the character of the iron that will ultimately find its way into plates, are as follows:

(1) Very low sulphur content iron is produced. The specifications for flange and firebox plates call for less than 0.04 and sometimes 0.035 or 0.030 in sulphur. As far as possible, the sulphur is eliminated before reaching the open hearth and this results in the production of pig iron that contains less sulphur than the standard basic pig.

(2) Equally as important as obtaining a low sulphur content is the practice at this plant of producing an iron that runs much higher in manganese than is usual. The manganese content runs up to 2 percent, whereas the usual iron made from lake ores runs about 1 percent. The purpose of this manganese is two-fold. It is a very distinct aid in desulphurizing and has the additional quality of acting as a general cleanser of the metal in the open hearth furnace.

A large part of the ores used in these furnaces comes from the company's own mines. Outside ores are also bought and mixed in order to get the results aimed at.

Conversion of Iron to Steel in Open Hearth Furnace

The next step in manufacture is the conversion of the iron into steel. The blast furnace department plays an important part in making the special grades of iron required and what is equally as essential, maintaining them uniform and of the highest possible quality. The final responsibility, however, lies to a large extent with the open hearth department, for most of the troubles experienced in rolling plates are due to steel that is not up to standard in one way or another.

Ten 50-ton, eight 75-ton and six 35-ton basic furnaces comprise the melting equipment of the open hearth department. Eighteen of these are housed in one large building in which every facility in the way of modern equipment has been provided.

One of the most important requirements that must be met has already been mentioned, namely, that of producing a steel low in sulphur. While the use of high manganese pig iron is considered of prime importance and care is also taken to have the pig much lower in sulphur content than usual, the melting practice at the open hearth plays a very essential part in obtaining the final results. As an example of the character of the operating methods it can be stated that whereas the most exacting specifications for boiler and firebox plate allow a minimum of 0.03 sulphur, some of the heats at this plant are made with the sulphur down to less than 0.03.

Low phosphorus is always an aim and the final result, as far as the amount of this element present is concerned in the finished product, is in accord with the very best practice. Much of the lowering of the phosphorus content comes with the reduction of the sulphur content.

Composition of Open Hearth Charge

Care in making up the charge which is to be melted in the open hearth furnace is another one of the important factors in obtaining a finished product of the highest grade.

A large part of the scrap used is from the company's own plate mills, which is preferred because it is of known composition and runs uniform.

The pig iron used is of the company's own make, the composition of this being maintained by the character of the blast furnace practice plus careful inspection and test.

The limestone that is charged is bought by the company to a specification.

The careful selection and inspection of the material used in the charge is only a preliminary to the great care required in running open hearth heats. They must be well settled and in first class condition before pouring the ingots.

The time for making a heat is variable. Where hot metal is charged it will require 11 hours or less, the exact time depending on the character of the material charged and other factors.

At this plant experience has shown that ingots for boiler plate rolling and similar purposes, where the plates are rolled directly from the ingot, must be bottom poured and that is the practice followed. Top poured ingots have not proven satisfactory because of cracks and snakes which follow right through into the finished plates and necessitate their rejection.

Pouring the Ingots

The capacity of the ingot molds varies, the largest producing an ingot weighing 26,000 to 27,000 pounds. Molds are placed on the bottom plates in groups of four, eight or more according to size, each group being filled through one central pouring gate. Markers are placed in the molds and all of a size are filled to the same level in order to obtain ingots that will roll to a given size plate.

Ingots, after being stripped from the molds, are taken to the soaking pits where they are brought to the proper rolling temperature. To maintain the correct heat in the soaking pits, producer gas is used.

A chemical analysis, as well as the weights of the ingots, is furnished to the mill office prior to the rolling of the plates. If the material is not up to the requirements for the class of work intended, the ingot is rolled into material subject to some other specification. A plant working on material of varied specification has much more testing and analyzing to do than is the case in plants running largely on one class of work.

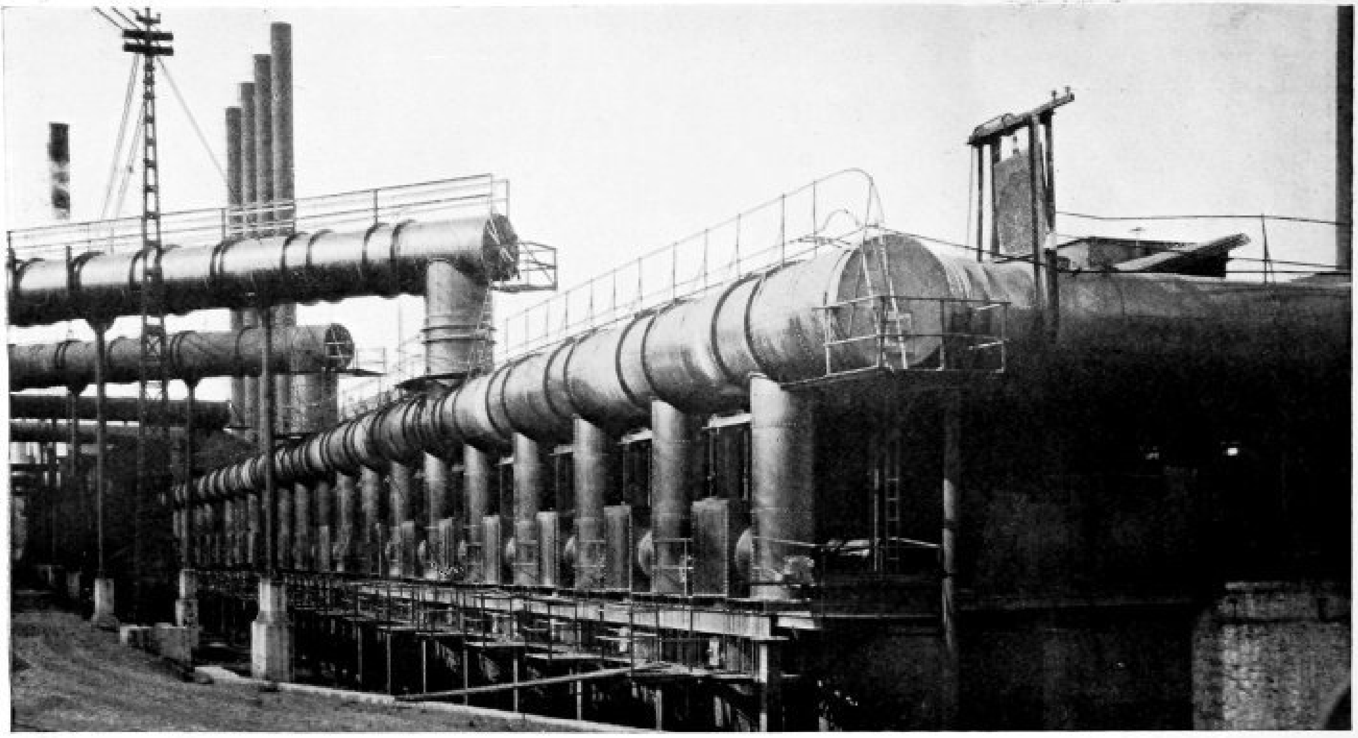
From the soaking pits the ingots go direct to the rolls and are rolled down into plates.

Rolling the Ingots into Plates

The first part of the operation consists in rolling the ingot lengthwise. Then it is turned and rolled crosswise to width. After the width has been obtained it is again rolled lengthwise to gage. Scale which forms in the course of the rolling is removed by the use of a steam blower, salt and water. Salt, thrown on the surface of the plate, produces a series of small explosions which loosens the scale. Scrapers are used for removing bad pieces of scale. The scale which is removed from the top of the plate and drops off the bottom goes down into a pit under the rolls where it accumulates quite rapidly and is lifted out by a conveyor.

After rolling to size, the plate passes onto the cooling tables

1. Blower House, Showing Four Engines Operating on Blast Furnace Gas, Developing 2,100 Horsepower Each. 2. Molds Ready for Bottom Pouring. 3. Fifteen-Thousand-Pound, 20-Inch by 49-Inch Ingots. 4. View of Some of the Soaking Pits. 5. Turn-over Machine Turning Plate for Inspection. 6. General View of Mill Showing Straightening Rolls, Mill Tables, etc., with Guillotine Shears in the Distance



Gas Producers Used to Supply Soaking Pits

and proceeds to the straightening rolls. Upon the completion of the straightening operation the plate passes onto a "turnover," which exposes the under side.

ADVANTAGE OF "TURNOVER" MACHINE

The "turnovers" require special mention. The advantage of using them is that an opportunity is given to examine both sides of the plate carefully.

There are two "turnovers." The first one, located just beyond the straightening rolls mentioned above, exposes the underside of the plate. As the plate travels along, after turning, the inspectors walk over it and inspect it. Then it comes to the second "turnover" which brings the top side up again. This in turn is inspected and then the necessary laying out and marking is done.

The inspection of the under side of the plate is a difficult proposition where "turnovers" are not used. It is necessary for the inspectors to get underneath and make their inspection with the aid of lights, a method at once awkward and not entirely satisfactory. As a result the inspection is not apt to be as thorough and in some cases is not made at all on the under side.

DEFECTS CAUSING REJECTION OF MATERIAL

Inspection of the plates at this stage may reveal one or more of the following defects:

(1) *Cold Pieces.* These consist of bits of scab or foreign material which have been rolled into the surface of the plate. They are very hard to see and sometimes are not found until the plate is thoroughly cooled and ready for shipment. In some cases these may be bits that have broken off the ragged edge of the piece itself while rolling.

(2) *Snakes.* These are caused by a crack in the ingot which is due to cooling strains or other causes. In any case, the crack runs out in a wavy line in the plate and hence the name. Cracks of this kind will not weld in the rolling operation. In the case of plates rolled to a cylindrical shape, the crack will usually open up but in ship plates it does not always show.

(3) *Cinder Pits.* These are usually caused by cinder rolled into the plate, but may include other defects. When tapped with a hammer the material loosens and crumbles. Scale or bits of dirt on the surface of the ingot are among the causes of cinder pits.

(4) *Surface Scab.* This is caused by a splash in the pouring of the ingot.

The foregoing list contains the principal defects that are encountered until the plate is shipped. Their seriousness all depends on their depth and size as well as the purpose for which the plate in question is intended. Firebox steel should be more free from defects than any other grade.

The inspection practice of the plant under discussion is very rigid and it is practically impossible for defective material to get out. All plates are rejected for snakes. In some cases the good part can be cut out and applied on items of smaller size. Plates are also rejected for any other injurious defects.

STAMPING THE FINISHED PLATES

After the mill table inspection:

(1) The heat number, quality and maker's name are stamped on the plate. Oftentimes a customer's serial number is also stamped. This latter holds true only in the case of boiler and firebox steel.

(2) The manufacturer's order number, customer's order number, any identification marks that are called for, gage, size and the like are painted on. Then the plate is laid out for shearing. The test piece is also laid out and carries the same stampings as the plate.

When the laying out has been completed, the plate is ready for the shears. The first set of shears cuts the plate into sections and also cuts the test piece out at the same time. The smaller pieces and scrap ends go to another set of shears while the larger or heavier pieces go to a third set. Rotary shears for cutting small circular plates are also provided. These shears are used for circular heads and the like.

After shearing, the plate is ready to be weighed. Following this comes another inspection on all four edges for evidence of laminations and other defects that might escape the floor inspector. The plate is also measured to check it up for size, recorded, placed on a pile on the loading bank and is ready for shipment.

Procedure Followed in Inspection Department

All plates are held on the loading bank by the inspection department until test results have been obtained. Immediately upon being sheared, the test pieces go to the testing laboratory and are subjected to the tests specified for the given material. Absolutely no plate is shipped unless it meets all inspection requirements, both chemical and physical and here again the practice of the plant under discussion is very rigid.

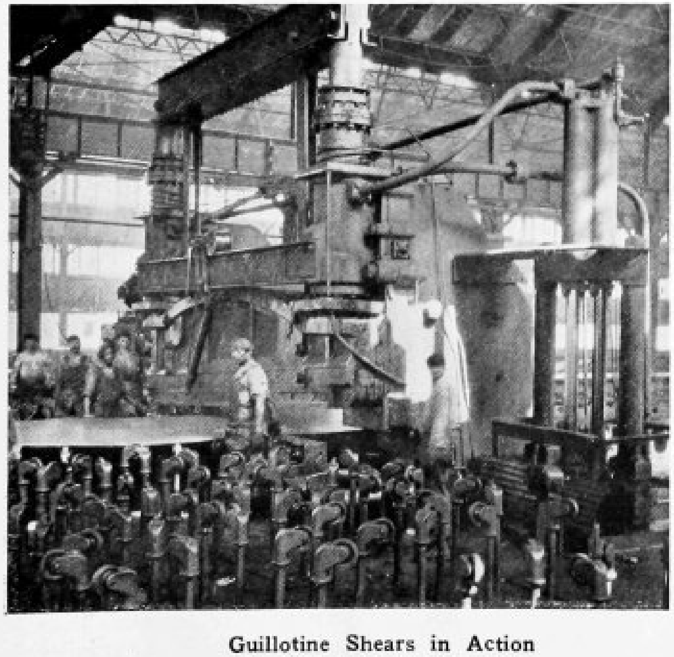
The majority of plates are subject to an outside inspection as well as a mill inspection before they can be released for shipment. All locomotive boiler steel has a second inspection by the plant's own or an outside inspector while it is being loaded.

Capacity of Mill

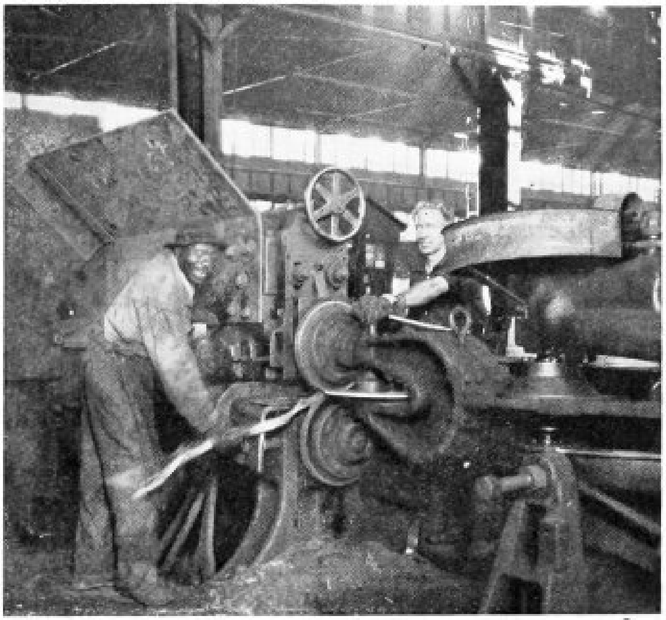
Plates up to about 140 inches in width and 2 inches in thickness can be rolled on the largest of the plate mills which comprise the equipment of the plant described. The rolls of the largest mill are 152 inches long. Plate shears with knives 15 feet 1½ inches long and heavy enough to cut plate 2 inches thick are included in the shearing equipment.

To a large extent the success of a plate mill depends, as has been mentioned, on the character of its open hearth practice. To obtain ingots which will roll into plates of the highest grade depends almost entirely on the care used in running the heats. Ample time must be allowed and speeding up is absolutely out of the question. From the description which has been given a very good idea may be gained of the care required at every step in the manufacturing processes. Every aid is provided for doing the work efficiently and economically. Well equipped chemical and physical laboratories take care of the testing end of the work. Not only this but, and this is a very important point which will bear repeating, rigid inspection at all stages is insisted upon and material is rejected without fear or favor. Only by following this practice can a high quality of material be consistently maintained.

Particular emphasis should be laid on the system in use at the plant described, by which the inspection department is placed under the charge of the testing department instead of the manufacturing department, as is often the case. This has a great deal to do with improving the quality of the material because there is less incentive to allow anything that is questionable to pass through.



Guillotine Shears in Action



Shearing Small Circular Heads with Rotary Shears

Slight Possibility of Defects Developing in Service

Careful manufacturing methods and inspection such as this result in a product that can seldom develop defects after leaving the mill though any user or manufacturer realizes that occasionally, despite the utmost precaution, it is possible for a piece of material to develop defects upon fabrication.

Many difficulties that arise between the manufacturer and consumer, however, are the result of misunderstandings in regard to usual practice and also lack of information. In coming to a conclusion, therefore, the writer wants to bring out this fact and give an idea of how they occur. It is to the advantage of user and maker alike to eliminate every possible source of difficulty.

Specifications Should be Carefully Prepared

For instance in the case of the plant in question, there is frequently a misconception as to what the plant can handle. A good example of this lies in the method of shearing plates. Plates at this place are always sheared full to size to allow for planing, beveling and finishing. The plant is not equipped with squaring shears. Shearing tolerances vary with the different plants, and this fact should always be taken into consideration. Some customers expect sheet mill service on certain products, but as a plant of this kind is a plate mill it is not in a position to render it. Such things as annealing furnaces do not comprise part of the equipment.

All orders are watched very closely by both the order and testing departments and none are submitted to the mill unless it is felt that the material can be made satisfactorily. Despite this care, however, trouble can arise through lack of information. The information given in placing an order should be complete and the use, for which the customer desires the material should always be specified. For instance if an order merely specifies tank plates and does not state that they must weld satisfactorily, ordinary tank plates which would not meet the requirements would be furnished and with good reason. Any trouble experienced would be due to the customer's fault in not giving complete information. Another example is in the case of plates that are desired for die work. Plates for this purpose must be absolutely flat, a condition which would not be met by plates as ordinarily furnished.

It is to be hoped that these few remarks and examples will emphasize the necessity of giving every bit of information possible on all orders. In no other way can absolute satisfaction be given by the plate manufacturer.

Progress of Boiler Regulation in Pennsylvania

Methods of Increasing Uniformity of Inspections Discussed at Special Session of Industrial Relations Conference

AT the industrial relations conference held by the Department of Labor and Industry of Pennsylvania in Harrisburg, in October, one session of the meeting was devoted to a discussion of the progress made by the department in the regulation of boilers in the state. The organization and growth of the department were discussed and plans for a closer union of all inspectors outlined.

Dr. Clifford B. Connelley, commissioner of the Department of Labor and Industry, opened the session by telling of the purpose of the meeting which he declared was the first conference of boiler men in the state.

Below is given an abstract of his address as well as of other papers that were read at the meeting:

Purpose of Boiler Progress Session

THERE are 636 approved boiler inspectors in the commonwealth of Pennsylvania, 431 are directly connected with insurance and casualty companies, 54 are unattached to any company engaged in boiler work and four are in the state service solely. Each inspector, by virtue of the commission of competency he holds, represents the commonwealth of Pennsylvania in so far as his duties are defined in the state boiler code. A closer working plan should be effected between these men and the Department of Labor and Industry, which is responsible for the administration and enforcement of the boiler code.

There is no line of safety work that requires so much real knowledge of the "job" as boiler inspection and cooperation will give us all a better idea of our work.

In the past the Department of Labor and Industry has often been called upon to interpret its own code and has had to resort to the roundabout, but very excellent and efficient service of the boiler code committee of the American Society of Mechanical Engineers. During the past year, however, we have appointed a boiler board of examiners, which because of its efficient personnel has also functioned as as interpretation committee of the boiler code. This board has recommended several very important measures towards the betterment of boiler enforcement and inspection in Pennsylvania, that have made and kept Pennsylvania a leader in this work.

Another reason for a better organization of our work through more intimate cooperation is because of the overlapping of inspection territories. The lack of uniformity in inspection charges where the inspection is done by other than the insurance inspectors and the unattached or the state inspector, causes dissatisfaction among owners of boilers who object to overcharging and duplication of inspections. The basis of a better understanding is in pooling our interests in a more or less permanent organization that will include all the boiler inspectors of the commonwealth, and which shall have the advantage of such an advisory committee as our Pennsylvania board of boiler examiners.

Inspection Work in Pennsylvania

By William P. Eales*

WHEN the Department of Labor and Industry was created by act of the legislature in 1913 the subject of boiler safety seriously concerned only one or two cities and but one county in Pennsylvania. Its predecessor, the old Department of Factory Inspection, required that all boilers used for steam or heat in any establishment be inspected annually and be provided with a safety valve and steam and water gages. Further than these modest requirements, there was nothing specific. A boiler was not clearly defined. It could be any kind of a receptacle, built in any fashion, of any material that would withstand the harm inflicted upon it during construction. When once installed, it could be operated at any pressure required to do the work imposed on it in accordance with the individual judgment of the inspector or of the owner or user of it. Experience indicates, however, that fairly good judgment was used because serious boiler catastrophes were infrequent in comparison with the experience of other states. It was the performance of boilers elsewhere that indirectly caused more stringent measures in this state.

Power Boilers in Pennsylvania

Pennsylvania leads other states in the number of power boilers in use. No reliable count has ever been made and there are no authentic figures as to the actual number of power boilers, but on the basis of total boiler insurance premium written in all states we can determine that one eighth of it is produced in Pennsylvania and I think this fairly establishes that one eighth of the number of boilers in the United States is located here. Pennsylvania also leads in the number of boilers manufactured.

It was natural, therefore, that one of the first features in the safety program undertaken by the department and the industrial board was the regulation of steam boilers. At the first committee meeting called to consider the subject, it was decided in the interest of uniformity to await the promulgation of the boiler code of the American Society of Mechanical Engineers, which had been in preparation for some time. When copies of the original American Society of Mechanical Engineers' boiler code were sent to us for consideration, some two years later, it was decided to adopt the code verbatim for new construction as well as for existing boilers.

The code established that boilers intended for the generation of steam shall be constructed of suitable material, of proper quality and strength, that the design shall be in accordance with modern practices and that the workmanship is good.

It contemplates not only the prevention of explosions and failures of boilers while in operation, but economy in construction and efficient performance, proper circulation, durability, the avoidance of frequent repairs and ease and accessibility in making them when necessary.

In order to be sure that these requirements were properly observed, it became necessary to qualify men for the work of inspecting boilers during construction as well as in actual operation. About two hundred men were examined at the beginning, but twenty-five percent of them were unable to qualify by reason of not having an intimate knowledge of steam boilers, or of insufficient experience, or on account of unfamiliarity with the code. All examinations were written and all papers were retained as a matter of record. This procedure has been followed at quarterly intervals ever since. At this time more than 500 inspectors have received authorization to inspect boilers and submit reports on them in the state.

The boiler code has now been effective for more than 5 years. It has been adopted by cities which are privileged

*The Travelers Insurance Company, and also chairman of the Pennsylvania Board of Examiners for the Department of Labor and Industry.

by the legislature to make and enforce local ordinances as well as by the public service commission.

On account of changing conditions that cannot be foreseen as well as the various uses and purposes for which steam is being utilized in industry it has been found prudent and necessary to make minor revisions. These changes and rulings generally affect repairs, appliances and attachments to boilers and to miniature boilers, all of which subjects are not brought out clearly in the code.

Appeals and petitions pertaining to construction are infrequent. Existing installations are being improved to meet the requirements. An extension of time has been granted to the owners and users of certain boilers of doubtful construction. The most complexity is in connection with used or second hand non-standard boilers, generally of the portable type. It would be expedient and desirable at this time to take a census of these boilers located in the state. They should be clearly marked or numbered for future identification so that some time hence there will be no question regarding the eligibility of such boilers.

The boiler code could with propriety be extended to include unfired pressure vessels such as pulp digesters, rubber vulcanizers, autoclaves used in the manufacture of chemicals, rendering tanks, economizers and all similar vessels containing steam, air and ammonia at pressures exceeding 50 pounds.

Some of these vessels equal or exceed steam boilers in size and working pressure and invite a greater catastrophe hazard.

Boiler safety is not dependent entirely on the strength of boilers, their excellence in construction or their condition. It is influenced very materially by the intelligence and wisdom exercised in the care and operation of them and until some authoritative measures are taken in this respect the safe performance of steam boilers through the state cannot equal that of its cities having ordinances that require proper qualifications for the boiler plant operatives.

The National Board of Boiler Inspectors

By C. O. Myers*

THE American Society of Mechanical Engineers a few years ago appointed a committee to formulate rules and regulations for boiler construction. When this was done, the next step was to have the various states adopt these rules and regulations so the American Uniform Boiler Law Society was created. This society has been successful in having the boiler code accepted in all the states having boiler laws, except that of Massachusetts. When the code is adopted by a state, however, its work does not end, as a law cannot be uniform, even though it is adopted in the same form in the separate states, if the boiler boards of the states interpret it differently.

The committee several years ago discovered that the uniformity which it was earnestly striving to bring about was being seriously affected by a diversity in the decisions of the state boards upon the same provision of the code. This condition has brought about the organization of the states for uniform enforcement into a separate body which is known as the National Board of Boiler and Pressure Vessel Inspectors.

Many requests are made to the code committee to approve specific designs of boilers and appurtenances not covered by the code, which they are not in a position to take action upon. Therefore, when such cases are submitted to this committee, they are forwarded to a committee on "specific designs and appurtenances" of the National Board. This committee determines whether the device is one upon which uniformity should be attempted and makes such recommendations as it deems advisable. If the committee reports favorably, the case is then referred to the members for their consideration and ninety percent affirmative vote is required to obtain final approval. When this approval is given, the device may be used in all of the states which are members of this Board.

*Chief Inspector of Ohio and secretary of the National Board of Boiler and Pressure Vessel Inspectors.

Uniform Stamping of Boilers

The approved stamping of the National Board is a combination embodying all the information required by former systems of stamping. First, the American Society of Mechanical Engineers' symbol is required, showing that the boiler is built in accordance with the American Society of Mechanical Engineers' code. The stamp is also placed upon the boiler in the presence of an inspector holding a National Board commission. The words National Board, a serial number and the manufacturer's name are also required. A report upon a boiler stamped in this manner is then filed with the secretary-treasurer of the Board in duplicate.

When the destination of a boiler is known the builder may file a copy of the report with the state department, or it will be the duty of the secretary-treasurer to furnish the state with such data. In this way we will always have a record of the boiler no matter where it goes or where it comes from.

Boiler Inspection Law Requirements

There are two conditions which enter into the administration of a boiler inspection law; one applying to existing installation, or field inspection and the other applying to the construction, or shop inspection. There is no immediate demand for uniformity in the enforcement of rules pertaining to existing installations and the enforcement of such rules must be governed greatly by local conditions. In the second case, however, there is a great demand for uniformity and it is necessary in this case that the states accept the inspections of other districts. To secure as near as possible standard qualifications for such inspectors, the National Board has appointed a committee to formulate questions and answers for the use of its members and an applicant passing this examination is entitled to a commission from the National Board, which is recognized by all the members.

This commission is active only when the holder thereof is employed by any political subdivision of the United States or by any insurance company authorized to insure boilers by any such political subdivision. The Board is now issuing commissions to persons holding certificates of competency obtained by taking a written examination. This is being done so that the present inspectors will not have to be reexamined. We are, however, protecting the members of the Board in such cases by requesting that the applicant have his application approved by the official in charge of the state where the examination was taken.

At this time we have one hundred and ten inspectors commissioned and thirty boiler concerns have been authorized to stamp boilers in accordance with the by-laws of the National Board and there are eleven states out of seventeen who have officially accepted the approved stamping. We would like to have the state of Pennsylvania take this matter under consideration in view of cooperation in securing the objects set forth in the preamble, constitution and by-laws of the National Board.

A hearing on a code for "miniature" boilers was held in conjunction with the annual meeting of the American Society of Mechanical Engineers, December 6. The work on this code was undertaken about two years ago, but up to within a few months little progress had been made in its formulation. C. W. Obert, secretary of the Boiler Code Committee requests that all interested in the subject send in comments on the matter to him at 29 West 39th Street, New York City.

Principles of Riveted Joint Design—VI

Effect of Calking and Rivet Shrinkage on Tightness of Joints and Driving Pressure of Rivets

By William C. Strott*

As the maximum pitch of rivets is practically the determining factor in designing any joint, this pitch must first be decided upon. It would seem a simple matter to assume any convenient pitch, and if, after calculating, it gave the required efficiency, to adopt that pitch. This is not always so in practice, for the pitch of the rivets on the calking edges must be considered. If this calking pitch, as it is commonly called, is made too great, it becomes difficult to maintain a tight seam. Fig. 36 illustrates (considerably exaggerated) how leakage takes place along the edges of any seam. The plate between the rivets on the calked edges may be considered as a beam of length "X" fastened at each end, and uniformly loaded with the internal pressure. If "X" be too great for a given load, the imaginary beam will deflect sufficiently to cause leakage.

The purpose of calking, as probably very few practical boiler makers realize, is to prevent this deflection by forcing some of the metal of the calking edge of the plate between the upper and lower laps. Driving the metal between the two plates slightly raises the upper edge, thus creating a reaction in the plate, which effectively resists the lifting force of the steam. Section B-B of Fig. 36 clearly illustrates this theory. No amount of calking will render tight a joint having the rivets spaced too far apart at the calking edge. If the distance "X" is too great, then during the calking process, the boiler maker keeps on crowding metal under the lap, until the edge takes a form similar to the dotted curve shown in the plan view of the illustration.

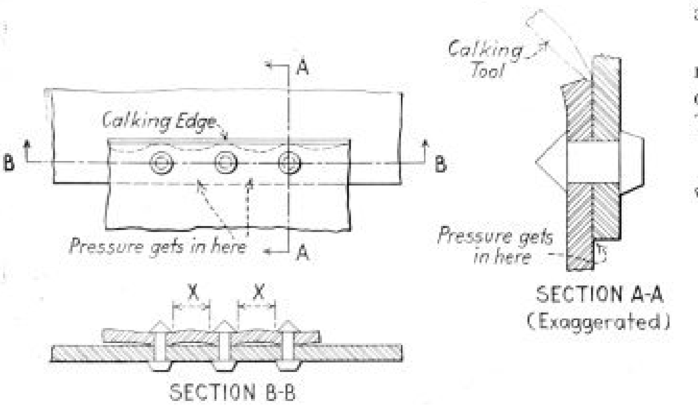


Fig. 36.—Demonstrating Effect of Calking on Joint Tightness

From the foregoing, there appears to be an upper limit for this pitch, but, on the other hand, if the rivets are pitched too closely, the net plate section may be so reduced as to result in a weak joint. Furthermore, the rivet heads might come so close together as to interfere with proper driving.

Joint Tightness Increased by Rivet Shrinkage

Rivets in cooling contract longtitudinally and draw the plates together with considerable pressure. They might also be expected to contract laterally and thus not exactly fill their holes when cold. Before crushing or shearing can take place, though, it is obviously necessary that the overlapping plates shall slip on each other until the plates and rivets are in contact. Such slipping is, however, resisted by the friction of the surfaces in contact. It has been variously estimated that this frictional resistance ranges from 14,000 to 30,000 pounds per square inch of rivet cross sectional area at each pair of surfaces in contact. As any appreciable slip of a boiler joint will result in leakage, it is the practice of some engineers to design joints on this basis. In other words,

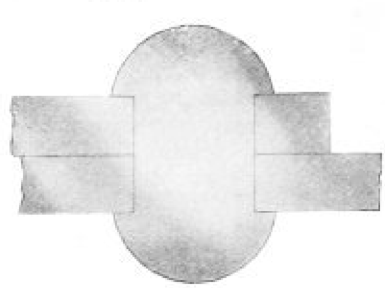


Fig. 37.—Rivet Driven by Heavy Hydraulic Riveter

instead of determining the rivet diameter with regard to shearing strength, they aim at the frictional resistance of the plates as the deciding factor.

There appears, however, no logical reason for such practice, as excessively large rivet holes are required, which greatly weaken the net plate sections and results generally in an unbalanced design.

It is a well established fact that the pressure under which rivets are driven has an important bearing on the tightness of the joint against leakage and also on its actual strength. This is apparent when we consider the pressures under which

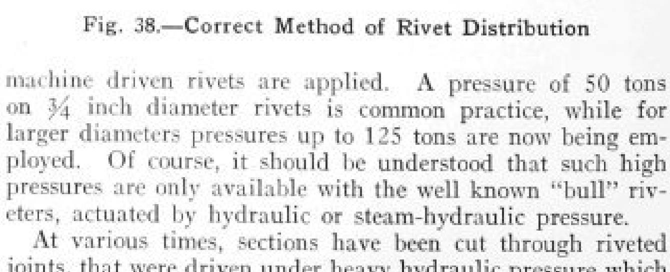


Fig. 38.—Correct Method of Rivet Distribution

machine driven rivets are applied. A pressure of 50 tons on ¾ inch diameter rivets is common practice, while for larger diameters pressures up to 125 tons are now being employed. Of course, it should be understood that such high pressures are only available with the well known "bull" riveters, actuated by hydraulic or steam-hydraulic pressure.

At various times, sections have been cut through riveted joints, that were driven under heavy hydraulic pressure which barely show a line of demarcation between the overlapping plates, or between the edges of the plates and the rivets. The illustration,* Fig. 37, is from an actual photograph of a joint sectioned for this purpose.

*Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

*Courtesy of American Bolt Company, Pittsburgh, Pa.

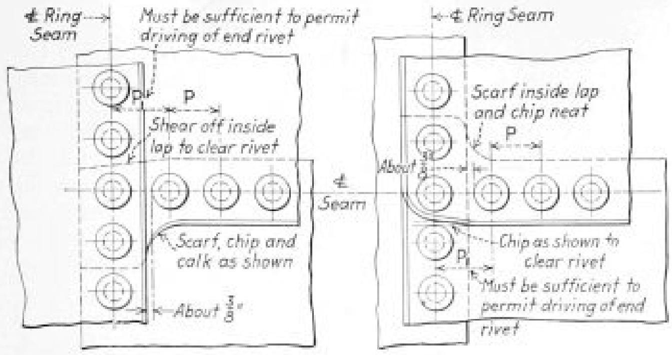


Fig. 39 (a) and (b).—Inside and Outside Seam, End Construction for Single Riveted Lap Joint

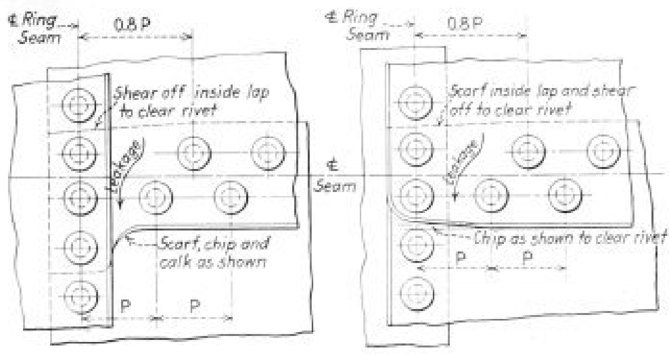


Fig. 40 (a) and (b).—Inside and Outside Seam Construction for Double Riveted Lap Joint

DETERMINING MAXIMUM CALKING PITCH

The maximum calking pitch is largely a factor of rivet diameter as well as plate thickness and the diameter of the rivets is in turn dependent on the plate thickness. Rivets must never be smaller in diameter than the thickness of the plate; if so, the punches will be liable to break. In a practical joint it will be found that the rivets must be somewhat larger than this proportion in order to obtain the required shearing and crushing strengths. The least diameter of rivets that should be used with any given plate thickness is found by the following empirical formula:

$$d = 1.2 \sqrt{t}$$

In which:

d = Diameter of rivet in inches.
t = Thickness of plate in inches.

No hard and fast rules can be laid down for maximum and minimum values of calking pitches. There are a number of empirical formulae in use although they vary widely in results. Some authorities have claimed that a tight seam is possible with calking pitches up to 8 times the thickness of the calked plate. For practical purposes, this gives altogether too high a value.

Table 3 gives the usual pitch and diameter of rivets for various plate thicknesses as adopted by some of the best establishments in the United States. It should be borne in mind that the pitches here given cannot always be adhered to exactly and a fraction of an inch either way can do no harm as far as producing a tight seam is concerned. The table, however, gives us something on which to base our trial calculations.

To facilitate matters for the layerout, the calking pitches should be equally spaced from the center line of one girth seam to the center line of the next; in other words, this dimension should be exactly divisible by the calking pitch. If it is not, then we must use the nearest value to this pitch which will give the result desired.

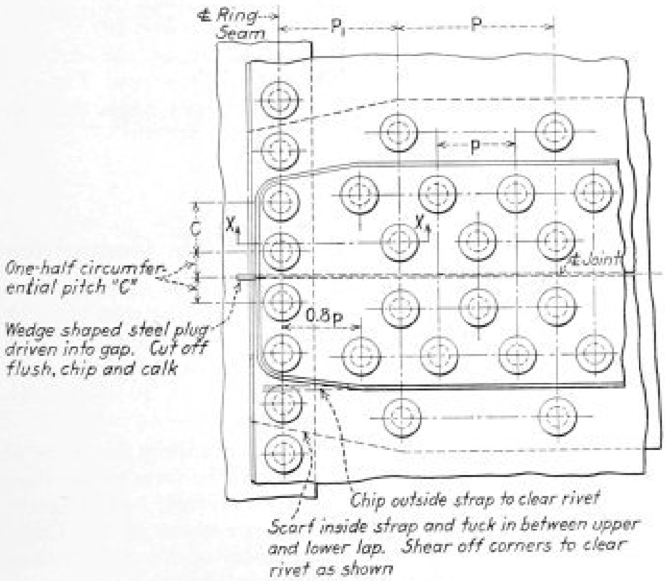


Fig. 41 (a).—Outside Seam Construction of Double Butt Strap Joint

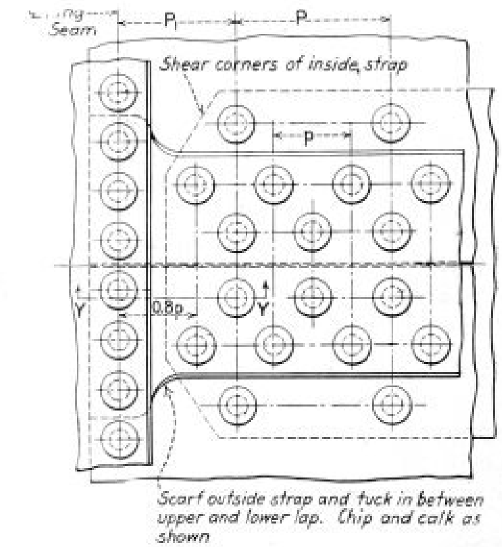


Fig. 41 (b).—Inside Seam Construction of Double Butt Strap Joint

TABLE 3.—PRACTICAL DATA FOR RIVETING

Thickness of plate, inches	1/4	5/16	3/8	7/16	1/2	9/16	5/8
Diameter of rivets, inches	5/8	11/16	3/4	13/16	7/8	15/16	1
Diameter of rivet holes, inches	11/16	3/4	13/16	7/8	15/16	1	1 1/16
Pitch, single or chain riveting	2	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8
Pitch, double or staggered riveting	3	3 1/8	3 1/4	3 3/8	3 1/2	3 9/16	3 5/8

NOTE.—For intermediate plate thickness use the proportions given for the next larger tabulated values. For plates heavier than given in the table, add 1/16 inch to the rivet diameter and pitch for every 1/16 inch increase in plate thickness.

As will be seen from Fig. 38, the number of spaces on the calking edge should be odd, as 27, 29, 31, etc. By so doing, it is possible to secure a symmetrical arrangement at each end of the joint.

Although we illustrate a quadruple riveted joint, the same condition prevails regardless of the number of rows of rivets as the student may prove by laying out different types of joints.

It is believed that Table 4 will be of value as a time saver when laying out riveted joints.

It should have been noticed from Fig. 38, and also from Table 4, that the end pitch P_1 is always somewhat less than

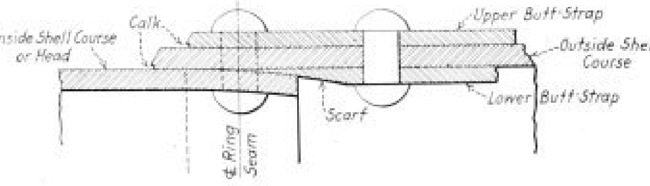


Fig. 42.—Section of Joint Fig. 39 (a) Along Line "X-X" (Outside Seam)

the maximum pitch P. Since the plate ligaments at the end of a joint are less than at the main section, the joint

TABLE 4.—RIVETING ARRANGEMENT FOR LAYING OUT BUTT STRAPPED JOINTS

Number of Calking Pitches Between Center Lines of Circumferential Seams	Maximum Number of Full Unit Lengths in Joint: For Double or Triple Riveting	Quadruple Riveting	Quintuple Riveting	Number of Calking Pitches Required at Each End of Seam: Double or Triple Riveting	Quadruple Riveting	Quintuple Riveting
5	1	..	..	1½	...	...
7	2	..	..	1½	...	...
9	3	..	..	1½	...	...
11	4	1	..	1½	3½	...
13	5	..	..	1½	...	...
15	6	2	..	1½	3½	...
17	7	..	..	1½	3½	...
19	8	3	..	1½	3½	...
21	9	..	..	1½	...	...
23	10	4	1	1½	3½	7½
25	11	..	..	1½	...	...
27	12	5	..	1½	3½	...
29	13	..	..	1½	...	...
31	14	6	2	1½	3½	7½
33	15	..	..	1½	...	...
35	16	7	..	1½	3½	...
37	17	..	..	1½	...	...
39	18	8	3	1½	3½	7½
41	19	..	..	1½	...	...
43	20	9	..	1½	3½	...
45	21	..	..	1½	...	...
47	22	10	4	1½	3½	7½

Note.—The spacing of lap joints, i. e., whether an odd or even number is immaterial.

is theoretically weaker at the ends, and for this reason some boiler makers claim that the strength of the joint should be calculated at these points instead of basing the efficiency

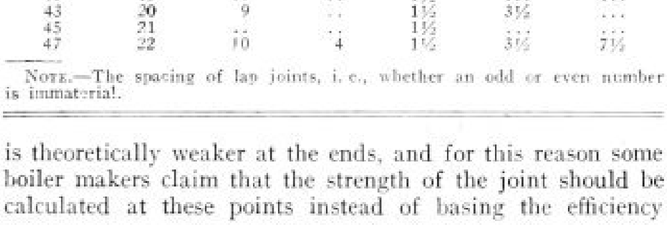


Fig. 43.—Section of Joint Fig. 39 (b) Along "Y-Y" (Inside Seam)

on the unit lengths. It is quite true that a joint proves by caculation to be actually weaker at the ends than at the main sections, and the efficiency may amount to as much as 10 percent less. In practice however, this discrepancy is disregarded because at the ends of a joint, which always come at the girth seams, the stress is a minimum due to the rigidity of the girth seam and the several thicknesses of overlapping plates.

End Construction of Riveted Joints

Fig. 39, (a) and (b), is self-explanatory. The details referred to are frequently overlooked in the drafting room and cause trouble and annoyance for the layerout if not taken care of on the shop drawings. The end pitch, where the longitudinal seam merges with the ring seam, must when necessary be made greater than the calking pitch, owing to the proximity of the end rivet to the girth seam.

For all cases of staggered riveting similar to Fig. 40, (a) and (b), the rivets along the calking edge may be equally spaced from center to center of the girth seams. This is so because, the calking pitches being greater, there is no liability of interference between the circular lap and the end rivet. It should be noticed that the distance from the center line of the ring seam to the center of the inner row of rivets, if located midway between two outer rivets as shown, would be excessive and very likely permit leakage to occur in the manner indicated by arrows on the illustrations. Owing to its proximity to the girth seam, it is not possible to locate an extra rivet in this space, but instead, the pitch of this end rivet is decreased to 0.8 of the calking pitch, which reduction will not seriously impair the plate efficiency of the joint.

When longitudinal joints of the double butt-strapped type are located on shells so that the center line of the seam comes midway between two rivets in the girth seam, they are constructed as illustrated in Fig. 41 (a) and (b). Notice particularly the wedge-shaped plug driven into the gap where the edges of the shell plate come together. This opening may also be closed by careful use of the electric arc or oxy-acetylene torch, although the author has seen steel plugs driven and calked so perfectly that the edge of the shell had the appearance of a continuous plate.

To further illustrate the manner of fitting the ends of double butt-strapped joints into the girth seams, Fig. 42 and 43 are given herewith, showing sections taken through the girth seams in Fig. 41 (a) and (b).

(To be continued)

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer.

Below are given the interpretations of the Committee in Cases Nos. 357 to 363 inclusive, as formulated and approved by the Council.

Case No. 357. *Inquiry:* Are the circulating pipes connecting down-draft furnaces to the shells of boilers to be considered as integral parts of the boilers themselves or as connecting piping outside of the boiler? Screwed connections as now used give both economy in space and flexibility.

Reply: It is the opinion of the Committee that such connections between boiler shells and down-draft furnaces are integral parts of the boiler, so that the requirements in paragraph 268 for pipe openings leading from a boiler need not be met, and screwed connections may be used. The requirement for the minimum number of threads given in Table 8 applies to all pipe connections and should be met, as well as all other requirements which bear on the structure.

Case No. 358. *Inquiry:* Is it permissible, under the requirements of the Boiler Code, to deliver feedwater into the shell of a boiler through what is known as an induction valve or spray nozzle located in the steam space and arranged to deliver the water through a number of constricted openings in the form of a spray?

Reply: It is the opinion of the Committee that such an arrangement at the end of the feed pipe for delivery of the feedwater to the boiler will not meet the requirement of paragraph 314, which requires that the feed pipe shall have an open end or ends to prevent stoppage by incrustation, unless the combined area of the passageways for the flow of water is at least equal to the area of the feed pipe and these passageways are so arranged that it will be impossible for them to become clogged by incrustation.

CASE NO. 359. *Inquiry:* Is it permissible, under the requirements of the Boiler Code, with heads stayed by through rods, to attach the rod ends to the heads by a special form of gland nuts that provide for packing between them, as shown in Fig. 1?

Reply: It is the opinion of the Boiler Code Committee that this construction does not conflict with the requirements of the Boiler Code, provided that the area of the nut bearing surface against the plate is greater than the minimum cross-sectional area of the rod. The value of C for this construction shall be 135.

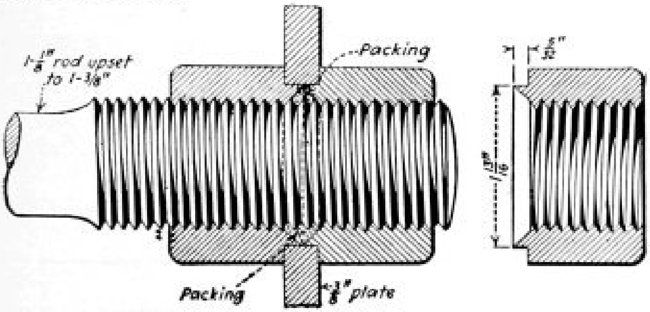


Fig. 1, Case 359.—Special Form of Gland Nuts for Ends of Through Rods

CASE NO. 360. *Inquiry:* Is it necessary, under paragraph 254, to remove heads, open up girth seams and remove manhole frames, braces, etc., in order to remove burrs formed by drilling or reaming of rivet holes?

Reply: Paragraph 254 refers specifically to the plates and butt straps at longitudinal joints.

CASE NO. 361. (Annulled.)

CASE NO. 362. *Inquiry:* (*a*) What is the minimum thickness of plates used for dome heads that is permitted under the requirements of the A.S.M.E. Boiler Code?

(*b*) Is it permissible to stay the heads of domes, where they are flat, by using angle or channel irons?

Reply: (*a*) There is no limit specified in the Code for the minimum thickness of dome heads except as given in paragraph 17.

(*b*) The heads of domes, if flat, shall be stayed in accordance with paragraphs 199 to 233 inclusive.

CASE NO. 363. *Inquiry:* Is it permissible, under the requirements of the Boiler Code, to apply a manhole in the upper head of an horizontal return tubular boiler over 40 inches in diameter, the area of the head surrounding the manhole to be stayed as provided in paragraphs 203*e*, 214 and others applying to stayed surfaces?

Reply: In accordance with paragraph 264, a manhole shall be placed in the upper part of the boiler shell, boiler head or dome head, of a fire-tube boiler over 40 inches in diameter. When applied to the head of such a boiler, the head shall be stayed in accordance with paragraph 203*e*.

FUSIBLE PLUGS IN VERTICAL BOILERS

CASE NO. 364. *Inquiry:* Is it necessary, as indicated in the index to the Boiler Code, to use an extra thick tube for the fusible plug when used with a vertical firetube boiler, in accordance with the requirements of paragraphs 429 and 430?

Reply: It is the opinion of the committee that inasmuch as paragraph 429 permits of the use of a 3/8 inch fusible plug, it would be desirable to insert it in a tube having a thickness of not less than 0.22 inch in order to allow insertion of at least four threads of the fusible plug.

CASE NO. 368. *Inquiry:* Is it permissible, under the requirements of paragraph 185 of the Boiler Code, to plane or mill down the plates forming the laps of circumferential joints to less than 1/2 inch thickness?

Reply: It is the opinion of the committee that there is no objection to planing down the laps of circumferential joints to a thickness less than 1/2 inch, provided, however, there is sufficient strength left in the joint to conform with the requirements of paragraph 184.

CASE NO. 369. *Inquiry:* Is it necessary, under the requirement of paragraph 195 of the Boiler Code, to increase the thickness of a dished head 1/8 inch when a manhole is inserted and provided the manhole opening is reinforced?

Reply: It is the opinion of the committee that the requirement in paragraph 195 for increase of 1/8 inch in thickness is applicable in any case when a manhole is inserted in a dished head.

Boiler Welding Repairs in England

Classes of Boiler Defects Repaired by Welding That May Be Accepted by Insurance Inspectors

IN order to definitely outline the types of boiler repairs that may be made by autogenous welding, and the procedure to be followed in order that such repairs shall be acceptable to the authorities, the National Boiler and General Insurance Company, Ltd., of Manchester, England, recently issued instructions to all its inspectors covering the details of such work. Engine repairs as well as boiler defects are dealt with, but the following abstract of the instructions will be devoted to the latter only:

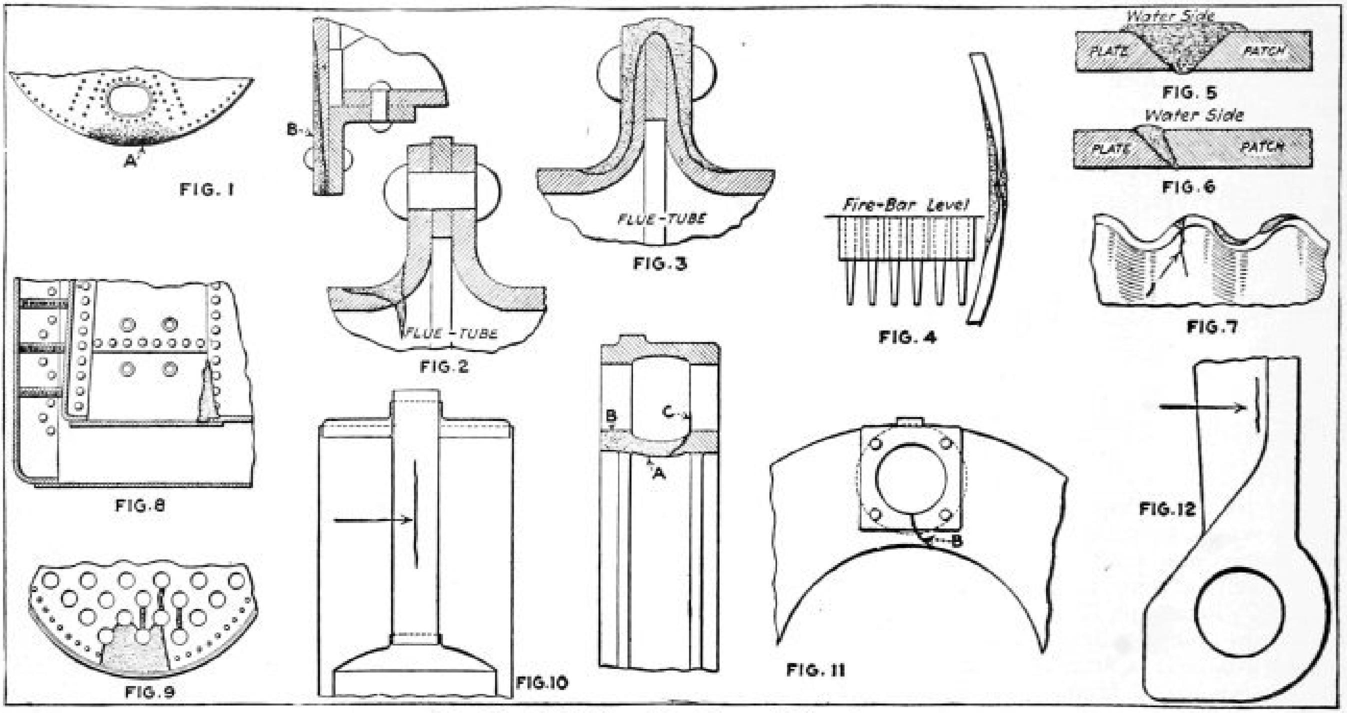
External Wasting of Lower Part of Front-End Plate—The lower part of the front-end plate of cylindrical boilers is often allowed to become badly wasted through contact with damp ashes and the wasting can be satisfactorily made good by welding. New metal is built up as indicated at *A* and *B*, Fig. 1, so as to restore the plate to its original thickness.

Grooving of Flat End Plates Over the Furnace Tubes—This class of defect, if not so extensive as to impair the safety of the boiler, may be repaired by filling in the grooving, but such proposals should be submitted for the chief engineer's consideration, as a repair by welding can be approved only in those cases where the grooving is confined to a few short lengths and where the end plate is not unduly stressed by insufficient breathing space being allowed in the design.

Broad Grooving in the Root of the Flanged Seams of Flue Tubes—Broad grooving of this nature, Fig. 2, extending for a length of 18 inches where the plate was fractured through for some distance, has been successfully repaired by cutting out the defect and building up again by electric welding.

Wasting of Flanged Seams of Flue Tubes—Fig. 3 indicates the manner in which wasted tube flanges have been built up and made good by welding. After sufficient metal has been added, the surface is dressed smooth by pneumatic chipping, and if the rivets have been removed new holes are drilled and the seam reriveted.

Wasting at Sides of Furnace Tubes—The first two rings of each furnace tube of a Lancashire boiler were found wasted on the fire side at each side of the bar level, as indicated in Fig. 4. It was decided to build up the wasted parts on the fire side by the oxyacetylene welding process. On completion of the process the boiler was hydraulically tested, but leakage occurred through the welded portion. On examining it on the water side, it was found that the plate had been drawn in, as indicated, during the operation of building up. Further repair was afterward effected by applying metal on the water side, and this made a satisfactory repair.



Details of Welding Repairs to Boiler Parts

Pitting in Furnace Tubes—It is often found that furnace tubes are pitted externally over considerable areas, and when the pitting has not reached too great a depth the plates may be built up again by welding. Sometimes this pitting occurs in the narrow space between the tubes where the defective part cannot be reached, and in such cases the plate has been satisfactorily built up by thickening on the fire side.

In other cases the defect has been cut out and a patch welded in, as indicated in Figs. 5 and 6. Proposals for welded patches, however, should be submitted to the chief engineer. Patches as shown in Fig. 5 are not recommended. Fig. 6 is a better arrangement, the patch being so formed that, even should the weld fail, the patch would not be blown out. Pitting and blotches of wasting on corrugated tubes may be filled in, also short fractures V'd out and made good, as shown in Fig. 7.

Wasting at Underlap or Overlap of Combustion Chamber of Marine Type or Cylindrical Dry-Back Boiler—In one case wasting at the bottom of furnace seam to combustion-chamber wrapper plate (Fig. 8) was built up by oxyacetylene welding. On completion all appeared satisfactory and the boiler was worked for a period of three months. On entering the combustion chamber it was found that the seam was again leaking, and on attempting to calk, the deposited metal broke off in layers quite freely. It was decided to remove this down to the original metal and afterward to build up the parts by electric welding; this was done and a successful repair made.

Fractures Between Tube Holes of Cylindrical Dry-Back Boilers—A satisfactory repair of these defects can usually be made by welding.

Fractures in Chimney Tubes of Vertical Boilers—Such fractures are difficult of access, and probably that is the reason why, in several instances, a repair that appeared to be quite satisfactory has failed and a new chimney tube had to be fitted after spending time and money on attempting a repair in position. Apart from the difficulty of access there would be no objection to repairing such a defect as the fracture shown in Fig. 10.

Wasting in Smokebox Tube Plate of Portable Multitubular Boiler—Wasting at the bottom of the smokebox tube plate of a portable multi-tubular locomotive boiler was built up by electric welding. When welding was being done three fractures occurred between tube holes in the vicinity of the weld, as shown in Fig. 9. These fractures were also welded up and the repairs appear to have been satisfactory.

Fractures in Cast-Iron Sectional Boilers—Fractures in cast-iron boilers may be repaired by welding, and if a satisfactory repair could be assured this method would possess several advantages over replacing sections. The two examples mentioned below are typical.

1. One of the sections was fractured as indicated at *A* in Fig. 11. As a new section was not obtainable, it was decided to attempt welding by the electric process. After three attempts the repair appeared to be satisfactory and stood for a time, but later it gave out, and it was finally decided to replace the boiler rather than go to further expense in welding experiments.

2. A short fracture, Fig. 12, occurred in one of the sections of a cast-iron hot-water circulating boiler. This was welded in position by the oxyacetylene process. The welding was apparently satisfactorily completed, but on cooling down, the section suddenly fractured with a sharp report close to the welded part, this being evidently due to contraction stresses,

(*Continued on page* 356)

Hearing on Code for Unfired Pressure Vessels

Air, Chemical and Refrigerating Tank Manufacturers Discuss Application of Autogenous Welding to Tank Work

A HEARING on the preliminary report of rules for the construction of unfired pressure vessels prepared by a sub-committee of the Boiler Code committee of the American Society of Mechanical Engineers was held December 5, in New York City. About seventy-five designers, manufacturers, and others interested in pressure tank work were present at the hearing and contributed to the discussion.

As stated in the foreword of the report, which is designated as Part I—Section IV of the Boiler Code, the hearing was held to obtain the cooperation of every one interested in the preparation of such a code, particularly in those parts dealing with welding and brazing. The preliminary drafts or rules for welding and brazing as presented were only suggestive and were submitted, as a basis for constructive criticism, by the committee in the hope that additional material would be furnished to assist in outlining adequate specifications. It has not been the intent of the committee to restrict the work too closely by outlining specific methods to such an extent that they might eliminate other methods equally good, but as far as possible to establish certain fundamentals applicable to any method.

The sub-committee of the Boiler Code committees on Air Tanks and Pressure Vessels requests that all those who took part in the discussion and others who were unable to do so send in constructive data in manuscript form which will be carefully considered before making a preliminary draft of the complete code. In preparing the final code, the sub-committee will confer with the sub-committee on welding of the Boiler Code committee, the welding conference committee of the American Welding Society, the welding committee of the American Society of Refrigerating Engineers, and any other committee or organization interested.

E. R. Fish, chairman of the sub-committee on air tanks and pressure vessels, presided at the meeting. The preliminary report which will be given completely in a later issue of The Boiler Maker, includes a section devoted to definitions of the types of vessels included in the provisions of the code; details of materials from which these vessels may be constructed; the safety appliances which must be provided; the methods of supporting vessels; the effect of corrosive chemicals on unfired pressure vessels and the methods to be followed in inspection and stamping.

One section of the code is devoted to a "Preliminary Draft of Rules for Welding and Brazing." This section and the following sections are suggestive only and the committee states that "in issuing this matter for discussion, the Boiler Code committee desires to bring out the fact that there is no way of determining the exact quality of a weld other than making a test to destruction. Tests can be made by an experienced person that will establish the safety of a welded pressure vessel within a reasonable doubt, but there is no absolute measure of the strength of the weld. That certain welds are safe is well established, but all depends on using the method of welding suitable for the service, and on the skill and ability of the workmen, and the care with which the work is supervised and tested."

In this section a proposal is made to divide autogenously welded vessels into three groups.

"Group 1 to include vessels in which autogenous welding may be employed, where the safety of the structure depends on the strength of the autogenous weld.

"Group 2—Vessels in which autogenous welding shall not be used for carrying the strain and where the safety of the structure shall not be dependent upon the autogenous welding.

"Group 3—Autogenously welded vessels at which an agreement cannot be reached as to whether they should be placed in Group 1 or Group 2."

An outline is given of the classes of vessels that would come under each group.

The other rules suggested by the committee include sections on a "Preliminary Draft of Rules for Unfired Pressure Vessels Welded by the Autogenous Process;" "Preliminary Draft of Rules for the Construction of Forge-Welded Pressure Vessels;" "Preliminary Draft of Rules for Unfired Pressure Vessels with Lapped and Brazed Seams."

Following the discussion of the provisions outlined for the use of welding and brazing in unfired pressure vessels, a list of questions was submitted for discussion dealing with specific points on which the committee desired information.

Questions Submitted for Discussion

These questions among others brought up the necessity of annealing welded joints. The general opinion on this matter seemed to be that annealing was not entirely practicable for welds of large size, the process having a tendency to warp the surfaces of a vessel. In the case of small vessels annealing is practicable, but of no very great value. A method of properly annealing gas welds was suggested, which called for the heating of the metal to about 1,700 degrees F., at which temperature the weld would be annealed. After cooling, the metal should be heated again to about 1,500 degrees in order to anneal the plate. It is possible in annealing to refine the grain and otherwise alter the structure of an electric weld, but the metal will still be brittle so that little is accomplished in the process. Another point brought out was that electric welds heated in the open air oxidize badly which is detrimental to the metal.

On the question of what method should be specified for attaching dished heads concave to the pressure in a tank, certain manufacturers of tanks making dished heads 24 inches to 102 inches in diameter stated that they have found a 2½ inch skirt, butt welded, to be satisfactory. Other manufacturers have found in refrigerating work that the sides of the pipe used for the barrels of small tanks when crimped over the heads and the edges welded, made extremely safe pots for refrigerating service. Pots of this kind are tested up to 1,000 pounds pressure and some of them have been subjected to as high as 4,600 pounds without failure.

Discussion on the question whether the Code should cover vessels used for ordinary hot water service such as range boilers and hot water tanks, or not, brought out the statement by the manufacturers of this type of equipment that any regulation by the Code would impose a burden on this industry without accomplishing any real increase in the safety of such household equipment. An explanation was given of the action taking place in a range boiler when it fails. Such failures are infrequent, but when they do occur, they are generally gradual and do not cause violent explosions. A relief valve, faucet or expansion tank when installed with a heating system would eliminate the existing causes for failure of such boilers. Prevention of the sale of second hand boilers and of standard size boilers for extra heavy service by jobbers should be in some way regulated. It was thought that a code for standardizing the manufacturing practice would not work any hardship on the industry.

The committee requests that all those wishing to contribute to the discussion send their communications to the committee at 29 West 39th Street, New York.

Service of the Inspector Necessary to Prevent Disastrous Boiler Explosions

SERIOUS lap seam crack explosions have been reported in the pages of THE BOILER MAKER from time to time during the past few months and in a recent issue of *The Locomotive* published by the Hartford Steam Boiler Insurance and Inspection Company mention is made of several additional cases that may well be repeated.

Some years ago a representative of the company called upon a mill owner in an endeavor to interest him in boiler inspection and insurance, but the owner could see no value in such service. About a month later a crack developed in the longitudinal seam of one of the boilers in this mill and a supposedly experienced mechanic was called in. The crack was drilled at intervals, the holes tapped out and soft iron plugs inserted to stop the leakage. About a week later the boiler exploded, fatally injuring the fireman and seriously injuring his wife who happened to be there at that time. Had this boiler received the attention of a qualified inspector the dangerous condition could have been pointed out in time to prevent the disaster which occurred.

Warning Signals for Lap Seam Failures

Many similar instances are recalled of the inevitable sad results which follow improper treatment of a lap seam crack. This type of failure frequently shows itself by a leak extending over a comparatively short distance. The boiler plate may very likely be cracked over a considerable distance but, not being apparent by casual inspection, this is not realized and repairs are confined to the vicinity of the leak. A soft patch is frequently placed over the leak, sometimes temporarily alleviating the leaky condition and at other times accentuating it. Sooner or later, however, the crack extends through the plate at other points and an explosion frequently results.

Other Causes of Failure

But the lap seam crack, although a frequent offender, is not the only cause of trouble. Many conditions, dangerous to life and property, are found on the trips of the boiler inspector. Cracks in other parts of a boiler, such as to make it unsafe to use, have often been found. In one such case, cracks twelve and fourteen inches long were found at the bend of the flange on each side of the fire door sheet of a locomotive type boiler and in addition, some smaller cracks in the side sheets, making it necessary to condemn the boiler as unfit for service. A second hand dealer purchased the boiler and sold it to a saw-mill in Virginia. A few days after it was put into service, it exploded and two persons were killed. In this case the inspector gave protection to the original owner and also did all he could to safeguard the public by warning the second hand dealer not to sell the boiler, but to cut it up for scrap. The unscrupulous dealer, however, was not so mindful of the safety of others and closed the deal.

Repairs, that to the inexperienced appear safe, but to the boiler inspector are immediately recognized as dangerous, are frequently found. In one such case a bag had developed in a boiler from overheating which resulted probably from an accumulation of scale. The "repair" made in this case is illustrated in Fig. 1. The center of the bag or bulge was tapped and a 7/8 inch threaded rod screwed in with the end upset or riveted over. The upper end was supported by a flat iron bar resting on the top row of tubes. The idea apparently was to prevent a complete failure at the bag. However, an excellent place for scale to accumulate was provided by permitting the bulge to remain and the condition presented was rather dangerous. Our inspector had the rod removed. The plate was then heated and the bag driven back, the small hole being plugged with a rivet.

Corrugated Furnace Failure

The corrugated furnace in one of two Scotch marine boilers collapsed and necessitated repairs to that boiler. Thinking it advisable to investigate conditions in the other boiler, a hydrostatic test was applied by an inspector and the furnace showed a decided tendency to collapse, indicating that the structure was weak for the pressure desired. It was recommended that a new furnace be installed and assurance was given that this would be done. A few weeks later the owners requested that another examination be made, which was done. The results were rather remarkable. It was found that the repair man who was called in to do the work, after looking over the boiler, and announcing that he could "fix her as good as new," apparently concluded that a cylindrical furnace, lying in a horizontal position, could only collapse from the upper side although subjected to pressure from all sides. He therefore placed four 1½ inch rods extending from the upper surface of the furnace, where the furnace had first shown a tendency to collapse, to the top of the boiler shell and then remarked to the engineer, "There she is, she's all yours." Unfortunately for the owner, this repair could not be approved.

Correct Application of Boiler Appliances Important

Improper attachment or use of boiler appliances often results in damage to the boiler even if an explosion does not occur. Such conditions are often found and corrected by the boiler inspector. As an example we cite the following:

One of the company inspectors, when calling at the office of a certain plant, was advised that considerable trouble had been experienced from leakage at the girth seams of the horizontal watertube boilers in use in the plant. The superintendent stated that they had recalked the seams a number of times, but to no avail and the boiler maker who had done this work had expressed the opinion that they had received a "bum bunch of boilers." On walking into the boiler room the first thing that struck the inspector's eye was that the water glasses were considerably below the drums of the boiler. A comparison of the water level in the gage glass with the height of the drums showed that the water columns were set 12 inches too low so that, when the normal water level was carried in the water column, there was absolutely no water in the drums. This resulted in rapid overheating as soon as the boiler was fired up. When the water column was correctly placed and the seams again calked no further trouble was experienced.

Improper pipe connections are often found. As an example of this condition, the following experience, related by an inspector, will be illustrative.

"As I was going about my regular work I stopped at a small mine and became engaged in conversation with the engineer who claimed he was a licensed man and said that he had installed the boiler plant. He took great pride in showing me the installation, but after looking it over I was unable to work up the same degree of enthusiasm that he had and the reason may easily be explained.

"The faulty connection that first struck my eye was that a ½ inch pipe had been run from the dome of the boiler to supply an injector and a feed pump, both of which required a 1 inch line. To this pipe the steam pressure gage had also been attached. The steam pressure, when first noted, was 100 pounds. Soon, however, the injector was started and, because of the pressure drop which then took place in the ½ inch pipe, the gage reading fell back to 60 pounds. The engineer noticed this and immediately forced his fire a little harder which soon resulted in the safety valve blowing off although the gage reading did not rise any great amount. Seeing this, the engineer remarked, 'Sometimes that safety valve doesn't work just right. I don't know what gets the matter with it. I've had it off several times and examined it, but I can't find anything the matter with it.'

"I stepped outside to look up at the valve which was about twelve feet above the boiler and while looking at it the blowing stopped. A few minutes later I walked in and looked at the pressure gage. It showed 140 pounds. I immediately

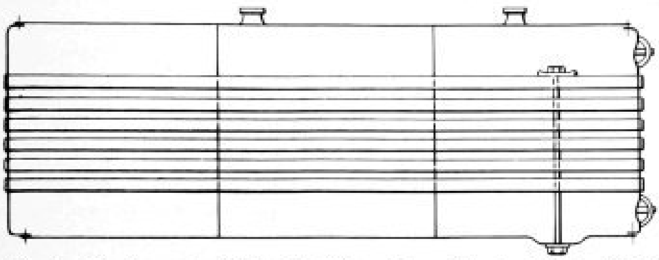


Fig. 1.—Inadequate Method of Repairing Bag in Boiler Shell

started an investigation to determine the reason for the safety valve remaining closed with this pressure behind it and, when I climbed up on the boiler, I soon discovered the cause. There I found a gate valve closed tight in the line leading to the safety valve. Apparently the engineer had closed it when I stepped outside, for just then I saw him come around to the front of the boiler, glance at the pressure gage, and then rush up the ladder to open the gate valve. This I cautioned him to do slowly as a sudden release of the pressure on the boiler might have caused an explosion. As soon as a few turns had been given the gate valve to open it the safety valve began to blow and continued to do so until the pressure was reduced to 100 pounds.

"A sketch of the boiler with its improper pipe connections is given in Fig. 2. In addition to what is shown there I might mention that the blow off line had been piped outside the building where a trap had been formed so that any water accumulating in it would freeze very readily. A man, in blowing down the boiler, would have been placed in a very dangerous position.

"A short time later I had to make an internal inspection of this same boiler and, although the engineer said that he had just had the boiler open the day before and that I could take his word as to its good condition, I found it to be in very poor shape. Although no great amount of scale was present, a considerable amount of corrosion and a number of cracks in different parts of the boiler were found. When this information was given the superintendent he ordered the boiler out of service."

Inspections Prevent Unnecessary Repairs

Inspections are of value not only in the detection of dangerous conditions, but also in preventing unnecessary expenditures for repairs. In one case a tube ruptured in a vertical watertube boiler and there was also some slight overheating of several other tubes. The coal mining company who owned the boiler engaged a repairman to put the boiler in serviceable condition. This repairman had them place an order for new tubes which were to cost $1,200. He expected to almost take apart the entire boiler, the total cost to be about $2,500, and had actually started work. Someone, however, suggested to the coal company that they obtain the services of a boiler inspector. As a result of his inspection the repairs necessary were limited to ten new tubes and some other minor repairs, amounting in all to about $250, or a saving to the owner of over $2,000. This was at pre-war prices and the figures would be considerably greater at the present time.

In still another case a boiler had been condemned by a steam fitter as unfit for further use but upon examination by a boiler inspector was found to be good for many years more of service.

The boiler inspector also finds a field of service in the help that can often be given a manufacturer in the arrangement of his steam generating equipment and piping.

In another striking instance, which seems almost incredible but which, nevertheless, is true, a furniture factory complained of the wastefulness of their boiler equipment from the standpoint of fuel consumption. After an inspection the installation of a boiler of a different type was recommended. Before the change, the plant used a car of coal a month in addition to the refuse from the mill. After the change, the coal consumption was reduced to a maximum of two cars of coal per year.

Many accounts might be given of the savings resulting from the suggestions of the boiler inspector, such as the covering of steam pipes, use of pumps and exhaust steam heaters in place of injectors, use of a lesser number of boilers to carry the load and so forth.

It would be practically impossible for the owner of a plant to give the time for a personal inspection of his boilers even though he were so inclined and sufficiently experienced in this line of work. No matter how efficient operating engineers may be in running their plant, but few of them have

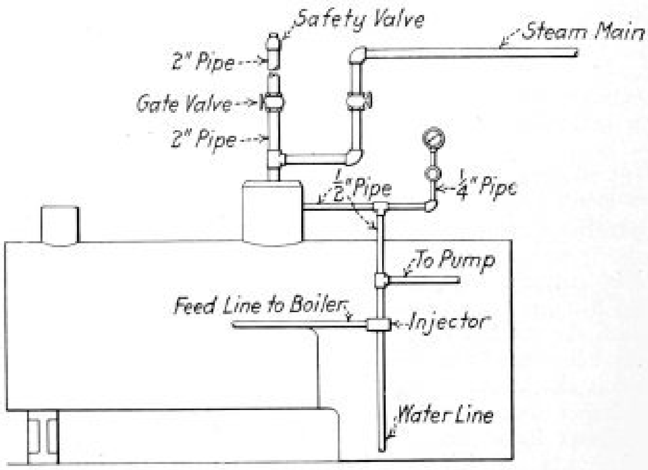


Fig. 2.—Diagram Illustrating the Necessity of Properly Locating Boiler Fittings

had the specialized training to qualify them as inspectors of boilers. On the other hand the expert boiler inspector examines the boilers for all known causes of trouble and then the owner is handed an unbiased statement of the condition of the equipment. If everything is in good shape the owner has a sense of security from accident, or, if there is trouble in sight, ample time is given to make repairs before the danger point is reached.

In commenting on the position of the steam locomotive in the United States, in the New York *Evening Post*, November 15, Professor W. J. Cunningham, professor of transportation, Harvard University, stated:

"From time to time, as certain railroads have changed from steam to electrical operation for portions of their lines, the passing of the steam locomotive has been confidently predicted by experts, but the steam locomotive not only appears to be holding its own, but by notable improvements in design and appurtenances seems recently to have taken a new lease of life."

Points for Plate Shop Draftsmen to Remember

By D. M. McLean

IN ordering plates for work containing both single and double riveted lap joints, don't forget when you come to the double riveted part, to add the extra material required between the rows of rivets.

Don't forget to add the extra material required for the camber on plates for the taper courses of stacks or other work having conical surfaces.

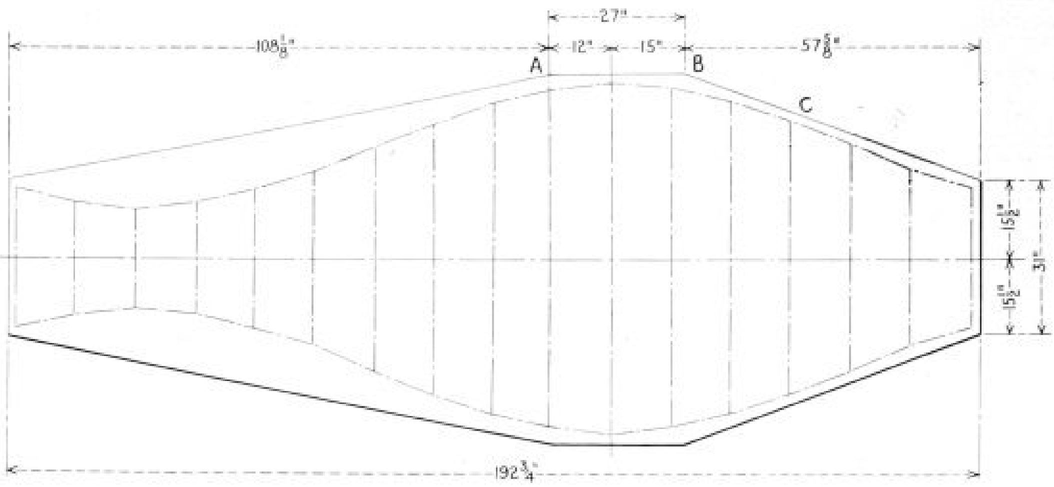


Fig. 1.—Wide Part of Elbow Plates Should Be Parallel So That Curves Can Be Provided for in the Plate Mill

Don't forget in ordering sketch plates that mills will not cut re-entrant curves or angles.

Don't forget to make the wide part of elbow sketch plates parallel for a sufficient distance to allow the mill to clear the haunch of the curve in the plate as it appears when finally laid out and sheared in the shop. See *C* in Fig. 1. The tendency is to make the straight part *AB*, Fig. 1, too short, with the result that when the correct curve is laid out, the rivet line runs too close to the edge of the plate or perhaps off it altogether, making it necessary to procure another and a larger sketch plate.

Don't forget the extra material required in a dome shell plate where it joins the boiler shell, due to the larger circumference of the outer edge of the flange as compared with the dome shell.

For the same reason, don't forget to provide the extra length of plate required for round or for rectangular fire boxes, etc., having ogee flanging at the bottom.

Don't forget that elbow plates handle best in the shop when the longitudinal joints are located at a point about one-eighth to one-sixth of the circumference around from the throat, as shown in Fig. 2.

Don't forget in developing plates for elbows with taper courses, to lay down the camber line first, then develop the sheet, using the camber line as the center or stretch-out line.

Don't forget, when ordering plates or sheets for circular stacks, that the diameter between the plates at the circular seams should be the same as the nominal diameter. In other words, the mean diameter is made the same as the nominal diameter.

Don't forget that when stacks made up of small and large, or "in-and-out," courses are built up in car length sections, to be connected at destination by slip joints or by bolted angle ring joints, it is much better to have an odd number of courses in each section, so that both ends of a section will be alike in diameter, and that it is also preferable to have these end courses small courses. Thus, if angle rings are used at the joints, they will all be of the same inside diameter, and will all take the same drilling or punching for bolts, regardless of the thickness of the plates to which they are riveted; or, if slip joints are used, the bands, etc., will be alike from top to bottom of the stack as regards their inside diameter.

Don't forget that stacks for out-of-door locations are generally made up of taper courses, with the small ends up, so as to shed moisture.

Don't forget that occasionally customers prefer to have the small ends of taper courses for stacks placed downwards, as

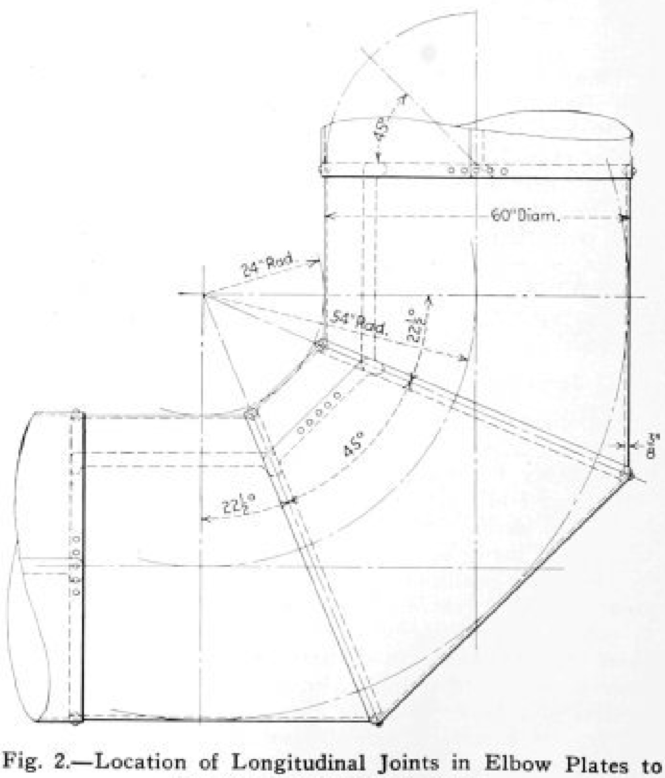


Fig. 2.—Location of Longitudinal Joints in Elbow Plates to Facilitate Handling in Shop

they consider that any moisture from above that may penetrate the joints will run down inside and be dried by the heat of the ascending gases, and that thus those unsightly streaks which sometimes come from moisture within the stack working through and drying on the outside will be avoided. These streaks are often noticeable where boilers have been put into service before the brick setting had thoroughly dried.

Number of Courses in Stack Sections

Don't forget that when stacks with taper courses are made up in sections with slip joints or with angle ring bolted joints, the number of courses in a section may be either odd or even. One end course, however, must be a parallel course, so that both ends of any section may be of the same diameter, and it is preferable to have them both inner or small ends, to keep either the slip or the angle ring joints, as the case may be, alike in diameter throughout the stack.

Don't forget that stacks of so-called oval section with taper courses and of rectangular section with round corners with taper courses are impracticable, and should not be undertaken. It is cheaper to make them with in-and-out courses and, if necessary in order to satisfy the customer and avoid the streaking mentioned above, calk them from top to bottom, rather than spend time on work which will not give satisfactory results.

Don't forget that in large stacks, erected in the field plate by plate, three plates to a course are better than two, as they handle much easier.

Don't forget that the published formulas for calculation of anchor bolts for self-supporting steel stacks, stand pipes and similar structures vary considerably in the results they give. Some engineers treat the stack as a cantilever, with the turning point on the center line of the stack and half the bolts in stress under any given wind moment, while others consider the stack as a movable body with all the bolts in action except two at the turning point which they consider as located at the heel of the stack base. Therefore, since the first method gives a sectional area for the bolts nearly double that of the latter method, it is well to know to which class the formula you use belongs and apply your judgment.

Don't forget to exercise a reasonable amount of scepticism and examine all drawings that pass through your hands to the shop, from whatever source, guarding against test pressures being specified that approach too closely the elastic limit of the material, insufficient strength in main members, weak details, insufficient bracing, or none at all, failure to comply with building, boiler or other construction codes, etc.

Acetylene Association Report on Gas Welding*

Low Cost of Welding Gases Has Increased the Application of the Process in Tank and Pipe Line Work

During the past two years the theory of the operation of gas torches has become better understood with the result that back-firing has decreased, lessening one of the annoying features of handling the equipment.

There has been a general increase in the application of the process, largely due to its application to war work which was continued after the war. Not the least notable accomplishment during the war period and after was the maintenance of practically pre-war figures for welding gases.

Acetylene welding is coming to be recognized as a safe method of construction and repair, when in the hands of good designers and skilled workmen. There has been much discussion on the welding of large storage tanks for oil and pressure vessels.

Large Capacity Tanks Developed

Designs have been prepared for storage tanks having a capacity of 5,000 barrels, while slightly smaller ones have actually been constructed and have proven their worth in service.

The pressure vessel situation is such that a code has been prepared for this type of construction by a conference committee on which the Acetylene Association was represented. This code has been presented to the Boiler Code committee of the American Society of Mechanical Engineers for consideration and, in due time, it will doubtless be a strong factor in the production of safe welded pressure vessels. This may be considered one of the most important developments that has taken place during the last two years, if not the most important.

Welding High Pressure Pipe Lines

The welding of pipe lines has been extended very greatly as it has been found that welded joints are more reliable than any other joint and cheaper than any other good joint for permanent construction, since there is no chance for leakage. In one instance, an eight-inch pipe line under very heavy pressure at all the welded joints was tested at 1,000 pounds hydrostatic pressure, and the welds were hammered with a sledge at that pressure. This test under pressure has been found very successful in determining defective welds. The method is not new in some other fields, as for instance in the testing of cast iron and lap welded pipe, but its application to welded construction generally is recent.

Alloy Steel Welding

A study of welding alloys indicates that metal of almost any desired composition can be deposited with the oxy-acetylene torch, but that there are many important problems like pre-heating, heat treatment and annealing to be considered.

"Duriron," which is a high silicon cast iron, is being successfully welded, but must be most carefully pre-heated. Manganese steel is difficult to work, but good results are being obtained on simple castings.

Nickel steel, chromium steel, vanadium steel, etc., are splendidly welded, but, as welds are almost always made where great strength of metal is needed at a point of maximum stress, further research in these lines is of importance.

With oxy-acetylene welding a single butt-weld is considered the best practice and, if properly made, this joint will give complete satisfaction for any gage of metal from the lightest to upwards of an inch in thickness.

Oxy-acetylene cutting has been in a severe competition with cutting by oxygen used with substitute fuel gases. It has been very thoroughly determined that a large part of this competition has been due to the difficulties of obtaining compressed acetylene during the war and immediately following. The efficiency of acetylene in this connection is being more and more recognized.

Oxy-acetylene cutting has been used for constructive work

(*Continued on page 356*)

*Abstract of report presented at the International Acetylene Association convention, held October 4, 5 and 6, in New York City. This report was read by S. W. Miller, chairman of the Committee on Gas Welding.

Locomotive Boiler Construction Code

Rules Include Methods of Determining Working Pressures, Staying Surfaces and Testing Boilers for Acceptance

THE locomotive rules given below will be incorporated in the American Society of Mechanical Engineers' Boiler Code when the 1922 revision has been completed.

In the meantime, copies of the rules in pamphlet form may be obtained from the secretary of the society, C. W. Obert, at 29 West 39th street, New York City.

Following is a continuation of the Boiler Code—Part I, Section III, as the locomotive regulations are known, which began in the November issue of THE BOILER MAKER:

ALLOWABLE WORKING PRESSURES

L—43. (*a*) The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in paragraph L—31, using 80 for the value of *C*.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table L—4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

TABLE L-4: MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Pounds Per Square Inch — For Lengths Between Supports Not Exceeding 120 Diameters	For Lengths Between Supports Exceeding 120 Diameters
a Unwelded or flexible stays less than twenty diameters long, screwed through plates with ends riveted over	7,500	.....
b Hollow stays less than 20 diameters long screwed through plates with ends riveted over	8,000	.....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *b*	9,500	8,500
d Welded portions of stays	6,600	6,600

(*b*) The maximum allowable working pressure for a stayed wrapper sheet of a locomotive boiler shall be determined by the two methods given above and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{55{,}000}{FS} \times \frac{t \times E}{r - s\ \Sigma \sin a}$$

in which;

a=angle any crown stay makes with vertical axis of boiler.
$\Sigma \sin a$=summated value of $\sin a$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.
s=transverse spacing of crown stays in crown sheet, inches.
E=minimum efficiency of wrapper sheet through joints or stay holes.
t=thickness of wrapper sheet, inches.
R=radius of wrapper sheet, inches.
P=maximum allowable working pressure, pounds per square inch.
FS=factor of safety, or the ratio of the ultimate strength of the material to the allowable stress.

The above formula applies to the longitudinal center section of the wrapper sheet, and in cases where E is reduced at another section, the maximum allowable working pressure based on the strength at that section, may be increased in the proportion that the distance from the wrapper sheet to the top of the crown sheet at the center, bears to the distance, measured on a radial line through the other section, from the wrapper sheet to a line tangent to the crown sheet and at right angles to the radial line, Fig. L—1.

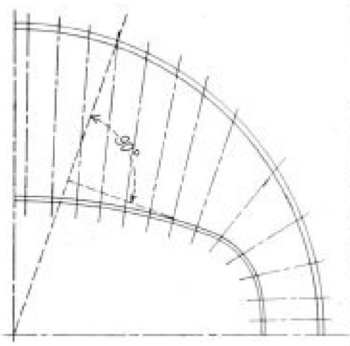


Fig. L-1. Staying for Wrapper Sheet of Locomotive Boiler

L—44. A segment of a head shall be stayed by through, diagonal, crowfoot or gusset stays.

L—45. The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 inches from the tubes and at a distance *d* from the shell as shown in Figs. 15 and 16, Part I, Section I (Boiler Code, 1918 Edition). The value of *d* used may be the larger of the following values:

(1) d=the outer radius of the flange, not exceeding 8 times the thickness of the head.

where;

(2) $$d = \frac{5 \times T}{\sqrt{P}}$$

d=unstayed distance from shell in inches.
T=thickness of head in sixteenths of an inch.
P=maximum allowable working pressure in pounds per square inch.

The feet for braces to back head and front tube sheet should be distributed so as not to concentrate the stress on any one section; preferably a proportion of the braces should be attached to the second course from the back head or front tube sheet.

No supporting value shall be assigned to the stiffness of inside liner plates on flat surfaces, except as provided in L—31.

L—46. In calculating stresses for stays and their attachments the angularity of the stays, if in excess of 15 degrees, must be taken into account.

L—47. All rivet and pin holes shall conform to the requirements in paragraph L—53 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the values of stresses given in Table L—4.
2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace."
3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."
4. Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) at least 25 percent greater than the "required cross-sectional area of the brace."
5. Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the

boiler at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

6. Design each branch of a crowfoot to carry two-thirds the total load on the brace.
7. Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."
8. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

L—48. Gusset stays when constructed of triangular web plates secured to single or double angle bars along the two sides at right angles shall have a cross-sectional area (in a plane at right angles to the longest side and passing through the intersection of the two shorter sides) not less than 10 percent greater than would be required for a diagonal stay to support the same surface, assuming the diagonal stay is at the same angle as the longest side of the gusset plate.

L—49. Crown bars and girder stays for tops of combustion chambers and back connections, or wherever used, shall be proportioned to conform to the following formula:

$$\text{Maximum allowable working pressure} = \frac{C \times d^2 \times t}{(W-P) \times D \times W}$$

where;

- W=extreme distance between supports, inches.
- P=pitch of supporting bolts, inches.
- D=distance between girders from center to center, inches.
- d=depth of girder, inches.
- t=thickness of girder, inches.
- C=7,000 when the girder is fitted with one supporting bolt.
- C=10,000 when the girder is fitted with two or three supporting bolts.
- C=11,000 when the girder is fitted with four or five supporting bolts.
- C=11,500 when the girder is fitted with six or seven supporting bolts.
- C=12,000 when the girder is fitted with eight or more supporting bolts.

Example: Given W=34 inches, P=7.5 inches, D=7.75 inches, d=7.5 inches, t=2 inches; three stays per girder, C=10,000; then substituting in formula:

Maximum allowable working pressure=

$$\frac{10{,}000 \times 7.5 \times 7.5 \times 2}{(34-7.5) \times 7.75 \times 34} = 161.1 \text{ pounds per square inch.}$$

In boilers with crown bars supported on firebox side sheets and sling stays, the sling stays shall be considered as carrying the entire load.

Finishing Tube Holes

L—50. Tube holes shall be drilled full size from the solid plate, or they may be punched at least ½ inch smaller in diameter than full size, and then drilled, reamed or finished full size with a rotating cutter.

L—51. The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

L—52. The ends of the tube shall be substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end and rolled at the smokebox end; 10 percent of the tubes shall be beaded at the smokebox end.

The ends of arch tubes must be belled out to a diameter ¼ inch larger than the hole in the sheet to which they are connected.

Rules for Riveting

L—53. All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed ¼ inch less than full diameter for material over 5/16 inch in thickness and ⅛ inch less than full diameter for material not exceeding 5/16 inch in thickness and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for drilling or reaming all rivet holes in boiler plates, except those used for the tack bolts.

L—54. Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal to those shown in Fig. 20, Part I, Section I (Boiler Code, 1918 edition).

L—55. Rivets shall be machine-driven wherever practicable, with sufficient pressure to fill the rivet holes and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

L—56. The calking edges of plates, butt straps and heads shall be beveled to an angle not less than 70 degrees to the plane of the plate and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than ⅛ inch. Calking shall be done with a round-nosed tool.

L—57. A locomotive boiler shall have washout handholes or screw plugs, as follows: One at each corner of the firebox just above the mud ring; one in the back head over the firedoor; one or more on each side of the roof sheet above the level of the crown sheet, which shall be staggered on opposite sides; one or more in the barrel of the boiler; and one or more in the back head above the crown sheet.

Screw plugs must have at least four full threads in the sheet, including reinforcement, if such are used.

L—58. All holes for injector checks, whistle and safety valves when screwed into the boiler and all holes in the boiler barrel, firebox, roof sheet and all unstayed surfaces when diameter of the hole is over 3¼ inches and exceeds 4½ times the thickness of the plate must be reinforced with a liner or flange riveted to the boiler.

The thickness of the liner or flange must be at least 75 percent of the thickness of the plate. The rivets must have a shearing strength of at least 52 percent of the tensile strength of the metal removed.

Safety Valves

L—59. Every locomotive boiler shall be equipped with at least two safety valves, the capacity of which shall be sufficient to prevent, under any conditions of service, an accumulation of pressure more than five percent above the specified boiler pressure.

L—60. Safety valves shall be set to pop at pressures not exceeding 6 pounds above the working steam pressure. When setting safety valves, two steam gages shall be used, one of which must be so located that it will be in full view of the person engaged in setting such valves; and if the pressure indicated by the gages varies more than 3 pounds, they shall be removed from the boiler, tested and corrected before the safety valves are set. Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting. When setting safety valves, the water level in the boiler shall not be above the highest gage cock.

L—61. Safety valves may have the seat and bearing surface of the disk inclined at any angle between 45 degrees and 90 degrees to the center line of the spindle. The valves shall be rated at a pressure 3 percent in excess of that at which the valve is set to blow.

All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve.

L—62. Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates permanently secured to the body and shall contain the following:

(*a*) The name or identifying trademark of the manufacturer;

(*b*) The nominal diameter;

(*c*) The steam pressure at which it is set to blow;
(*d*) Blow down, or difference between the opening and closing pressures;
(*e*) The weight of steam discharged in pounds per hour at a pressure 3 percent higher than that for which the valve is set to blow;
(*f*) A.S.M.E. Std.

L—63. Safety-valve capacity may be checked in the following manner; and, if found sufficient, additional capacity need not be provided:

By making an accumulation test with fire in good bright condition and all steam exits closed; with the fire forced under these conditions, the safety valves should relieve the boiler and not allow an excess pressure of more than 5 percent above the working pressure.

L—64. Each safety valve shall have full-sized direct connection to the boiler.

L—65. If a muffler is used on a safety valve it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit.

L—66. When a boiler is fitted with two or more safety valves on one connection, this connection to the boiler shall have a cross-sectional area not less than the combined area of all of the safety valves with which it connects.

L—67. The seats and disks of safety valves shall be of non-ferrous material.

L—68. Springs used in safety valves shall not show a permanent set exceeding 1/16 inch ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least 1/10 the diameter of the seat before the coils are closed or before there is other interference.

L—69. The spring in a safety valve shall not be used for any pressure more than 10 percent above or below that for which it was designed.

L—70. When the valve body is marked with the letters A.S.M.E. Std. as required by paragraph L—62, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

L—71. Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other steam outlet connection or of any internal pipe in the steam space of the boiler, the area of opening to be at least equal to the aggregate nominal area of all of the safety valves to be attached thereto.

L—72. Each boiler shall have at least one water glass provided with top and bottom shut-off cocks, and lamp and two gage cocks for boilers 36 inches in diameter and under, and three gage cocks for boilers over 36 inches in diameter.

The lowest gage cock and the lowest reading of the water glass shall not be less than 2 inches above the highest point of the crown sheet on boilers 36 inches in diameter and under, nor less than 3 inches for boilers over 36 inches in diameter. These are minimum dimensions, and on large locomotives, and those operating on steep grades, the height should be increased if necessary to compensate for change of water level on descending grades.

The bottom mounting for the water glass, and for the water column, if used, must extend not less than 1½ inches inside the boiler and beyond any obstacle immediately above it, and the passage therein must be straight and horizontal.

Tubular water glasses must be equipped with a protecting shield.

L—73. No water-glass connection shall be fitted with an automatic shut-off valve.

L—74. Every boiler shall have at least one steam gage which will correctly indicate the working pressure. Care must be taken to locate the gage so that it will be kept reasonably cool and can be conveniently read by the enginemen.

Every gage shall have a siphon of ample capacity to prevent steam entering the gage. The pipe connection shall enter the boiler direct, and shall be maintained steam-tight between the boiler and the gage. The siphon shall be of brass, copper or bronze composition.

L—75. The dial of the steam gage shall be graduated to not less than 1½ times the maximum allowable working pressure on the boiler.

L—76. Each boiler shall be provided with a valved connection not less than ¼-inch pipe size for attaching a test gage when the boiler is in service, so that the accuracy of the boiler steam gage can be ascertained.

L—77. Locomotive boilers are to be equipped with at least one blow-off cock located at the lowest water space practicable, directly connected to the boiler, either with screw connections or flanged.

L—78. Each boiler shall be equipped with two injectors, or two pumps, or one injector and one pump, with separate delivery pipes connected to checks. The water shall be delivered to the boiler at a point nearer the front than the back flue sheet.

L—79. After a boiler has been completed, it shall be subjected to a hydrostatic test of one and one-fourth times the maximum allowable working pressure. The pressure shall be under proper control so that in no case shall the required test pressure be exceeded by more than 6 percent.

L—80. During a hydrostatic test, the safety valve or valves shall be removed, or each valve disk shall be held to its seat by means of a testing clamp, and not by screwing down the compression screw upon the spring.

L—81. In laying out shell plates, furnace sheets and heads in the boiler shop, care shall be taken to leave at least one of the stamps, specified in paragraph 36 of Part I, Section I, so located as to be plainly visible when the boiler is completed. Butt straps shall have at least a portion of such stamps visible, sufficient for identification when the boiler is completed.

L—82. Each boiler shall conform in every detail to these rules, and shall be distinctly stamped with the symbol as shown in Fig. 23, Part I, Section I, denoting that the boiler was constructed in accordance therewith.

After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known, is to be notified that an inspection is to be made and he shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet together with the stamp on the boiler shall denote that it was constructed in accordance with the Boiler Code. The stamp shows:

1. Manufacturer's serial number.
2. State in which boiler is to be used.
3. Manufacturer's state standard number.
4. Name of manufacturer.
5. State's number.
6. Year put in service.
7. Maximum allowable working pressure when built.

L—83. The stamps shall be located on the dome.

L—84. Each boiler shall be equipped with a metal badge plate, showing the maximum allowable working pressure, which shall be attached to boiler head in the cab.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY
in conjunction with
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* ROY V. WRIGHT, *Secretary*
HENRY LEE, *Vice-President and Treasurer*
Woolworth Building, New York, N. Y.

Chicago: Transportation Bldg. Cleveland: 4300 Euclid Avenue
Washington: Home Life Bldg. Cincinnati: First National Bank Bldg.
Boston: 294 Washington Street
London: 34 Victoria Street, Westminster, S. W. 1,
Cable Address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price, United States, Mexico and Canada, $2.00; foreign, $3.00; single copy, 35 cents.

WE GUARANTEE that of this issue 4,850 copies were printed; that of these 4,850 copies 4,346 were mailed to regular paid subscribers, 16 were provided for counter and news company sales, 67 were mailed to advertisers, 34 were mailed to employees and correspondnts, and 493 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 57,500, an average of 4,791 copies a month.

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

GENERAL: PAGE.

The Manufacture of Boiler Plates.................... 329
Progress of Boiler Regulation in Pennsylvania.................... 334
Inspection Work in Pennsylvania.................... 334
The National Board of Boiler Inspectors.................... 335
Principles of Riveted Joint Design.—VI.................... 336
Work of the A. S. M. E. Boiler Code Committee.................... 338
Boiler Welding Repairs in England.................... 339
Hearing on Code for Unfired Pressure Vessels.................... 341
Service of the Inspector Necessary to Prevent Disastrous Boiler Explosions 342
Points for Plate Shop Draftsmen to Remember.................... 344
Acetylene Association Report on Gas Welding.................... 345
Locomotive Boiler Construction Code.................... 346

EDITORIAL COMMENT 349
ENGINEERING SPECIALTIES FOR BOILER MAKING.................... 350
QUESTIONS AND ANSWERS FOR BOILER MAKERS:

Pressure for Oil Burning.................... 352
Straightening Buckled Plates and Frames.................... 352
Development of Spout for Settling Tanks.................... 352
Gusset Layout for Blast Pipe.................... 353

BUSINESS NOTES 354
LETTERS:

Information for Apprentices.................... 355
Top Heating for Flange Work.................... 355

OBITUARY 356
ASSOCIATIONS 357
TRADE PUBLICATIONS 357
PATENTS 358

From the results of the hearing on the proposed addition to the Boiler Code of rules for the construction of unfired pressure vessels, held in conjunction with the annual meeting of the American Society of Mechanical Engineers, it is quite apparent that a vast amount of additional data from tank manufacturers will be necessary before the final formulation of such a code of rules will be possible. Standards which will be equitable to the producers of all classes of pressure vessels, whose problems are in many cases at wide variance, can be made only after a more complete discussion of the suggested provisions than was possible at the hearing.

In the preliminary code, three general classes are suggested, into which all autogenously welded unfired pressure vessels may be divided; the first class to include vessels in which the safety of the structure depends on the strength of the weld; the second group to deal with vessels in which welding does not carry the strain and the third group to contain all vessels not placed in the other two. In order to insure that vessels are properly classified in these groups, the designers and manufacturers must give complete and accurate information on their products which will enable the sub-committee of the American Society of Mechanical Engineers' Boiler Code committee to determine the effect of strain and service on these vessels.

It cannot be too strongly emphasized that this code when finally completed will be a basis for the acceptability and scope of autogenous welding in the production of unfired pressure vessels. For this reason the committee should have the complete cooperation of every individual even remotely interested in the subject. Constructive suggestions and data on the results obtained with the processes in the various industries effected by the code will greatly facilitate the work of the committee and hasten the final draft of a code which will meet with the approval of all manufacturers of unfired pressure vessels.

Boiler economy depends first of all on design and construction. Suggestions for improving either of these factors in the final performance of equipment should interest every man in the industry. Dr. D. S. Jacobus in a paper on "Boiler and Furnace Economy" read at the annual meeting of the American Society of Mechanical Engineers points out the value of economizers in obtaining high boiler efficiency.

Economizers can in many instances be installed without effecting the structural features of a boiler. However, the design may often be altered to advantage when it is desired to include economizers in the equipment. For example, when economizers are used, additional efficiency may be obtained by adding to the height of a boiler. Increasing the height from 14 tubes to 20 tubes will result in this increase in efficiency with but little increase in draft loss. Higher boilers may be operated with natural draft at the desired capacity, thereby eliminating the addition of induced draft apparatus that would otherwise be required for economizers.

In dealing with furnace design, Dr. Jacobus points out that to consume the combustible gases within the furnace chamber there should be a proper length of flame travel before the gases strike the tubes as well as a sufficient furnace volume. In addition, there must be a mingling action of gases and the furnace should be of a form to prevent the flow of gases containing excess air through the boiler to the uptake without combining with unconsumed combustible gases.

The effect of the absorption of radiant heat on the tubes of boilers should also be considered in the design. With fuels producing maximum temperatures which can be carried by the brick work without deterioration, it is best to absorb but little radiant heat in order that a high furnace temperature may be maintained. With stronger fuels, however, it is necessary to absorb a great deal of the radiant heat so that there will be no danger of the brick work collapsing or deteriorating rapidly.

In order to secure the best results, furnace and boiler design must be coordinated. It is impossible to separate boiler efficiency from furnace and stoker efficiency in such a way that the value obtained for the former will depend solely on the construction of the boiler and not be influenced through the construction of the stoker and furnace.

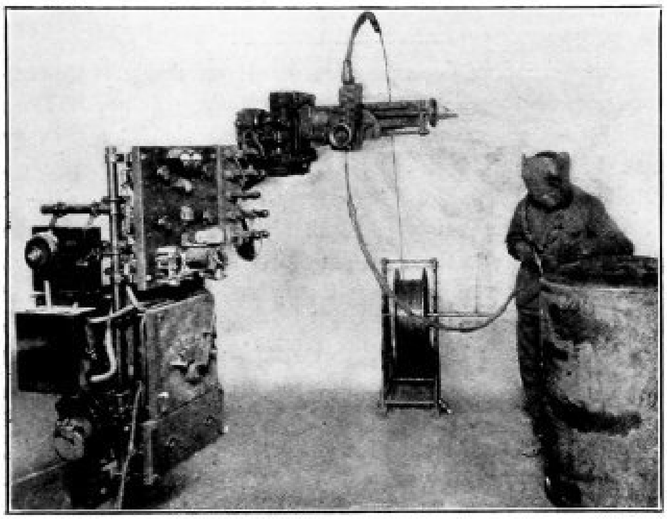
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Semi-Automatic Arc Welding Lead

A semi-automatic arc welding lead has just been developed by the General Electric Company, Schenectady, N. Y., for use in conjunction with its automatic arc welding head, which retains the continuous features of the automatic apparatus, yet allows the operator to direct the arc as required by the conditions of the work.

The apparatus consists of a welding tool to be held by the operator, which acts as a guide for the electrode wire. In the handle of the tool, which greatly resembles an automatic pistol, is a switch for operating the control on the panel of the automatic welder to start and stop the movement of the electrode wire. Attached to the tool is a 10 foot length of flexible steel tubing, called the "flexible wire guide," with an adapter on the other end for attaching it to the automatic welding head. The wire passes from the feed rolls of the head into the flexible tubing, and thence to the arc through a "guide nozzle" in the welding tool. The automatic welder functions in its accustomed manner, tending to hold the arc length constant, and the operator merely directs the arc as required by the particular job in hand.



General Electric Semi-Automatic Arc Welder

The field of application of the semi-automatic lead is the welding of products where the seams to be welded are of very irregular contour, or on very large work where the travel mechanism and clamping necessary for the full automatic welder would be complicated and costly. In many cases the edges of the seams are not accurately prepared, making gaps in some places and tight fits in others. The automatic welder with mechanical travel cannot compensate for these conditions by varying the speed, or by manipulation of the electrode, but with the semi-automatic, they are taken care of.

The semi-automatic welder may also be used for building up metal rapidly, as in the case of the filling up of blow holes in castings, or the building up of worn spots, etc. The speed of deposition of the metal varies widely, being somewhere between the ordinary hand speed and that of the automatic, according to the conditions of the particular job. In general it is about twice as fast as hand welding.

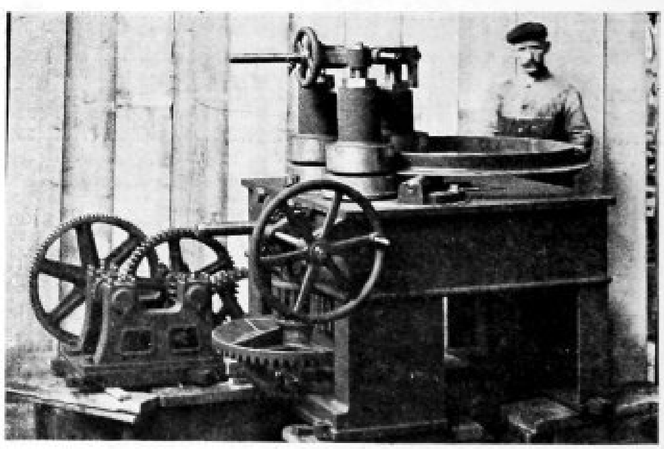
The advantages claimed for the automatic welding equipment may be summed up as follows: (1) Saving in time which is ordinarily lost in changing electrodes; (2) Saving of from 10 to 20 percent in electrode material ordinarily thrown away as waste ends; (3) Operators can become proficient in the use of the tool very quickly, as they do not require the muscular training necessary for hand work; (4) Continuous operation results in few interruptions in the welding, each of which is a potential source of defective welds.

Bending Angles and Other Structural Shapes

For bending angles, beams, channels and other shapes, the Hercules power bending machines produced by Amplex, Inc., 6-8 West 32nd Street, New York, have capacities for angles 3 inches by 3 inches by 3/8 inch, up to 8 inches by 8 inches by 1 inch. Hand driven machines are made in sizes which will bend angles 2 inches by 2 inches by 3/8 inch, up to 3 inches by 3 inches by 1/2 inch.

The variety of forms in which structural shapes occur has made the design of a machine to bend any shape difficult. The Hercules machine, it is claimed, meets all the requirements of strength and simplicity of operation. The bar to be bent runs horizontally into and out of the machine so that even the largest sections can be handled by a simple roller trestle.

The bending is done while the metal is cold so that heating apparatus is unnecessary. Universal rolls are fitted which will take care of the bending of large or small sections, whether the legs of the shape are to come on the inside or outside of the curve.



Type BO4 Hercules Bending Machine

This type of machine by means of a slight adjustment will bend right or left hand curves as desired. Reverse curves can be made in the machine without taking the angle or other shape out of the machine for adjustment.

The machine illustrated has an approximate weight of 35,000 pounds, a pulley diameter of 29 inches, and an operating speed of 200 revolutions per minute. The height is 9 feet, the length 12 feet, the width 12 feet, and 12 horsepower is required for operation.

The business now controlled by Amplex, Inc., was formerly conducted by the Wiener Machinery Company.

Overhead Handling System Lowers Shop Costs

For use in repair shops, machine shops and the like, where floor space is at a premium, the Cleveland Crane and Engineering Company, Wickliffe, Ohio, has developed a tramrail which provides an efficient overhead handling system for material.

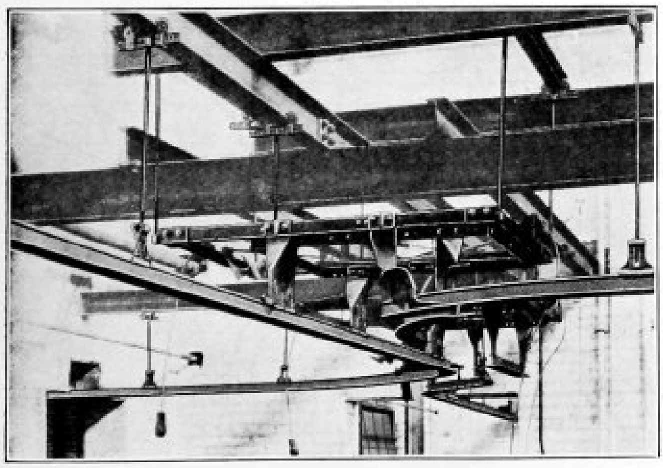
The feature of this system, which is the flexibility of the installation of the rail, is evidenced by the methods of suspension. These consist of hanger rods, brackets and rail clamps which can be attached to the purlins of a building or almost any support available. For all loads up to the maximum capacity of two tons the rail support clamps are placed three feet apart.

The system is standardized and a mechanic can lay out, order and install the rail, rail fittings, switches, turntables, carriers, etc. By the use of cold bends in the rail any curve down to a 4-foot radius can be made without sacrifice of safety. The bend is easily made by the use of a special bending device.

Like the other units of the system, the switches designed for this tramrail are standard. The same switch is installed for hand power or electric operation, thus permitting a hand power system to be electrified at any time. When the switch is in position it is automatically locked, thus preventing the carrier and its load from sliding the switch out of alinement. When additional safety is desired, the installation of trolley wire insulator makes it impossible for an electrically driven carrier to run at full speed against a safety stop or open switch.

Overhead Handling System

By the use of the central control system several carriers can be operated by one man. When an unobstructed view of the system is not possible, the operator is informed as to the location of the carriers he controls by signal lights on a



The Curves in the Rail Illustrate the Flexibility of the Tramrail System.

board before him. With this arrangement the dispatcher can switch the carrier to any track or location desired.

Through combinations, 1,200 types of carriers are possible with the standard equipment. A standard rail, installed along the length of the building on both sides, forms the runway for the transfer bridge which permits the carriers to operate from the tramrail track onto the bridge. Working parts are fully enclosed so that fumes, moisture and dirt cannot shorten their life. The ball bearings and other bearings of bronze graphite inserted bushings with ample provision for self lubrication are so placed that if it becomes necessary to remove them they are readily accessible.

Slitting Gage for Rotary Shear

A new slitting gage for a rotary sheet metal shear is being placed on the market by the Niagara Machine & Tool Works, Buffalo, N. Y. The accompanying illustration shows the application of the gage to a No. 2 Niagara slitter.

The gage permits of keeping the work being fed into the machine at a predetermined distance from the cutters. The

The Gage Is Set by Turning a Nut on the Gage Block.

guideway of the gage is arranged horizontally on the front face of the machine and is integral with the frame. A guide block is movable longitudinally in the guideway and may be clamped thereto at any point. Detachably secured to the upper part of the block there is an angle-iron wear strip arranged transversely of the machine and this fits into an abutment that is made integral with the guide block. When circle and ring cutting, the guide block and its wear strip may be quickly removed by sliding them forward until the head of the clamping bolt is disengaged from the guide. Ordinarily, however, it is sufficient to merely slide the gage rearwardly out of the way. There is but one adjustment to make in setting the gage, namely, turning the nut on the gage block. The gage cannot be thrown out of adjustment when accidentally moved along the guide and the large area of contact between the block and the guide eliminate the tendency of the block to slip longitudinally after the adjusting nut has been tightened.

William Moody has left the Cramp and Sons plant in Philadelphia for Charles C. Moore & Co., San Francisco, Cal., which is the Pacific Coast branch of the Babcock & Wilcox Co.

Horace B. Spackman, president Allegany Ore & Iron Company, owned by the Lukens Steel Company, was elected president of the Eastern Pig Iron Association at its monthly meeting in Philadelphia on December 2.

O. C. White, formerly agent in the Fort Worth, Texas, territory for the Youngstown Boiler & Tank Company, Youngstown, Ohio, has been appointed sales manager in the Southwest, with headquarters at 801 North Houston Street, Fort Worth.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *Woolworth Building, New York City.*

Pressure for Oil Burning

Q.—With what pressure (pounds per square inch) is the oil to be sprayed from oil burners (specific gravity of oil, 0.89)?—L. T.

A.—In burning liquid fuel, it is necessary to obtain a proper mixture of oil and air for its combustion. This is done by the use of a burner or atomizer which reduces the fuel oil into a spray, by the aid of a steam jet or compressed air. The oil is pumped into a settling tank wherein it is usually heated to a temperature of about 180 degrees F., which is done by means of a steam coil. This heating process separates the water from the oil and causes the oil to flow freely. Strainers are used to separate the grit and dirt from the oil, as any small particles of this nature would affect the operation of the burner. Strainers are made of wire cloth and are placed in the service line leading from the storage tanks to the oil pump.

A common method of spraying the oil is with a steam jet and the atomizers or burners are similar to those using compressed air. In the compressed air type the air jet may be inside or outside the jet of oil as it flows through the burner. The air pressure required is not very high; with an ordinary fan blower it is less than 1 pound per square inch and with an air compressor from 20 to 25 pounds per square inch. Additional air which should be preheated is introduced into the furnace to promote perfect combustion.

Straightening Buckled Plates and Frames

Q.—Will you give me a little advice on straightening light plates that are badly buckled and twisted, also locomotive frames that are 7/8 inch to 1 1/2 inches thick that have been bent after they have been through the straightening rolls?—"Boilermaker."

A.—The straightening of light sheet steel or boiler plate will prove a disagreeable job to anyone unfamiliar with such work. There are two ways or a combination of these by which plates or sheets are buckled or bent. Before hammering a buckled sheet determine the extent and shape of the way the plate is buckled and further consider where the blows should be struck to remove the buckle; otherwise if this is not done, and, if the blows are not struck in the right place, the buckle will be worse and it will be extended over the flat sections.

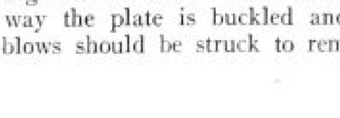


Fig. 1.—Showing Buckle on Edges

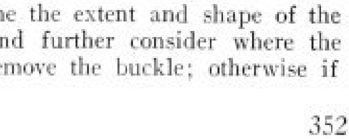


Fig. 2.—Showing Buckle in Center of Plate

In Fig. 1 the plate is bent up and buckled along the edges, therefore the hammering must be done from the middle of the plate working the buckle out toward the edges of the plate. To remove the buckle as in Fig. 2, the blows must be reversed, striking from the edges and working the heaviest blows from this section to very light ones at the center, as the buckle is taken out. Heavy blows must not be struck, many light blows being better than fewer heavy ones.

Also be careful not to allow the face edge of the hammer or sledge to cut into the metal. In particular work where a smooth surface is essential use a flatter. The plates can also be run through straightening rolls or ordinary bending rolls several times which will cause the buckles to run into smaller ones; after this they can be hammered out with less work.

The straightening of the frame you refer to would depend on the way it is twisted, if the twist cannot be taken out cold in the rolls heat it slightly at the point where the twist is the greatest and place it under a steam hammer giving it a few blows either away or toward the twist according to the way it is bent.

Development of Spout for Settling Tank

Q.—Will you please give me a method of laying out the settling tank shown in Fig. 1?—J. L. F.

A.—This problem as I understand it should be developed as illustrated in Figs. 2, 3 and 4. In Fig. 2 an end and side elevation shows the spout A intersecting a cylinder B. The shape of the spout is a section of a frustum of a cone intersecting the cylinder so that the axis a'-a' of the cone is parallel with the center line of the cylinder. By this arrangement, it is necessary to find in the side view the shape of the miter line as shown at e"-b". To accomplish this, consider a number of parallel planes, the edges of which are shown in

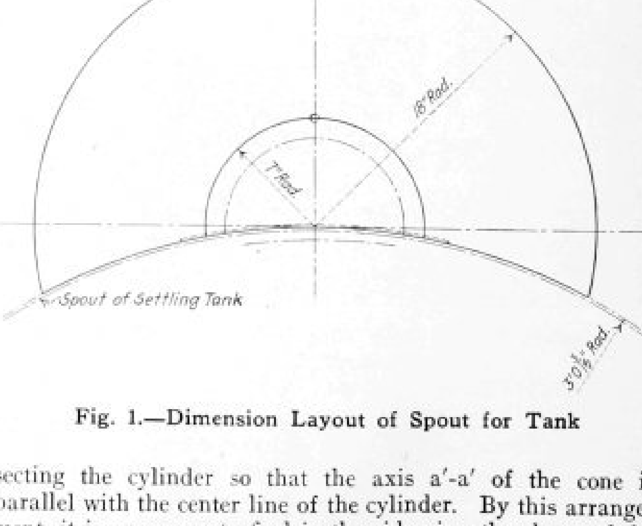
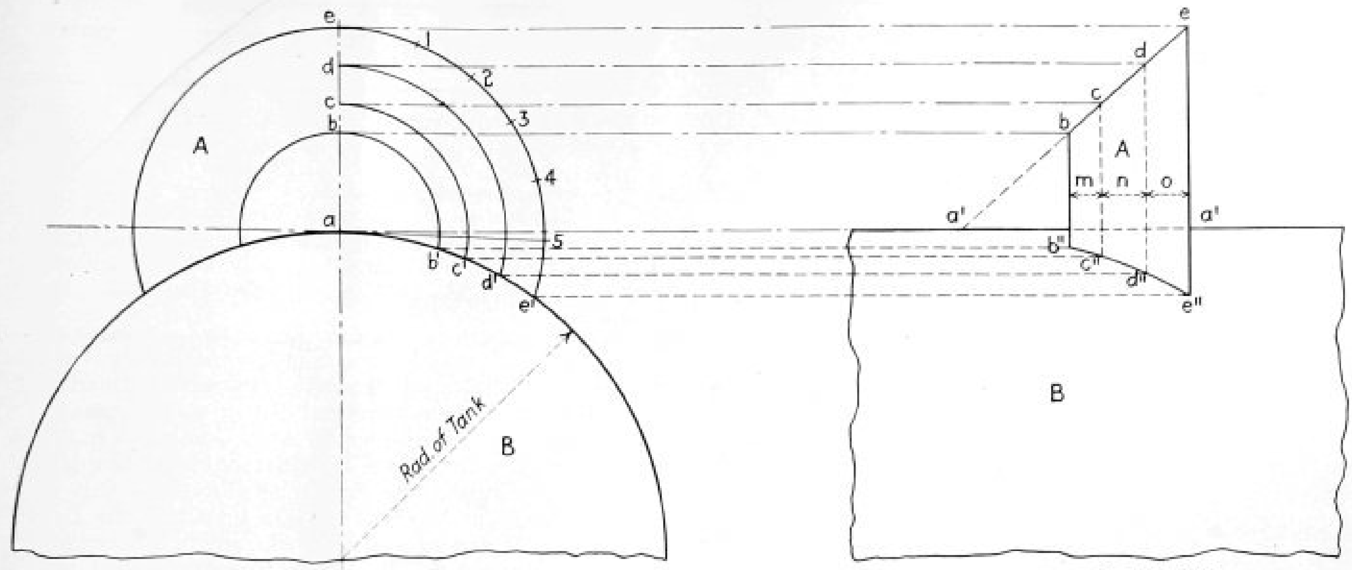
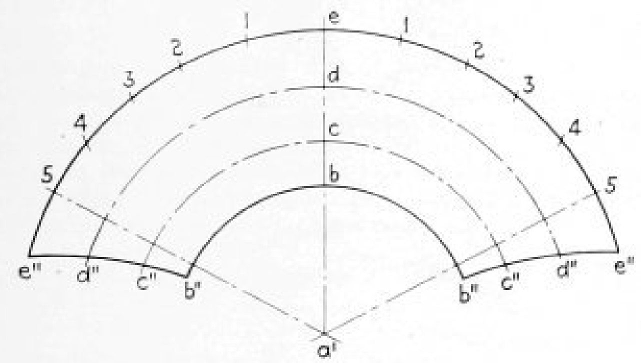


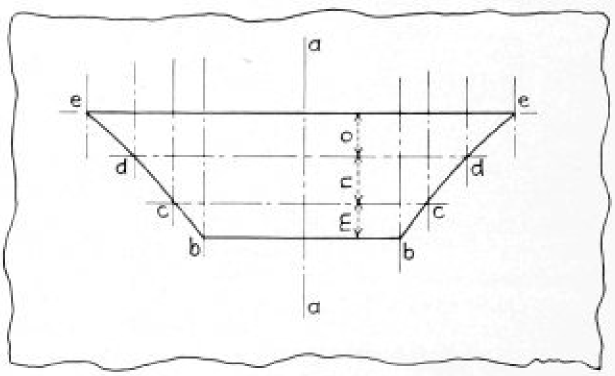
Fig. 1.—Dimension Layout of Spout for Tank



END ELEVATION FIG. 2 SIDE ELEVATION



PATTERN FOR SPOUT BODY
FIG. 3



DEVELOPMENT OF OPENING IN CYLINDER
FIG. 4

General Method of Developing Spout

the side elevation from e to e″, d to d″, c to c″ and b to b″ to be passed through the conical section. The shapes of the sections of the cone are parts of circles as shown at e-e′, c-c′, d-d′ and b-b′ of the end view.

Project the points b′, c′, d′ and e′ (which are the intersecting points between the planes and circle end view) to the side elevation intersecting the planes at b″, c″, d″ and e″. Draw in the miter between these points. From the views, Fig. 2, develop the patterns in Figs. 3 and 4. Fig. 3 is the layout for the pattern of the spout. Draw a straight line a′-e and from a′ set off points b-c-d and e making the distances between equal respectively to a′-b, a′-c, a′-d, a′-e of the line a′-e of the side view, Fig. 2. With a′ as a center, Fig. 3, draw arcs from points b-c-d and e. Lay off the stretchout on the base e-e″, Fig. 3, making it equal to the arc length e-e′, Fig. 2, of the end elevation. This may be done by spacing the arc as at 1-2-3-4 and 5, Fig. 2, and setting off corresponding lengths in Fig. 3. Then draw the line a-5 in Fig. 2 and a′-5 in Fig. 3. From a-5, Fig. 2, transfer the arcs 5-e′, d′, c′, b′ and locate them at 5-e″, d″, c″, b″, Fig. 3. Draw in the curve e″-b″ which gives the true shape to miter with the cylinder.

The pattern or shape of the opening in Fig. 4 is made in the plate for the body of the tank. Lay off a straight line a-a and from this line set off the arc lengths a-b′, a-c′, a-d′, etc., taken from the end elevation. From a base line e-c of Fig. 4, set off the distance o, n, m taken from the side elevation, Fig. 2. The intersection of the construction lines locates points b-c-d-e which gives the outline for the opening. The strainer supports can be laid off directly from the side view, Fig. 1.

Gusset Layout for Blast Pipe

Q.—I am inclosing a sketch, Fig. 1, of a part of a bustle pipe showing the blast pipe connected to the bustle pipe by means of a gusset, *G*, which is riveted to the blast pipe, *A*, the outside pipe, *B*, and inside pipe, *C*. The center lines of these pipes are inclined at an angle of 15 degrees from the horizontal, while the center line of the blast pipe is square or 90 degrees with center line of pipe *B*. The center line of the gusset lies in the center of pipe *B*, 2¼ inches above the center of the blast pipe. Kindly give me the best method for developing the gusset.—R. J. W.

A.—The developments, Fig. 2, illustrate the principles of projection as applied in examples of this kind. Fig. 2 is not laid off exactly as Fig. 1, as the center line of the gusset is brought to intersect in line with the intersection of the center of the blast pipe. This arrangement does not affect the construction as the steps in the development are the same in either case. Having laid off the elevation showing the outline of the pipes and gusset in their proper relationship, the next step is to show a section through the center of the gusset, on line X-X. This view is the profile taken at right angles to X-X. It is a one-half ellipse having a minor diameter X′-X′ equal to the diameter of the bustle pipes and a one-half major diameter equal to 1-5, the greatest width of the gusset **G**. With these dimensions, describe a circle or semi-circle using the lengths 1-X′ for the minor axis and 1-5 for the major length. Divide the axes into equal parts and draw projectors from the points on these axes to intersect as at

1-2-3-4 and 5 in the profile view. These points are then projected to the gusset G. The miters between the gusset and pipes are straight lines, therefore the pattern of the

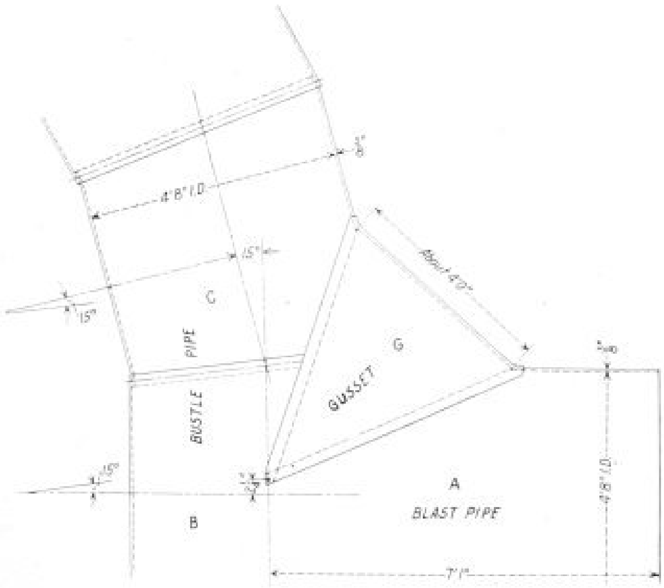


Fig. 1.—Gusset Connecting Blast Pipe to Bustle Pipe

gusset can be laid off as shown to the right of G. At right angles to X-X in the pattern draw lines from a-b-c-d, etc. The distances between these points are equal to those between points 1-2, 2-3, 3-4 of the profile view.

In Fig. 2 is also illustrated the pattern layout for the blast pipe. Line Y-Y is made equal in length to the circumference of pipe A and from the miter in the elevation, projectors are drawn from 1'-2'-3'-4'-5' to intersect the circle. The arc lengths are then transferred to Y-Y of the pattern. Draw the construction lines from the points Y-Y and transfer the lengths of the corresponding lines in the elevation, making allowances for lap seams.

BUSINESS NOTES

The Rich Tool Company, Chicago, Ill., has appointed the Busch Corporation, St. Louis, Mo., its representative in the St. Louis territory.

The Combustion Engineering Corporation, New York City, has opened two new branch offices—one at 216 Latta Arcade, Charlotte, N. C., in charge of T. E. Nott, and one at Seattle, Wash., through Fryer-Barker Co., 1133 Henry Building.

The Westinghouse Electric and Manufacturing Co. has announced the following changes in its service department: B. B. Burkett has been appointed district service manager in the Seattle office, succeeding N. P. Wilson, who has been transferred to sales service activities on switchboards and similar apparatus in the Seattle territory; the Salt Lake service department has been made a branch of the Denver office under the direction of A. F. Maccallum, district service manager, Denver. M. R. Davis, formerly district service manager at Salt Lake, will remain at Salt Lake and devote his time to field-service work and to securing repair business for both shops.

Geo. L. Bourne and Fred A. Schaff, president and vice-president, respectively, of the Superheater Company, New York, have just returned from Paris where they have formed as a French connection the Compagnie des Surschauffeurs, which has been given full rights for the sale and manufacture of the "Elesco" superheaters and forged return bends controlled by the Superheater Company, for locomotive, marine and stationary service.

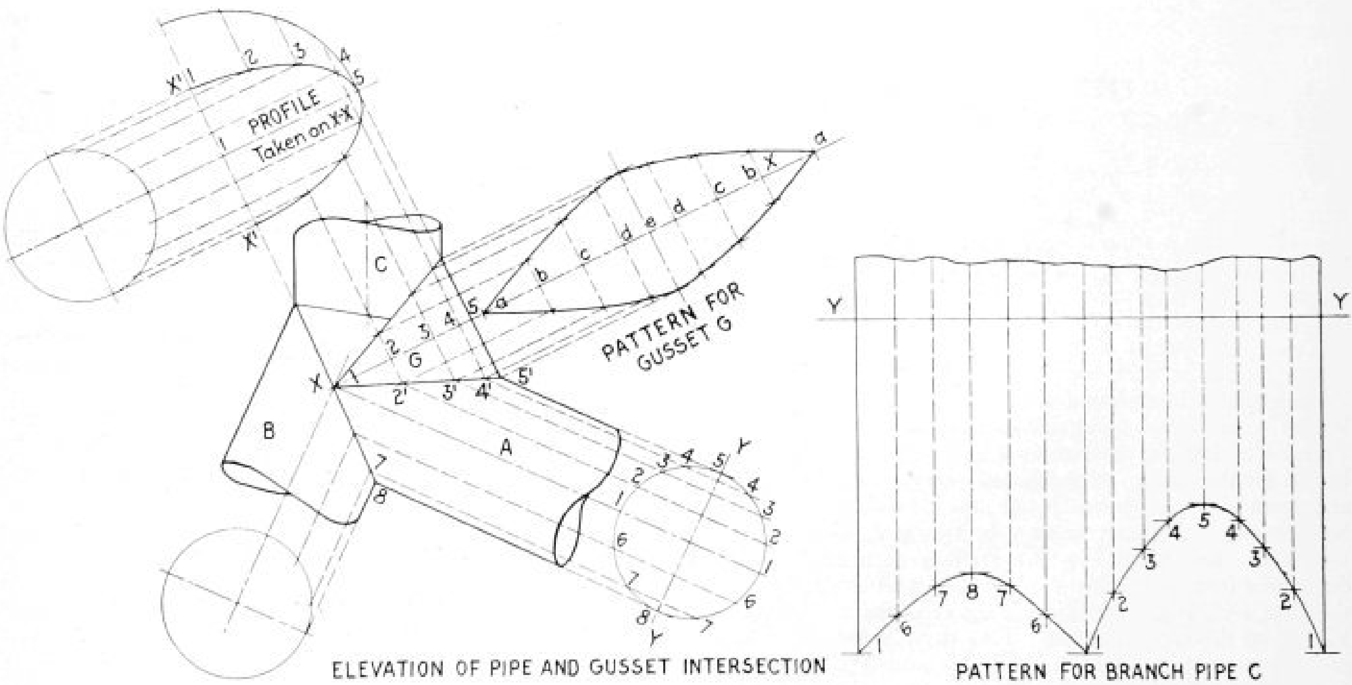


Fig. 2.—Development of Gusset Patterns

Robert Arthurs, 122 Berkeley Street, Ontario, Canada, has recently opened the only floating boiler shop in Ontario. In addition to this floating outfit, a second shop is operated by Mr. Arthurs near the waterfront. Previous to his connections in Toronto, Mr. Arthurs was one of the leading boiler makers in Washington, Pennsylvania, and later master mechanic for the Canadian Stewart Company.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Information for Apprentices

Q.—When applying a patch to a firebox sheet, should the defective part be cut out, or is it practicable to apply the patch over the defective part without removing it?

A.—The defective part of the firebox sheet should always be cut out so as to permit the patch to come in direct contact with the water within the boiler. If the patch is applied over the defective part without removing the latter, the patch will become overheated by the flames, and hot gases which come in contact with it. Patches can, however, be applied to certain parts of the boiler not exposed to the flames and hot gases without removing the defective part. Patches applied without removing the defective sheet are generally found behind the grate bearing bars on the mud ring, which is below the fire line. It is better in applying a patch, when it is possible to do so, to have all of the patch come in direct contact with the flames and hot gases, or have all of the patch below the fire line. Patches designed in such a manner that they come half below the fire line and half above, are hard to keep tight on account of the inequality in expansion and contraction.

Q.—What is grooving?

A.—Grooving is a form of boiler deterioration usually occurring near seams or bends. The plate is deeply scored with grooves having irregular edges.

Q.—What is pitting?

A.—Pitting is the eating or wasting away of the plates in small spots.

Q.—What is corrosion?

A.—Corrosion is a general term to include all forms of chemical decomposition or eating away of the parts of a boiler. There is both internal and external corrosion; the former is the agent which does the greatest damage. I am of the opinion that all braces, stays, etc., should be made one-eighth larger than calculated diameter due to the losses by corrosion.

Beading Locomotive Flues

Q.—Why are flues beaded on the firebox end and rarely on the smokebox end of a locomotive boiler?

A.—The beading of the flues on the firebox end increases the holding qualities, and also prevents the ends from becoming overheated, and burning off. They are not beaded on the smokebox end because by the time the hot gases reach this point, the temperature has been reduced to below the burning point of the metal. Further, the gases at the smokebox end of the flues are passing out instead of coming into the flues, and thus impinge less on the edges of the flues in the smokebox end. However, it is customary to bead all superheater flues in the smokebox end, and ten percent of all small flues adjacent and surrounding the superheater flues. The beading of a flue increases its factor of safety from 200 to 400 percent. The holding power of an expanded tube is from 15,000 to 22,000 pounds, and in some cases greater.

Q.—What is meant by sewing up a crack?

A.—The sewing up of a crack is the installation of a series of screwed plugs in the crack for the purpose of closing it. However, it is not practical to plug a crack over eight inches long.

Q.—What is a mud burnt boiler?

A.—The accumulation of mud or scale in a boiler at any point which prevents the water from reaching the sheet causes mud burns. If the sheet is in contact with the flames and hot gases and the mud accumulates in quantities, the sheet will become overheated and bulge.

Canton, Ohio. George L. Price.

Top Heating for Flange Work

While looking over some of the past issues of The Boiler Maker recently, I came across an article by Charles A. Norton on the "Cause of Cracks in Tube Sheet Flanges" which interested me very much. He stated that he had had trouble with the flanges in boiler sheets cracking and after trying for some time to locate the cause, decided that it was the use of hemlock wood as a covering in heating the metal.

In my work I have never used hemlock for top heating, but have tried nearly every other possible wood for this purpose and have had excellent results. When I was running a flange fire and fitting up at Creston, Iowa, for the Chicago, Burlington & Quincy railroad, my father was foreman (from 1872 to 1885) and to obey his orders I had to heat with charcoal. This practice was carried out for eight years, and we had good success and annealed every sheet when flanged. We used oak and maple wood to heat with. In straightening sheets, I used wood blocks with a ¾-inch pipe handle. I was not allowed to use flatters or steel hammers and did not put the sheets on a cold cast iron slab to buckle them all up. We had a fine pulverized cinder bed to lay them on and they were soon hot. Many times we did not have to hit the sheet once, for they were made to form and straight. After, we used hard maple malls with heavy iron pipe for bands, riveted through with four ⅝-inch rivets. We hardly ever had any sheets crack out even from rivet holes in the firebox.

Later I used coke and coal with a light wood top fire. The coal had too much sulphur in it and that crystallized some of the sheets so we had a few cracked flanges that were caused by the sulphur and overheating the metal.

On some fire door holes one time we had quite a struggle. To start with we cut out a small hole in the sheet, 2¾ inches by 4¾ inches, and flanged it out with 8 pound malls to 14½ inches by 19½ inches oval, making a 7½-inch flange so that the flange would come through the outside head and avoid having a row of rivets in the water space.

Upon coming west to California, I was employed by the Southern Pacific at Los Angeles where we used coal with charcoal and wood for the top fire with much success. Also I was employed at San Bernardino, Cal., for the Santa Fe railroad doing the same work as the Southern Pacific. Here I went back to my hard wood malls as they made the neatest flanges and were less trouble to straighten; for when I used a sledge and flatter it stretched the metal so that when we annealed a sheet there were buckles in it until taken out with the wood flatters.

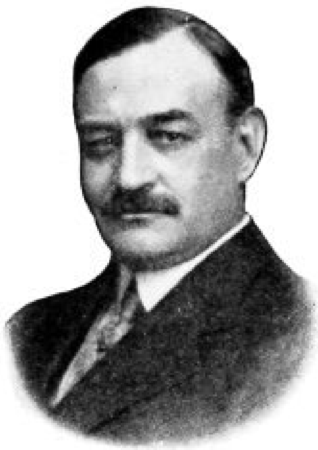
It is now nearly eleven years since I have done any boiler work, but I have been operating all kinds of boilers since then and am always greatly interested in the experiences of my old friends in the shop.

Los Angeles, Cal. Joe B. Holloway.

OBITUARY

The death of Jarrot Prator Dugger, former secretary of the Kewanee Boiler Company, Kewanee, Ill., has been announced by the company. Mr. Dugger died October 29.

B. E. D. Stafford, general manager of the Flannery Bolt Company, Pittsburgh, Pa., whose death occurred on November 30, at Atlantic City, N. J., was born in 1866 in Brooklyn, N. Y., and was educated in the public and night schools. At the age of 15 he took up patent office drawing and soon became an expert penman. During his period of training he acquired a practical knowledge of the machine tool and screw making trades and within a few years ranked as one of the few expert operators in America of the universal type of milling machine and the automatic screw machine. At the age of 21 he was made foreman of the tool shop of a large manufacturer of cotton machinery at Hopedale, Mass., and built most of the automatic machinery for the plant. Later he became a specialist in reducing shop costs, and in 1895 was engaged by B. M. Jones & Company to demonstrate the uses of self-hardening steels. Five years later he was employed as a staybolt salesman by the Ewald Iron Company. In the fall of 1904 Mr. Stafford was engaged by the Flannery Bolt Company to develop and market the Tate flexible staybolt for locomotive firebox service. During the time he has been identified with that concern, Mr. Stafford has done much to advance the methods of locomotive firebox construction. Mr. Stafford lived in Millville, N. J., and funeral services and burial were in Vineland on the morning of December 3.


B. E. D. Stafford

Acetylene Association Report on Gas Welding

(Continued from page 345)

very much during the past two years. Forgings have been trimmed practically to dimension and in some cases cutting has been so developed that intricate shapes such as connecting rods have been cut out with the torch.

Cast iron cutting is an extremely interesting development of the past several years, with the real service work limited to the past two years.

Although cast iron cutting is more expensive than is the actual preparing of the work by compressed air tools, it is certainly very economical in the above case when we consider that two operators must stand by at an expense of ten dollars to fifteen dollars a day each.

One of the interesting developments is the use of automatic machines for welding tubing from strip steel.

Problem of Training Welders

It is gradually being discovered that welders cannot be made in six weeks, except for the simplest operations. While there is not complete agreement as yet on the best methods of training welders, the work is being crystallized and the condition will improve rapidly as soon as those vitally interested appreciate the need of proper and thorough training not only in the actual handling of the apparatus, but also in the fundamental principles involved.

During the past two years, considerable progress has been made in the study of the fundamental problems of gas welding, such as the best quality of welding wire, the necessity for a satisfactory quality of steel plate for welding, and other problems which are strictly research matters.

Already progress has been made in this direction, but much remains to be done. Your committee hopes that active cooperation of the members may be secured in furthering these very important matters.

Composition of Welding Wire

Research on the proper composition of welding wire seems to show that ordinary straight carbon steel is not the best metal for the purpose, but that alloy steel of the proper composition should be used if the best results are to be obtained. This is very important and the subject requires a large amount of experimenting, but there is no question that the better results may be expected within a reasonable time.

Boiler Welding Repairs in England

(Continued from page 340)

The section was therefore scrapped and a new one fitted. Since the time the repair was made the firm that carried out the attempt has installed a heating furnace at its works to use with this form of repair. The whole section is first put into the furnace and raised to a red heat, the casting is then withdrawn and the crack immediately welded up by the oxy-acetylene process. The section is at once put back into the furnace and the fire allowed to die out. It is stated that the cost of carrying out this form of repair is about equal to a new section, but it is reported to be successful and may with advantage be adopted when new sections cannot be readily obtained.

General Note on Boiler Repairs

From the examples of repairs given it will be seen that the National company will sanction repairs to parts in compression and, within limits, to parts that may be in tension but are adequately stayed. In such cases the extent of the defect and the degree of staying will have an important bearing on the question whether a repair by welding is allowable. For instance, in a case of grooving in the front-end plate, referred to in the foregoing, short isolated grooves that are clearly distinguished and do not amount in the aggregate to any considerable length may safely be repaired, while similar grooving, where it has extended to a greater length and when the full extent is difficult to determine, must be regarded as outside the scope of such repair.

In the same way the degree in which a flat plate is stayed must be taken into consideration when defects in such parts as angle rings or flanged end plates have to be dealt with. Grooving in the flange at the circumference of a dished end is, for example, more serious than grooving in a similar position in a Lancashire boiler, because in the latter case the end plate is stayed with gussets. In either a proposal to repair grooving at the circumference of an end plate would require to be considered fully and should be submitted to the chief engineer for consideration.

Provided the work is satisfactorily carried out the inspectors of the National company may approve of the repair by welding of such defects as cracks in furnace tubes and stayed flat end plates, grooving in the same parts, wasting of the flanged seams of flue tubes, wasting of furnace rings such as often occurs about the firebar level and for reinforcing wasted or pitted plates provided they are not in tension, or are effectually stayed.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspector—J. M. Hall, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

President—A. G. Pratt, Babcock & Wilcox Company, New York.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg. Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.

Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry street, Bloomington, Ill.

Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 Clarence avenue, Oak Park, Ill.

Secretary—Harry D. Vought, 26 Cortlandt street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood avenue, Columbus, Ohio.

Executive Board—John F. Raps, general B. I., C. R. R., 4041 Ellis avenue, Chicago, Ill., chairman.

TRADE PUBLICATIONS

Drill Chucks.—Three circulars describing ball bearing, geared, and two jaw drill chucks have been sent out by the E. Horton & Son Company, Windsor Locks, Conn. Price lists are given, as well as the specifications.

Radial Wall Drills.—Bulletin No. 206 has been issued by the Pawling & Harnischfeger Company, Milwaukee, Wis., describing a new type radial wall drill recently perfected. Examples of interior and exterior drilling of large steel drums and the drilling and reaming of structural material are given as well as dimensions, drawings and data on the machines.

Sectional Watertube Boilers.—The Almy Watertube Boiler Company, Providence, R. I., describes the various type boilers produced in its plant for steamship and stationary work. Lists of vessels in which these boilers are fitted are given and numerous illustrations of steam yachts, houseboats, steam auxiliary schooners and the like.

Tube Facts.—The manufacture of condenser tubes at the works of the Scovill Manufacturing Company, Waterbury, Conn., is taken up in detail in a booklet recently issued by this company. Season cracking and corrosion are the two principal causes of the failure of condenser tubes. In the Scovill laboratories investigations are being carried on continually to determine and eliminate causes of weakness in the structure of the metal. Modern manufacturing processes to a great extent eliminate many of the defects. Production of seamless tubing by both the drawing and cupping processes are outlined, as well as the production of Scovill Admiralty tubes. Special alloys, as bronze, nickel silver, naval brass, and the like, are made into Scovill tubing, as well as the condenser work.

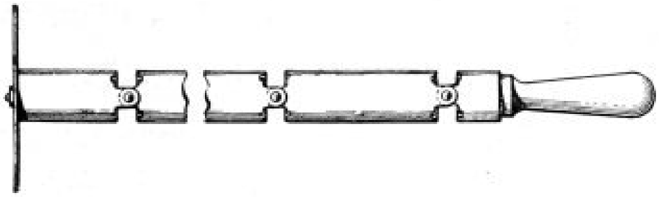
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Hutchinson.

1,388,560. FURNACE CLEANER. JAN DE GRAFF, OF DETROIT, MICHIGAN.

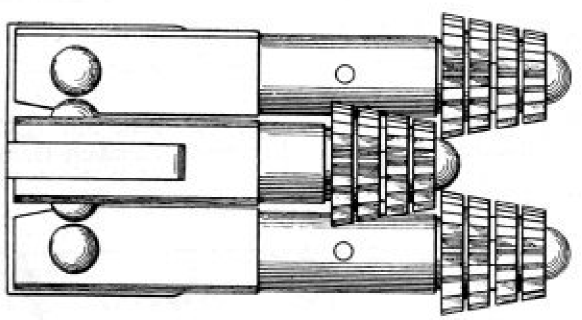
Claim 1.—A flexible device comprising a plurality of tubular members



having apertured ears at the end thereof, pins connecting the apertured ears of one member to the ears of an adjacent member, caps on the confronting ends of said members, and prongs carried by said caps engaging the outer sides of said members between said ears. Three claims.

1,393,613. CUTTER FOR TUBE CLEANERS AND OTHER PURPOSES. WILLIAM S. ELLIOTT, OF PITTSBURGH, PENNSYLVANIA.

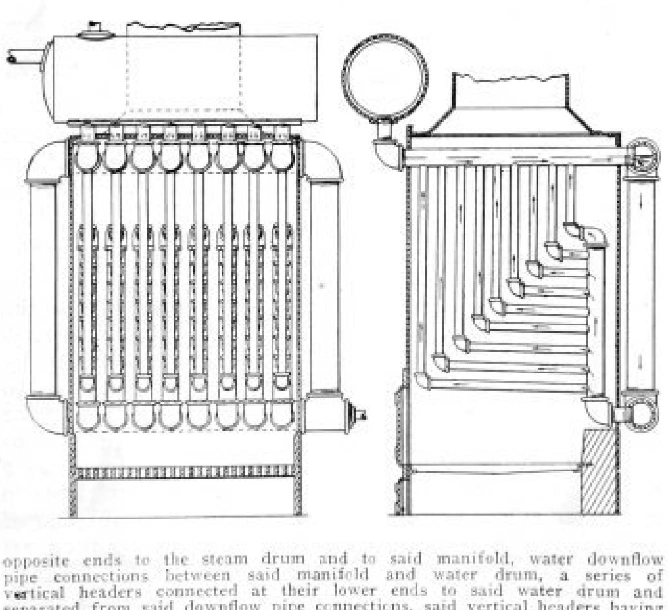
Claim 1.—As a new article of manufacture, a cutter for the purposes described, said cutter comprising a frusto-conical body having peripheral



teeth extending longitudinally thereof, some of said teeth being staggered with respect to others thereof and said body being composed of a plurality of separate endwise abutted sections having interlocking engagement with each other, whereby the sections are maintained in fixed relation to rotate as a unit about a common axis, substantially as described. Two claims.

1,356,162. PIPE BOILER. THOMAS H. LEE, OF BREMERTON, WASHINGTON.

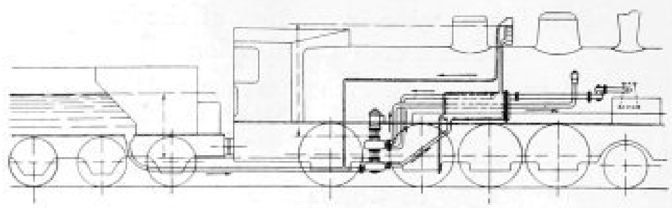
Claim 1.—In a steam boiler, the combination with the steam and water drums, of a manifold, a series of horizontal headers connected at their



opposite ends to the steam drum and to said manifold, water downflow pipe connections between said manifold and water drum, a series of vertical headers connected at their lower ends to said water drum and separated from said downflow pipe connections, said vertical headers having their upper ends terminating at a distance below said horizontal headers, and steam generating tubes connecting said vertical headers with said horizontal headers. Three claims.

1,391,308. MEANS FOR SUPPLYING STEAM BOILERS WITH FEED WATER. SEBASTIEN OTTO ALFRED FIEDLER, OF PARIS, FRANCE, ASSIGNOR TO L'AUXILIAIRE DES CHEMINS DE FER ET DE L'INDUSTRIE, OF PARIS, FRANCE.

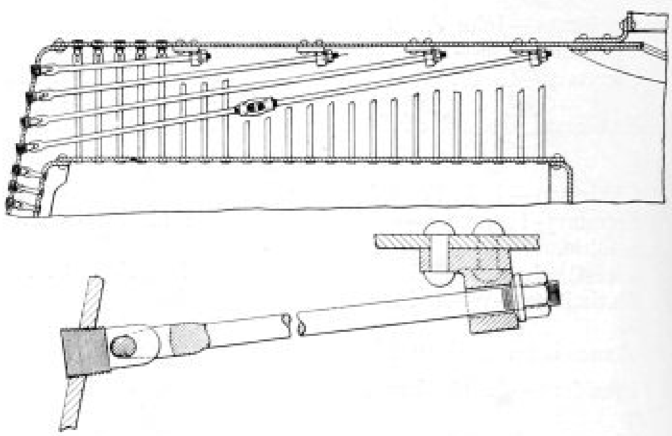
Claim 1.—An installation for supplying steam boilers with feed water, comprising in combination a feed water tank, a tandem pump having a cold



water cylinder and a hot water cylinder, a water-heater, an expansion vessel in communication with the atmosphere at its upper part, said expansion vessel being located on a level higher than both the level of the feed tank and the level of the hot water cylinder of the pump, means connecting the inlet of the cold water cylinder of the pump to the feed tank and the outlet to the water-heater, means connecting the inlet of the hot water cylinder of the pump to the water heater and the outlet to the boiler, means for connecting the lower part of the expansion vessel with the water heater at the highest point which can be reached by the water in the latter and means for establishing a communication between the upper part of the expansion vessel and the feed water tank. Three claims.

1,389,889. BOILER BRACE. ROBERT J. McKAY AND FREDERICK R. COOPER, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO THE BREAKLESS STAYBOLT COMPANY, OF McKEES ROCKS, PENNSYLVANIA, A CORPORATION OF DELAWARE.

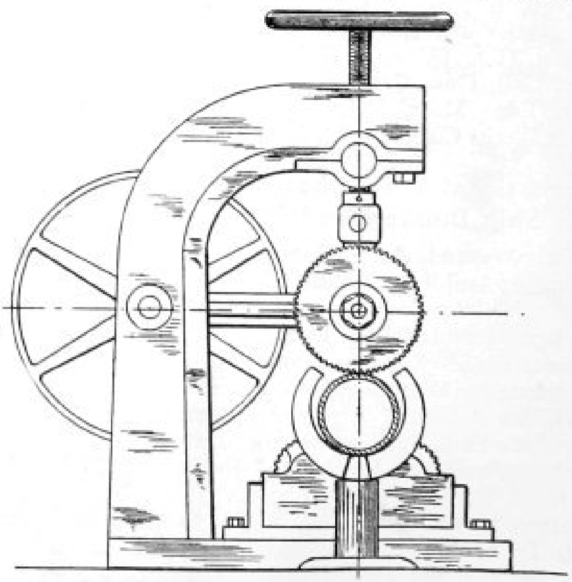
Claim 1.—The combination of a bracket secured to the inner wall of the



top boiler or roof-sheet, a diagonal stay-rod loosely and detachably fastened to said bracket, a plug in the boiler head flexibly connected to the rod, said stay-rod and flexible connection being sufficiently small to pass through the plug opening in the back boiler-head, whereby the rod and its flexible connection may be inserted through the plug opening and the parts connected, though slightly out of alinement. Three claims.

1,388,309. BOILER TUBE CLEANING DEVICE. JAMES ROSS, OF CHICAGO, ILLINOIS.

Claim 1.—A pipe cleaning machine comprising means for supporting a



pipe and a rotary cutter having teeth arranged spirally there around whereby rotation of the cutter simultaneously removes the scale and traverses the pipe over the supporting means. Seven claims.