

INDIAN BOILER REGULATIONS, 1950.

COC 43] of inbia EXTRAORDINARY PART 11—Section 3 PUBLISHED BY AUTHORITY NEW DELHI, FRIDAY, SEPTEMBER 15, 1950 GOVERNMENT OF INDIA MINISTRY or WORKS, MINES AND POWER CENTRAL BOILERS BOARD NOTIFICATION BOILERS New Delhi, the 15th September 1950 S.R.O. 1300 .—in exercise of the powers conferred by section 28 of the Indian Boilers, Act, 1923 (V of 1923), and in supersession of the Government of India Notification No. A. 470, dated Simlo, the 27th October 1923, the Central Boilers Board is pleased to make the following Regulations, the same having been previously published as required by sub-section (I) of section 31 of the said Act, namely : REGULATIONS PRELIMINARY 1. Short Title, Extent and These Regulations may be called the In lian Boiler Regulations, 1950. (2) They extend to the whole of India, except Part B States. (3) They shall come into force at once



2. Definitions.—In these Regulations, unless the context otherwise requires,— (a) the "Act" means the Indian Boilers Act, 1923 ; (b) "accident" means an explosion of a boiler or steam-pipe or any clamage - \$0 a boiler or steam-pmpe which is calculated to weaken the strength thereof so as to render it liable to explode ; (c) • "boiler" means any closed vessel exceeding five gallons in capacity which is used expressly for generating steam under pressure, and includes any apparatus



forming an integral part of a boiler, which is wholly or partly exposed to the action of the flue gases for purpose of recovery of waste heat, and also includes any mount- ings or other fittings attached to such vessel which is wholly or partly under pressure "ithstanding anything contained in section 2(b) when steam is shut-off but not of the Act does not include an econmuiser as defined in clause (cc) of section 2 thereof. (d) "Chief Inspector" and "Inspector" mean, respectively, a person appointed to ae a Chief Inspector and an Inspector under the Aet ; (e) "economiser" means any part of a feed-pipe that is wholly or partly exposed the action of flue gases for the purpose of recovery of waste heat ; [607] dog INDIA (f) "feed-pipe" (i) moom any pipe or connected fitting wholly or partly under preasure through which feed-water passes directly to boiler. (ii) every reference to a steam pipe or steam pipes shall be deemed to include also a feed-pipe or feed-pipes respectively ; (g) " Inspecting Authority " means on authority recognigecl by the Central Boilers Bourd us competent to grunt certif cate in Form J (h) "Inspecting Offcer" means— (i) in respect of material monufactured 01' boilers m any Stote an omer appointed by the Tnspecting Authority in that State. (ii) in respect of moterial munufactured or boilers conetructed outside the States offcer acting on behalf of the Inepecting Authority ; (i) i 'owner" includes any pergon using a, boiler 8B agent of the owner thereof ancl any person using a, boiler hich he has hired or obtained on loan from the owner thereof; (3) "prescribed" means prescribed by regulations or rulee made under the Aot ; (k) "Steam-pipe" means any main pipe exceeding three inchee in internal dia- meter through which etoam passes directly from a boiler to o prime-mover or other first user, and includes any connected fitting of steam-pipe ; (l) "State" or "States" Inean 1--1 State or the Statea to which these regulations extend ; and (m) " Structural alteration, addition or renewal" shall not be deemed to include any onowal or replacement of petty nature when the part of fitting uscd for re- placement is not inferior in strength, emciency or otherwise to the replaced part of fitting. LI't of Inapertmg AuthorLtnegr recogniBed by the Oentral Bollera Board. gee Appell(1lh (J

CHAPTER 1 GENERAL REQUIREMENTS, APPLICATION OF STANDARD CONDITIONS AND EXCEPTIONS THERETO 3 (1) A boiler shall not be registered under sub-section (4) of Section 7 of the Act and a certificate shall not be issued under sub-section (5) of that section with reference to a boiler, unless the standard conditions in respect of material, design and construction, are specified in the subsequent Chapters of these Regulations as applied in respect of such a boiler. Notwithstanding anything contained in sub-regulation (1), the Chief Inspector may, subject to the provisions of Regulation 7, register a boiler and order the issue of a certificate authorising the use thereof, although the standard conditions are not fully satisfied in respect of such boiler : Provided that the Chief Inspector shall not register a boiler or order the issue of such certificate, if a structural part of a boiler which is subject to pressure is made of Bessemer process steel of best quality or malleable cast iron. STANDARD REQUIREMENTS 4. (n) Material.—All plates, rivets and bolts used in the construction of a boiler shall be tested and found to conform with the hereinafter contained tables. (b) Construction.—Boilers during construction shall be under the supervision of an Inspecting Officer. (o) Inspecting Authority's certificate.—For boilers imported into the State a certificate from an Inspecting Authority in



Form 11 certifying that the material used shall be furnished to the Inspector before or with the application certificate the Inspecting Authority. Together with such certificate the Inspecting Authority shall furnish a Menu of Inspection book in Form I in accordance with (c), the certificates proscribed, under clauses (i) and (iii) need not be furnished to the Chief Inspector when application is made for registration of the boiler. But should any question arise in respect of the fitness of the boilers for the working pressure approved by the Inspecting Authority within a period of three years from the date of their certificate, the owner shall, if requested by the Chief Inspector, obtain and furnish the original documents specified in the said Regulation. (e) Maker's stamp.—The boiler shall have stamped upon its front plate in a conspicuous position the following particulars:—

Form IV as prescribed in Regulation 26 may be accepted in lieu of a certificate from an Inspecting Authority. The Central Boilers Board shall decide whether for the purpose of this Regulation a maker is "well-known" or not. (d) Certificates, etc. under section 14(1) (c) of the Act. —In advance of or along with an application for registration of a boiler, the following certificates and drawings or specifications should be furnished to the Chief Inspector, namely:— (i) A certificate in Form III of manufacture and test signed by the maker or by a responsible representative of the maker of the boiler containing a description of the boiler, its principal dimensions, particulars of the kind of material used in its construction, the thickness of all plates, the diameter of and method of forming the rivet holes in the shell plates, particulars of any departure from ordinary practice in making the shell such as solid rolling or welding, the hydraulic test to which the boiler was subjected, the intended working pressure, the area of heating surface, the maximum continuous evaporative capacity, the year and place of make, and the works number of the boiler. There may be included in such certificate a further declaration that samples of the angle, stay or rivet bars and rivets used in the construction of the boiler have been certified by the makers to have been tested and found to comply with the requirements of Chapter 11; in which declaration the kind of material used and the limits of tensile breaking strength with which the tests comply shall be stated with sufficient detail. Where such further precision to obviate the risk of confusion in making a declaration is included in such certificate, the detail in clause (iii) of this sub-regulation shall not be required. (ii) A drawing or print to a scale, in the case of large boilers of not less than 1 inch to the foot and, in the case of small boilers, of not less than 1/2 inches to the foot, showing the principal dimensions and a longitudinal section and end view of the boiler, and bearing the works number of the boiler and the maker's office stamp. The drawing shall show details of riveting of longitudinal and circumferential seams with pitch of rivets, cross spacing of rivet rows and diameters of rivet holes: the radii of curvature of dished end plates, fillets of flange and corners of bent plates, and where gusset stays are fitted, the number and diameter of rivet holes in each gusset stay. In the case of water tube boilers, the foregoing scales shall apply to the main boiler drums only, but in addition a general arrangement drawing of the boiler to a scale of not less than 1/2 inch to the foot shall be provided. (iii) A certificate from the steel maker and a certificate from the maker of the plates, rivets or bars, of the nature referred to in Regulations 26 and 27. The certificate from the maker of the plates, rivets or bars, shall show the charge numbers, the plate or bar numbers and the number and dimensions of the various plates, etc., tested, their ultimate tensile breaking strength in tons per square inch of section, the number, kind, elongation and the length on which measured, the other tests made and the date of tests: Provided that where an Inspecting Authority furnishes certificate in Form 11 together with a Menu of Inspection book in Form I in accordance with (c), the certificates proscribed, under clauses (i) and (iii) need not be furnished to the Chief Inspector when application is made for registration of the boiler. But should any question arise in respect of the fitness of the boilers for the working pressure approved by the Inspecting Authority within a period of three years from the date of their certificate, the owner shall, if requested by the Chief Inspector, obtain and furnish the original documents specified in the said Regulation. (e) Maker's stamp.—The boiler shall have stamped upon its front plate in a conspicuous position the following particulars:—

Work number entered to lbs. lbs. Maker's name Year of manufacture In inspecting Certificate or Inspecting Authority's Report, 6. Modification of Under the Regulations for determining the working pressure to be allowed on various parts of boiler, the material to which the formulae apply shall in the absence of express provision to the contrary be steel complying with the requirement of Chapter 11. (ii) Where no test certificates for shell plates and rivets are produced, the material may be treated as iron, if the Chief Inspector is satisfied that the material is of suitable boiler quality. If in such case the Chief Inspector is clearly satisfied that the material is of good quality, a higher strength than that allowed for iron may be permitted but the strength of the shell plates shall not, save for special reasons be assumed to be more than 26 tons. In such cases S and S1 in equations 1, 3 and 4 of Chapter IV may be respectively 26 and 21 for steel and 21 and 18 for iron. For iron across the grain S may be 18. (iii) Where end plates, furnaces, flat plates, girders, gussets and other stays, etc. are made of

For steel or iron for which no test certificates are produced, the working pressure as found from the formulae in which S is to be taken at the lowest limit prescribed for the pressure, reduced by 15 per cent, shall, except where such material is specially provided for in Regulation 17, be the working pressure permitted. For flat plates of copper, the working pressure as found from the formulae, reduced by 50 per cent. shall be the working pressure permitted.

6. Standard specifications for materials.—The standard specifications for steel wrought iron and copper plates and for cast steel shall be those prescribed in Chapter 11, but certificates or test* of material for wrought iron (except for special wrought iron for screw stays) copper and CRIB steel shall not be required unless special allowance is required. Such special allowances shall be in the discretion of the Chief Inspector.

7. Boiler Shells not in accordance with standard conditions.—When the standard conditions are not complied with, additions to the appropriate coefficient as defined in Regulation 176 shall be made as follows: (R) When there are no proofs of test* of steel, 15 per cent. of the standard coefficient. (b) When a boiler has not been inspected during construction by an Inspecting Officer and certified by him, 10 per cent. of the standard coefficient. (c) When the workmanship is in any way doubtful and the Inspector is not satisfied that any of the foregoing additions to the coefficient would be sufficient. THE GAZETTE OF INDIA EXTRAORDINARY 611 to meet the circumstances, such Inspector deems fit. percentage of the standard coefficient as the Chief Inspector Provided that nothing in this regulation shall apply to a hollow forged or a fusion welded drum if it is constructed under the supervision of an Inspecting Authority.

8. Welding.—The use of welding in the construction of boilers shall be permitted only where specifically provided for in the standard conditions.

CHAPTER 11 MATERIALS OF CONSTRUCTION STEEL PLATES, RIVETS AND BARS 9. Process of manufacture.—Structural steel for boilers shall be by the Open Hearth or an electric process, acid or basic. 10. Chemical Analysis. (a) The steel shall contain not more than 0.05 per cent. of sulphur or of phosphorus. (b) A sulphur print test shall be taken from the material of each charge used for rivet bars for the purpose of ensuring that sulphur segregates are not concentrated in the core. The stage in manufacture at which this test is made shall be at the option of the Steel Maker.

11. Freedom from Defects, etc.—The finished material shall be sound and free from cracks, surface flaws and laminations. Hammer dressing, patching or welding is prohibited but this does not prevent the removal of slight scale or shell by the use of chisel, file or buff, providing the material is not reduced to under the specified thickness.

12. Rolling Margin —No plate or rolled section shall be under the specified thickness at any part, nor more than 5 per cent. over the calculated weight, except that in the case of thin plates and wide plates the weight tolerances shall be as set out in the table below. Tolerances for boiler plates. Width in inches Thickness in. 1/4 to under 5/16 5/16 to under 3/8 3/8 to under 7/16 7/16 to under 1/2 1/2 to under 5/8 5/8 to under 3/4 3/4 to under 1 1 to under 2 Under 1 48 60 to 120 120 to 150 150 to 180 180 to 240 240 to 300 300 to 360 360 to 480 480 to 600 600 to 720 720 to 840 840 to 960 960 to 1080 1080 to 1200 1200 to 1440 1440 to 1680 1680 to 1920 1920 to 2160 2160 to 2400 2400 to 2640 2640 to 2880 2880 to 3120 3120 to 3360 3360 to 3600 3600 to 3840 3840 to 4080 4080 to 4320 4320 to 4560 4560 to 4800 4800 to 5040 5040 to 5280 5280 to 5520 5520 to 5760 5760 to 6000 6000 to 6240 6240 to 6480 6480 to 6720 6720 to 6960 6960 to 7200 7200 to 7440 7440 to 7680 7680 to 7920 7920 to 8160 8160 to 8400 8400 to 8640 8640 to 8880 8880 to 9120 9120 to 9360 9360 to 9600 9600 to 9840 9840 to 10080 10080 to 10320 10320 to 10560 10560 to 10800 10800 to 11040 11040 to 11280 11280 to 11520 11520 to 11760 11760 to 12000 12000 to 12240 12240 to 12480 12480 to 12720 12720 to 12960 12960 to 13200 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192400 192400 to 192640 192640 to 192880 192880 to 193120 193120 to 193360 193360 to 193600 193600 to 193840 193840 to 194080 194080 to 194320 194320 to 194

Inch. Where the test piece is over 1 inch diameter, test piece B1 (see App. B) may be used. Any straightening of the test pieces which may be required shall be done cold. The ultimate tensile stress and elongation of the various of not more than 4 in each class of material shall be permitted. Should a tensile test piece break outside the middle third of the test, gauge length the test may be discarded and another test be made of the same plate or bar. But for A and IN butt joints, and gusset plates for flanging or welding of integral stiff angle and tee bars rivet butt. The minimum elongation per cent. Table place A 23 for 26-30 20 for 28-32 20 for 32-36 30 for 28-32 23 for 26-30 20 for 28-32 20 for 32-36 TOBI place B 23 for 26-30 20 for 28-32 20 for 32-36 25 for 23 for 26-30 Test C 28 for 26-30 24 for 32-36 30 for 24-29 28 for 30 17. Number of tests. (a) plates—For plates, butt straps and gusset plates one tensile test piece shall be cut from each end of every plate as rolled. (b) For other plates such as end plates, furnace and flanging plates etc., tensile test piece shall be cut from one end of every plate rolled. (c) Angle, tee, rivet and stay bars.—One tensile test shall be made from each 15 or part of 15 bars rolled of each section or diameter from the same charge, but not less than two tensile tests shall be made unless the total number of bars rolled from the same charge is 8 or less than 8 and the bars are of the same section or diameter, in which case one test shall suffice. For round bars of 11 inches diameter and 1 inch diameter under, the numbers 50 and 20 shall be substituted for 15 and 8 respectively for determining the number of tests required

18. Dump Test.—Short lengths equal to twice their diameter cut from the rivet bars shall, when cold, without fracture being compressed to half their length. A dump test shall be made for each Tensile Test

19. Bend Cold Bends.—Test be sheared lengthwise or crosswise from plate or bar, and shall not be less than 1½ inches wide, but for small bars the whole section may be used. For rivet bars bend tests are not required. (b) In all cold bend tests, on samples ½ inch in thickness and above, the rough edge or arris caused by shearing may be removed by filing or grinding, and samples 1 inch in thickness and above may have the edge beveled, but the test pieces shall receive no other preparation. The test pieces shall not be annealed unless the material from which they are cut is similarly annealed in which case the test piece shall be given fully and simultaneously treated with the material before testing, (c) For cold bend tests the test piece shall withstand, without fracture, being doubled over until the internal radius is equal to 11 times the thickness of the test piece and the sides are parallel, (d) For small sectional material these bend tests may be made from the flattened bar. (e) Bend tests may be made either by pressure or by blows

20. Number Bend Plate.—A bend test shall be taken from each plate as rolled. For plate exceeding 2½ tons in weight, one bend test shall be taken from each end. The bend test from the plate, straps and other plate which have not, to be flanged or worked in the fire or which when in use are not to be exposed to flame shall be cold bend test, (b) Angle Bar.—A cold bend test shall be made from each angle bar (c) Stay Bar.—A cold bend test shall be made from every 15 stay bars as rolled from each charge

21. Manufactured Quality of Material.—Rivets shall be manufactured from steel complying with the aforementioned requirements of this Chapter in respect of rivet bars. (b) Tests. —(i) The rivet shanks shall be bend cold, and hammered until two parts of the shank remain, without fracture on the outside of the bend. (ii) The rivet heads shall be flattened while hot, without cracking at the edges, until their diameter is 1½ times the diameter of the shank. (c) Number of Tests. —10 to 15 per cent of rivets of each size shall be selected by the Inspector or Inspecting Officer from bulk for the above tests

22. Additional tests before rejection. Should the test pieces be rejected by the Inspector or Inspecting Officer not fulfil the test requirements, two further tests of the same kind may be made, but, should either of these fail, the plate or bar from which test pieces were cut, be rejected. In all such cases further test shall be made before any material from the same charge can be accepted

28. Branding.—Every plate and bar shall be clearly and distinctly marked by the maker in two places with an approved quality brand indicating that, the material has complied with the required conditions; and with the number or identification marks by which they can be traced to the charge from which the material was made

24. Defacing of rejected material.—In the event of the material failing in any one to withstand the prescribed tests, the Inspector or Inspecting Officer shall see that the quality brand stamped on the material has not been defaced by punch marks extending beyond the brand in the form of a cross, denoting that the material has been rejected. GAZ* -LINDIA *NA

25. Facilities for identification.—The maker shall adopt a system of marking the ingots, billets, plates, pipes, bars, etc., which will enable the finished material to be traced to the original charge, and the Inspector or Inspecting Officer shall be given every facility for tracing all plates and bars to their respective charges, and for witnessing the required tests. When he is satisfied with the material and with the results of the tests, he shall be furnished with two copies of the advice notes of the material for his signature.



28. Steel not produced where rolled.—Where steel is not produced in the works at which it is rolled, n
certificnte in



Form IV shall be supplied to the Inspecting Officer deputed to witness the testing of the Tn u,terinl, stating the Open Hearth or Electric Procerqs by xvhielh it was [e, the natnerof the Steel Maker who supplied it, BINO the numbers of tho ('hargeg for rferencee to the books of the Steel Maker. The number of tho chau•gre Bhull be murked on each plate or bur for the purpose of identi- fication



27. Maker's certificate.— Before the plans are signed, the maker shall furnish the Inspecting Officer with a certificate in



Form IV guaranteeing that Lho material has been nuode by the Open Hearth or un Electric Process acid or bngio and that it has been gubieoted to, and has u-withstooel satisfaeborily the test above described in the presence of the Inspecting ()ffleet. WROUGHT IRON STAV AND RIVET BARS 28. Rivet Baw.- —The tensile breaking strength shall bo botween 21 and 25 tong with un of not lcsq than 25 per cent. measured on tho standard Tost Piece B (a,s rolled) or per cont . measured on the Test Pjeoc Bl (os rolled)

29. Manufactured Rivet8 Tests.— To comply with Regulation 21

30. Stay Bar8.—The tensile breakfrlg strengih shall be between 21 und 25 tons with elongation of not, less thun 22 per cent., measured on the Standard Test Piece B or 27 per cent. Tnea,surecl on the Standard Test Piece Bl. 31 Stay Bend TegtB.— mo comply with Regulation 19 32. Special Iron for Screw Stays for Fireboxes and Combustion Chambers.—In order t hart, iron gi n.,ys may be H,pproved of the garne size ag would be required for mild steel, the Ilion ust withdlund the following tests:— (a) Tensile Tutg.— -The tensile breaking Btrenchth shall not bo less than 21 \ torw per square inch, with an elongation of not less than 25 per cent. measured on the Standard Test, Piece B 01' 30 por cent. Ineusured on the Standard Test Piece Bl. (b) Bend Testa. —Tosi, pioces (lither of tho bur as rolled, or turned down to I inch shall stand bending cold until the sides Ute parallel oncl the space between the Lwo Bides iN not grent,er than the climneter of the test piece. (c) Number of Tengile Tegu.—The burs as rollod shall bo placed in batches of twenty und one tensile test shall bc t &ken from ach batch. If this is unsutisfactory two other bars Bhall be gelectecl for fest, und should either of these fail tho batch Shull be rojected. (d) Number of Bend Teatg.— One ordinary bond tost Bhall be taken from eaoth batch, and a similar test piece fr•cnn eoeb. batch Shull be lightly ond evenly nicked on one side with sharp cutting tool and bent buck ot this point through an nnglo of 180 dogrees by cgsure or by o succession of Light blows. The fraotuce must be clean, fibrous, free florn sing or dirt or ony coarse crystalline gtructure, If either of those is unsa,tãBfactory, other bars shall be selected for test, and should either of these fail the batch shul-I be rejected. (e) In ull coses the selection of tho test pieces Bhull be mudc bv the Inspector or the Inspecting Officer. OF INDIA COPPER PLATES, STAY AND RIVET BARS AND TUBES 33. Proce88.—Tho copper Shall be fire.reßnod or clcetrolytio, and hoL-rolled from suitable cakes. (b) Chemical Composition.—The plates Bhall contain not legs than 99 per oent. of copper, and hctween •3 0/0 uncl •5 0 of arsenic. (o) Freedom from defect8.—The plntcs shall be clean, smooth and froe from defectg gand Bhull have o workmanlike finish They shall be thor oughly unneolcd. (d) Rolling Margin.—No plute *hull be under the specified thickness at any over the ca Leulbted The scrop margin, partly part, nor more tham 50 sheured ancl left attached, Bhull bc nod ICEH than 3 inches at the ends and 1 } inches ut ench side. (e) Tensile Tegt8. Ono tengile test Shull bo taken from each plato us rolled. The tensile breaking strength, Stuncldß'd Test Piece A, shall not be less than 14 tons per sq. in. •mth an elongai Ion of not less than 350/ (f) Hot and Cold Bend tests. —Ono hot (tornperature between 12000F. and 14000 and one cold hend test, shall hr taken from eoeh as rolled. For either hoL or 001(1 bend i eg18 the test piece shall withstand boing doublem ovel wii,hont fruci ure uni il the sides are touching uncl parallel

34. Stay and Rivet Procæ.—To comply with Regulation 33 (a). (b) Chemical Composition.—To comply Wii h Regulation 33 (b). (c) Freedom from Defect8.—To comply with Regulation 33(0) (d) Rolling Margin. —The bars in any purt shall not be moro than 100 over or more than 1/2 00 under the specified diametel (e) Tensile Teøtg.—The tonsile breaking-sft ength Shull not bc less than 14 tone per sq. in. with an clongotnon of not ICSH thun 400/0 on the Standard Test Piece B. (f) Band Tegte. —To comply wil h Rogului ion 33(f). (g) Durnp Test8. -A piece of rod 1 in. long shall be placed on cnd and hammered or crushcel cold to a thickness of 3/8in. wit hout showing either erack or flow on tho cirournfrence of the rosulting (h) Number of Teßt8.— (One bar, from wLIoh the required test gpacimens shall be token, shall be sole(ted ut runc10111 from each batch of 50 (or purt thereof) bars of ea,eh size from each mc•Jt. From cael) bar gelectcd one i,ensile tegt., onc cold bend test, ono hot, bend test, and one dump test Shull bc Ilibde

35. Tub08 coppor shall be fire-refined or olootrolytio and Nhoil be made ini,o tubes eithel by the hol 'A'olling or cold dra,wmg process.The tubas shall be fifilNhed by cold awing. (b) Chemical Composivion.—To comply with Regulation 33(b). (c) Freedom from Defeot8—The f*ntghed ubo», both externally and internally shall be sound, (Ilea,n, smooth well (i rushed oncl :free from surface defects und longi- tudinal grooving, and the end* ho cleon and square. (d) actual woight of oooh tube shall not be more

than 50/0 Bbove the calcula ted weight. Unless, otherwise specified, they shall be Btruight cylindricol, of uniform kness and external diamet,cr throughout. (e) Treatment of T08t Specimens.—All teat material, if not already in an annealed condition, Bhull be unnea,lod before teqt,ing and Rhall comply with the mrehonicol tests without further heat or mechanical Lreatment. 16 GAZETTE OF INDIA EXTRAORDINARY mLD DRAWN SEAMLESS STEEL BOILER AND TUBES FOR DESIGNED STEAM TEMPERATURE NOT 8500F (45400) 86. (g) Material.—Tho tubes Shall eean)lef4B and made of BtA51 produoed by an Open Hoarth or Electric Process, ucid or basie, und Shall be certified as such by the makers of the steel ond tubes. Tho materiol of the tubeN Shull show on analysis not more than O • 045 por cent .of sulphur and O • 04 per cent. phßphorug and the manufacturer shall supply certificotc of the anolysis when required to do go. Note.—Where the material is used for designed stoam temperature' above 7500 F (39900) and not exceeding (4540C) the steel shall be of non-xegregated of fully killed type. (b) tubes shall be carefully annealed throughout their length after the operation of drawing and the ends shall be eurefully unnealed after the process of swelling or reducing the diometer. (o) Fwedom from Defeco.—'L'he tubes both internally and extornally Bhall be sound, Cleon, smooth, well ffinghecl ond free from surface defects, rust, longitudinal seaming and grooving. The ends Bhull be clean and square. (d) Thiokne88.—Tho toleranee in thickness shall be 5 por cent. below and 10 por cent. obove the gpecified thickness. (ii) or Reduced Endg.—Where tho endy of tubes are swelled or reduoed, the thickness ut the ends may be reduced, 011 increased under or over, the actual thickness of the tubes by mnou-llt strictly in proportion to the percentage of such swelling or reducing and in addition to this allowance the tolerances specified in parograph (i) of this sub-regulation Bhall also u,pply. (iii) Diameter.—The extarnal diurnoter of the tubes, measured at nny point shall be not greater than thot specifiod, but may be logs by not more than J per cent, (iv) length.—The length of the tubos Nhull be not lces than thot gpeoiflod und not more than 1/8 inch greater

37. Selection Of Tubes for Tent—Two per oont. of the tubes of oooh thiokneeg and diameter ond only one for every or part thereof above 40() tubes of such •similar size shall be made a,vainble to the Inspocting Officer for teNting to the extent of such numbers

38. Tensile Test.—Tegt pieces eut fronn the endg of the selected tubes shall comply with the following requirements Ultimate tent-llle ßtret38. Tons por sq

111. Not Not Mirmnum olongatnon por cont.m. thick and OVOT 20 On 2 in. in. thiok L6Nß then and over thick. Strip out from tubee und tegted in their curved oondition.B. Tect lengths taken from finished tubes (endB to be plugged for than 20 20 than 28 28 LOBB thun thick. 18 23 go 28 31 THE GAZETTE OF INDIA fiXTRAÖRDINABY BIT 39. Flattening Tæt.—A ring not less than 2 inohu in length cut from one end of ea,eh selected tube aohll be flattened between two porollel flat yurfaoee, the width of which shall be not legs than 1 i times tho diameter of thc tube. When the preg- sure is releu,sed, the interior surfuc•eg of tho fest, piece (ot, the middle) shall remain at the following distances apart nnd the tegt piece Bhall then show no Nign of crook or flaw. Tubes over IO S.W.O. thiQknDN8 Nof more twice thioknep,e ot the Tubog up to and includmg IO S. W.G. in thickneHg. Until the interior All_rfaoea maat at the 18 40. Expanding Teet8.—The tubes shall withstand expanding by a drift expander having total incllled R,ngle of between 400 and 600 (200 to 300 per Bide) to the following increa,ses in external (limneter without showing crook or flaw. Thickness of tube 6 S. W.G. and th-uxn.er Thinner than 5 S. W.G. upto ond including 3 S.W,G. Thicker than 3 s.w.a. Incroase in d.i»mater per cent. 16 12 9-5 41. Additional test before rejection.—(a) Should b tube Belected for testing purposes show defini(c signs of failure in a,ny one or moro of the testa specified in RegulaHJions 38, 39 amd 4(), two further teats of the gamo kind may be made at the option of the manufQcturer from two bdditionol tubeg selected from the some batch. (b) If the ropea,t tests are sotiBfoetory the tubes shnl] be ocoopted provided that in all other respcet,9 they fulfil the conditiona of this Standard. Should either of the tubes fail in any test, {he bbtc of tubes represented may be re-hcat-treated in accordoncc with. Rogulation 36(b) und then retested in accordunco with Regulations 38, 39 und 40 but ernploying twieo the munber of test pieces. If these second repeat testa ore B&tisfactory, the tuber/ Hhall be ocopted provided that in all other respects they fillfil iJhc conditions of thig Standard; but if definite defécts ore again shown, the buteh of tubes which flho fest pieces represent shall be rejected

42. Hydraulic Test.—Each tube shall be tested at the makers works by hydraulic pressure in accordance with the following table governing the relation between the test pressure and the design pressure which the tube will be subjected in service. Design pressure lb/sq. in. Up to and including 500 Above 500 up to and including 1000 Above 1000 Hydraulic test pressure lb/sq. minimum 0.002 Twice the design pressure. GAZETTE OF INDIA EXTRAORDINARY [PART II, Section 3 Sub-section (2)]

In all cases the tensile stress (S) on the material when under these tests shall not exceed 10 tons per sq. in. as determined by formula $S = \frac{PD}{4t}$ Where D = outside diameter of the tube in inches P = test pressure in tons per sq. in. t = nominal thickness of tube wall in inches. HOT FINISHED SEAMLESS STEEL BOILER AND SUPERHEATER TUBES FOR DESIGNED TEMPERATURES NOT EXCEEDING 850°C (1550°F).

43. (a) Material.—To comply with Regulation 366. (b) Annealing.—The tubes shall be carefully annealed to a length not less than 6" if they have been subjected to a process of swelling or reducing the end dimensions. (c) Freedom from defects.—To comply with Regulation 36(c). (d) Tolerances. —The tubes shall be of the dimensions specified, straight, cylindrical, of uniform thickness and external diameter throughout, subject to the working given in the table below :

(i) Diameter.—The external diameter of the tubes measured at any point shall be within the following tolerances of (nominal diameter) of tubes. Up to 10 in. Over 10 in. (ii) Thickness.—The thickness tolerances of tubes. Up to and including 10 in. Over 10 in. Tolerance of the tubes shall be within the following Tolerance 50 Where the ends of the tubes are swelled or reduced the thickness at the end may be decreased below or increased above the nominal thickness of the tube by an amount in proportion to the percentage of such swelling or reduction and, in addition to this allowance, the tolerance relating to thickness shall also apply. (iii) Length.—The tubes shall be not less than the nominal length but may exceed it by the amount given below : Up to and including 30 ft. Over 30 ft. (e) Selection of tubes for test.—To comply with Regulation 37.

44. (a) Tensile Test.—Test pieces cut from the ends of the annealed portions removed from the ends of the selected tubes shall comply with the following requirements : Ultimate tensile strength tons per square inch Minimum elongation per cent. on 8 in. on 2 in. 1/4 inch Not less than 25 Strips cut from tubes and tested in their curved condition. Test If the tubes are from finished tubes (ends of tubes to be plugged from Not more than 28 inches over 20 inches Less than 28 inches thick and over 30 inches diameter (b) Flattening Test.—A ring not less than 2 inches in length cut from the unswelled portions removed from the ends of the selected tubes shall be flattened between two parallel flat surfaces, the width of which shall be not less than 1/2 the diameter of the tube. When the pressure is released, the interior surface of the test piece at the middle shall remain flat, and if not, more than three times the thickness of the tube and the test piece shall show no sign of crack or flaw. (c) Expanding Test.—The annealed tube ends shall be expanded by a drift expander having a total included angle of between 120° and 180° (per side) to the following increase in external diameter without cracking or other defect. Thinner than 5 in. and up to and including 3 in. S.W.G. Thicker than 3 in. Minimum Diameter per cent. 15 12 45. (a) Additional tests before rejection.—Should tube for testing purposes show definite signs of failure in any one or more of the tests specified in Regulations 44(a), 44(b) and 44(c) further testing of the same kind may be made at the option of the manufacturer of additional tubes selected from the same batch. (b) If the repeat tests are satisfactory the tubes be accepted that in all other respects they fulfil the conditions of this Standard. Should either of the tubes fail in any test, the batch of tubes represented may be re-heat-treated in accordance with Regulation 43(b) and then re-tested in accordance with Regulations 44(b), (b) and 44(c) but employing twice the number of test pieces. If these second repeat tests are satisfactory, the tubes shall be accepted provided that in all other respects they fulfil the conditions of this Standard; but if definite defects are again shown, the batch of tubes which the tests pieces represent shall be rejected.

46. Hydraulic Test.—Each tube shall be tested at the makers' works by hydraulic pressure in accordance with the following table governing the relation between the test pressure and the design pressure to which the tube will be subjected in Design pressure lb./sq. in. Up to and Including 500 Above 500 up to and including 1000 Over 1000 Test pressure lb./sq. in. 1½ times the design pressure 1000 above the design pressure. In all cases the tensile stress (S) on the material when under these tests shall not exceed 10 tons per sq. in., determined by the formula $\frac{DP}{D}$ Where D outside diameter of tube in inches. P = test pressure in tons per sq. in. t Nominal thickness of tube wall in inches.

SEAMLESS HALF-PER CENT. MOLYBDENUM STEEL BOILER AND SUPERHEATER TUBES

FOR DESIGN STEAM TEMPERATURES NOT EXCEEDING (51000) 47. GenenL—Those Regulations q. over both hot finished and cold drawn seam. leBB boiler ond superheater tubC8 Mthieh Shall conforrll ull respeeetg with the require- mentN herein specified. 48. (o) Material.—The i ubos shall be Inanufactured from steel produced by the Open Hearth ot Eloc,ric processes and shall conform to the following limits of chemical compositions ('arbon Wi"nganeso '311-ion Sulphur Loephorug M QI ybdenum 15% maximum 0 0 40 to 700/ O, 10 O, 0/90 maxzmurn The steelmgker Shal-I supply certificate of the normality of the steel. (b) Neat tubes shall be normalised at a temperature between Id880F (9200 C) and F (9600 C). (o) Workmanship and toleruoe. 'L'he tub03 shall be well finished, •olean and free from harmful defects. They Bholl bc reosonobly straight, smooth, cylindrical* and aubject to the following tolerances before bending (i) Diameter.—The oxternnl diameter of the tubee measured at any point shall be within the following tolerances of the cliometer specified : — 50 Type of Tube Hot finished (hld drawn anoos:— Ty-pa of Tube Hot, finished Cold drawn Outside Dlbmeter of Tube Up to Including In. Over 111. Tolerancz 1/(34 in. — 1/32 in. (ii) thicknesg of the Lubes *hall be within the following toler- OLIIt8ido Diameter of Tuba Up to killd including in. All Tolerance O O O o 50/0 Where thc encls ot the (JILbes R,rc or reduced the ot, the ends may bc (Iccreased below or increased above the nennina,l f,hicknegs of the tubes by an onaountJ in proportion to i,hr ercontnge of such swelling or reduction and, in addition to t,hiq i he relut,ing to thickness shall also apply. Swelling or reduction Bhu,ll 110 eured ont before the heut treatment, specified in Regulation 48(b). (iii) Length.—rllhe tubes shall bo not less the nominal length but may exceed it by i,hc Olnount given below : Up to incluchng 30 Ovpr fti. ot JNL)IA (d) Selection of tubes for testing.— After heat treatment, tho Cubop, fthall bo preentcet teHting in aeoorduncc• With RcgulR,tions 490), 49(b) and 49(c) in batches of not jnore thai 100 01' the same nenninal diameter and thieknes*. The manufacturer shall provide Ot, liiN own expense ex Cru tubes at, the rate of 2 per cent. of each diazneter and thickness of tube Epeeified und the 1 nspccting Offcer Shull glect, for t est guch of the tubes us he Ina..y think proper to the extent of the percnt,uge Inentioned, Should the ntunber of tubes or ed of any one nominal Sizoe exceed 401) then, for evcry tubeg or part thereof ubove that nurnbcr, one additional tube *hau be provided. The sa.,tnplC8 for testing shall not bc heat-treated after golection. 49. (H) Tensile pieces cut, from the of tho selected Bhall comply tho following requirelments : Ultimut4' 'INengile Strengs tone per sq. Not 188B than Not more Minimum elongution per cont. on 8 inehe8 Strip8 rut from tubBB and t.108toc{ in their curved condition. Tegtg LongthH token :from eniBhocl tube8 (end* of tilb0H to be plugged for griPH). 27 25 thun 33 33 1/4* thick and over 23 LOHR than 1/4* thick 17 21 (b) Elattening Test.—A ring not less than 2 inches in length cut from one ond of each sclceLed tube shall be flB,iJtenecI between two parallel flut surfoceg, the width of which shall be not less than times tho diameter of the tube. When the essure ig releu,sed, the interior surfaces of the test piece (ot the Inidcllc) shall renmin at a distance a,part of not more than three timos the speeified thickness of the tube and the Lest, piece shall then show no Bign of crack or HAM'. (e) Expanding fest8.—Tha tubes *hall with*i and expanding by u drift, expander having a total included u.nglc of between 400 and to 300 each side) to the following increases in external dimneter without ing cruck or flaw : 'DhickneHH of tuba] O S. W.G. ond thinner Thinner than 9 S. W.G. up to and inv]uding d • Thicker than 6 S.W.G. Inel'(in diurnetor per cent

50. Additional tests before rejeotion.—Should n tube, glected for tosting purposes show definite signs of failure in any one or ntore of the tests specified in Regulations 49 (a), 49(b) and 49(c), two further teats of tho same kind may be made ut the option of the manufacturer from two additional tubes selected from the some botch. If the repeat tests ore Nbtisfactory the tubes Bhall be accepted provided that in 011 other regpects they fulfil the conditions of thig Standard. Should either of the tubeg fail in any test, the botch of tubes represented mtbY be rcuheat-trea,ted in accordance with Regulation 48 (b) and thon retested in a,oeordance with Regulations 49 49(b) ond 4É(c) but employing twieo the number of test pieces. If these geoond repeat tegt,a ore aotisfa,ctory, the tubeg Bhull bo accepted provided that in all other respects they fulfil the eondiLions of thig Standard ; but if definite defects are aguin shown, the batch of tubes which the test pieces represent shall bo rejected

51. Hydraulic Te8t.—Each tube shall bo to, ted at the moker'* worke by hydraulio pressure in accordance with the following table governing the rolatjon between the test pressure ond the design pressure to which the tube will bc subjected in ervice. Design pressure lb 'sq. in. Up to and inoluding 500 Above 500 up to and inoludmg 1000 Above 1000 Hydraulic t,e8t pressure lb/Hq, in. minimum 1 ooo Tvfcc the dogign pressure. 1000 above the d0ßign pressure. In all cases the tonsile stress (S) onitho moterial when under

these tests Bboll oot oxoæd 10 tons per sq. in. determined by the fonnula DP Whoro D —outside diameter of tube in inches. P —test pressure in tong per sq. in. t —nominal thickness of tube wall in inoheg, SEAMLESS CHROME-MOLYBDENUM STEEL BOILER AND SÜPBR. HEATER TUBES FOR DESIGN STBAM TEMPERATURES NOT EXCEEDING (53800) 52. Be Rogulntiong covor both Hot _Hinished and Cold Drawn Sea,mlcgg Boiler and Superheater Tubos which Bhall conform in 811 respects with the requirem nts herein gpocißocl. 53. (o) Material.—Th hall be manufactured from stool produced by the open Elea,rth o.' Electri and Bboll conform to the following limits of chemi• cal composition. - Carbon Munganeße Silicon Sulphur Phoaphoru.B Molybd onurn Chromium . 0 •12% maximum. o .35 to o •650/ O •050/ maximu-rn maximum 0150 to 0-700/ o .75 to 1 •25% The sholl su pply a, certificato of the normolity of the Btee]. (b) Heat tube3 shall bo fully annealed, nr normalined at B -temperbtüre between 16880 F (9200 C) and 17600 F (9d00C). (o) Workmanship and tolerance.—The tubes shall bo well finished, Olean and free from hor mful dcfcet*. They Bha,ll bc strangtlt, gnu-10th I cylin(lrieu.t ond qubject to Lhe follow-Ing i oleranec*s before bend! rjg : (i) Diameter. —The external diameter of tubcs rneuyured at any point 811011 be within the following tolorp,nces of the diameter specified : Typo of Tube Hot finished Cold drawn (ii) Thickness.- tolerances ; Typo of Tube Hot fln1Bhed Cold drawn Outside Diameter of Tube Up to and Includrng 2i in. Ovor 2} in. Ilho [hieknys of tho tubes shall be Out81do Lhumotf-)T of ube Up to and including 2} in. Over 2} m All sizes Tolerance within the following Tolerance o 5 OX + 100/ Whr•re Lho encls of Lhe tubes lire swelled or rcdueed, the thickness at tho ends moy bo (leczea,Necl below or Increa,qed bovo Lhe nomina] thickneqs of the tubes by on n,rnonnL in proportion to tho per centage of such swelling or reduction bild, in addition to this allowmneo, the toler ü,nccg relating (go thickncsq shul' also apply. Swelling or reduction shall be carried out befote the heut trentnnt specified in (iii) Length.—tl'ho tubes shall be not than (he nominal length but may be 1/8 in. greater. (d) Selection o} tubes for teeting.—After heat troatrnent, tho til b('N Shull be pro- sented mechanical testing accordance Willi Rcgulation•1 54(u), 540)) und 54(c) in of noi rnore than the sn,rne (118tne(er awl thic 'l'he monufR,ei Bhall at own expense exi rn i ubeq nt t he a,te of 2 por ecnt. of each diamefor and LluекneN"A of tube specified and d Ile Inspect,mg Officer shall select for. such ot the tubo he Inay think proper to Lhe extent of the poreent,uge mentioned. Should the number of specified of any one nominal size exceed 400 then, for every tuboy 01' vort t 11 51 eof above that n umbel, one additional tube shbll be provided. The somples for testing shall noi, be heat treated after Selection. 54. (a) Tensile Test.—Test pioc,0N cut from the ond8 of the selected .tubos shall comply with the following req unements : IT It Ton.ßlle Sl,re88 in Ions per 8(4. In. Mtnimum Elongation per coni., on 8 Inches Not, than 27 25 Not moro bhan 33 Strips cut from tubes and tegted in thali' curved oondltwn Toet lengthH takan from fimshed tu bea (enda of tubag to bo plugged for griPB). 1" thick & over 23 than thick 17 21 (b) Flattening Test.—A rmng not loss 2 ineH0H in length eut from ono end of eBCh selcted tube shall be flattened between two parallel flat qurfacc*s, the width of which E4holl be not legs than 1} i,nnes the chametel of the Lube. When the presauco iN released, the intem ior surfaces of the test pieces (at the mulclle) shall remmn at distance "part of not rnore {Jhan three tillitiB the Npceified thi('knegs of the tubc and tho test, piece shall then Hli('w no Bign of crack 01 flaw. (c) Expanding Tests.- Tho tubcs shall with8tand oxpuncing by drift expander hoving b totbl Includerl angle OE bet,ween and and per side) to the following in oxternul (Limneter without showing en æk or flaw : Thickness of Tubo .10 W.G. and thinner Thmnor Chon S.W.C. up to und including 6 S.W Thicker than d Increase Lhur.noter per cent. 9} 55. Additional tegts before rejection.- -Should a tube selected for sting purp08(4B show definite Nigns of flMlurc m nny onc or more of Lhe tests specified 1 {cgulHt10ng 54(a), 54(b) and 54(e), two further tests of the samo kund I-nay be made at the option of tho monufaot,ucer from. two addit,ionol selected tubes. If the yceput tests are satis- factory Lhe Lubeg shall bo accopted provicled that in ail other respcj(tg they fulfil the conditions of thid Should eithor of the tube fail in u ny test, Lhe hatch of tubeg represented Tnay bc re-hoat-i reui,ed in oceordn nee with Reguluton 53(b) ond thon retested in accorda neo With Regulations 5401), 54(b) and 54(c), but employint' twice the nurnber• of i,cst pieces. If these second repeat t,0Nts are sat,1Bfietyory, tho tubes shall be accepted provided that in all othor respects thoy fulfil the conditions of this standard but if definite defects are again shown, the butch of tubcg which the i]CBt piece* represent Shull be rejected. INDIA 56. Hydraudo Tgt.—ER0h tube phall bo tested at the maker'e workg by hydraulic pressure in accordance with the following tablo governing the relation between the test progsure and the design pressure Io which the tubes will be subjected in service.)08ign pf08aura lb. /HGI. m. 500 or Above 500

but not exceeding 1000 Above 1000 Hydraulic test pressure lb/gq. in. In-i-n.imur:n. 1000 Twice the design pressure, 1000 above the design preegure. In 011 cages the tensile stress (S) on the material when under these tests shall not exceed IO tong per sq. in. ag determined by the formula :— Where D P t DP outside diameter of tube in inches. —teet pressure in tons per sq. in. —nominol thickness of tube wall in inches. ELECTRIC-RESISTANCE-WELDED STEEL BOILER TUBES FOR TEM- PERATURES UPTO 7500 F, AND PRESSURES UPTO 840 Lbg./SQ. IN. (FOR EXTERNAL PRESSURE)

57. General.—These Regulations cover electrically-resistance-welded tubular mode of steel and intended for boiler tubes. 58. (a) Material.—The material shall be made either or both of the following processes : Open-hearth or electric-furnace. (b) Manufacture.—Tubing shall be made by electric-resistance and shall be normalised at a temperature above the upper critical temperature. (c) Chemical Composition.—The steel shall conform to the requirements as to chemical composition prescribed in Table below : TABLE — Chemical requirement'. Carbon, per cent Manganese, per cent Phosphorus, per cent Sulphur, max., per cent. Low Carbon Steel 0.04 to 0.045 Medium Carbon Steel 0.25 to 0.35 max. 0.30 max. 59. (a) Flattening A section of the tube not less than 21 in. in length shall be flattened cold between parallel plates until the opposite wall of the tube meets the GAZETTE OF INDIA EXTRAORDINARY 627 meet. No cracks or breaks in the metal shall occur until the distance between the plates is less than the calculated value of 'H' by the following formula : Where H distance between flattening inches, t nominal wall thickness of tube in inches, D actual outside diameter of tube in inches, and deformation per unit length (constant for u, given grade of steel, 0.08 for types A, 0.07 for type C). Evidence of laminations or burnt joints, or incomplete penetration of the weld, shall not develop during the entire flattening process (ii) The weld shall be placed 90 deg. from the line of direction of the applied force. (iii) Superficial rupture as a result of minor surface imperfections shall not be cause for rejection. 7b) Flange Test. (i) A section of the tube not less than 4 in. in length shall be capable of having a flange turned over at a right angle to the body of the tube without cracking or showing flaws This flange, as measured from the outside of the tube, shall not be less than 1/8 in. nor more than 1 in. Within these limits, the width of the flange shall be not less than the following Width of Flange Outside Diameter of Tube, in, Type A 15% of outside diameter Type C 2 1/2 and under 2 1/2 to 3-3/4 over 3-3/4 to 5. 75 per cent of that 3/8 in. 10% of outside diameter required for *type A. (ii) In making the flange test, it is recommended that the flaring tool and die block shown in Fig. below be used. AFTER USING FLARING TOOL - BC A. 10% OF TUBE LESS 1/8 TUBE ITSELF Pt-US TOOL POSITION AFTER TUBE PASSES (c) Orueh Test.—When required by the Authority If crushing test shall be made on sections of tube 2 1/2 in. in length which shall stand crushing longitudinally, without cracking, splitting, or opening at the weld, as follows thickness of tube, in. 0.185 and under 0.185 Height of Crushed Section, in. Type A 1/8 Type C 3/4, or until outside of tube is crushed not folds are in contact required. Slight surface checks shall not be cause for rejection. 628 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 (d) Reverse Bend Test. in which shall be taken every 1500 A 4 In . ft. of finished welded tubing to be split, longitudinally 180 deg. from the weld and the sample opened up, flattened with the weld at the point of max. bend. There shall be no evidence of cracks or lack of penetration or overlaps resulting from flange removal in the weld

60. Tensile C tubep S'hull conförn) Io the require ments as to tensile properties preecribed in Tablo below : Ten 8ile Requirements Tengila Htrentgh, Inin.. per sq. nn Yield point. nun., Elongation in 2 in. , min., per cent, For longitudinal Nt rip tests deductiou Cor ()RCh 1/32 in. decreaae in wall thicknesg below 5/1 f] m. from tho Jilin. elongation of the fi-)llow- ing porcentago. lbs. 37000 lbe. 30 61. Hydraulic Te8t. —(u) Each tub? shall b*t t at the mnkc r 'N works uncl shall with' tand för minirnurn of 10 seconds R hydraulic lest pressure which Shull impose u minimnrn fibro coss of lhs(sq. inch and not oxceeding lbs/sq. inch. for type A aud not exceeding lbs/gq• inch. for typo C 0B detormnined by the [Ollowing for.' nula:— Where P S T Hydru ulic test prossure in lbs/sq. in. fibrc stress. Outside diameter of tubc in inches, und thioknoss of tube wall in inches. (b) Il'tube Nhall be struck near both ends while under (Ilje toet pressure with o 2-lb. steel harnmcr or its equivalent

62. Test Specimens.- (a) The specimens required for the flattening and flange tests specified in Regulations 59(1) shall be taken from the ends of finished tubes prior to upsetting, rolling, expanding, or other forming operations, or before being cut to length. They shall be on the ends and free from burrs and flaws. (b) If desirable and practicable, tensile tests may be made on full sections of the tubes up to that of the testing machine. For larger size tubes, the tensile specimen shall consist of a Strip cut

longitudinally from the lube and not flattened between gauge marks. The sides of the specimen shall be parallel between gauge marks; the width, irrespective of the thickness, shall be 1 in., the gauge length shall be 2 in. (c) All specimens shall be tested at room temperature.

63. Number Of Tests.—(a) For type A, one of the tests specified in Regulations 59(1), 59(b) and shall be made from each lot of 25() tubes or fraction thereof and from each ft., or fraction thereof safe end (n) uteria]. For type C, one of each of (the tests specified in Regulations 59(u), 59(b), and 60 shall be made from each lot of 25() tubes or fraction thereof. A reverse bend test specified in Regulation 59(d) 81.1011 be made on each ft. of finished tubing. (b) any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted, (c) If the percentage of elongation of any tension test specimen is less than that specified in Regulation and any part of the fracture is more than 3/4 in. from the centre of the gauge length, as indicated by scribe scratches marked on the specimen before testing, re-test shall be allowed. (d) Each tube shall be subjected to the hydraulic test specified in Regulation 61. SEC. 3] THE GAZETTE OF INDIA EXTRAORDINARY 629 LAPWELDED STEEL BOILER TUBES (FOR EXTERNAL PRESSURE) 64, (a) Materials—The tubes shall be made, from steel which shall show on analysis not more than 0.05 per cent. of sulphur or phosphorus. The manufacturer shall supply a certificate of the analysis required to do so. (b) Annealing.—The ends of all tubes shall be carefully annealed. (c) Freedom from defects.—To comply with Regulation 36(c). (d) Tolerances. — The tubes shall be of the dimensions specified, straight, cylindrical, of uniform thickness and external diameter throughout, subject to the working margins given in table below. On diameter On thickness on length Outside diameter of tube Under 2½ inch 2½ inch and over Inch 64 Per cent. 1 Minus Inch 1 Per cent. 1 Per cent. 10 Minus Per cent. 10 Plus Inch 1/8 Minus Inch (e) Selection of tubes for test.—To comply with Regulation 37. (a) To comply with Reg. 44(a)

65. Tensile test.(b) Flattening test.—To comply with Reg. 44(lj), the weld being placed 450 from the horizontal. (a) Expanding test.—The selected tubes shall, when cold, withstand being expanded by a drift or a roller expander to the following increases in diameter without showing crack or flaw :— Thickness of tube S. M' .G-. Up to 10 Above 10 to 6 Above 6 Increase in diameter per cent. 9-5 5 66. Additional a tube selected for testing purpose in accordance with Regulation 37 fail to satisfy the requirements of any one or more of the tests specified in Regulations 65(a) (b) (c), if so desired by the manufacturer, the tubes represented shall be re-annealed and then retested in accordance with these Regulations and if the repeat tests are satisfactory, the tubes shall be accepted provided that in other respects, they fulfil the conditions of these Regulations, but if the tube again fails to satisfy the requirements, the tubes which the test pieces represent shall, be rejected

67. Hydraulic test.—Every tube shall be tested at the Maker's works by hydraulic pressure to not less than 1,000 lbs. per sq. in. Any tubes failing to withstand this test shall be rejected. —THE INDIA WROUGHT IRON LAPWELDED BOILER TUBES (FOR EXTERNAL PRESSURE) 68. (a) Material.—The tubes shall be made from wrought iron which shall show on analysis not more than 0.100/0 manganese and 0.03% sulphur. (b) Annealing.—The end of all tubes shall be carefully annealed. (c) Freedom from defects.—To comply with Regulation 36(c). (d) Tolerance. The tubes shall be of the dimensions specified subject to working margins given below. They shall be straight and cylindrical, of uniform thickness concentric and unless otherwise specified, of uniform external diameter throughout. The working margin shall be as follows : On thickness—plus or minus 10%. —plus 1/64" and minus 1/32". On external dia. for tubes under 21" for tubes 2" and larger—plus or minus 1 per cent. (e) Selection of tubes for test.—To comply with Regulation 37. 69. (a) Tensile Test.—Lengths or strips cut from the selected tubes shall comply with the following requirements : Ultimate Tensile Strength in tons/ sq. m. Not less Not more Strips cut from the tubes clear of the welds and tested in their curved condition Tested lengths taken from finished tubes (ends of tubes to be plugged for grips) than 20 20 than 24 24 Elongation per cent. on 8 in. 10 12 (b) Flattening Test.—To comply with Regulation 39

70. Expanding Test.—The selected tubes shall, when cold, withstand being expanded by a drift or roller expander to the following increases in diameter without showing crack or flaw :— Thickness of Tube SW G Above 6 Increase in Diameter per cent

71. Crushing Teste—A ring 2 in. in length cut from one end of each selected tube shall withstand, without showing crack or flaw, being crushed on end by hammering or pressure when cold, until the length is reduced to 1-5/8 in

72. Hydraulic TBt.—Every tube shall be tested by internal hydraulic pressure to not less than 1,000 lbs./sq. in. Any tube failing to withstand this test shall be rejected. **STEEL CASTINGS** 73. Scope.—Steel castings shall be of the following grades, according to the purpose for which they are to be used and as may be specified :— Grade 1 . erade 11. 28 to 35 tons per sq. in. 35 to 40 AZ. .L . 1 LYDIA. .x. 74. (8) Process o! manufacture.—Steel for castings Bhall bo made by the Opon Hearth or an Electric Process, acid or bogie. (b) Ohemical Analygig.—Stool for grados I und 11 castingN ahull not show on analysis more than 0.06 per cent. of Bul-phur or phosphorus as determined from the test samples, ancl tho manufa,cturer Shull supply on onalysis of each oagt when requested. (c) Heat treatment.—All castings Nhall be heat treatod to refine the crystalline structuro throughout tho costing by heuting to a uniform temperature not than the normalising temperuturo and allowing to cool *lowly from Lhe maximum tempe- roture in a practically uniform I-nunner: or alornutivoly normolised by heating in a similar manner Olid ullowing to cool in still air. (d) Freedom from defect8.—All castings Bhall be free from twists, crooks. flows and Nimilor defects

75. Repairs to defective shall not bo repaired or weldod with ont the specific sanction of the Inspecting Officer, If required the castingg 2b all be suitably re-heattreated to retnovo internal stresses.Should o defect impair the strength of the castings, ropuir by welding or otherwiso shall not be permitted, 76. Number of loast ono tensile and one bend teBt shall bd made from the casting from eueh charge, and when more than one casting is mode from one charge, at least one tensile oncl one bend tost shall be mode from the castings run from ono common pouring head ; but geparate tests Nhall be mode from each cost. ing or set of costings run from each acparute pouring head. Test pieces Bholl not be c,ntJ off until Lhey huve been stomped by {he Inspecting Officer after the unnealing has been completed

77. Tensile tests.—The ultimnt," tonsil") strosg, yield point and elongation for grados I ond 11 costings shall be not less (Iban shown in table below:— Tensile Tests on Steet Ca8tings Grade 1 11 Minimum ultimate 'Lionailo Btrongth Tong per sq. in. 28 35 Minimum yifld point Jn tor-rny of 'Ilonelle strength per cent,. 50 50 Minimum Elongotion on teat picco 'C' (figure 5 to Appx, B) per cent. 20 15 Should b tensile test pieoe break outside the middle holf of its gauge length, the test moy at the manufacturer's option be discarded and another test be made of the earne outing

78. Bond tests.—Cold bend tests shall be made upon test pieeos having reot- angular sootion of one inch Wide by 3/4 inch thick. The test pieces Bhall be moohined and the edges rounded to o radius of 1/16 inch. The test pieoes shall be bent over the thinner geaqon. 632 THE GAZETTE OF EXQRAORDINARY [PART 11 Bond tests nxn y be nut(le by essnre 01 by blows, and the test pieces shall without turo withstand being bent touncl r having n raclius of I inch through an angle not less than that given the lollowing table . Grado 01' Ca.Httctg 1 Bond 79. Additional tejts before rejection. —Should a t+lt first by the -lugpector not Itulfil the test roquiremonts, two odditiona] tests of the samo kind from the ensting or group of eagl lngs Nhall be mude. Should onc of tho additional test pieces filll to fu Ifil the specified test requirements, the eastings shall be rejected

80. Waiving Ot te8ts.—No tests *hall be mudo from unituportunt steel custmg or from Hteol eastings which ure 118ed Tor articles usually rnacd• ot cust iron, if the geantJinge are not materially reduced below what would be required if cast iron were used. **CARBON STEEL FORGINGS (OTHER DRUMS)** 81. (a) Process of manufacture. —Carbon . feel ror forgings 'Ahull be mado by Open Hearth or an Eleci,ric Process, ucid or bagic. (b) Chemical analysis.—Tho steel shall (ontain nol. than per cent . ot sulphur or of phosphorus. (c) Freedom from detects. forgings *hall be froe fronl defect N ot any kind blld Nhall be finished to the prescribed (Innensions. Defé(ts In forgings shnll not, be repaired without, the previous sanction of the Officer. (d) Heat treatment.— h forgill(f shall be efli('lentlv -treat ed u nless during the last stage of rnuuufacture it been finished Rt such telnpernturo as to ensure that the material of the for gmg •w ill have sntiBfaactory mechanical proper- 82. Selection Of test pieoas.—Suffu iont material shall be left on h forging for test pieces. In the caye of a nurnbel' of forgings, not less than two per cent. of the total 01' not less Lhun 2 forgings from each cast. 83. (a) Tensile tests. —The ultimuto tensile 'illd elongation Shull bo between the lirnitiN of 26 and 32 Tons per sq. in uncl 2800 und 2200 respectively deterrnined on BlitlNh.

Standard Test, Piece C, or sul)HH1ary Standnu! -Rou nd Tegf Picce (See Appendix B.) In no eusc shall the sum of the ultimote tensile and esponding tion be loss than 54. broak outside tho Illi(ldl half of the test (b) Should tensile i..ost piece gouge length the test tnay, Rt f he nuaufucturot•B option, bc urded and anothel test be made of tho forging

84. Bend tests.(R) Bond test pioeces shall be rectangular section I in. wide by 3/4 in. thick. The edges shall be rounded to a rodus of 1/16 in. The test pieccs Bholl be bent over the thinner section. THE GAZETTE OF INDIA EXTRAORDINARY 633 be en,pable of boing bent, without fracture (b) 'The test pioeces shall, v, hen (Old, through nn mngle of 180% the micrnal radlll* of the bend not greater thun Inch Bend tests may bc mudc by oresgure or l)y blows. tensile or a bend teut 85. Additional texts before rejection.- Should either fall, two further Leets of the type which falJe(l may be rnade on lost cut from retesl,8 1-Irc satisfactory, the the Blime forging. If the results obtained h (hose forgings shall bc ucccepted, provided that in other respc ctg they fulfil the conditions if these letestN do not give satisfactory results loid down above for stoel forgings. the forgings represented may IJC re-heat-treated togethel With the rcnuunder of the toet blocks und presented for further tcetmgs. retest* do not give satisfactory results, the forgings In all cage* where final repreHented by the test peces which full Bhall bc rejected GENERAL GREY TRON CASTINGS (GRADE A) 86. (u) Proces8 of manufacture.—Tho eustingq shall be east, from metal melted or refined in any metallurgical plant other thun an Iron ore smelting firrnnce, for the use of which furnua•e perJniB'-jlon writing Inusl. bc Ived :from the Inspeeting Authority . (b) Chernical composition. The composition. of the iron cast shall be left to the (liserotlon of the manufacturer but the Ina,ximurn pereontuge of phosphorus may bc specified by the Inspeetmg AllthQf It,y If he so (10911es. (e) Moulding.—(i) The crust Ing* Shall be Hecuraiely moulded in accordance with the potteyn 01 working drawings supplied by the Inspccfing Authority, with tho addition of such let!termg us mny bc llied. out of t M oncl ee fyorn blow ho!ee, (ii) The ng *11011 be sound, elca,n, digi,ortion nncl all suTfneec and other 'llhe.y shall be well dressed or fettled ond Shull be .tnach1 liH,bIe by nonnol methods PROVISJON OF BARS 87. lhc I nspectinr* Authority shnll state ut thB t "no of cnqtury whother he requires tensile or tranynverse teqtfti, or both, n nd he rnny Olso specify cost-on barg where the design of he Ing and ei l unning pet tmt. When iJhc tesgt burs sopu,r H tely tho. be pour(d at i,hc t,lme uncl from {jhc supine ladle of tnptal ag Ihr r a Ai 'ing 01 cnrstingg they reprog(nt 'The number or tost spe(]fied Regulation 92 shall be applenb'e to HII ('Ftinga of each melt. When the u -on, the Inonl(l For the en,Nting u nd the moul(l fol Lhe tost piece Bhull be joined together such u, rna,nneT that the liquid ln•etel fills both moulds bt the saane operut ion All tost bars shall be ea,qt in green sand or dry sand moulds according to whether the casting or castingg they lepregnt ure moulded in green gand, or in loom or dry sand respect ive]y. rl'he test bars Bhall not be subjected to any heut troa,tment after leaving the moulds. DIMENSIONS OF TEST BARS 88. (a) Transverse Test Bars.—Tho trunsverge tost bars of the diameter specified by the Inspecting Authority according to the mn,in cross sectional thickness of the casting represented, shall conform to the following dimensions Diumoter of toet Bor in. O •875± Limits on diamotor in. o •045 0 090 0-10 O verall Ian gth in. 10 15 21 21 27 Main crogg-eeetional thickness of caating repreacted Not excoodi-ng 3/8 Over 3/8 and not exoeeding 3/4 Over 3/ # and not exceeding 1.1/8 Over, 1,118 und not excooding l. 6/8 Over 1,518 Bars cast to size in excesg of the limits given mbove may bc machined to 8 diameter within the specified limits. BOL'S cast within these lirnity of dimneter may Olso bc machined before the transverso test is n) ado, providing thu,t the finished diameter follB within those hinit. SCREPÆ Ddi AREA @RALLEL) SCREWED) TABLE ends Diarmtnr Gauge D. 875 1 596 Area pommel adlU_B length of plB1-n Approximate mi-nil:nuxn ovaall length Plain ands ends 2 B.S.F. Main thickn• of cest-mg Not exeædxng 31S Over 3/8 not 3/4 Over 3/4 and not oxemdin.g 1-1/8 Over l, 1/8 not exe.æiing 1-5/8 over 1-5/3. The b6N shall be as parallel bars of the dibrneta giva:r in Column and to the dime.nsi01* D ond P in the above t,abk. If the diameter of u test va ries with in the limits specified I n Regulation 88 (B) IJhe equivalent along load for i he t bur dia- lth the factors given Appendix F. meter *holl be ed in o TENSELE TEST 91. A tensile test, bar to the dimensions Nshown in Regulation 88 (b) (b) Tensile Test Bars. 'Ilho tensile test bus of the diameter specified by the Impeeting Authority, according to the rnnin cross-yectionarl thicknegs of the ousting represented, shall conform to Che (limenslong shown ill the following table. Borl-J may bc tested with either plann or screwed ends. (c) For costings over 2 Inches in thickness a tost bar of lbrger diometer thon 2-1 inches mu,y be uged by agreemnt bet ween the manufacturer und the -Inspecting Authority. For diagram uncl table sce pp. 28 to 29 MECHANICAL TEST 89. rl'he casting

must comply with the transverse and torsion tests specified in Regulations 90) and 91. All test, shall be selected by the inspector and tested in his presence and to his satisfaction. TRANSVERSE TEST 90. A transverse test bar cast in accordance with Regulation 88(a) must, when placed on supports get of the distance shown in column 2 of the following table sustain a load applied at the centre of less than that shown in column 3 and must show before fracture a deflection not less than that shown in column 4. The supports and the point of application of the load shall be rounded to of not, less than 1/8 inch. 1-2 2-1 Diameter of test bar in. 0.875 1-2 2-1 Distance between 2 in. 9 12 18 18 24 Minimum breaking load—Grade A 3 1,050 6,660 4 in. 0-12 and tested with weight, not less than that, shown in Diameter of test bar in. or screwed ends must show a, breaking strength of not less than the following table. but NOTE]. —Self-aligning grips to ensure axial loading ultimate load 110 A Pons per 11 are recommended. NUMBER OF TRANSVERSE TENSILE TESTS of required for each batch of castings be in 92. The number of the various classes of (being divided hence with the following four representative test, whether taken (one test shall refer to one transverse and one tensile or two test bars at each. Group 1 2 3 of Up to 28 lb. Over 28 lb, and up to Over 1 cwt. and up to 10 cwt. one ton required One test for each 30 cwt. of rough, mgd or part 2 of castings or One test for each part thereof. (One test for each tons of casting or part thereof. In the above Groups, 1, 2 and 3, all castings representing, each by one test must be poured from the same ladle or gate heat the furnace or charge provided for the test. Over 1 ton and Important castings One for each 4 tons of castings or 4 part (hereof or for each casting weighing where mutually agreed upon. 4 tons or less.

93. Additional Test8.—The additional tests to be carried out, bcfbre or botch of eastings is rejected Shidl be in accordance with the following tem lo Te8t piero Evont If thi* failg If thiR pu,RHØH If this Condition8 The aocond t0Ht pleco Rhull be teetod. 'The boteh or Fgoparnto ing reprascentrocl Bhall bo urcoptod. Fl'ho bul eh or separeto custmg ropregenLod be rejooted Provided i hat, ill the enge of failure of both d,est pieces if either show obvious (lefeei hil d test pic•ee .rna,y be aken frotn broken Q&8Ling or pieec may bc cut ft•orn u, usnble ing for fnrLher testing as follows : 3rd 94. welding If thig paggea If fnilH Tha batch or 8epu,rute easting reproeontecl shall bo accepted. The bnreh or N8pnra,to coating repreftentcd may be rejected. COVERED FOR METAL ARC (FOR TIAND (hERATION) Construction.— Tho motRl eleotTQ(lcs be provided with a flux eov ••ring externully by pointing, spruying, (I ippingr or other lncethod, covered 01, redes shall Application. —The b) suitable for motal are of rnild si,cel having tensile Ntrengih not exceedig 33 tons per 1 HY', uAz. INDIA Au

96. Quality.—The electrode shall be uniform in quality and when used in accordance with the appropriate instructions of the Manufacturer shall be capable of flowing freely and smoothly without producing an undue amount of heat under cutting in the parent metal adjacent to the weld.

97. Covering—(a) Strength.—The covering shall be sufficiently robust to withstand without, damage the normal conditions of transport, storage, handling and use to which the electrodes are to be subjected. (b) Uniformity.—The covering shall be substantially uniform in colour, diameter throughout its length and shall fuse evenly. (c) Stability.—The stability of the covering shall be such that if the electrodes are stored they shall, after a period of three months, be capable of giving results similar to those of the date of despatch from the supplier. (d) Storage.—The requirements of paragraph (c) above shall apply only if the electrodes have been kept in their original packages in an enclosed dry storeroom.

98. Moohaniool properties of All-weld Metal test pieoes.—The mechanical pro- perties shll be determined on oLWe]d-metBl test gpecimens followe : (o) Tensile Test.—The tensile test Bhall be made on a specimen having a gauge length of 3 •54 times the diomot,er of the test, piece. The ultimote tensile stress, elongation ond reduction of areo of tho deposited metul BhB11 be not leB8 than the figures given In the iob]e. (b) Impact Test.—Impaot tests shall be made on a three notoh epeoimen. At 1068t two of Lhe three values obLBined shBll be not less than that given in the tablo. Ultimate abregs (tong per eq. in.) min. 28 Elongation on 3 •541) (per cent.) min. 20 Roduction of Area (per cent.) min. 35 Impact Value 30 ft. lb

CHAPTER 11.1 CONSTRUCTION AND WORKMANSHIP GENERAL 99. Preparation of Plates.— With the exception of gusset plates, which may be sheared, the edges of all plates and built-up Straps shall be planed or machine cut to an angle of approximately 80° with the surface of the plate.

100. Annealing after working in fire.—All steel plates which are welded, dished, dinged or locally heated shall be afterward efficiently annealed

101. Minimum thickness of boiler shall be than inch in thickness. SHELLS, ANGLE RINGS, BUTT STRAPS, ETC

102. Cylindrical Shells.—Each ring shall be bent while cold (so cylindrical from to the extreme ends of the plate. The bending shall be done entirely by machine and heating or hammering is prohibited.

103. Position of Longitudinal Seam.—Each ring of plate forming the shell, barrel or drum shell, where practicable, be in one piece and have its longitudinal seam well out of line with those of the adjoining ring. In Lancashire, Cornish, and other types of boiler, parts of the shell are exposed to flame, the longitudinal seam shall, where it is in the steam space, be arranged on each girth of the crown and on the outer of the shell work.

104. Circumferential and End The strength of the joining the end plate. flat end Lancashire Cornish boilers With the cylindrical shells (and, of the strength of the calculated thickness of the shell is not less than 38 per cent of the strength of the longitudinal seam but in no case less than 42 per cent of the strength of the calculated thickness of the plate. (b) In boilers of other types the strength of the circumferential and transverse seams shall be not less than 38 per cent. of calculated thickness of the plate as found by Equation (1) and not less than per cent of that of the longitudinal seams whichever is the greater. (c) When the shell plate thickness exceeds 11/16 inch the intermediate circumferential seams, shall be double riveted. (d) In the case of the electric arc welded shell where the thickness of the shell does not exceed 18", the end plate may be attached to the shell by means of Electric Arc fillet welding providing the welds are stress relieved and the cubic capacity and working pressure (do not exceed 30 gallons per sq. in. and 120 lbs. respectively).

105. Angle Rings.—Angle rings for the attachment of end plates to shell plates and flue sections shall be rolled or machined so that they fit closely to the flat and surfaces to be connected, and shall be machined or machine cut on the inner edge.

106. Thickness of Shell Angle Rings.—Where shell plates and end plates are connected by means of an external angle ring, the angle rings shall be not less than in thickness as follows: (1) For shell plates up to and including 5/8 inch in thickness (2) For shell plates exceeding 5/8 inch thick and up to and including 1 inch thick (3) For plates over 1 inch in thickness 10 per cent in excess of the thickness of the shell plate. 90 per cent of the thickness but not less than 11/16 inch. Made from angle bar having nominal thickness of 1 inch. (a) Except as provided for in Chapter V and in 107. Welded Shell Plates. Regulation 112, where longitudinal seams are welded the weld shall be entirely covered by a, butt strap or butt straps securely riveted to the shell. (b) For marine steam engines when the welding is done by machine and the plates (do not exceed inch in thickness butt straps may be omitted. (c) The strength of the weld covered by butt straps shall be assumed to be 50 per cent of that of the solid plate. The thickness of a single strap or combined thickness of double strap shall be not less than the thickness of the shell plate.

108. Seams.—The longitudinal seam shall be butt-jointed with double straps when the diameter or Working Pressure exceeds the limits stated below Type of Boiler Loco Vertical Other Type When diameter exceeds Feet. When Working Pressure exceeds lbs. 200 80 109. Butt Straps.—Butt straps shall be cut from the shell plates or, alternatively, 81.1 the butt straps of each required thickness shall be cut from one plate. The lengths of the straps wherever practicable shall be transverse to the direction of rolling of the plate. Straps shall be pressed or bent in rolls to the shell curvature. 110. Thinning of Butt Strap.—Thinning of the ends of butt tuck under shell rings, shall be done cold by machine and not by heating or hammering. The shell plate shall be notched out to receive the thinned end of the butt strap, so that there shall be no undue thinning of the butt strap, 111. Alternative AFI and the tucking of butt strap ends under the shell rings, the ends may be terminated at the edge of the shell rings or end butt and electrically welded thereto.

112. Lobe Welding Of Butt The ends of longitudinal butt seams of shell rings may be welded for length not exceeding three times the overlap of the circumferential seam, provided the butt straps are run as closely as practicable to the circumferential seam. (b) Only metal arc welding of the butt seams of shell rings shall be permitted.

113. Flat End The end plates of boilers shall preferably be in one piece made from one rolled plate. Alternatively, the end plates shall be built up by butt-welding two pieces. In the latter case the line of

welding shall be parallel to the horizontal axis of the boiler and shall run through the centre line of furnace or furnaces of Lancashire boilers and between two rows of stays of marine type boilers. In the case of flat end plates the fusion welding, shall comply with stress relieving requirements only in the case of dished end plates the fusion welding shall be subjected to both stress relieving and radiographic examination. (b) The peripheral flanging of end plates shall be done by machine. Such flanging shall preferably be done in one operation, but where this is impracticable sectional or creep machine flanging may be permitted, provided that the plate is worked at a suitable temperature, and the plate is heated to an adequate distance beyond the portion under immediate treatment. (c) It must be taken care to see that the flanges are circular and of good surface, free from local irregularities, and that they are parallel square with the bore of the plate. For the purpose of relieving internal stresses, plates which have been flanged or locally heated shall afterwards be efficiently annealed unless during the last stage of manufacture they have been uniformly heated through-out. (d) Flat portions of end plates, on completion of all flanging end machining operations, shall be flat and free from set or distortion.

114. Strengthening of Flat End Plate of Lancashire Boiler type the mudhole in the lower part of the front end plate shall be fitted with a dished riveted strengthening ring, the thickness of the flat portion of which shall be not less than $(1 + \frac{T}{8})$ in. where T equals the thickness of the end plate in inches. (b) In boilers 7 ft. 6 in. diameter and above, the mudhole from the front end plate shall be fitted with a peak to reinforce the portion of the end plate between and below the furnaces, and this peak shall be securely riveted thereto with rivets of similar pitch to the remainder of the flange. (c) In all cases; the front end plate gusset stays below the furnaces shall be placed as closely possible to the mudhole flange. (d) Where end plates are flanged for connection to the shell, the inside of flanging shall be not less than 75 times the plate thickness, with minimum of 1 in.

115. End Plates in steam spaces.—When the end-plates of boiler are situated in the steam space, they are liable to contact with hot gases the end plates shall be efficiently shielded from such contact.

116. Hemispherical All segment shall be pressed in one heat to correct curvature. The adjacent plates shall be bedded at the seams and wherever possible at the junction of two seams the plates shall be machined down to provide fair surface to the joint. If the thinning is done by hammering on the plate shall be subsequently annealed. (b) The cylindrical portion of the crown shall be tangential to the hemispherical portion and follow truly to the shell. (c) Where hemispherical shell crowns are prepared from one plate they shall be pressed to form by machine in progressive stages without thinning and on completion shall be annealed.

117. Dished End and Crown The inside radius to which a is dished shall not be greater than the external diameter of the shell to which it is attached, except in the case of Lancashire and Cornish boilers when the radius shall not exceed times the diameter of the shell. (b) The inside radius of curvature of the flanges to the shell or firebox shall not be less than four times the thickness of the crown or end plate unless in no case less than 2 inches. (c) The inside radius of curvature to the shell shall be not less than twice the thickness of the crown plate and in no case less than 1 in. (d) Bunged mouth-pieces may be welded on to end plates in place of the orthodox flanges for the mouth of furnace tubes. Such welding shall comply with provisions of Regulation 125. (e) Main frames may be girders on the front end plates, and be subject to provisions of Regulation 125.

118. Tube Plates.—Smokebox tube plate shall be flanged for attachment to the barrel or shall be fitted and connected thereto by external riveted angle ring.

119. Parts the Smoke Tube Plates within the tube Where the total area, of all the necks, exceeds 7 sq. ft. stay tubes shall be fitted within the neck. Where stay tubes are not fitted the necks shall be beaded or bolt mouthed. (b) The edge of tube plates which is outside the nests of tubes shall be stayed or supported wherever the size of the area, of plate subject to steam pressure necessitates, by bracing or support, either by marginal stay tubes or other means.

120. Flanging End Plates.—All flanges shall be of good fit to the shell and flues. Flogging and caulking in the fitting of these parts is prohibited. The caulking edges of all flanged plates shall be machined or machine cut. FURNACES 121. Furnaces in No furnace or firebox top, whether plain or corrugated, shall exceed 7/8 inch in thickness, and all circular sectioned furnaces when new shall be near

the truly regular form as the type of joint will permit. (b) The use of Z angle rings for furnace foundation seams shall be prohibited

122. Furnaces Of Horizontal The sections (if the into nal flues shall each be in one plate and shall be bent while cold to circular form and shall be welded longitudinally. (b) The maximum permissible variation in diameter of any cross section shall not exceed the thickness of the plate. (c) The welds shall be placed at the lower part of the flues, and shall break joint in successive sections by at least 12 inches. (d) Each flange for the circular forms shall be formed at one heat by suitable machinery. (e) The sections shall be allowed to cool gradually to avoid internal stresses. (f) The caulking edges of all flue flanges shall be machined or machine gag cut. (g) The circular seams shall be arranged so that they do not fall in line with those of the adjacent flue or with the circumferential forms of the shell and are least 6 inches apart. (h) When flues are flanged for attachment to both end plates the total length of each completed flue shall not exceed the length of the shell measured from the inner surface of the back end plate to the inner surface of the front end plate, both adjacent to the shell. (i) Where the flues are flanged for attachment to the end plates, the end sections shall be $\frac{1}{16}$ inch thicker than the remaining sections, except in cases where the calculated thickness is over $\frac{13}{16}$ inch, when the end sections shall be $\frac{7}{8}$ inch in thickness. (j) The flanged portion of furnace rings shall have a radius of curvature of not less than 1 inch on water side. (k) Section of corrugated flues may be fusion butt welded circumferentially and afterwards stress relieved by heat treatment



123. Furnaces Of Vertical The vertical portion shall be in one plBtc and shall be bent to circular



form in o similar man-nor to the shell plates.(b) Circular furnaces shall preferably be tapered, taper of 1} in. in diameter per 1 foot of height being recommended. The minimum water space at the bottom between the furnaces and the shell shall not be less than 2 in. for boilers up to 2 ft. 6 in. in diameter and shall be not less than 2} in. for boilers over 2 ft. 6 in. in diameter. (c) Where hemispherical furnace crowns are pressed from one plate they shall be pressed to form by machine in progressive stages without thinning and on completion shall be unannealed. (d) Gages flanging where integral with the firebox or in a separate ring shall preferably be formed at one heat by suitable machinery and shall be allowed to cool gradually to avoid internal stresses. (e) Furnaces of vertical type boilers may be attached to the shell at the fire-hole by solid rectangular section steel ring riveted together or by a circular ring of substantial section fusion welded to shell and firebox. Where the latter construction is employed the opening in the shell for firehole shall be substantially compensated by a ring welded on the outside of the shell plate. (f) At the firehole the firebox plate and the shell plate may be flanged and fusion welded together. 8] THE OF INDIA EXTRAORDINARY 640 124. Longitudinal Seamg.—The longitudinal seams of furnaces may be either : (a) Forge Lap Welded. (b) Fusion Butt Welded. (c) Riveted. Longitudinal seams of furnaces exceeding 3/8" thickness shall not be riveted

125. Fusion Welded Longitudinal Seams.—Where the longitudinal seam is fusion welded the following precautions shall be observed (b) Plates over 5/8 in. in thickness shall be bevelled from both sides of each abutting edge, but the bevel need not necessarily be the same on each side (see Figs. 1 and 2). Plates less than 5/8 in. in thickness may be bevelled from one side only of each abutting edge (see Figs. 3 and 4). The included angle of the bevel shall be not less than 60°, and the bevelling may be any one of the forms shown in Figs. 1—4. Fig. 1. Inside of tube or end of tube

5. Fusion Welding of Cross Tubes of Vertical or Horizontal Tube Boilers.(b) In order to obtain full penetration of the weld metal a gap be maintained between the plates when they are being welded. Joints shall be welded from both sides, and the slag shall be removed after making each run. Before THE GAZETTE, OF INDIA EXTRAORDINARY [PART 13 the second side of the joint welded any slag or defect at the bottom of the first run shall be removed by grinding, chipping or machining. There shall be no appreciable undercutting of the plate. (c) For the purpose of relieving internal stresses the plates adjacent to a fusion weld shall be immediately annealed after welding, and when the firebox is welded it should be allowed to cool gradually

126. Furnace Crown shall not full in line with any part of the boiler shell.(b) the furnace crown shall be riveted to the vertical portion of the firebox, or else the joint may be fusion butt welded by the electric arc process, provided the conditions as to fusion welding in Regulation 125 are observed. Where the joint is fusion welded the edges of the furnace crown and the firebox body shall accordance with -Fig. 3 or Fig. 4. The depth of the flange of the bevelled in furnace crown plate from the commencement, of the curvature of the flange radius shall be not less than four times the plate thickness, with minimum of inches. On completion of welding the firebox shall be effectively stress relieved by heat 128.) **127. Cross Tubes.**—(a) Cross tubes shall be made from weldless steel tube or from plate or strip rolled and forged water gas welded. Where welded tubes are used the longitudinal weld shall be so situated that they are not exposed to the direct impact of the flame. (b) The minimum thickness shall be 5/16 in. (c) Where cross tubes are flanged and riveted to the furnace, the flanges shall be set to the curvature and taper of the furnace, and shall be a good fit before riveting. (d) Where welded construction is employed the tubes shall be of sufficient length to enter the furnace plate and be flush with the water side all round or project not more than 5/8 in. into the water space at any part of the circumference. Where the tubes are fusion welded in position, the firebox plates shall be suitably chamfered and the joints shall be welded externally and internally (See Fig. 5)

128. The uptake shall be formed from weldless, forged water gas welded or fusion butt welded steel tube and shall be securely riveted to the furnace crown plate and riveted to the shell crown plate. (b) As an alternative to riveting, the uptake may be fusion butt welded by the electric arc process to the upward flange of the opening in the fire box crown plate provided the conditions as to fusion welding in Regulation 125 are observed. The edges of the upward flange and the adjacent end of the uptake shall be bevelled in accordance with Fig. 3 or Fig

4. The depth of the crown plate opening from the commencement of the curvature of the flanging radius shall be not less than twice the plate thickness with a minimum of 1 inch. On completion of welding the uptake and crown plate shall be effectively stress relieved by heat treatment. Where the firebox crown plate is also fusion welded to the body of the fire box, the firebox complete with uptake shall be effectively stress relieved by heat on completion of the (a) Welded uptakes shall be so arranged that the weld is directly facing the longitudinal centre line of the manhole

129. LOCO Type foundation shall be of riveted construction but all other seams may be welded subject to the depth of the flange being such that the welded seams fall between the 1st and 2nd row of screwed stays or between the flange and the adjacent row of screwed stays. 830. 8] GAZETTE OF INDIA EXTRAORDINARY (b) The firehole mouthpiece may be similarly welded when the firebox and shell are flanged for the purpose. (c) The welding shall comply with Regulation 125. STAYS 130. Bar stayg.—Bar stays shall not welded in any part, generally, preferably have plus threads, the ends of the stays being upset or the middle portion being reduced for this purpose. Stay bars, which have been worked in the fire shall be subsequently annealed

131. Longitudinal Stays.(a) Longitudinal and similar solid stay shall be efficiently scoured with nutg at each end and not internally riveted over. Where they are over 12 feet in length, they shall be supported at intervals of 6 ft. along its length. (b) Where the stay is screwed through both plates, the stay and holes shall have a continuous thread and fitted with nutg and washers on the outside. Where the stay passes through clearing holes an internal nut and shell also be fitted. Where the stay is not normal to the surface of the plate the washers shall be shaped so to form a true surface for the nuts or a knuckle joint may be fitted. (c) In vertical boilers the stays shall either be screwed into both crown plates or screwed into the furnace crown plate and passed through clearing holes in the shell crown plate

132. Nuts and Washers for Stays.(a) The washers shall be of the diameter of the threaded portion of the stay and not less than 1/4 in. in thickness. (b) The thickness of the external nuts shall be at least equal to the diameter of the threaded portion of the stay. Where bar stays pass through clearing holes in end plates, internal nuts of a thickness not less than 1/2 in. or third of the diameter of the threaded portion of the stay shall be fitted 133. Jointed Stays. —Where 11 ft longitudinal stays are used, they shall, where practicable, be fitted with pins having an effective sectional area 25 per cent. in excess of that of the stay. If the pins are slack in the holes, the total clearance shall not be more than 1/10 inch. The pins shall be as close as possible to the shoulder of the eye forging. The shoulder of the forging shall be at least 1/2 inch wide all round, i.e., the diameter at the shoulder shall be not less than the diameter of the hole plus 1 inch

134. Diagonal bar or rod stays.—The sectional of diagonal rod or bar stay shall bear the same proportion to that of a direct stay as the length of the diagonal stay bears to the length of the perpendicular line from the end of the diagonal stay to the surface supported. The ends of diagonal stays, shall not be bent, but shall be attached to the plate with bevelled washers and nuts or with riveted tee, blocks or angles and shackle pins (see Regulation 133 for eyes and pins). STAYS 135. Screwed stays.—The holes for these shall be screwed with a continuous thread. (b) The screwed threads of the stay shall be clean, free from checks or imperfections, of full depth, correct Whitworth form and a good fit in the holes. The middle portion shall preferably be turned down to the bottom of the thread. (c) The stays shall be screwed with fine thread of not less than 11 threads per inch. 646 THE GAZETTE OF INDIA EXTRAORDINARY (d) The diameter of the stay over the threads shall not be less than 3/4 in. or twice the thickness of the firebox plate whichever be the greater. (e) The pitch of the stays at the furnace of vertical boilers shall not exceed 11 times the thickness of the furnace plate. (f) Where the stays are not fitted with nuts, the ends shall be riveted over to form substantial heads. (g) Crown stays of Loco Type boilers shall either be fitted with nuts or riveted over on the fire side

136. Axial drilling.—(a) Stays less than 14 in. long shall be drilled with a, drill hole 3/16 in. diameter to a depth of 1/2 in. beyond the inner face of the plate. Stays which are oblique on one side should preferably be made from hollow staybar. 137, Stay nuts. (a) Nuts to serve stays in combustion (furnace and fireboxes) not be less than 3/4 inch thick for stays up to 1 1/2 inches diameter over threads, 7/8 inch thick for 1-5/8 inches and 1 1/2 inches diameter, 1 inch thick for 1-7/8 and 2 inches diameter stays, and 1-1/8 inches thick for stays over 2 inches in diameter. (b) The nuts shall be made of solid mild steel or of iron which shall be without weld if exposed to flame

138. Spacing of end girders.—Allowance for curves, etc.—For fireboxes ELIM-I combustion chambers the distance between the rows of stays nearest to the tube plate or firehole plate or back plate or the base, and the commencement of curvature of these plates at their flanges shall not be greater than the horizontal pitch of the stays. **GIBBER STAYS** 139. Girder Stays for Firebox and combustion Chamber (h. R) When of the normal type, fitted with Stay bolts and nuts, shall be of the double plate interconnected type of sufficient strength to support its proportion of the load on the crown plate independently of the crown plate. (b) The clear waterway between the crown plate and the underside of the girders shall be as large as practicable but in no case less than 1-1/2 inches. (c) The ends of the girders shall not rest on the landing of the flat crown plate but shall be carefully fitted to bed directly on the bends of the corners of the vertical end or side plates. (d) The toes of the girders shall be solid with the girder plates and not separate pieces attached thereto. (e) Girders shall be properly attached to the crown plate by bolts or screws. **NOTE.**—Alternative methods of staying may be used, or unstayed firebox, or one of special or patented design of equivalent strength may be fitted. See Regulations 230, 231 and 232. (f) Where on a full welded firebox is fitted, the girder stays may be welded to the firebox prior to stress relieving. The girder stays shall be recessed for waterways as in paragraph (b) (Figs. 6 and 7). Such girders shall be securely welded by an approved method to the firebox crown. The method of welding and the proportions of attachment shall be to the satisfaction of the Inspecting Authority. **THE GOVERNMENT OF INDIA EXTRAORDINARY** Not less than Fig. 6 **GUSSET PLATES** 647 Gusset plates shall be flat, and perpendicular to the 140. Gusset Stays. The gusset angles shall be fitted to bed closely to the shell end and gusset plates. Cranking or setting of the plates is prohibited. (b) Gusset stays, where fitted, shall comprise flat plates secured by double angle to the shell and end plate respectively, and shall be designed in accordance with the following conditions 141. Breathing Space. (c) Gusset stays shall be arranged to allow sufficient breathing space around furnace connections and tube nests. (b) For Lancashire boilers the proportions shown in the table below are recommended for the portion of the end plates above the furnaces and flues Thickness of end plates in. 13/16 Above 18 10 9 10 11 12 10 11 12 18 1.3} **THE GAZETTE OF INDIA EXTRAORDINARY** Fig. 8 [PART 11 (c) Fig. 8 shows the breathing space recommended for the following conditions: Flat end, furnace or flue flanged for attachment to end plate, furnaces and flues formed with Adamson flanged girth, (d) Fig. 9 shows similar conditions to Fig. 8 except that the end plate is flanged outwards for the furnace or flue ring connection, the breathing spaces allowed being 1 in. more than those for the same thickness of plate in Fig. 8. (e) Where a corrugated section not less than 6 feet long is included in each internal flue of a Lancashire boiler, the dimensions given in the table above may be reduced by approximately 1 in. throughout. (f) It is recommended that the breathing space below the furnaces and flues shall be approximately one half the dimensions given in the table above. Where it is desired to use any other arrangement which gives a greater or less degree of flexibility, the amount of breathing space shall be specially considered and modified as the necessity of the case requires. (g) For gusset stays above tube nests, as fitted in waste heat boilers without internal furnaces, a breathing space of 8 inches from the centre line of the top tubes to the centre of the two rivets of the gusset angles is recommended (see Fig. 9)

142. Gusset angles.—The gusset angles connecting the shell and end plates shall be at least 7/8ths of the thickness of the shell plate, but shall be not less than 1/2 in. in thickness 148. Load on Gusset Stay.—The gusset stays supporting the end plate of a boiler shall be designed to carry the whole load due to pressure on the area supported 144. Gusset Riveting.—(L) The girth gusset shall be not less in diameter than the thickness of the cylindrical shell plate and the riveting shall be arranged so that the strength of the shell plate where drilled for the gusset rivets shall not be less than the strength of the longitudinal seams, (b) Not less than three rivets shall be used to connect any gusset plate to any angle or any angle to the end plate or to the shell plate. **BOILER TUBES SUBJECT TO EXTERNAL PRESSURE** 145. steel and Wrought Iron Tubes.—(a) Both plain and tubes may be made either of wrought iron or steel and may be either lapwelded or welded. (b) Tubes may also be fabricated by electric resistance welding from strip plate. This may be accepted for temperatures up to 7500 F and pressure up to 840 lb./sq. in

146. Pitting Plain stay tubes are not fitted, the ends of the tubes shall be beaded over at the fire box end and beaded or bell-mouthed at the other end. If bell-mouthed the tubes shall protrude not less than 1 inch the tube plate. **GAZETTE OF INDIA EXTRAORDINARY** 147. Screw Threads of stay tubes.—Stay

tub(N shall be screwed at both ends with continuous threads, and the holes in the tube plates shall be tapped with continuous threads. The pitch of the threads shall not be finer than 11 threads per inch. The stay tubes shall be expanded by roller expanders and not made tight by caulking only

148. Minimum thickness of stay tubes.—The minimum thickness of tubes in the body or at the ends under threads shall not be less than $\frac{1}{32}$ inch. If stay tubes are required to have their thickened ends of stay tubes, thickness increased at the screwed ends so that the thickness at the bottom of the threaded end is approximately the same as in the body of the tube the thickening may be attained by upsetting and not any welding process, and the tubes shall be annealed after the upsetting. (8) Stay tubes shall be fitted to the boiler to be whole. 150. Load on stay tubes. Load due to pressure on the area to be supported in each cage to be calculated as follows : (b) For a stay tube within the tube nest the net area to be supported shall be the product of the horizontal and vertical pitches of the stay tube less the area of the tube holes embraced. Where the pitch of the stay tube is irregular the area shall be taken as the square of the mean pitch of the stay tubes (i.e., one-quarter the sum of four sides of any quadrilateral bounded by four adjacent stay tubes) less the area of the tube holes embraced. (c) For a stay tube in the boundary row, the net area to be supported shall be the area enclosed by lines passing midway between it and the adjacent points of support less the area of any tubes embraced. The adjacent points of support may be stay tubes, or the commencement of curvature of flanging or centre line of the circle of rivets securing the end plate to the boiler angle, BOILER AND SUPER HEATER TUBES SUBJECT TO INTERNAL PRESSURE 151. Steel Tubes. (a) All tubes which are subjected to internal pressure of water or steam shall be cold drawn or hot finished seamless in accordance with Regulations 30 to 56. Except as provided in sub-reg. (b) below they shall be without joint. (b) Tubes having an external diameter not exceeding 5 inches may be jointed and such joints may be flash welded, machine forge welded, or gas welded. (c) Flash welding shall be undertaken on a welding machine of the type approved by the Inspecting Officer and the external fin caused by welding shall be completely removed. The internal fin caused by welding shall also be removed subject to maximum height of 20 per cent. of the wall thickness of the tube. (d) Gas welded butt joints shall be made by the metal arc welded process. (e) When gas welding is employed the technique followed shall be approved by the Inspecting Officer and all welds shall be suitably heat treated. (f) For design steam temperature over 8500 F the material to be used shall be in accordance with Regs. 48 & 53

152. Attachment Of steel Tubes to be connected to the tube plates by one of the following methods (I) Expanding. (2) Strength welding. (3) Mechanical bolted ball joint. 150 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 (b) Drift or roller expanded tubes shall project through the neck or bearing part in the holes by at least quarter of an inch and shall be secured from drawing out by being bell mouthed to the extent of $\frac{1}{32}$ inch for each inch in diameter plus $\frac{2}{32}$ inch. (c) Tubes may be gas welded into fittings or headers for both boilers and superheaters after they have been expanded and flared provided the material in the fittings or headers does not contain carbon in excess of 0.35 per cent. (d) In the case of drifted or roller expanded tubes, the tube holes in the tube plates of drums, pockets, or headers shall be formed in such a way that the tubes can be effectively tightened in them. Where the tube ends are not normal to tube plate, there shall be a neck or belt of parallel girding of at least $\frac{1}{2}$ inch in depth measured in a plane normal to the axis of the tube at the holes. (e) Where the tubes are strength welded direct to the tube plate, the technique followed shall be approved by the Inspecting Authority and all welds shall be suitably heat treated. (f) Tube spacers, supporting clips and lugs may be welded to the tubes. Flash welding of studs for supporting refractories, etc., is also permissible. (g) The tubes shall be so arranged that they are accessible for cleaning internally and externally

153. Copper tubes.—Copper tubes up to one inch in external diameter may be used for small boilers ; such tubes shall be not less than 12 s.w.g. thick. HEADERS, MUD BOXES, ETC., OF WATER TUBES BOILERS of water tube boilers may be of solid drawn. 154. (a) Headers, mud boxes, etc., may be of welded steel, or of cast steel complying with the requirements of Regulations 73 to 80. (b) Each piece prior to being fitted in place shall be subjected to hydraulic test to double the working pressure of the boiler into which it is to be fitted. For pressures over 1000 lbs. per sq. inch, the hydraulic test pressure shall be the permissible working pressure plus 1 lb. per sq. inch. (c) (i) the sighting hole doors shall be substantial and capable of being removed and replaced from time to time without loss of efficiency or safety. (ii) The bolts by which they are held in place shall be fitted to them in such a way as to satisfy the above conditions. (iii) The

doors shall be so designed that they will not blow out in the event of breakage of the bolt. (iv) Circular holes also may be provided in addition to elliptical holes, if provision is made to prevent the door bolts from turning, while securing the joint. (d) All flanges shall have a fillet with a radius of curvature at least equal to the thickness of the neck to which they are attached. STAND PIPES, PADS, ETC

155. Stand Pipes and Pads.—Stand pipes and seatings for carrying mounting shall be made of wrought, cast or fabricated steel. Where pipes are fabricated by welding they shall be stress relieved. These shall take the form of short stand pipes, pressed steel plate gaddles, forged pads or pad cut from round rolled may be most convenient and secured to the boiler by riveting or welding. Where short stand pipes are used they shall be of solid forged, fabricated or cut steel. They shall be carefully bedded to the shell before attachment and where riveted the rivets shall be so pitched to ensure tight joint. The jointing face to which mountings are to be bolted shall be machined. Pads shall have sufficient thickness to allow the drilling of stud holes for mountings without the inner surface being pierced and the length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud

156. Design of Stand Pipes.—Where short stand are used, the bolting flanges shall be forged solid with the boiler or attached by combined screwing and welding or by welding alone. The thicknesses of the stand pipes shall comply with table below:—

Working pressure (lbs. per sq. in.)	Flange diameter (in.)	Stand pipe bore (in.)	Pressed saddle (in.)
Up to 150	Up to 150	Up to 150	Up to 150
150 to 250	150 to 250	150 to 250	150 to 250
250 to 350	250 to 350	250 to 350	250 to 350
350 to 600	350 to 600	350 to 600	350 to 600

Where pressed plate saddles are employed they shall be formed to bed closely to the boiler, and be machined on the face jointing the mounting and on the edges. The studs for the attachment of mountings, if screwed through the saddle, shall each be fitted with a nut on the inside having a thickness equal to the diameter of the stud. Where the stud holes do not penetrate through the gaddle, the length of the screwed portion of the stud in the plate shall not be less than the diameter of the stud

158. Seatings Mounting.—For pressure not exceeding 25 lbs. per sq. in. mountings with bored end not exceeding 1 in. B.S. P.T. may be used; the screwed portion of any such mounting being an integral part thereof and the thickness at the bottom of the thread being not less than 3/16". The mountings may be screwed: (a) Directly into the boiler shell plate, nuts being fitted on the waterside, or (b) Into steel distance pieces the length of thread engaged being in no case less than the bore of the mounting plus 1/4 in

159. Attachment of Mountings.(a) Mountings shall be attached direct to any shell or end plate where the plate is of sufficient thickness to allow a suitable surface to be obtained for the attachment of the boiler mountings. (b) The minimum thickness at the hole in the shell or end plate shall be not less than the thickness required for the maximum permissible working pressure considering the plate being unpierced. (c) Where the boiler mountings are secured by studs, the studs shall have a full thread holding in the plate for at least one diameter. If the stud holes penetrate the whole thickness of the plate, the stud shall be screwed right through the plate and be fitted with a nut inside having a thickness equal to the diameter of the stud. Where bolts are used for securing mountings they shall be screwed right through the plate with their heads inside the shell or end plate

160. Insufficient thickness of End Plate.(a) In cases where the thickness of the end plate is insufficient for this purpose the mountings shall be jointed to suitable steel seatings as provided in Regulation 155. (b) The following construction as to stand pipes attached to end plate shall be permissible:— (i) Where the internal diameter of the stand pipe does not exceed 1 inch, the stand pipe may be screwed into the plate and fitted with a nut on the waterside. (ii) Where the internal diameter of the stand pipe exceeds 1 inch but does not exceed 2 inches, it may be screwed in and seal-welded. (iii) Where the diameter of the stand pipe exceeds 2 inches, it may be welded to the end plate. The foregoing provisions as to the stand pipe shall be regulated by the following conditions. (iv) When stand pipes are screwed, the screwing shall be British or American Standard Pipe Thread. (v) Where stand pipes, saddles or other forms of seatings are fabricated by fusion welding they shall be stress relieved by heat treatment before attachment to the boiler. (vi) Where the bore of the stand pipe or seating and the hole in the plate does not exceed 5 inches plus twice the thickness of the plate, the seating may be welded to the plate without

subsequent heat treatment of the weld so made. Where the hole in the plate exceeds 5 inches plus twice the thickness of the plate, the plate to which the seating is attached shall be stress relieved by heat treatment.

161. Attachment of Water and Pressure gauges.—Water gauges and pressure gauges syphons may be attached direct to the front end plates without the intervention of a pad or standpipe, provided they are flanged and secured by studs. If the studs are screwed through the plate, nuts shall be fitted on the inside of the plate.

162. Mountings on Flat Plate.—Where the flanged mountings are attached direct to the flat plate, such mountings shall be provided with substantial spigot, the full thickness of the boiler plate.

163. Bolts and Nuts.—Bolts and nuts shall be of the best quality and shall be in contact with the flanges, and all holes in the flanges and pads shall be drilled. In cases where the boiler is lagged, the joint of the mountings shall be clear of the lagging surface or the lagging kept clear of the flange so that the joint can be impacted and, when necessary, remade. **MANHOLES, MUDHOLES, ETC.** (b) Sufficient sight and cleaning holes shall be provided to permit access for efficient inspection and cleaning. Such holes shall normally be elliptical in form and not less than 3 in. X 2 in.* (b) At least one manhole or sight hole shall be provided in the upper part of the cylindrical shell or in the shell crown, or end plate and this shall not be less than:— Boilers not exceeding 2 ft. 6 in. Boilers over 2 ft. 6 in. diameter and not exceeding 3 ft. Boilers over 3 ft. diameter and not exceeding 3 ft. 6 in. Boilers over 3 ft. 6 in. diameter and not exceeding 4 ft. 6 in. (c) Where the size or construction of the boiler does not permit of entry for cleaning and inspection sufficient cleaning holes shall be provided in the shell for these purposes. (d) Where cross tubes are fitted in vertical boilers one cleaning hole shall be provided opposite to at least one end of each tube. At the bottom of the narrow water leg at least three cleaning holes shall be provided. The cleaning holes shall be so arranged that the circumferential distance between them does not exceed 3 ft. unless the foundation is sufficiently accessible to permit of cleaning and inspection from the inside of the boiler. (e) Cleaning holes or mudholes in Loco Type boilers shall be provided at each bottom corner of the outer firebox casing, above the fire hole line and on each side of girdle plate in line with bottom of barrel. (f) In the case of horizontal boiler or where the foregoing provision is impracticable the cleaning holes or mudholes shall be in the corner of the outer firebox casing and the holes large enough to permit it.

165. Compensating Rings and Frames for Openings in Shells of Cast Steel.—The compensation provided shall preferably be of flange which be fitted in all cases where the shell plate exceeds 9/16 in. thickness. Flanged frames shall be weldless and shall be flanged and pressed to provide a tight fit for the cover. **NOTE.**—Wherever practicable the frames shall be secured to the inside of the shell so that the shorter axis is parallel to the longitudinal centre line of the boiler. The size of mudholes and sight holes are 7 in. X 5 in. and 9 in. X 2 in. (b) All compensating rings and frames shall be formed to fit closely to the girth flange to be connected. Where attached to cylindrical shells and are 12 in. X 9 in. or larger they shall be at least double riveted. All caulking edges shall be machined or machine gas cut. (c) The flat jointing surfaces of all flanged and pressed frames and all doors or covers shall be machined.

166. Doors and Cross Bars. (a) All internally fitted doors of manholes, mudholes and sight holes shall be of wrought steel built up or of steel to shape and annealed or made from one thickness of plate with a machined recess for the jointing flange, or may be of steel casting. Their spigot part or the recess shall not have a greater clearance than 1/16 in. all round, i.e., the recess shall not be less than 1/8 in. smaller than the holes in which they are fitted. The studs or bolts of large doors shall be screwed through the plates and riveted over. (b) Internal doors for openings not larger than 9 in. X 7 in. in size need only be fitted with one stud, which be provided with an integral collar and screwed through the plate with a nut on the inside of the door. Internal doors for openings not larger than 5 in. X 7 in. may have the stud forged solid with the door or if screwed be efficiently riveted to the doors. (c) Cross bars shall be of suitable proportions and either solid steel forging or of cast steel.

167. Raised Manhole frames and Cover plates.—(a) Raised circular manhole frames not exceeding 10 inches in diameter shall be at least 3/4 inch thick in all parts. The circular cover plates and joint flanges for such frames shall be not less than: 1 inch for pressures not exceeding 12 lb. sq. inch. 1-1/8 inch thick for pressures over 120 lb. but not exceeding 200 lb. sq. inch. 1-1/4 inch thick for pressures over 200 lb. sq. inch.

exceeding 250 lb. sq. inch. For pressures 250 lb. sq. inch and over ruiscd circular manhole frameH shall not be fitted. The cover plates shall be Necuuecl by nt least, *ixteen steel bolts not legs than inch (limneter. (b) External raised ciroulor mouthpieces Bhall be : (1) formed in one piece without, welds, (2) formed fit om suitable rolled section and forge welded, or (3) fbbriegcted by fusion welding provided they are stress relieved by heat treatment ofter weldill!t and before attaching to the boiler. Wolds *Inould be positioned so that they ore located on the trousvorsc centre line of the boiler. The jointing flanges of mouthpieces und covers shall be mochined on the fove ond edge and on the beut Ing *urfoce for the bolts. Bolts Rnd nutl-l *hull be much ined where in contact with the flanges and the joints *hould be formed inside ond outside the bolts to preclude the pogsibility of Bonge distortion. Cover plates shall bc dlHhed outwards to o depth of upproxilnatoly one-eight of the internal diameter of the frame. All fromeg und mouthpieces ghoill bed closely to the surfoces to which theyRare to be connected, and where riveted to cylindrical shells Shall be at least double dveted. All Coulking edges shall be moehined or machine gag cut. •SEO. B] GAZETTE OF INDIA EXTRAORDINA±Y 666 168. Position of Manhole in Shell.—Manh0108 in oylandrioml shells shall be placed fa,r as possible from any riveted sea,ms, pretorab]y town,rd8 (he book end of the boiler top

169. Compensation Rings to Manholes.Componsation shall pr. ovided' in every case for the part cut out or R, Bhell for u Illu,nhole. The Ntrench the net qeetion of eornponsatjng rinc•• u,Jld of the rivets securing it to "hell pared with that Df the part Gf shell cul out shn]l not ho IONS than the sti ongtth loogi-tudinal (b) The spacing of the rivets shbll be not to reduce the of the Shel! plate below that of the longitudinnl seams

170. Compensation for cutting large holes in shell Type Boilers.-- Where holes ore cut in the cylin(Irical Bholl for the purpo,ye of oti,uching R, seating, trauno or door, compensati011 shotl be provided such that the added Bectional n,rtb, including porte of the frame within 4 inches of the *hell ancl excluding rivet holes, shall be not, lexe than the gect,iontbl toreu of the plate removed which Nhull be the produci of the dio- meter of the opening ond tho calculated thickness of the phâc• found by Equa• tion l. Where holes a,rc cut in tho cylindrica,l shell for the purpose of fixing Ebt,ing for mountings und the diameter of the holed iH greater l,hun 2• 1/2 times the thickness of the shell plate plus '2' 3/4 inches, compensul,ion gha,ll bc provided. Where lbrge opening is rut in a, cylindricul shell to reeeivo another port of the structure, the side* where cut uwoy Nh oll be efficiently cross staycd or Strengthened in qorne other effective 'nunner

171. Rivets gecuring compensating Rings and Stand Pipes.For nmrliholes or tot±hl effecLive shear strength of the vets on Bide of the centre line shibll be not loss than the tensile streug(h of that pox tinn of the hhell Dound by Regulation 170, Thich is renlove(l und the rivets '4 •eurin',,f nny cmnpemat,ing ring or fr•n.ltcl 8hB,ll bc so a-tanged thu,t JOnt •effeciency caleulatecl on any line parallel the axis of the boiler through any Pint of such ring or frame shall not be less thon i ho efficiency of the Of the boiler. For Stu nd. pipes.—Wherc the hole in the *hell to ocoornmodote u Stundf)lpe (loes not exceed 8 inche* (liumeter, the total shca.r strength or t,hc rivets un en,eh centrc line shall not bc lccqg thun 75 per cont. of thw tenqi Atrc•ngth nf the portion of the plate, as found by Regulai,ion 17(), w hieh hay been removed The strength of rivets in double Nhcnr shall bc ta,ken 0B I • 875 times the strength of rivet* in *ingle shear. RIVETING 172. Rivet Holes. (a) Rivet holes shall be punched, but Bhall be drilled full Eize from the solid plate, und wherever possible rivet holes shall be drilled in plaoe with plutes, straps nnd ends bolted in position. After drilling, the plates ahoill be separated, the burrs and the sharp edges of the holes shall be removed and the contact surfaces of the plates shall be elcnnd. All tacking holes shall be drilled to a size which will ollow tho holes to be enlarged to the required rivet size by drilling or remnering. All rivet holes *holl be slightly countersunk under each rivet head. (b) The diametel of the rivet hole shn.,ll be not, Inoro than 1/16 in. lorgor than ltho standard diameter of the cold rivet us Innnufactured. (a) Where sizes of rivets ure mentioned the sizes refer to the diameters-of the rivet holes not to the diameters of the rivet* used before closing

173. Rivets shall be closed by hydrnulic machinery wherever the design of the boiler permits the rivets bc closed by hand or pneumatlø Lhammer in position where hydroulie riveting iB impracticable.GAZEÄTE OF INDIA EXTRAORDINARY [PART (b) Rivet,g shall be of xuffcient length to fill rivet holes and form sound ond aubNt,n.tiA.l headR. The heads sha,ll be finished concentrically with the rivet . Rivets shall be heuted unifonnrrly throughout their full lengtfi. (c) Drift piDN not be iVith such focco as to diHtort the rivet holes. If the rivet holes me found not to bf fa,ir when the

plates bolted up for riveting the holey shR,II be reamerecl fair befo re the vivel,ing iN eommeneed. (d) For hydraulic riveting the prc•Henre shall be the least necessary to onsm..ue a tight joint,, oncl only yufficient proNgurc shall be uscel to close the rivets properly and securely without indenting, l) nckling or otherwise dumoging the plate. 'The rivete Shall be 01 lowed to Nhrink while under pressu re frorn_ i,hc riveting machine

174. Fullering and Caulking.—All seams Shall be fullered or caulked inside and outside and thix shall be (Iona in such o Inanner that the platßN ure not sprung or damaged. CHAPTER rv REGULATIONS FOR DETERMINING WORKING PRESSURE TO BE ALLOWED ON VARIOUS PARTS OF BOLERS OTHER THAN FUSION WELDED AND SEAMLESS FORGED DRUMS. 175, The 1-nuxitnum precssu_re which u, boiler may be used shall be deter- nnnenr l in n eecn•clonee with the provisions of this Chapter. The Regulations in this Chapter refer to Jilbi,erial subjected steam f,etnpernturc not exceeding 5000 P SHELLS 176. Formula for working pres.eure of Shell. (a) For cylindrical shells, barrels, Btea,ln and water and of boilerg the moxirnurn working pressure per squnre to be nllowed shall be enleulai,ed from Che following formulb : [NOTIC. Where parts of drums of tubo boiler are perforated for tubes, the work- ing preesure Bhull be calculated by equation (53) under 'Tubs Platea'.] jN the working pressure in lbs. per square inch, t is Ohe thickness of Bshell plates in 32nds of on inch, Eqn. (1) S is the minimum tensile breaking strength of the shell plates in tons per square• illa•h or wha,tever strength is allowed under Regulation 5, is the percentage of strength of the longitudinol geome of Shell or of line of hol('k in the shell for stays, or rivets, or of an opening in the shell not fully compen- Bated, whichever ig least colculated by the methods hereafter described, (n eo-efficient os follows 75 hen i,he longitudinld seams are mule -with double butt straps and when gmall sh are formed from solid rolled geotions ; 83 qrhen the longitudinal scamf-l aro made with lap joints and treble riveted hen I hc longitudinal seanns are made with lop joint* and ore double riveted 2, '0 when i,he longitudinal seornng are welded ond ore fil ted with o single butt strap •3 when the longitudinol seams are mgde with lop joints and are Bingle riveted. D IS tho inside diameter of the outer strake of plating of the cylindrical shell mnasured in inoheg. s.o. 8] OF INDIA (b) The Factor Of Safety shall in no oase be less than 4. The aot,unl Foetor of Sufety in each case may be found from the eqnotion With the best form of joint ond leust eo-emcient (C) Safety for shell plbt,es, inch to 12 inches in thioknesa, varies from 5' 13 to 3 • 99. (o) An addition of IO per cent. 8ball be mado to the appropriate co-efficient for shells of boilers in which. the longitudinal sea,ms are la,p jointed and not urce*Bible to cloc visual ingpeotion bnd for shell pln,teg of externally fired boilers exposed to the direct inpoct of furnace flame ; provided that this addition shall not a,pply to the gteorn ond water dru_ms of water tube boilers where the drums are noi close to the fire-grate and there ore tubes between the fire-grate the drunu. (d) The obove co-emcient ore Btandardß and shall be used only for boilo opelk to unspection by an- Inspecting Offcer during the whole period of construct ion and which arc certified by him ha,ving been constructed in accordance with Lhe stowi- ord oondition.ß laid down in these Regulbtions

177. Methods of calculating the strength o} riveted joints.— The Ik3rcntag•e Of strength of riveted joint (J) ahull be found from the following formulæ (i) (ii), (iii) : (i) and (ii) are applicable to any ordinary •type of joint ; (iii) is applicable only to thot type of joint in which t,ijc number of rivets in the inner coq is ble that of the outer row. The lowest value given by the application of these formula, ig to be taken as the percentage of strength of tho joint ith the solid Plate percentage LUO A' AxNxS Sl - Rivet percentage PxTxS IOO(P- 21)) IOOxAxCxSl —Combined plute Litcl rivet Eqn. (41 P ig the pitch of rivete at outer row in inches, D is the diameter of rivet holes in inches, A iB tho aectional area of one rivet hole in square in c hrs N is the nutnber of rivets per pitch, (P), 'P iB the thicknees of plate in inches, C --1 for rivets in single shear as in lup jointe, and 1 •875 for rivets in double shear us in double butt strappod joints, Sl is: the shearing strength of rivets, which Bholl be taken to be 23 tons per Bquare i-noh for Bteel and 18 tons per squnrc inch for iron, S is the mi-nirnum tensile b] euking si,rengh of shell plates in tons per sque re inch, or whatever strength is allowed under Régulation 5 of Chapter I. In the fomnula (i) D is the diameter of the rivet holeg in the outer YOV, s and in the third formulu J) iB the (libineter of the livet holes in the next rows. {n the last A is the nrea of onc ri et hole in the outer row. (b) When the sectional urea of the rivet holes ig not the same in all rows, and when some of the rivets nre in double shear and others in single shear the rivet sections per pitch of each size nr shear Nhall bo oomputed nud added together to fomn the total rivet section. 658 THE GAZETTE OF INDIA EXTRAORDINARY 11 178. When Pitch exceeds

maximum allowed.—Should the pitch of the rivets exceed the maximum pitch allowed, the permissible pitch shall be used in place of the actual pitch in determining the percentage of plate section. No greater percentage than 85 shall be allowed for any type of riveted joint

179. Butt Straps and spacing of rivets below requirements.—Should the spacing of the row of rivets or the distance between edge of plate and rivet hole or the thickness of butt straps be less than is specified in Regulations 182 and 184 the percentage representing the strength of joint shall be modified as prescribed in those regulations

180. Percentage of Welded and Strapped Seams.—In determining the percentage of strength of a welded seam covered by a strap or strap the formulae and allowances in Regulations 177, 178 and 179 shall be applied, but 50 per cent. shall be added to the rivet percentage for the weld

181. Percentage to be allowed for Solid Rolled Shells.—When small shells are rolled from the solid, J in equation (1) shall be taken as 100 per cent

182. Thickness of Butt Straps.—The minimum thickness of butt straps for the longitudinal beams of cylindrical shells shall be determined by the following formulae but all straps should be of sufficient thickness to permit of efficient caulking, and in any case shall not be less than $\frac{3}{8}$ inch in thickness. Single butt straps having ordinary riveting : $1.125T$ Tl Eqn. (5) Single butt straps having every alternate rivet in the outer rows omitted $1.125T_x$ (P—2D) Double butt straps of equal width having ordinary riveting $1.625T$ T Eqn. (6) Eqn. (7) Double butt straps of equal width having every alternate rivet in the outer rows omitted $1.625T_x$ Eqn. (8) Double butt straps of unequal width either having ordinary riveting, or having every alternate rivet in the outer rows omitted. $1.75T$ Tl (wide strap) $1.625T$ Tl (narrow strap) . Eqn. (9) Eqn. (10) Tl is the thickness of the butt straps in inches. The other symbols have the same significance as in Regulation 177. Single and wide butt straps shall, wherever practicable, be on the inside of the shell. Should the thickness of butt straps be less than that above described, the least percentage of joint as determined under Regulation 177 shall be reduced in the portion of the actual thickness to the prescribed thickness

183. Maximum Pitch of Rivets in longitudinal joints.—The maximum pitch of the rivets in the longitudinal joints of boiler shells shall be $0.25T + 1$ maximum pitch in inches. T is the thickness of the shell plate in inches. Eqn. (11) Number of Rivets per Pitch 3 4 5 THE on INDIA O is efficient, as given in the following table :— 1 .31 Co-efficients for Lap joints 3 .47 4-17 Co-efficient 3 for Single Buttrapped joint 1 .53 Co-efficient for double Buttrapped joints 5 52 184. Spacing of rows of rivets. In joint, whether lapped or fitted with butt straps, in which there are more than one row of rivets and in which there is an equal number of rivets in each row, the distance between the rows of rivets shall be not less than— Zig-zag riveting. $1.93P + 1.67D$ distance between centre lines of rows (R) . Chain riveting, $2D =$ distance between centre lines of rows (R) . Eqn. (12) Eqn. (13) (b) In joint in which the number of rivets in the outer rows is one half of the number in each of the inner rows, and in which the inner rows are chain riveted the distance between the outer rows and the next rows shall be not less than as required by equations (12) and (13) whichever is the greater, and the distance between the rows in which there are the full number of rivets shall be not less than $2D(R1)$. (c) In joint in which the number of rivets in the outer rows is one half of the number in each of the inner rows and in which the inner rows are zig-zag, the distance between the outer rows and the next rows shall be not less than— $2P + 1.5D =$ distance between centre lines of outer and next rows (R) Eqn. (14) The distance between the rows in which there are the full number of rivets shall be not less than— $1.65P + 1.67D =$ distance between centre lines of inner rows (R1) Eqn. (15) P is the pitch of the rivets in the outer rows, D is the diameter of the rivet holes in inches or the mean of the diameters of rivet holes when the distance to be determined is between two rows of rivets of different diameters. (d) Should the distance between rows of rivets be less than as prescribed above the plate percentage determined by equation (2) shall be modified thus— actual distance 100 prescribed distance modified plate percentage, Eqn. (16) (e) In all cases the clear space between a rivet hole and the edge of a plate shall not be less than the diameter of the rivet holes, i.e., the centre of the rivet hole shall be at least $\frac{1}{2}$ diameter distant from the edge of the plate (E)— Provided that, if this condition be not observed, the strength value of the rivets affected shall be reduced in the proportion of the actual distance between the outer edge of the rivets and the edge of the plate to the prescribed distance. on INDIA 185. Circumferential and End Seams of Water Tube Boilers.—The suitability of circumferential seams including

the Beams joining ends to Shell-18 shall be verified by the following formula : is equal to or greater than WP
 $D \times C \times K \div 2150$ for 26/30 ton tensile plate. $K = 157$ for 28/32 ton tensile plate. Due to higher stresses, see Reg. 271 and 340. WP The working pressure in lbs. per sq. in. Eqn. (17) D — The diameter of shell in inches, measured inside the outer ring of plates. J Circumferential Joint efficiency calculated by Eqns. 2 or 3. $C = 8 \div 24$ where the seams are made with lap joints and are triple riveted - 8 where the seams are made with lap joints and are double riveted - $9 \div 60$ where the seams are made with lap joints and are single riveted. t thickness of plate in 32nds of an inch

186. Compensation for Manhole and other openings.—The percentage of compensating section shall be determined by the following formula :— $200 (W - D) \times Tr$ percentage strength of compensating section
percentage strength of rivet section $(J \div 2D) \times T$ s Eqn. (18) Eqn. (19) W is the width of compensation ring in inches measured in the direction of the longitudinal axis of the boiler, L is the length of opening in shell in inches measured in the direction of the longitudinal axis of the boiler; D is the diameter of rivet holes in inches, Tr is the thickness of compensation ring in inches, T is the thickness of shell plate in inches, A the area of one rivet hole in inches, N is the number of rivets on one side of the longitudinal line. When the rivets are in double shear $1 \div 875$ times the single rivet section shall be allowed. Parts of raised manhole mouthpieces within four inches of the shell shall, in addition to the ring, be included in the compensating section



187. Uncompensated Holes in Water Tube Boiler.—The maximum diameter of any uncompensated opening in a shell shall be determined, subject to the condition that the minimum thickness at the hole in the shell or end plate shall be not less than the thickness required for the maximum permissible working pressure, considering the plate as being unpierced, as follows : $d \leq \frac{2}{3} \{XV(D+T)\}$ Eqn. (20) Where d = Maximum mean effective diameter of uncompensated hole in inches. T Thickness of drum shell in inches. Internal diameter of drum in inches, but not exceeding 60. $\frac{2}{3}$ where does not exceed 0.50. in other cases 0.50 Eqn. (21) The required thickness of seamless unpierced shell Where n — Eqn. (22)

DISHED END PLATES 188. Complete hemisphere without stay or other support made of one or more and subjected to internal pressure.—The maximum working pressure shall be by the following formula (t-2) $\times S \times J \times R$ W.P. is the working pressure in lbs. per square inch, t is the thickness of the end plates in inches, Eqn. (23) S is the minimum tensile breaking strength of the end plates in tons per square inch or whatever strength is allowed for them, J is the least percentage of strength of the riveted joint of the plates



forming hemisphere or securing it to the cylindrical shell, R is the inner radius of curvature in inches, C for single riveting $\frac{1}{3} \times 3$, C for double riveting $\frac{1}{2} \times 9$, C for treble riveting $\frac{1}{2} \times 83$

189. Dished end subject to internal pressure. For unstayed end of steam and water drums, tops of vertical boilers, etc., when dished to partial spherical form maximum working pressure shall be determined by the following formula $W.P. = \frac{15}{18} \times \frac{t}{R} \times S$ where $W.P.$ is the working pressure in lbs. per square inch, t is the thickness of end plates in 32nds of an inch, R is the inner radius of curvature of the end in inches, which shall not exceed one diameter of the shell to which it is attached, S is the minimum tensile breaking strength of plate in tons per square inch, or whatever is allowed for it. (b) The inside radius of curvature at the flange shall be not less than 4 times the thickness of the end plate, and in no case less than inches. (c) When the end has manhole in it ($t=5$), 811811 be substituted for ($t=1$) in the formula. (d) In the case of the electrode boiler where the attachment of end is permitted by fillet welding as per Regulation 104(d), for efficiency 15, the efficiency 10 shall be substituted. (e) The total depth of flange of manhole from the outer surface in inches measured on the minor axis shall be at least equal to $\sqrt{\text{depth of flange in inches}}$ Eqn. (25) where T is the thickness of the plate in inches and W is the minor axis of the hole in inches. Note.—The foregoing provisions shall not preclude the use of dished end' compliance with Regs. 275 to 278 where not fitted with an uptake.

190. Dished end subject to external pressure.—In the case of unstayed dished ends, for the efficiency 15 in equation (24) the efficiency 12 shall be substituted, and R shall be the outer radius of curvature of plate. For plates exposed to furnace gases the efficiency shall be 10.6. In no case shall R exceed 2.75'. **191. Dished end of Lancashire and Cornish type.** For dished ends of Lancashire and Cornish boilers with external or internal flanges for furnace gases formed in one piece, without stays and subject to internal pressure the maximum working pressure shall be determined by the following formula $W.P. = \frac{8}{30} \times \frac{t}{R} \times S$ where $W.P.$ is the working pressure in lbs. per square inch, t is the thickness of the end plate in 32nds of an inch, R is the inner radius of curvature of the end in inches which shall not exceed one and half times the internal diameter of the shell to which it is attached, S is the minimum tensile breaking strength of the plate in tons per square inch or whatever is allowed for it. (b) The inside radius of curvature of the flange shall be not less than 4 times the thickness of the plate and in no case less than 3 inches.

192. Dished shell and pressure box. In determining the working pressure in accordance with Regulations 189 and 190 no account shall be taken of the flange of the uptake tube in vertical boilers. If dished crown plates having taken care for higher pressures, when considered as flat plates, under Reg. 191 a higher pressure shall be allowed. (b) The radius R of the dished part may be found as follows Eqn. (27) C and d are the lengths in inches of half the base line or chord on which measured and the height of the dish or camber at the middle of the chord respectively. **FLAT PLATES** 193, Flat plates supported by solid screwed stays, marginal seams or flanges.—(a) For flat plates supported by solid screwed stays or riveted marginal seams the maximum working pressure shall be as follows Eqn. (28) In the following formula and in the following regulations relating to 'Flat Plates' unless otherwise specified. $W.P.$ is the working pressure in lbs. per square inch, t is the thickness of the flat plate in 32nds of an inch, t_l is the thickness of the washers, strips, or doublings employed, m is 32nds of an inch) A is the horizontal pitch of stays in inches, B is the vertical pitch of the stays in inches, C is a coefficient which varies in value with the method of fixing the stays and nature of the support. Where the plates are exposed to the direct impact of the flame the following value of C shall be reduced 12 per cent. — 60 for stays screwed into the plate with their ends riveted over. 80 for stays screwed into the plate and fitted with nut on the outside, 100 for stays passed through the plate and fitted with nuts inside and outside, $C = 110$ for stays riveted to flange, in the flat plate securing it to the shell side plate, end plate, furnace or uptake. Where portions of plate are supported by stays or riveted seams or flanges having various values of support, the value of C shall be taken as the mean of the points of support concerned. The support of riveted seam shall be assumed to be the line through the centres of rivets in the nearest row and of flange at the commencement of curvature. In the latter case, if the inside radius of curvature of the flange exceeds three times the thickness of the plate, the support shall be assumed to be at distance of three times the thickness of the plate from the inner side of the flange. (b) For portions of plate where the stays are irregularly pitched D shall be used instead of A , D being the diameter in inches of the largest circle which can be drawn passing through not less than three points of support, viz., the centres of stays, or rivets or the commencement of the curvature of flanging, whichever

is applicable). (c) For the tops and sides of combustion chambers and fireboxes the distance between the rows of stays nearest to the back tube plate, or the back or firehole plate respectively, and the commencement of curvature of those plates at their flanges, shall not be greater than the allowable pitch of the stays. (d) For the tops of combustion chambers and fireboxes where they are joined to the sides by curved portions, if the outer radius of the curved portion is less than half the allowable distance between the girders, the distance between the first girder and the inner surface of the side plates shall not exceed the allowable distance between the girders. If the radius of curvature is greater than half the allowable distance between the girders, the width of the flat portion measured from the centre of the girder shall not be more than half the allowable distance between the girders. (e) Where tube sheets are not fitted in most of tubes, in tube plates of locomotive type boilers, and parts of plate outside the girth, occupied by tubes are supported, in accordance with Regulation 212 (b), by screwed stays each stay in the row nearest the tubes shall be sufficient to support the plate up to the edge of the tube holes in addition to its share of the plate on the opposite side of the line of stays. The working pressure for the plate between a row of stays shall be determined by Eqn. (28), A being the horizontal pitch of the stays in the nearest row, B twice the distance between the centre line of stays and a line touching the tubes opposite them and C the coefficient appropriate to the kind of stay

104. Flat plates supported by stays and nuts and large washers or strips or Where the plates are supported by stays passing through and are fitted with nuts inside and washers and nuts outside, the diameter of the washers being at least three-fourths of the pitch of the stay, and the thickness of the washers being at least two-thirds of the pitch of the stay, but not greater than that of the plate, the maximum working pressure shall be : 100 Eqn. (29) (b) where the washers have a diameter of at least two-thirds of the pitch of the stays and a thickness of at least two-thirds of the thickness of the plate, but not less than that of the plate, and are riveted to the plate in an efficient manner, the maximum working pressure shall be 100 Eqn. (30) (c) Where the plate is stiffened by strips at least, two-thirds of the pitch of the stays in breadth which have a thickness of at least two-thirds of that of the plate but, not greater than that of the plate, and are riveted to the plate in an efficient manner, the maximum working pressure shall be 100 Eqn. (31) (d) Where the plates are fitted with doubling plates having a thickness of at least two-thirds of that of the plate but not greater than that of the plate, and are riveted to them in an efficient manner, the maximum working pressure shall be : 100 Eqn. (32) 195. Flat tube For the portions of tube plate in the neighbourhood of tubes where stay tubes are required and where the minimum thickness and cross section of tube plate are not less than as prescribed in Regulation 211 the maximum working pressure shall be Eqn. (33) P is the mean pitch of the stay tubes supporting any portion of the plate (being the sum of the four sides of the quadrilateral divided by four). $C = 70$ for stay tubes screwed and expanded into the plate and no nuts fitted, $C = 85$ for stay tubes screwed and expanded into the plate and fitted with nuts. (b) No nuts shall be fitted to stay tubes at the combustion chamber or firebox end. (c) Where the plates are exposed to the direct impact of flame, the coefficient C shall be reduced by 12 per cent., and where the thickness of the plates is less than as prescribed in Regulation 211 the appropriate coefficient shall be reduced in proportion to the deficiency. (d) For the wide water space between the nests of tubes and the inner rows of tubes and the shell, the maximum working pressure shall be :— $C = 55 \frac{1}{2}$ Eqn. (34) A is the horizontal pitch of stay tubes in inches measured across the wide water space from centre to centre, B is the vertical pitch of stay tubes in the bounding rows in inches measured from centre to centre, $C = 100$ for stay tubes screwed and expanded into the tube plates and no nuts are fitted, $C = 80$ for stay tubes screwed and expanded into the tube plates and fitted with nuts, $C = 70$ for stay tubes screwed and expanded into the tube plates and nuts are fitted only to alternate stay tubes, t is the thickness of the flat, P is the pressure in lbs. per sq. in. W is the thickness of the washer or strip doubling employed in the nests of tubes (e) Where the plates are exposed to the direct impact of flame, the coefficient C shall be reduced 1 per cent

196. Plates supported by gusset For the end plates of Locomotive, Cornish, Vertical and locomotive boilers, and other flat gusset supported by irregularly pitched gusset the maximum working pressure shall be :— Eqn. (35) D the diameter in inches of the circle which can be drawn passing through not less than three points of support, viz., the centre lines of rivets or the commencement of the curvature of flanging, whichever is applicable. $C = 100$ for plates not exposed to flame. $C = 88$ for plates exposed to flame. (b) Where such plates are stiffened by suitable tees or angle bars securely riveted to

the plate within the circle D, the appropriate coefficient may be increased thirty per cent. Such stiffening bars shall be placed as to transmit their load in a direct manner to the gusset butt, and the shell plate. (c) For the part of the end plate containing the manhole in Lancashire boilers the maximum working pressure shall be as Eqn. (36) D the diameter in inches of the circle which can be drawn enclosing the manhole and passing through the centres of the rivets in end plates connecting the shell and gusset angles and flanges or to the commencement of curvature of flanging, whichever applicable where the circle passes through only three of the possible five points of support mentioned the remaining two shall be embraced within the circle. t is the thickness of the end plate in 32nds of an inch, t₁ is the thickness of the boss of the mouthpiece or flat ring in 32nds of an inch, C 90 where the manhole mouthpiece is of either of mild or cast steel, and has a turned-in flange of a depth, measured from inside of end plate, of not less than 4 times the thickness of the end plate, and thickness not less than the thickness of the end plate, C — 70 where only a flat flange is fitted, C is to be taken the mean of the points of support through which circle passes in accordance with Regulation 93 where there is no mouthpiece or flat flange and the end plate flanged around the manhole to the depth required in Regulation 201

197. Flat Crown plates vertical boilers. For the flat crown plate of vertical boilers either with or without bolt stays, Equation (35) shall be used in determining the working pressure with C — 80, when the plate is not exposed to flame, and 70 when they are exposed to flame. In this case D is the diameter of the circle in inches that can be drawn passing through the centres of the rivets or bolt stays when fitted, or the commencement of the curvature of the flanging, whichever applicable. Where bolt stays are fitted with washers of the same thickness the plate securely riveted thereto, the circle shall pass through the centres of the washer rivets but where the washers are not riveted or where none are fitted the circle shall pass through the centre of the girth. In the case of electrode boilers where the attachment of ends is permitted by fillet welding only per Regulation 104(d), the working pressure shall be determined by Equation (35) with (b) Where the crown plate is flanged the inside radius of curvature of the flange shall not be less than 4 times the thickness of the end plate, but in no case less than 2½"

198. Circular flat ends of drums, etc., supported only at For those ends C in Equation (35) shall be taken as 140 when the plates are not exposed to flame, and 122.5 when they are exposed to flame. In this case the circle D shall pass through the centres of rivets or bolts securing the end to the shell or, where the end is flanged, through the commencement of curvature. (b) Where flanged the inside radius of curvature of the flange shall not be less than 4 times the thickness of the end plate but in no case less than 2½"

199. Bar or bulb stiffened end plates and smokebox tube plates of locomotive boiler.—Where such plate instead of being supported by stays are stiffened in the steam space by substantial tees at an angle shall be securely riveted to the plate and tending across the plate to within the margin allowed by Equation (37) or where such plates are formed with a deep bulb extending across the plate to well within the margin allowed, for the support thus given, C shall be taken as equal to 80 and 70 for plates not exposed, and exposed, to flame respectively. The margin or pitch for such stiffening shall be measured from the centre line of rivets or commencement of curvature of bulb provided it is not more than 2 inches from the centre line of bulb. For the flat plate above the stiffening or bulb, C shall be taken the mean of the values appropriate for the points of support

200. Flat plate margins.—The amount of support in relief of stays which may be credited to the side of shells, furnaces, upper bridge, fireholes and foundation rings to which flat plates are attached shall not exceed that found by the following formula Width or in inches t Thickness in 32nds of an inch w.p. Working pressure in lb per inch C = 3.47 for plates exposed to flame — 3.70 for plates not exposed to flame. c Eqn. (37) Where the plates are flanged (the margin shall be measured from the commencement of curvature or from a line times the thickness of the plate distant from the side of the flange next to the inner radius of the corner whichever is the less. In other cases, the margin shall be measured from the centre line of rivets in the nearest row of the girth by which the flat plate is attached. Doubling plates shall cover the area supported between the stays and extend beyond the stays so that the centre of the rivets securing the doubling plate to the end plate shall be at least half the distance from the outermost stays to the nearest girth point of support. Where flat end plates are flanged for connection to the shell, the inside radius of flanging shall be not less than 1.75 times the plate thickness with a minimum of 1½ inches. szo. 8] THE GAZETTE OF INDIA EXTRAORDINARY, 667 201.

Manholes and Mudholes in Flat Plates.—Where a flat plate is flanged to stiffen it a, manhole or sighthole, to permit same working pressure as would be allowed upon an unpierced plate, the depth of the Bonge measured from the outer surface shall be at least equal to— $\frac{v}{T} \times W$ —depth of flange in inches Where T is the thickness of the plate in inches, and W is the minor axis of the hole in inches. STAYS Eqn (38) 202. Solid screwed stays.—For screw stays to combustion chambers and boxes and for longitudinal and cross stays, the maximum working pressure for the stays is to be calculated from the appropriate one of the following two formulae: Eqn. (39) Eqn (40) W.P. is the working pressure in lbs. per square inch, D is the diameter of stay over threads in inches, DI is the diameter of body of stay at its smallest part in inches, N is the number of threads of stay per inch, A is the area in square inches supported by one stay [for area, to be supported by four in liltbox tube plates of locomotive boilers, see Regulation 193(c)], for steel or wrought iron screw stays to combustion chamber or fireboxes for steel longitudinal or cross stays fitted with nuts, for copper screw stays to fireboxes. Where stays are made with enlarged ends and the body of the stay is smaller in diameter than at the bottom of the thread the working pressure shall be calculated from the second formula 1110

203. Stresses in steel jointed stays.—The section of least strength whether of Hiny, rivets, gables or Pin shall be used in calculating the working pressure for the stay. For parts in tension stress of 9,000 lbs. per square inch of net section shall be allowed, and for parts in shear stress of lbs. per square inch of net section. (b) Part, in double shear shall be allowed a section of 1.875 times the single section 204. Stay tubes.—For horizontal tubes, whether of wrought iron or steel, seamless or lap-welded the Timmerman (Irking) formula shall be calculated from the following formula: W.P. 5900 Eqn. (41) D is the diameter of the tube over threads in inches, DI is the internal diameter of the tube under the threads in inches, N is the number of threads of stay per inch. A is the area in square inches supported by one stay tube, measured from centre to centre of stay tube*. When the area contains tubes or ports of tubes their aggregate area, calculated from their smallest external diameter of body when in tension 668 THE GAZETTE OF INDIA EXTRAORDINARY [PART II and internal pressure] provision, shall be deducted from the area of the containing figure and the used as A in the formula, 205. Stays in tension and compression.—(u) The same stress shall be allowed. The strength of short stays in compression and not in tension shall be calculated on the net section at the bottom of thread or in body, whichever is the least. (b) For stays to be used on a horizontal port, of a boiler, not provided with foregong shall be the same as that allowed for stays, or parts of stays of up proximate like kind in condition*

206. Measurements of stayed areas in the end plates of locomotive and vertical boiler.—When the areas supported by stays are generally circular as in the upper part of the end plate and smokebox tube plates of locomotive boiler, or annular or in the crown plate of vertical type boilers, the area to be supported by stays, A in Eqn. 39 and 40 shall, in the first case, be the area of the plate contained within the margins credited to caging or barrel lugs, screw stays, fire door ring or tube stays the case may be, and in the second case be the area of the annulus between the margins credited to uptake and shell. When bolt staying is necessary, the stays shall be properly distributed; the aggregate stay section shall then be used in the formula for calculating the working pressure

207. Gusset stays.—The working for gusset stays shall be calculated by the following: $9000 \times C$ W.P. Eqn. (42) C, the coefficient, is the number representing the least of the following (2) 1.875. (3) 1.875. (4) N, the number of rivets in the joints of each gusset stay, only diameters and sectional areas of the rivets in the supported area, to be considered effective the order of the joints being shell angles to gusset, and (1), angles to end plate, (2) end plate angles to gusset, (3) (4) angles to shell, G is the depth in inches of gusset plate measured through the line of rivets attaching it to the end plate angles. GI is the depth in inches of gusset plate measured normal to the slant edge of plate through the rivet nearest to the end plate in the joint attaching gusset plate to shell angles, t is the thickness of the gusset plate in inches of an inch, A is the area in square inches of flat plate supported by the gusset stay which, in the case of Lancashire and other horizontal boilers, shall be determined as follows: (L) The margins allowed under flat plate regulations for shell and furnace shall be marked on end plate and the lengths of the centre lines of gussets between them measured, also the distance between each pair of gusset lines from the middle of the smaller in one direction normal to the greater. If L and LI be the lengths of two adjacent or INDIA gusset

liræ and if the distance between them be W , the area contained by the gusset lines and the shell and furnace margin line may be apportioned between the stays $W(8L+Li)$ Portion of area in square inches, 8 apportioned to L line gusset $W(3L+L)$ Portion of area in square inches 8 apportioned to Li line gusset. Eqn. (48) Eqn. (44) (b) The portion of the area on the other side of each gusset line also, except when of triangular form, be found in like manner and its amount added to that already found to form the total. For the triangular portion B in the wing spaces the area B shall be taken as half the product of the length of gusset line into the perpendicular distance between it and the intersecting point where the marginal curves meet.

BOLTS AND STUDS 208. (a) Bolts and studs connecting parts of boilers such as shell, end plates, tube plates, furnaces, uptakes, externally fitted manhole covers, mountings, etc., may be made either of steel or good quality wrought iron. (b) The maximum working pressure for the bolt or stud shall be calculated by the following formula : Eqn. (45) D is the diameter of bolt or stud over threads in inches, N is the number of bolts or studs securing the part, n is the number of threads of screw per inch, for steel bolt or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than $3/4$ inch. for steel bolts or studs of 30 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than $3/4$ inch. for steel bolts or studs of 35 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than $3/4$ inch. for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is not less than $3/4$ inch and not greater than $7/8$ inch. for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is greater than $7/8$ inch. When the material is iron, a reduction of 15 per cent shall be made in the working pressure are calculated by the formula. A the area in square inches of the surface supported by the bolts or studs. For jointed flanges the area shall be taken to extend to midway between the pitch line of the bolts and the inner edge of the flange by which the part is secured.

INDIA TUBE PLATES [PART 209. Compression of tube plate.- (a) For fire-box or combustion chamber tube plates which are subject to compression due to the pressure on the roof plate, the maximum working pressure shall be :— $W.P. = \frac{L \times P}{t}$ t is the thickness of the tube plate in inches, Eqn. (46) P is the pitch of the tubes in inches, measured horizontally where the tubes are chain pitched, and diagonally where the tubes are zigzag pitched and the diagonal pitch is less than the horizontal, D is the internal diameter of the plain tubes in inches, L is the internal length of the fire-box or combustion chamber in inches measured at top between tube plate and firehole plate or back plate, or between tube plates in double ended boilers with combustion chamber common to two opposite furnaces, $C = 875$ for steel and 437.5 for copper, Provided that the above formula shall not apply in the case of fire-boxes where the girders do not rest on the tube plate, or where the roof plate is stayed direct to the outer shell or to girders supported by the shell. (b) where girders rest on the side plates or the roof plate is so formed that the load is carried both by side and end plates, in no case shall the compressive stress on the plates exceed its. per square inch for steel of 7,000 lbs. per square inch for copper

210. Parts to be Taken into Account of tube plate and pitch of stays within the nests of tubes where stay tubes are not required and where marginal stay tubes are required in support of blank spaces adjacent, to or between the nests shall be determined by flat plate rules under Regulation 195. (b) Tube plates within the nests of tubes whether fitted with stay tubes or not shall comply with the requirements of Regulation 211 in regard to thickness and angle section between them.

211. Minimum thickness and cr088 section.—To provide a socure attachment for plain tubes in the tube plates Lhe Illiekneqs and erogg section. of tho plate between Tthe tube holes shall not be less than • Steei tube plate, • 1251)+ • thickness in inches • 17D+ • 025 —minimum cross section in square inches Coppey tube Plato, . 21) + • 4—minimum thickness in inches • 527 D— •263æminimu-m cross section in square inches Eqn. (47) (48) Eqn. (49) Eqn. (50) D the dicbtncr in inches of the tube at the port of attachment to tube plfl,te. Where the thi and cross section of the tubo plates ame less than the Ininirnum the appopr iute co-ccfficient jn Eqn. (51) shall bo reduced in proportion to the 212. Holding power of plain tubes. (o) W hero tube plates ore not specially Bta,yod in nests of t,ubcs, the working pxessuce, based on the holding power of the t,ubcs shall not, exceed that found by the following formula, CxD W.P. Eqn. (51) GAZETTE OF INDIA EXTRAORDINARY 671 D is tho cliom3ter of tube the part of ottachment to tube plate in inches, A is the oreo in square inchoa ot the tubo plate supported by each tube, which generally ma,y be taken the product of Lhe horizontol and vertical pitohos of the tub) less the area of the tube itself, C 470 for Lubeg expanded into parallel holes in steel or iron tubo Platea, C = 53() for tubes expanded into taper holes in steel or iron tube plates. For copper tube plates or copper or bross tubes the approprioto co-cmcient 8hould be reduced 20 per cent. (b) In the unstayed tube photos of locotype boilers and in other tube plotog in which Stuy tubes arc not required the support bffordecl by the ploin Lubes shall not bc taken to extend beyond the lines enclosing the outer edged of the tubes. Port8 of flbt pliito outside thia line shall either lie in the plate margin or be separately supported. No o,ccount need be taken of tho stiffness of tubo plate jn the nests of tubes when tho a,bove conditions ame fulfilled. Ordinarily (.,hc requirement,8 of this clouse ore applicable only to expanded smoke and water tubes in flit, continuous tube plates containing moro than one row of tubes. (See Reg. 152 for n,ttoclncnt of tubcg in Water tube boiler.) 213. Tube plates, other than ends, of vertical boilerg torming parts 01 outer shell. (@) When vertical boilers have a nest or nostg of horizontal tubcg so that there is direct tension on the tube plut0B duo to the vertical load on the boiler ende, or to their aci,ing os horizontal ties across the *hell, the thickness of the tube ploteg and the spacing of the tubes shall be such tha,t the section of metal toking the loa.d i.ß sufficient to keep the sbresg wit,hin that allowed on the Shell plates. (b) Each alternate tube in the outer vertical rows of tubes shall be b Stoy tube. The tube plates between the Stoy tubes ahl-l be in accordance with the rules for tube plates and in addition, considered 0B port of shell, the maximum working pressure,— Eqn. (52) RxP t i8 the thickness of the tube plote in 32nds of an inch, P is the vertical pitch ot the tubes in inches, D is the dia,meter of the tube holes in inches, S is the minimuT11 tensile breaking strength of the tube plutes in tons per square inch, or whatever is ollowed for them, R is tho radiol distance oc the centre of the outer row of tube hole from the axis of tho Sholt in inches, 214. Curved Tube plates of water-tube boilers.—For tube

forming part of cylindrical drums the maximum working pressure shall be $\frac{2S}{D} \times \frac{t}{p}$ W.P. D = thickness of tube plate in 32nds of inch, Equ. (53) *Efficiency of the longitudinal joint or the ligament between the tube holes, whichever is less, S = Minimum Tensile Stress of the tube plate in tons per sq. in. or whatever is allowed for it, D — Inside diameter of the drum in inches. 672 THE GAZETTE OF INDIA

EXTRAORDINARY [PART 11 216. Efficiency of When a, shell or drum is drilled for tubes in a longitudinal line to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows (a) When the pitch of the tube holes on every row is equal (as in fig. 11). The formula is : $E = \frac{p-d}{p}$ = efficiency of ligament. P Where p = pitch of tube holes, inches, d = diameter of tube holes, inches. Eqn. (54)) The pitch of tube holes shall be measured either on the flat plate before rolling or on the median line after rolling. Example.—Pitch of tube holes in the drum as shown in Fig. 11 is 5 in.

Dia. 36 in. Diameter of tube holes — 3-9/32 in. Pitch of tube = 5, $E = \frac{5 - 3.281}{5} = 0.338$, efficiency of ligament, 33.8% Fig

10. Example of Tube Spacing with Pitch of Boiler equal in every Row. (b) When the pitch of tube holes on any one row is unequal (as in FigB. 11 & 12) the formula is $E = \frac{p-d}{p}$ and Equ. (55) Where p = efficiency of ligament, unit length of ligament, inches, number of tube holes in length p , — diameter of tube holes, inches. Example.—Spacing shown in Fig. 11. Diameter of tube hole = 3.9/32 in. Pitch 12 — $E = \frac{12 - 3.281}{12} = 0.728$, efficiency of ligament. 72.8% Fig

11. Example of Tube Spacing with Pitch of Holes Unequal in every Second Row. Example.—Spacing shown in Fig



12. Diameter of tube hole = $29 - 25 \frac{5 \times 3,281 \cdot 0 \cdot 4}{r}$, 'efficiency of ligament. 29-25 THE OF INDIA EXTRAORDINARY' Fig. 12 Example Tube Spacing with Pitch of Holes varying in every Second and Third Row (c) The strength of (ligament) between the tube holes which are subjected to longitudinal stress shall be at least one half the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress. (d) When a shell or drum is drilled for tube hole 30 or to



form diagonal ligaments shown in Fig. 13, the efficiency of these ligamenta shall be that given by the diagram in Fig

14. In this diagram the abscissae are—and the ordinates Where p d longitudinal pitch of tube holes, or distance between centre of tubes in o longitudinal row, inches, diagonal pitch of tube holes, inches, diameter of tube holes, inches. Longitudinal/ Fig

13. Example of Tube Spacing with Tube Holes on Diagonal Lines To use the diagram in Fig. 14. The volucs of— and — d are computed and the efficiency for the corresponding points is rood off from-the diagram. Should the point fall above the curvo of oqual emcienoy for the diagonal and longitudinal ligaments, the longitudinal ligaments will be the weaker, in which ooge the efficiency is computed from the following formula : $P D xampZe$.— (1) Diagonbl pitch of tube holes in (Itum ag shown {n Fig. 13 d 42 in. 674 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 Diameter of holes — in Longitudinal pitch of tube holeg 11 •5 4-031 6-42 o, 558. 11 The point corresponding to these values ig shown at A on the diagram in Fig. 14 and the corresponding efficiency is 35 •3 per cent. AB the point follß below the curve of equal emcienoy for the diagonal ond longitudinal ligaments, the diagonal I ligament iB tho weaker. (2) Diagonal pitch of tube holes in drum Diameter of tube holes Longitudinal pitch of tubö holes 6-35/64 in. 4-1/04 in. 7 in. d 7 4-0156 p' 1 •743 6,547 o .935. The point corosponding to these values is shown at B on the diagram in Fig. 14 and it will be Been thot it falk above the line of equal efficiency for the diagonal and longitudinal ligaments, in which case the emeiciency is computed from formula (I). Applying formula (I), wo have . 7--4,015d O •426, emcienoy of ligament, or 42 •d per cent. 7 For holes ploood longitudinolly along drum but which do not oome in B straight line, tho obovo rules for oaloulotlng emoiency shall hold, exoopt that the equivalent longitudinal width of o diagonal ligamjnt shall b3 used. To obtain tho oquivalent width the longitudinal Pitoh of the two holes having B diagonal ligament shall be multlp110d by tho eff(.nency of the diog mal ligement. Tho effoiency to be ngod for tho diogonal ligaments iB given in Fig. 15. •0 30 •O 7.5 SO DIAGMM 'OR DETERMXNINO Eh FIC!ENCY OV DIAGONAL LIGAMEt OkDcp TO OBTAIN LONGITUDINAL EPFICJENCV BOILER AND SUPERHEATER TUBES SUBJECT TO INTERNAL PRESSURE 216. The rn working pressure for the tubo shall be detorminul by Equation No. 87. (See Regulation 338). The minimum thickness of the tubos shall comply with the table given fn Regulation 338(b). HEADERS AND SECTION BOXES OF WATER TUBE BOILERS 217. see Eqn. 88 Reg. (340) BOILER TUBES (SMOKE) SUBJECT TO EXTERNAL PRESSURE 218. Steel and Wrought Iron Tubes.— (a) The maximum working pressuro for the tube B shall be . 100 (t W.P. t ig the thioknogs of the tubes in 100th3 of on inch, D is the external diameter of the tubes in inches, Eqn. (56) (b) No tube shall be leu than 12 S. W. G. (•104') thick

219. Brags and Copper Tubes.—The thickness of tapered brass and copper smoke tubes for locomotive boiler is $\frac{1}{16}$ inch, in the case of tubes of an external diameter of 1 to 2 inches inclusive, but not less than 12 S. W. G. ($\frac{1}{16}$ inch) at the smoke-box end and 10 S. W. G. ($\frac{1}{16}$ inch) at the other and in the case of tubes of an external diameter of 2 to 2½ inches inclusive, the thickness at the smoke-box end shall not be less than 11 S. W. G. ($\frac{1}{16}$ inch) and at the other end not less than 9 S. W. G. ($\frac{1}{16}$ inch).

FURNACES

220. Plain Furnaces of Horizontal Boilers.—For plain furnaces or furnaces strengthened by Adamson or other joints or stiffeners of sufficient strength and for the semi-cylindrical tops of fire-boxes and bottoms of combustion chambers where the sides are securely stayed, the working pressure shall not exceed the smaller of the values obtained from the following formulæ:

$$W.P. = \frac{C \cdot D}{L + 24} \quad \text{Eqn. (57)}$$

$$W.P. = \frac{C \cdot D^2}{L + 24} \quad \text{Eqn. (58)}$$

where D is the external diameter of the furnace or chamber top or bottom in inches, t is the thickness of the furnace plate in 32nds of an inch, L is the length of the furnace or other part in inches measured between points of substantial support, i.e., centres of rows of rivets in end seams or commencement of curvature of flange, whichever is applicable, $C = 1450$ where the longitudinal beams of steel furnaces are welded and 1300 where they are riveted, $C = 725$ where the longitudinal beams of circular copper fire-boxes or furnaces are fitted with double butt straps and 650 where they are lapped, $C = 50$ where the longitudinal seams of steel furnaces are welded where they riveted. $C = 25$ where the longitudinal seams of circular copper fire-boxes or furnaces are fitted with double butt straps and 22½ where they are lapped.

221. Corrugated Furnaces of Horizontal Boilers.—The maximum working pressure to be allowed on corrugated furnace shells shall be determined by the following formula— 1). . Eqn. (59) D is the least, external diameter in inches measured at the bottom of the corrugations on the water side, t is the

thickness of the firebox plate in 32nds of an inch measured at the bottom of the corrugation or chamber, C 480 for the Fox, Morrison, Deighton, Purves, and other similar furnaces and 510 for the Leede Forge Bulb Suspension Furnace

222. Plain Furnaces of Vertical Boilers.—The same formulae as for the plain furnaces of horizontal boilers shall be used, but where the furnaces are tapered, the diameter to be taken for calculation purposes shall be the mean of that at the top and of that at the bottom where it meets the substantial support from flange or ring. The length for the same purpose shall be the distance from the centre of the row of rivets connecting the crown and the body of the furnace to the substantial support at the bottom of the furnace, or to a row of gored stays connecting the furnace to the shell, provided that the pitch of stay at the furnace does not exceed 14 times the thickness of the furnace plate when the stays are riveted at their ends, or 16 times when the stays are fitted with nuts. Such screwed stays shall be in diameter over the threads not less than twice the thickness of the furnace plate and in no case less than $\frac{1}{4}$ inch diameter (see Reg. 135(d).)

223. Hemispherical Furnaces of Vertical Boilers.—When furnaces are hemispherical and subject to pressure on the convex side and are without support from stay of any kind, the maximum working pressure shall be : $2750 - \frac{1}{2} W.P. Eqn. (60)$ t is the thickness of the top plate in 32nds of an inch R is the outer radius of curvature of the furnace in inches

224. Corrugated Fireboxes of Vertical Boilers—For the semi-spirally corrugated fireboxes of "Sentinol" standard motor wagon boilers the working pressure shall be determined by the following formula : t is the thickness of the firebox plate in 32nds of an inch, E is the modulus of elasticity of the material of the firebox measured over the plain part at each end at commencement of curvature of flange

225. Foundations of Vertical Boiler Furnaces.—Where circular furnaces or fireboxes of vertical boilers are not connected to the shell crown by uptake tube, smoke tubes or bolted stays and the whole load on the firebox vertically is borne by the bottom part of the firebox where it is connected to the shell the working pressure for the part, if firebox is joggled out to meet the shell or if an ogee ring is fitted, shall not exceed that found by the following formula $\frac{DO - DI}{D}$ Eqn. (62) t is the thickness of the joggled firebox plate or ogee ring in 32nds of an inch, D is the inside diameter of the boiler shell in inches, DI is the outside diameter of the joggled firebox at the commencement of curvature above joggled part or the outside diameter of the firebox where it joins the ogee ring,

226. Foundations of Loco-type Boiler Fireboxes.—Where the firebox roof in loco-type boilers is not stayed direct to the external casing crown or to girders carried by the casing or is not connected to the casing by slings in accordance with Regulation 229 (c) and the whole load on the firebox vertically is borne by the bottom parts of the firebox where connected to the external casing the working pressure for the parts, if plates are joggled out to meet the casing or if an ogee ring is fitted, shall not exceed that found by the following formula $70 \left(\frac{L}{X} \right) \left(\frac{W}{L+W} \right)$ Eqn. (63) t is the thickness of the joggled firebox side plates or firebox floor plate (whichever is less), ogee ring in 32nds of an inch, L is the length of firebox casing in inches measured between the water side of front end plate and side plate at the foundation seam, W is the width of firebox casing in inches measured between the water sides of side plates at the foundation seam, WI is the width of firebox in inches measured between the water sides of firebox side plates at the common tangent of curvature above joggled part or where it joins the ogee ring, Where only a comparatively narrow strip of the firebox roof is stayed directly to the casing crown the area so stayed shall be deducted from the area represented by $L \times W$ in the bottom line of the formula thus, $(L \times W - A)$ $(W - WI)$ and NO used in Equation (63) in determining the working pressure for the parts, ('A' being the area in square inches of the part of roof supported by the casing crown

227. Crogg Tubes.—The working pressure of the tubes shall be determined by the following formula : D Working pressure in lbs. per sq. inch, t — minimum thickness in 32nds of an inch, D — the internal diameter in inches of the cross tube. Eqn. (64)

228. Uptakes Of Vertical Boilers.—The working pressure for uptake tube(s) of vertical boilers shall be determined by Eqns. 57 and 58 but only half the least pressure so found is to be allowed for uptake tubes.

SUPPORTS FOR COMBUSTION CHAMBER AND FIREBOX CROWN

229. Girder Support for firebox For girders supporting plates of rectangular fireboxes, where the ends of the girders are supported by the vertical end or side plates, their proportions shall be calculated from the following formula:— $CST \ W.P.$ Where WP = Working pressure in lb. per sq. inch, Eqn. (65), s = Minimum tensile strength of the material in tons per sq. inch, Total thickness of the

stay in thirty seconds of an inch, Depth of the girder stay in inches, Length of girder stay in inches measured between the inside of the tube plate and the firehole plate, or between the inside of the side plate, according to the method of support. Pitch of girder stay in inches, — 22 for steel plates or girth forgings 19 for steel casting. (b) Where girders are supported in any other way (than by the end or side plate) of the firebox or combustion chamber the calculations for finding the working pressure shall be made in accordance with actual conditions of support. In such cases the length of the strip of firebox or combustion chamber top plate to be supported by the girder shall, subject to the limit imposed on the distance of the nearest stay, be taken as equal to the product of the number of bolts carried by the girder into the pitch of the bolts. A maximum stress of 14,000 lbs. per square inch on girder section shall be allowed for steel. (c) Slings, links, pins, rivets, and connections to shell of blung girders shall be sufficient to carry the whole load that would otherwise be carried by the girder, and each girder must be equally slung or supported. For regges allowed on the section see Regulation 209. (d) In the case of girders supported at the ends only by angle bars riveted to the casing crown, the length L in the formula, when the girder extends over the full breadth of the angle face, be taken as the distance between the centres of the angle faces. When this distance does not exceed that of L in the formula, the pressure shall be determined in the ordinary way. The supporting angles and rivets shall be of sufficient section for the intended purpose. For stresses allowed on the sections, see Regulation 203.

PATENT FIREBOX ROOFS OF LOCOTYPE BOILERS

230. Marshall Type.—For Messrs. Marshall Sons and Company's patent Bayley's roof for fireboxes of locotype boilers made of steel in which the centre lines of the corrugations meet the centre lines of the end riveted seams at points not further distant from the side plates than one-half the inner radius of curvature of the corner formed by the roof and side plate, in order to ensure that the thickness and height of the principal diagonal corrugations of the camber are satisfactory, the working pressure shall not exceed the smaller of the values obtained from the following formulae: $25000 (t - 1) \times H^2$ (66) $W \times W.P.$ Eqn. (66) Eqn. (67) t is the thickness of the roof plate in 32nds of an inch, H is the height of the corrugation at its highest point measured perpendicularly on one side of the plate in inches, W is the width of the roof plate between the flots of side plates at top less the inner radius of curvature of corner of roof and side plate in inches, i.e., $W + \text{radius}$ — internal width of firebox at top, L is the length of the roof plate between centre lines of rivets in inches

231. Garrett Type.—For Messrs. Richard Garrett and Son's corrugated stay-less roof for fireboxes of locotype boilers made of steel in which the side corrugations are parts of true circles and the radius of the middle corrugation not more than about one-third of the radius of the outer corrugations and the corrugations are cambered longitudinally, the working pressure shall not exceed the smaller of the values obtained from the following formulae: $(1 + 24) W.P.$ t is the thickness of the corrugated plate in 32nds of an inch, Eqn. (68) Eqn. (69) L is the length of the roof plate between centre lines of rivets in inches, R is the external radius of the circle corrugations at the middle of the length in inches, $C = 363$ where the roof and side plates are in one piece and 325 when they are riveted, $12 \cdot 5$ where the roof and side plates are in one piece and $11 \cdot 25$ where they are riveted

232. Fowler For Messrs. John Fowler and Company's (Loed's) corrugated roof for fireboxes of locotype boilers made of steel in which the crown of the roof is transversely curved and corrugated in the style of Fox's corrugated furnace and the roof plate, if not soldered with the side plates of the firebox, is securely riveted thereto and to the flanges of the tube plate and firehole plate and there is a row of suitably sized and spaced screw stays below the commencement of corrugations on each side attaching the roof plate to the external casing, when the conditions hereunder are complied with, the working pressure shall not exceed the smaller of the values obtained from the following formulae: $1) W.P.$ Eqn. (70) Eqn. (71) t is the thickness of roof plate before or formed, in 32nd* of an inch, t_s is the thickness of side plates of firebox to which roof plate is attached in 32nds of an inch, R is the radius of transverse curvature or camber of middle part of corrugation measured from the bottom of corrugation on water side, in inches, W is the width of firebox in inches measured over water sides of side plates at the seams attaching them to roof plate, l (b) The corrugation, A measured from top to bottom on one side, shall not be less than three times the thickness of the finished plate in depth H , and not more than 12 times the thickness of the finished plate up to, (c) The inner radius of corner at sides where corrugations merge into the flat sides shall be not less than 4 times the thickness of the finished plate. (d) The length of the plain parts at ends

of roof between the centre lines of riveted seams and commencement curvature of corrugations shall not exceed that allowed for flat plate under Regulation 200

CHAPTER V FUSION WELDED AND SEAMLESS FORGED DRUMS FOR WATER TUBE BOILERS AND SUPERHEATERS GENERAL REQUIREMENTS 238. Where applicable the general provisions of Chapter I relating to Coriolis fittings from Makers, Inspecting Authorities, etc., and of Chapter III concerning construction should be followed. **MATERIALS OF CONSTRUCTION 234.** Material For Fusion Welded Boiler Tubes of Regulations 9 to 20 go for 8B they relate to plates, shall apply to steel plates for fusion welded boiler drums excepting that the ultimate tensile strength and elongation of the materials shall be between the limits shown in table below and shall be specified for each component part of the boilers. Degree, portion Ultimate tensile strength in inch elongation strength per ton in plates (54 for drum diameter up to 18 in. and 28-32 tube plate). Drum strength or strength on 180 degree for 1 inch diameter. 1 per cent. Weight per square foot or 20 to 23 for 26—30 lb per sq. in. (2) for 28—32 lb per sq. in. (b) Plates over 2' in thickness before being fabricated, shall be uniformly heat treated to produce grain refinement. Heat treatment involving quenching in a liquid medium is not permitted. **SEAMLESS FORGED DRUMS 235.** Process of Manufacture.—Carbon Steel for steam drums shall be made by the open hearth or an electric process, acid or basic

236. Chemical Analysis.—The steel shall contain not more than 0.05 per cent. of sulphur or of phosphorus

237. Freedom from defects.—The drum shall be free from surface defects and shall be machined to the prescribed dimensions. Defects in forgings shall not be repaired without the previous sanction of the Inspecting Officer

238. Heat treatment.—Each drum shall be efficiently heat treated : (a) At various stages during manufacture, as required. (b) On completion of the forging process but prior to the hydraulic test

239. Mechanical Tests.—Material shall comply with the mechanical tests herein specified. Sufficient material shall be left on the open end or ends of each forging to enable tangential test pieces to be taken. These tests shall consist of not less than one tensile and one bend test from each open end. In the case of drums with open end the test material shall not be parted off before heat treatment. If the drums are closed in at the end the test rings shall be flanged off immediately before this operation ; Subsequently the test rings and the forging shall be similarly, and simultaneously heat treated in the same furnace

240. Selection Of Test Pieces.—The test pieces shall be taken by the qualified Inspector and shall be tested in his presence and he shall satisfy himself that, the conditions herein described are fulfilled. (b) Tensile test—The ultimate tensile strength and elongation shall be between the limits shown below. A range of not more than 4 tons per sq. in. for any one forging shall apply, such range to be specified for each drum. (i) Ultimate tensile strength 28 to 38 tons per sq. in. (ii) Elongation 29 per cent. to 19 per cent. determined on British Standard Test Piece C, or a subsidiary standard round test piece (see Appendix B). In no case shall the ratio of the ultimate tensile strength and corresponding elongation be less than 57. Should tensile test piece break outside the middle half of the test gauge length the test may be discarded and another test be made of the same drum. (c) Bend Test Pieces.—Bend test pieces shall be of rectangular section 1 in wide by 1 in. thick. The edges shall be rounded to a radius of 1 in. The test pieces shall be bent over the thin section. (d) Bend Test.—The test pieces shall, when cold, be capable of being bent without fracture, through an angle of 180°, the internal radius of the bend being not greater than that specified in table below. Ultimate tensile strength, Tons per sq. in. Up to 32 Above 32 and up to 36 Above 36. } and up to 38 Bend test may be made by pressure or by blow. Internal radius of bend Inches 1/4 241. Additional tests before rejection.—Should oil test or a bend test fail, two further tests of the type which failed may be made on test pieces cut from the same test ring. If the results obtained from these re-tests are satisfactory, the drum shall be accepted, provided that in other respects it fulfils the conditions of this Chapter. If these re-tests do not give satisfactory results the drum represented THE GAZETTE OF INDIA EXTRAORDINARY 688 may be re-heat-treated together with the remainder of the test rings, and presented for further testings. In all cases where final re-test do not give satisfactory results, the drum represented by the test pieces which fail shall be rejected. 242. discard shall be from the open end of each ingot to ensure soundness in the portion for forging

243. Forging.—The forging shall be made from a solid cast ingot, punched, bored or trepanned, or alternatively, hollow cast ingote may be used. The resultant wall in the case of the solid cast ingot, or the wall of the hollow ingot as cast shall be reduced in thickness by at least one half in the process of forging. (B) Tubes shall be of cold drawn wrought iron or hot finished welded steel. Tubes shall comply with Regulations 36 to 56. Heads and similar pressure parts shall be of forged steel, seamless steel tube or of cast steel, to comply with the appropriate Regulations in Chapter 11

245. Pipes.—Pipes forming an integral part of the boiler unit shall comply with the Regulations of Chapter V.LII

246. Steel Castings.—Steel castings for pressure parts shall comply with Regulations 73 to 80 (28 to 35 tons per sq. in.). **FUSION WELDED DRUMS** 247. Definition of term 'Fusion Weld'.—The term 'Fusion Weld' is, for the purpose of this Chapter, applicable to all welded joints made by the metal arc process with covered electrodes or other electric arc process in which the arc stream and the deposited weld metal are shielded from atmospheric contamination. It is intended that this Chapter shall apply to the single run or heavy run welding process and that welded boiler drums manufactured by that process shall conform with all Regulations of this Chapter, excepting those in which divergence is necessary solely because of special requirements essential for the most efficient utilisation of that process. Thus all Regulations governing quality of material construction, workmanship and testing (both non-destructive and otherwise) are applicable. When welded drums ordered to this Chapter are made by the single run or heavy run process it will be understood that Regulations 252 and 267 do not apply in their entirety

248. Equipment of The welding plant and equipment are to be of good quality and maintained in an efficient working condition. The welding apparatus is to be installed under cover and arranged so that the welding work may be carried out in positions free from draughts and adverse weather conditions. The procedure is to be such that there is regular and systematic supervision of the welding work, and the welding operators are to be subjected by the works officials to periodic tests for quality of workmanship. Records of these tests are to be kept and are to be available to the Inspecting Officer for scrutiny. (b) The Works should be equipped with an efficient testing laboratory which should include apparatus suitable for carrying out tensile, bend and impact tests, micro-examination of specimens and X-ray examination of the actual joints in pressure vessels. The Works should also be equipped with a suitable heat treating furnace having satisfactory means for temperature control, but as an alternative, arrangements may be made whereby the drums can be heat treated elsewhere. 684 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 249. Constructional details and preparation for welding.—The manufacturer shall supply the Inspecting Authority with fully dimensioned sectional drawing showing in full detail the construction of the drum (8) for approval before putting the work in hand. A full sized dimensioned sketch of the weld groove for the longitudinal and circumferential seams shall be shown on the drawing. Full sized dimensioned sketches shall also be shown of the details of the joints for straight pipes, branch pipes and seating and the position of those joints relative to the longitudinal and circumferential seams and other openings shall be indicated

250. Preparation of plates.—The edges of all plates shall be prepared and surfaced by machining or chipping. Before welding is commenced, the grooves shall be thoroughly cleaned of rust, oil or other foreign matter. Before welding of the joint is commenced (apart from tack welding) the surfaces of the plates of the longitudinal and circumferential seams shall not be out of alignment with one another by more than 10 per cent. of the plate thickness, but in no case exceeding 1/8 in. for longitudinal joints or 3/16 in. for circumferential joints

251. Cylindrical shells of drums.—Each drum shell plate shall be of cylindrical form to the extreme edges of the plate. The bending shall be done entirely by machine and local heating or hammering is prohibited. Where the plates are bent to a diameter less than 40 times the plate thickness they shall be efficiently heat-treated after bending to relieve internal stresses during the last stage of bending they have been uniformly heated throughout

252. Method of making welded joints.—The seams shall be welded from both sides of the plate. Before the second side of the plate is welded, the metal at the bottom of the first bead shall be removed by grinding, chipping or machining. Additional run of metal shall be deposited at both surfaces of the welded seams so that the weld metal at the level of the surface of the plate is refined as far as possible.

The surfaces of the welds shall thereafter be machined or ground so as to provide, smooth contours and to be flush with the respective surfaces of the plate. There shall be no undercutting at the junctions. The positions of the welds shall be marked permanently to facilitate their location. Not less than two runs of metal shall be deposited at each weld fixing stay pipes, branch pipes and seatings. Each run of weld metal shall be thoroughly cleaned and freed from slag before the next run is deposited.

253. Type of welded joint.—The longitudinal and circumferential be made with butt joints of the single or double U or Vee type.

254. Number of joints.—Where, having regard to the approved design, the dimensioning is such that the shell cannot be made from a single plate, it shall be made with the minimum number of joints and the longitudinal seams in successive rings shall not fall in line.

255. Position of tube holes.—Tube holes shall not be located in a welded joint. The distance between the edge of hole and the edge of a longitudinal or circumferential seam shall be not less than 1 in. where the plate has a thickness less than 1 in. In plates 1 in. to 2 in. thickness the minimum distance shall be not less than the thickness of the plate. For plates of thickness greater than 2 in. the minimum distance shall be 2 in. NOTE.—The edge of the weld shall be on the side of the edge of the weld groove on the inside of the plate prior to welding. SEE 31 THE GAZETTE OF INDIA EXTRAORDINARY 68b 256, Circularity of drums.—The difference between the internal diameter of the drum measured at any cross section and the nominal internal diameter of the drum should not exceed per cent. of the latter. Any departure of profile measured on the outside of the drum with a gauge of the designed form of the exterior of the drum and of length equal to 1/4 of the internal diameter, shall not exceed the percentage given in table below :— Nominal Internal diameter of drum Inches Up to and including 36 Over 36 up to and including 45 Over 45 Percentage of nominal internal diameter Flat* at the welded Beams shall not be permitted and any local departure from circularity shall be gradual.

257. Mechanical tests and test plates for fusion welded joints shall comply with the mechanical tests herein specified. Not less than one set of test plates shall be provided to represent the welding of each longitudinal seam. The test plates may be attached at each end of the longitudinal seam or the test plates may be located at one end only. (b) Where the drum shell is formed in two or more courses, the staggered longitudinal seam shall be regarded as a continuous longitudinal seam, provided the welding be effected in one reasonably continuous operation and by the same operator or operators. (c) Where there are circumferential seams only or where the method of welding the circumferential seam differs from that employed for the longitudinal seams, the method of providing the test plates shall be decided by the Inspecting Authority. (d) The test plates shall be of a size sufficient for the preparation of the test pieces specified in Regulation 258 (e) and for any repeat test pieces that may be required. The material for each set of test plates shall be cut from the respective plate or plates forming the appropriate seam, and before being cut shall be stamped by the Inspecting Officer. (e) When the analysis of the plates is approved by the Inspecting Authority and is considered sufficiently similar, the test plates may be cut from one drum shell plate. (f) In the case of insufficient material being available on the shell plate to permit the cutting of test pieces, these shall be acceptable if they are made from another provided it is made from the same material. (g) The weld groove in the test plate shall be similar to that adopted for the corresponding groove of the longitudinal seam, and the respective fusion faces shall be in continuous alignment. The test plates shall be reinforced or supported during welding in order to prevent undue warping. The weld metal in the test plates and the seam shall be of the same grade of electrode and shall be deposited continuously in the same operation. SEE 31 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 (h) The weld in any test plate shall not be repaired unless agreed by the Inspecting Authority and the repair shall be done in such a manner as will ensure that the repaired seam in the test plate is still representative of the material in the main seam. (i) Where it is desired to straighten test plates which have warped during welding they may be straightened at a temperature below the temperature of heat treatment of the drum to which they belong. Straightening shall take place before final heat treatment. (j) For heat treatment see Regulation 267. (k) If any defects in the weld metal of a test plate are revealed by radiographic examination, the position of those defects shall be clearly marked on the plate and test pieces shall be selected from such parts of the test plates as may be decided by the Inspecting Authority. 258. Selection of Test From the test plate or plates on each longitudinal seam, test pieces shall be selected

for the following tests, the specimens being cut out shown in Figs. 16 and 17 and stamped by the Inspecting Officer for identification :— (i) One tensile test specimen for the welded joint. (ii) One all-weld metal tensile test specimen. (iii) Two bend test specimens. (iv) Two Izod impact test specimens. (v) One specimen for micro and macro examination. The remainder of each lot of test plates shall be retained for any re-tests required. Any specimen for re-test shall be cut off from the same lot of test plates as the original specimen. (b) Surfaces of tensile, bend and Izod impact specimens corresponding with the outside or inside of the drums shall be only lightly dressed so that the rolled surface of the parent metal is not wholly removed, except that where the rolled surfaces of the abutting plates are not level with one another, one plate may be machined at each face of the weld, provided the depth of metal removed does not exceed 1/32 in. to 2 3/4 in. 3. 4

5. Fig.1d.—Detailå of tegt plBte8. Tensile for joint. Ten-Bild tost for bll.weld meta]. Bend outer ond innor gurfaca,y of plate (at weld). a. Izod impact togt, outer surface of Plato. b. Izod in- puct t3At, Inner surface of Plato. Micro and mocro specimen. Exemplad showing approximate dispositions of the teat pie (50B in the test plates shown in Hgb. 16 and 17, l. 3

5. Fig.17—D9tails of plate. te-t, for joint. test for Bll-wold mota_L B tests, (Yiter and unner surfoe.es of plat • (at. Izod l_rnpa.rt outer surraca of plate b. Izod t, ft, inn-or surfan OF plat* . Micro and macro THE GAZETTE OF INDIA EXTRAORDINARY 11 259. TJ119ile Test Welded Joint.—The dimensions of the epccimens shall be in accordance with the sketch in Fig

18. Specimen 1, and the specimen shall be cut transversely to the welded seam. When the capacity of the available testing machine does not allow the full specimen to be tested, two narrower tensile specimens shall be substituted. These specimens shall be the full thickness of the plate at the welded joint and their breadth shall be as great as the testing machine will reasonably allow, provided the effective cross sectional area of the test piece is not less than sq. in. (see Fig. 18 Specimen 1a). (b) All-weld Metal.—The dimensions of the specimen shall be in accordance with the sketch in Fig. 19, Specimen 2. The specimen shall consist entirely of deposited metal and shall be cut longitudinally from the geometry of Specimen 1: Tensile test for joint B. Specimen 1a. Tensile test for joint* plates). Fig. 18.—Tensile test pieces. Thickness of plate. Breadth of test piece: Specimen 1. Not more than 108B than T, and not more than 14 in. Specimen 1b. T x b not less than 1½ in. W = Width of weld groove. p c Parallel length, minimum = 3 x W. Rt shoulder, minimum = ½ in. all-weld metal. R = radius at Parallel length shoulder J = diameter 2 82 70 0-50 1-79 0 • 45 Specimen 2 Fig. 19.—Tensile test pieces: Gauge length g = in. 798 0 0 • 564 0 • 505 0 • 479 0-452 0, 437 • 424 0 • 399 0, 357 0 • 5000 0 • 2500 0-20 0, 18 0-16 0-15 0, 1412 0, 1250 0, 1000 1-70 1 • 55 P minimum in. 3 • 18 2 • 25 2 • 01 1 • 58 • 42 R minimum • 42 0-40 0-39 0 • 37 0-35 0 • 31 260. Tensile Welded Joint. The ultimate stress shall be not less than the lower limit, specific to the plate (see table under Reg. 234). (b) All-weld Metal.—The ultimate tensile stress shall be not less than the lower limit specified in the table under Reg. 234). The elongation shall not be less than 20 per cent. on a gauge length of four times the square root of the cross sectional area of the specimen, and the reduction in area not less than 35 per cent. (a) Two bend test specimens shall be made

261. Bend Test Pieces. The specimens shall be of rectangular section and shall be cut transversely from the weld so as to have a width equal to one and a half times the thickness of the specimens. The corners of the specimen shall be rounded to a radius not exceeding 10 per cent. of the thickness of the specimen. (b) Where plate thicknesses do not exceed 1 1/4-in. the thickness of the specimen shall be equal to the full thickness of the test plate. Where the plate thickness exceeds 1 1/4-in. the specimen shall in all cases have a thickness of at least 1 1/4-in. The specimen to be tested with the outer surface of the weld in tension shall be prepared by cutting to waste the metal local to the inner surface of the weld so that the desired specimen thickness is obtained (see Fig. 20, Specimen A). The specimen to be tested with the inner surface in tension shall be prepared by cutting to waste the metal local to the outer of the weld so that the desired specimen thickness is obtained (see Fig. 20, Specimen B). Where the thickness of the plate permits, both specimens may be cut from the same piece of plate, the specimen being located in the plate one above the other (see Fig. 20, Specimen C). Specimen Out of Normal spectrum hmr Boeh xca—C C0*Ms nun Oed Surface of weld In Fig. 20.—Specimen 3 Bend Test

262. Bend Tests.—One specimen shall be tested with the surface corresponding to the outer of the drum in tension and the other with the surface bonding with the inner surface or the drum in tension. The

specimens to be mounted on the of which one by a distance not more than 5/2 times the thickness of the specimen, and the other shall be pushed through the support by forcing a pin of diameter equal to three times the thickness of the specimen. On completion of the test, no defect on the outer surface of the specimen shall be more than 1/8 in. measured on the specimen or 1/8 in. measured along the length of the specimen. Premature failures at the corners of the specimen shall not be considered a cause for rejection.

263. Izod Impact Test.—The dimensions of the two specimens shall be in accordance with Fig. 21, Specimen, and 4b. One specimen shall have the notch cut at the middle of the outer surface of the weld and the other the middle of the inner surface of the weld. The Izod test shall show a minimum Izod test-value of 30 ft. lb. per inch of thickness. [GAZETTE OF INDIA EXTRAORDINARY 22mm. 691 75mm & in diameter OF Fig

21. Specimens 4a and 4b Izod impact test piece

284. Additional tests before rejection.—(a) Should one of the specimens 257 to 263 to which specified requirements taken in accordance with Regulation one re-test, shall be allowed for each specimen that fails, provided the following minimum figures have been obtained: (i) Reduction in urea PCI cent, (ii) Any other test except, the bend and impact tests, 90 per cent. of the specified requirements. (b) If cold bend specimen should fail to meet the specified requirements, two re-tests shall be taken from the same test plate and these shall comply with the requirements of Regulations 201 and 262. (c) If an Izod impact test fails to meet the specified requirement, two re-tests shall be taken from the test plate, one each side of the original specimen and from it by not more than 5 mm. Both re-tests shall show a minimum Izod impact test value of 30 ft. lb. (d) If it be found there is insufficient metal to permit the preparation of specimens for re-test from the remainder of the test plate which the original specimen was taken, the specimen for re-test may be cut from the test plate relating to the opposite end of the same longitudinal seam.

265. Non-Destructive Tests.—(a) Micro and Macro specimen, the full thickness of the plate and not less than half an inch wide may be taken from each test plate by the Inspecting Authority for the purpose of micro and macro examination. (b) Examination.—Every portion of the longitudinal and circumferential welded joints of the shell shall be subjected to radiographical examination. The method employed in obtaining the radiographs shall be such as to show clearly defects having magnitude equal to 2 per cent. of the thickness of the welded joint. To determine whether this result is being obtained an indicator of approved form which includes portion equivalent, to not more than 2 per cent. of the joint thickness, shall be placed in the vicinity of the weld to make record on each radiograph. Each section of every weld shall be marked so that the radiographs can be easily correlated to the particular part of the joint represented. 692 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 'like examination shall be made from the original films and the acceptability of the welds shall be decided by the Inspecting Authority. The welds deemed unsatisfactory shall be rejected or dealt with under Regulation 266 and be radiographed again. REPAIRS TO SEAMS 266. (c) General.—Any repair to a weld carried out by the manufacturer shall first be agreed to by the Inspecting Authority. Where defects occur in distributed positions in a seam, to the extent of 15 per cent. of the total length of the shell, he is permitted to replace the defective welding. Where the defects are localized in single continuous length, the permissible extent of repair shall be decided by the Inspecting Authority. (b) Longitudinal Seam.—Where the weld metal in any way fails to comply with the requirements specified, the whole of the weld metal may be removed and the seam re-welded provided that: (i) the original test plates are similarly treated, or (ii) new test plates of the thickness as the joint and of similar quality of material are attached to one end of the seam and re-welded with it. In either case the plate be treated in accordance with Regulations 257 to 265 and the requirements for heat treatment shall be in accordance with Regulation 267. (c) Circumferential Seams.—With regard to the extent of permissible repair and when agreed by the Inspecting Authority a circumferential seam shall be treated in the same manner as longitudinal seam. The Inspecting Authority shall be entitled to call for representative tests for re-welded seam. (d) Removal shall be cut out by chipping or machining only and not by burning of the defective part. (e) Examination before Re-welding.—Where a defective part has cut out, the Inspecting Authority shall be entitled to make an examination before re-welding. (f) Process used for Repairs. (i) If metallic arc welding shall be used for repairs. (g) Radiographical examination of Repairs.—All repaired areas shall be subjected to radiographical examination.

(h) Spnnämtü Representing Repairs.—The Inspecting Authority shall be on- titled to cali for Bl)e• imens representing any welded repair, for the purpose of exa- mition und test. (i) Diagram of Welded Repairs. (j) On completion of welded repair the manu- facturors ghull, If roqnesLed, supply for rooord purposes a dotoilod diagram Bhowmg the position, longth, depth ond width of all such repairs. HEAT 267. (a) After the cornple,tion of the welding of the soams and the welding on of the stand pipes and including welding repairs but before the hydraulic test, each drum shall bo heat treated for sLresy rehev ing ; during this heat treatment the official test plates shall be lying inside the drum. (b) Where the shell it-I subjected to a primary 8tross relieving treatment identi* 001 to the final heut troatmont to bo given to the drum, the test plates may be plao ed inside the shell during the primary treatment and thereafter cut up and tegted with- out waiting for the finol treatment of the drum. 'l. or INDIA (c) Where the shell is not guffiectcd to prima,r,rv rolieving treatment or iB subject, to B, stress relieving troutnnont which, iB not identical T9ith the final heut the tost plates may be pluceed inside anv oi,hor drum of comparable dimenNions which to be hoat treated in a,coordon, e w It,h thig Chapter. The heat trebtmont iB to in the furnace in which the (Iurn relntincr to Lho test platcg will ovontumllv bo given , ts final heat ironi,melit•. (d) Totnporoturo Thurts bo submitted to indicato that tho test plates and cooling troatnont. (e) For thig heat troatment Lho drum shall be placed in a, furnace guff(iently large Io to the whole druJn. The furnace shall be slowly roiged to a temperaturu between (i000C. and and the drum 8hatl remain unt,ll it Jug, uni- fornly vouchcd thiN telnperature. Such tompen,turc ehRll bo Bustained for 75 to 90 minuteiä per I inch thioK ncFf-N of metal. Tho drum Jna,y bo allowed to cool in tho furnace, but, if withdrawn, Nhall be spreoned from draughts whilst cooling. (f) Alternativo proceduro for tho heut treatment of the drum may bc submit- ted to tho Inspecting Authority for approval. (g) In Npocial it rna,y be permissible to heat troai, the togt platcg separate. ly from the drum, provided the Inspecting Authority Bbtigfiod with tho meanB adopt- ed to onsurc that the following factors will bo the game for the drum RIB for the test plat08. Rate of heating. MaximuTn tennperature. Time held at Tnoximum temperature. Conditione of cooling. Hy DRAULIC AND TESTS 268. Each drum on ion of all welding and after heal tread ment shall be subjected to a, hydraulic test pressure of ono-and-a-hblf Limes the boiler drum moxirnum permN8iblo working pressuro, and while the pressure is applied the vold8 shall be given thorough IIR,mrncr test throughout their length, raro boing taken to ovoid darn ugg to tho surface of the platog. After thig Lho pressuro Bhull be rn,iged to tw ice boiler drum maximum permiseiblo working progsuro uncl bo maintained for R length of ilitno Bumcient to enable an in- gpoction to be _t•nado of a,ll sea,mg and eonnecti011B, but for not leBß than half an hour. INSPECTION AND T p,srnnva 269. Inspection durinx construction.—Ingpoction shall be made bt least nt the following Ftogog of congtruotion : (i) When the tost platog ore readv for Btumping for identification and before they are ouL from the parent plato or plaies. flnngod, tho welding grooves ore rna,cllinod, and tho parts arc assembled readv for woldin(l. (iil) When wolfling is in progress. (iv) W hon wolding at the outside surfaco has been cornpleted. (v) W hon the inside Burfnoe hag been prepared for wolding and beforo the outside surface dre8sed. (vi) When the seams are dregsed . (vii) When the geoms are being radiographed. .LLL ux -INDIA Ad-i.- 11 (viii) When the openings are preparod for stand pipes and seatings, and these are being welded in place. (ix) Whon the drum has boon heat treated, prior to the hydraulic test, (x) When the test plutes aro ready for Inarking off the test spoaimens. (xi) When Lho test tspoelmens havo Leon machined and are rondy for testing. (xii) W hon the drum iB ready for hydraulic test. (xiii) When the tube holeB ore bored and tho drum iN e ompleLed. REGULATIONS FOR DETERMINING THE WORK-DIG PRESSURE OF WATER TUBE BOILERS WITH FUSION WELDED AND SEAMLESS FORGED DRUMS SHELLS 270. Shells of steam and water The working pressure shall be detennined by the following formula: $2fE(T - 0.03)D + T - 0.03$ (Eqn. 72) T D WP E Thickness in inches. Maximum internal diamoter in inches. Working pressore in lb. per sq. inph. Permissible stress in lb. por sq. inoh at working metal tem- peroturo (Seo Rog, 27]). Effi"ienoy of Ligaments between tube holos or other openingh in Bhel_l or of longitudinal jointB (expreseod ag u fraction) whichever applies. In the particular case of an unpierced wrapper plato of fusion weldod drum and f=permmissible stress on butt weld from the table in Reg. 271, column B. (b) Irrespective of the thickness obtained by the use of the foregoing formula "T" shall not be less than (i) For tube plotes (whero the tubes ore expanded therein) the thicknesB *holl be at least Buch 8B to allow a rminimum parallel bolt width of tube seat of 3/8 inch, this seating to be measured 0B explained below. (ii) All tubes shall be carefully expanded into the holcs in (Jhe tubo plateae The tubeg shul-I be belled of beacl to resist

withdrawal and if belled they shall project through the tube not at least $\frac{1}{4}$ inch, (c) The Belling shall be shown in table below TABLE Outside diameter of tube Up to and Including in. Over in. up to and including 2 in. Over 2 in. up to and including $3\frac{1}{2}$ in. Over $3\frac{1}{2}$ in. up to and including 4 in. Amount, of (hamets of bell-mnng over diameter of the tube hole BEO. 81 GAZETTE OF INDIA EXTRAORDINARY 695 (d) The tube holes of the tube plates of drums, pots of headers shall be formed in such a way that the tubes be effectively tightened in them. Where the tube ends are not normal to the tube plate, there shall be angles to the of the tube of parallel going to right neck or (going) the of the tube least in in 13 PLH in in, at the hole. (e) Where the tubes are parallel to the tube plate or the header less than $\frac{1}{4}$ inch, over pressure be 8 this p L'R.IIBI m. 8 in depth 271. Permissible working stresses for shells of Boiler and Integral Superheater headers shall be as given in the Table below : Form 18A1b1a fD" gt lxuv.ng LLltlt Lt to str3*8 tons per sq. in. 01 , Working temperature 6500 14' 700QF 7500F 8000F 8500F 9000F NV r pper 1" vetod forge drains 200 15 13 400 8 300 300 BLitt weld* of fusion welded drums lb./sq. 14 000 13 500 9 000 7 000 5 700 Tube plate 28 I votocl. fusion welded forged drums 10 8 500 headf 15 13 (100 000 8 000 Snorn 10BH forged and headore lb /sq. in 17 300 14 200 600 11 300 Intorm 3A1ato values Jnu,y bo Interpolated. The working metal temperature shall be taken as (a) For fabricated steels, water and muddy-urns, the saturation temperature corresponding to the pressure WP plus 500 F (b) For superheater drums, the designed maximum steam temperature for that drum plus 500 F Where the drums are adequately protected from the gases of combustion or swept by gases the third or subsequent pass of a boiler, the working metal temperature shall be taken the saturation or designed steam temperature as defined above, whichever is lower. A covering of or mauling material which may liable to become dislodged shall not be deemed adequate protection. Note —Where for *-3rvlee at 18A1.1P rat,nr., -1 Dt 70) F It *hall be 80 Bt,oted and the 811Lcon content shall be 0 10 per cent maximum, or Alternately the material must "Proof Test for Oreop Quality of Carbon Steel of Boiler Plate Quality" in the App. D. 696 THE GAZETTE OF INDIA EXTRAORDINARY [PART 272. nt ffeils noy- of drum shells Shall comply with g. 21 5, 273. Longitudinal Stress.—The maker of boiler and the Inspector (Engineering Authority concerned) shall be responsible for ascertaining that the longitudinal stresses resulting from the action of steaming from internal pressure, the self weight of the drum and (and) the externally applied load, shall not exceed the permissible working stresses corresponding to the working metal temperatures included in Regulation 27]

274. Intermediate Boiler Drum Supports.—Where a drum is supported at intermediate points its length at distance greater than one internal diameter from the end of the parallel of the drum shell, the shell shall be thickened so designed that when the stress set up by the super-pressure and supported load, the maximum resultant stress does not exceed the permissible working stress at the working metal temperature. TABLE 275. Shape of Dished End Plate.—Where an end plate is dished to a semi-spherical or partial spherical form, the maximum radius of dishing shall not be greater than the internal diameter of the shell (to which the end is attached and the corner radius to the thickness shall be not less than four times the thickness of the end plate or whichever is the greater

276. General.—The thickness of the end plate after pressing and is applicable over the whole area of the end plate up to the point where the dishing radius joins the corner radius. From the point of the gradual thinning up to the maximum of the thickness of the end plate at the point, the thickness of the straight portion of the flanged end plate. This permissible thickness applies also the flange for the manhole opening. In no case, however, the thickness of the edge of the flange for connection to the shell shall be less than the thickness of an unpierced girth of the same diameter and in addition. When an end plate has flange in manhole 277. End Plate with Manhole. or access opening the thickness shall be increased by the thickness of the flange. The thickness shall be increased less than (b) The depth of the flange cut in the access opening measured from the outer surface of the plate at the radial axis of the opening shall be not less (Eqn. 73). than of the end plate thickness ; when full compensation is provided $W = \text{Length of } n \times \text{ID} \times \text{ID}$ for an unflanged end plate, no additional thickness is required. 278. End plates subject to pressure on the concave side. (q) The maximum working pressure of an unstayed end plate subject to pressure on the concave side shall be determined by the following formula: $WP = \frac{2f(T - 0.06) DFK}{\text{Working Pressure in lb./sq. in.}} \times \text{Permissible Stress in lb./sq. in.}$ (Eqn. 74) in the working metal temperature (See SEC. 3] THE GAZETTE OF

INI)YA EXTPXORDINARY of end Dlate in tnenos. D=Mean Dianneter of end plate ;nche;-: R 697 end b'aouÜ holes, o: sDaced -j_t• Q iameter no greater for olates a flan (complying witl: Eqn. Ro). he effective externa] Far •toye upon the ratio he If) frt»n lil (Eqn. 75) Mean raclijs of dishing in inches. r—Mean e orner radius of flange. Outside diam+ter of Drum end in inches. DI 045 ot 698 THE GAZETTE OF INDIA EXTRAORDINARY (b) Macimurn permiY8bbZe 8tre88 of 8steel 'l'onsilc Strength of Plato in lbs. inch. Working metal temperaturo 11 24 28 tony 20—30 tong 32 32—36 tony 34—38 tons m r sq. in. per qq. in, 6500 T 7000 8000 8 500 13'40 11600 per in. 15700 13400 1 5200 9000 6300 18500 13900 9000 0300 h D Fig. 28 STAND PIPES OR BLOCKS 279. Compensations.- Exc for those cas3B where no cmponsoation iB necessary ag defined in Regulation 187 adequate compnensation for tho hole cut for - gtand pipe Bhall be providod. Compensation Bhall bo considered adequate when the equivalent cross sectional areo provided is not loss than 1 25 times the cross sectional areo obtained by multiplying the diameter of the hole cut in the 8holl by tho thiok- negg required for on t-)quivulent unpierced drum Bhell. (b) The equivalent cross se 'tional area providod Shull. calouluted as follows (1) The crOBB sect ional area of the wall of the Btand pipe upto a point 4 in from the outside au rfaco of the drum 8hell, but proportionately roduced In tho ratio of the ultimate tenailo stresges of the motalB composing tho stand pipo and the drum shell. (2) The cross sectional arcu of the welding fillets external to the drum shell. (3) 'l'he arou obtlilned by Inultiplied the difference between tho actual drum shell thic•knss and tho thickness of an equivalent geamless (See Fig. 25). unpierced drum shell a, lentrt,h 2 (3-1-T). (c) In oases where the total compensation obtained by tho aum of the areae i ven above is loss than the total cornpengation requ ired, u eompengoting plate 'hall bo fittod to the drum Shel] ot the si and pipe and socured by fillet welds •B ghown in Fig. 26. N0TE.—An rquivblent unpored drum Bhøll Bhall mean seamless drum ehell of gimilar matcmal designed for the eomo conditionx of prcut'0 and temperaturo tho drum *hell in queetton. (d) The minirnu13E of i,he fiangoa and of the body of stand pipes shall bo m oeeordance tho table under Reg. 156

280. Attachment Stand Blocks—(a) The mc(hcd of nt shall be in at cordanoe -mih (hut Nhown in Fig9. 24 25, 26 0} 27 und after tho welding lthe parts shall he heui, ireuted. holo drilled in the *holl plate for tho reception of the Ntand pipe bo in. greater in diameter than the outgido diamotor of the stand pipe where this if-I secured bv fillet welde only aB Figs. 24 and 2.1 Fig

24. Minimum weld attachment for stand pivs 2 im bore and under.(b) Bloc shall c•ornplv TV ith the of Regulations 94 to 98 (Covered Elcetrodeg for Matul Are Welding). (c) Where ono S'de of a, double Vee ueld hus boon c•oznpleted, the under gurfaeo of the originlll first run of' znotnl *hall be ('hipped before welding on the other side i8 commenced. (d) The final finish of f he shall bo Htu h thai or gor tion from 8heII to gradual and free from sharp (e) So far us f he att H'jnnen(of flungee to is concerned construc- tion shown in 28 & 29 shall be pennif4BJDe. Fig

25. Aru —Minimum weld attachment for stand pipog over 2 in. bore upto and including 4 in. bore. 'J. H L (JI IINLJIA Fig. 28. —Minimum weld attachment for stand pipe over 4 in. bore where compen- sating ring ig required and tor attachment 01 flange to stand pipe8 8-in. bore and over. (Alternative to flange bttachment Bshown in Fig. 27). 702 GAZETTE OF INDIA EXTRAORDINARY I PART 11 Fig. 27.— Minimu19 weld attachment stand pipes over 4 in. bore where a compen- sating ring is not requ•red mirimum weld attachment of flange to stand pipes over 4 in. bore

CHAPTER VI VALVES, GAUGES AND SIMILAR FITTINGS 281. *Requisite Mountingg and Fittings.—Every boil(r shall fitti d at least with the following Two safety valves (Mtl)lnnnn 3 4") Two independent Inenns of ill(lIcatmc.a the water level ; A steam pressme gaur A steam stop e A feed check valve ; Two n)ean8 of feedlnu• the boiler the heating sutfaco ceedb 200 sq. feet • A blow down cook or valve ; A fusible plug hen boiler has internal furnacf s. An attachment for Inspector's test ganee. A manhole, vvhere thn size and construction pot nut, and such nmdholes or sightholes as are nece-nary for effectively cleaning, the boi]et GENERAL Materials, Temperature and Pressure Limits Tlu xuaicrials in the IP,9hL1fcrcfure of I odi(of 282. (a) Materials. fittinos shall co the *NOTE. —It IS lerommended that Lanc ashzre and Cornish Boilers one of the safety s. alves should be of flyo•h steam and 10M irvpp In water tub• and horizontal Inult1tlLhtL• lar boilers a low a f A alarm should be fitted Ranisbottom type safet' als,es of ! wo salves With lg an lei er rnnm m u be oon-ldpred as two safetv '•lxes the purpose of thlS Regulation In the case of man m• t. pe but!ens I 'w w, ter alarm mav he fitted rn Place of a fusihle OF

INDIA F, EXTRAORDINARY 708 (i) *Steel castings shall comply with 28 tons grade 11. See Regulations 73 to 80. (ii) Stool forgings shall comply with Regulations 81 to 85. (m) Iron castings shall comply with Regulations 86 to 93. (iv) Bronze castings shall have a tensile breaking strength of not less than 16 tons per sq. in. With an elongation of not less than per cent. measured (in standard test, piece C. (v) The scum valves of boilers shall be made of non-corrodible metal. (b) Limits of Cast Iron.—Cast iron shall not be used for : (i) Temperatures above (ii) Steam pressure exceeding 160 lbs. per sq. in. (gauge). (iii) Feed water valves directly connected to boilers for pressure above 160 lbs. per sq. in. (gauge). (iv) Blow-down fittings. (c) Limits of Bronze Fittings.—Bronze shall not be used for steam temperature 425°F. METHOD OF CONSTRUCTION 283. All castings shall be smooth, sound and free from flaws, cracks or other injurious defects. - Variations in thickness at any shall be gradual, and substantial fillets shall be provided. (b) The body of a boiler mounting shall be connected to the boiler by a strong and stiff neck. In no case shall the thickness of the neck of bronze mountings be less than 3/16 inch for sizes up to and including 3/4 inch bore or 1/4 inch for sizes over 3/4 inch bore

284. Packing of Cocks.—The bodies of all cocks except those for pressure gauges shall be packed with asbestos or other heat resisting material and shall be of substantial design, those over one inch bore shall have special provision, other than the gland for securing the plug. Water gauge column cocks may be either asbestos packed or solid plug type

285. Covers and Spindles.—Valves of 1 inch bore and over directly connected to boiler, and other valves of 1 inch bore and over which are fitted with a cover shall have a cover secured by bolt or studs and the screwed portion of the spindle shall be outside the stuffing box. All valves for superheated steam shall be fitted with an external screwed spindle. (b) Where the covers of valve are secured by gudgeons, the studs shall be screwed into the body with full thread for length of length of spindle. The stud hole shall not penetrate into the pressure space of any casting. * Note.—Steel which will to the extent of feed water shall be made of of which the maximum elongation does not exceed 8 per cent. The metal must be free from corrosion and/or erosion. 704 OF INDIA EXTRAORDINARY [PART 11 (c) Valves with screwed covers shall be fitted with a suitable locking device* to prevent rotation of the cover

286. Direction Of Operation.—Valves shall be clearly marked to indicate the direction of flow. Valves directly connected to boilers shall be fitted with indicators to show clearly whether the valve is closed or open and all valves shall open by anti-clockwise rotation

287. Moving Parts.—The valves and spindles shall be efficiently guided and means shall be provided in every case to prevent them leaving their guides. The working parts shall have sufficient clearance to ensure freedom of movement under all conditions of service

288. Flanges shall be in accordance with the tables for the appropriate pressure.(App. E). (b) In the case of safety valves, the drilling, thickness and bolting of inlet flanges shall be in accordance with tables for the appropriate pressure and for the diameter of flange adopted. In the case of outlet, flanges the pressure taken shall be the pressure on the outlet side of the valve. (c) For the purpose of determining particulars of flanges for blow down and scum pipe fittings, the design pressure of the fittings shall be assumed to be the working pressure of the boiler. (d) All flanges shall be machined on the face, spot faced, or machined at the back, and the bolt holes shall be drilled

289. Valve Seatings.—Where separate seats are fitted they shall efficiently secured. Means shall be provided in every case to prevent the valve leaving their guides

290. Chests etc., in All chests and fittings shall be sound and free from flaws, cracks or other injurious defects. After compact they shall withstand satisfactorily a hydraulic test to at least twice the pressure of the boiler for which they are intended. (b) Valves may be fabricated from seamless steel pipes of stress not exceeding 250 lbs. per sq. in. and temperatures not exceeding 800°F The welding should conform to Regulation 125 and the valve chests should after fabrication. The working pressure of the valves shall be as in equation 91 where 2 S shall be substituted by 1.8 S. The wall shall be less than 3/8". They shall withstand satisfactorily a hydraulic test twice the working pressure of the boiler for which they are made (c) The working pressure and thickness of the chests shall be as follows (Subject to the minimum thickness in Rule 704 W.P.— W.P.x D is the internal diameter of the chest in inches t is the thickness of the chest in inches C is a coefficient from the following table, stress relieved material shall not be used by

the 283(b). X is a provision for tolerance, etc., from the following table : Table of Values of C and X Material of Outing Cast iron, least 10 tons tensile strength Bronze, at least 16 tons tensile strength Steel, 28/35 tons tensile strength— For up to 5500 F. For temperature up to 6000 F. For temperature up to 6500F. For temperature up to 700 F. For temperature up to 7500F. For temperature up to 8000F. For temperature up to 8500 F. For temperature up to 9000F. Intermediate values may be interpolated. SPECIAL REQUIREMENTS SAFETY VALVES 160 175 350 315 280 265 252 230 220 154 x 6 4 8 8 8 8 8 8 291. General—Safety valves, ordinary, high lift and full lift, shall be so constructed that breakage of any part will not obstruct the free and full discharge of steam from the boiler

292. An ordinary safety valve is a valve which lifts automatically at least $D/12$, where D =diameter of valve seating.(b) A high lift safety valve is a valve which lifts automatically to a distance a discharge orca round the edge of the valve seating equal to the orca, through the valve orifice, when the valve is fully lifted, after deducting the area of guides or other obstructions

293. Minimum Aggregate Saturated Steam.— The minimum aggregate area of the orifices through the seatings of the safety valves on each boiler* (including high steam and low water safety valves) shall be found by the following formula Eqn. (78) Where A —for ordinary and high lift safety valves the aggregate area in square inches of the orifices through the seatings of the valves. for full lift safety valves the net area in square inch through the seat, after deducting the area of guides or other obstructions when the valves are fully lifted. E —total peak load evaporation in lbs. per hour (including evaporation from water heating, steaming economiser, and other heating surface in direct communication, with the boiler), for which the boiler is specified. In no case, however, shall the evaporation as calculated for this purpose, be based on less than 6 lbs. per hour per sq. ft. of heating surface (exclusive of superheater and non-steaming economiser). *Subject to the application of Eqn. 79 to the term "boiler" shall include any superheater to the boiler without an intervening stop valve. THE GAZETTE OF INDIA EXTRAORDINARY 11 pressure in lbs. per sq. in. to which the safety valve is set. constant, as follows 'Lift' of Valve (Ordinary Valve High Lift Valve Full Lift Valve* Spring Valves, Direct and Lever c. 4 8 For water tube boilers of capacity greater than water per hour C may be increased as follows:— Type of Valve Ordinary Valve High Lift Valve Full Lift Valve* Spring Valves, Direct and Lever c. 9-6 20 Weight 10 lbs. or over c. 16 10,000 lb*. of Weight loaded Valves, Direct or Lever c. 4-8 9-6 20 Where two valves are loaded by a single spring the above areas shall be increased by 50 per cent. (b) Superheated Steam.—If the valves have to pass superheated steam the area shall be determined in accordance with the following formula : Eqn. (79) $1000 W$ where A_s =area, in sq. inch for superheated steam. A —Area in sq. inch for saturated steam. L —degree of superheat in deg. Fahr. 294 Over valves shall be so designed that the maximum peak load evaporation for which the boiler is specified will be completely discharged with a design pressure of not more than 10 per cent. of the safety valve blow-off pressure. 295, Pressure Drop.—The valves shall shut down at a pressure (b) not more than 5 per cent. and (b) not less than per cent. below the design valve blow, off pressure. For valves less than 1 inch diameter the limits shall be increased to (c) and (b) 5 per cent. respectively. Valves for Superheated Steam and for water tube boilers of capacity greater than lbs. or water per hour shall be exempt from the minimum requirements (b)

296. Attachment to All the safety valves of boiler, may be fitted in one chest but, with the following exception, such chest, shall be separate from any other valve chest. In the case of boilers with overhead engines where the cylinder casting is mounted directly on the shell, the safety valves may be attached to the engine cylinder provided that the passage way to the valve complies with the above rule. GAZETTE OF INDIA EXTRAORDINARY (b) The chest shall be connected to the boiler by a strong and stiff neck, the passage through which shall have a cross sectional area at least equal to the sum of the areas of the valves. (c) Safety valves shall be mounted so that the axis of the valve is vertical. (d) Shut-offs or obstructions or any description shall not be placed between the boiler and the safety valve. (e) The inlet and outlet, flanges shall be drilled in accordance with the appropriate table in App. E for the diameters of flanges adopted. 297. in Shell.—No accessories other than those integral with the Safety Valve shall obstruct the openings in the boiler shell. steam shall have direct access to the safety valve without flowing through internal pipes

298. Discharge Steam Safety V81ves.—The urea of the waste steam possoge both in the vulve itself in the oscape pipe, shall bc not lose than sq. in. for high lift valves, ond sq. in. for ordinor.y for full lift valves. Where E oncl P are definecl in Reg. 293

299. Drainue.—For each enclosed safety valve chest a means of drain- ing shall be provided. The drain pipe shell be loid with a, continuous (lownwordg gradient of the boiler duo a, place where the discharge is vlBit)lo and ennnot do Injury to any person

300. Moving Parts.—The volves and Npindleg shnll bo effoiently guided and meana Bhull be provided in every case to prevent their lifting out of tliü-•ir guideH. The working ports shall have sufficient ('learoneo to ensure frecdorn of rnovement under all conditions of service. The apindle shall not be fitted with a, Btumng box. r Phe bearings of tho levers of lever valves shul] bo 301. Bearings tor Levers. 60 designed to allow of free working of the valve under all conditions of service. Where (Jhe lever is mounLod on pin bearinga, the holes in the lever shall bc bushed with non-corrodible metal, or tho pins shall be of metul

302. Attachments of Weights and In n lever and weighi Nüfoty valve the weight shall be in one pieec and attached to the lover in such a way that i,he 88.fet,y valve cannot bo overloaded. (b) In the case of spring loaded safety valves, woghers or ferrules *hull bD fitted under the adjusting screwe NO that the valves cannot bo overloaded when under steam. W horc springs are in tension, links or other suitable stopt* BhalJ bc fitted to I provenlJ the spring being extended a greater amount than that, corresponding to valve lift of D/4, where of valve seoting

303. Easing Gear.—Safety valves Shull be NO arranged thai thoy can be ('as-led off their Beats when under pressure and the easing lofen Shull positively lift the 804. Lift.—Safoty valves shall be capable of being lifted u diBtunco such that the oreo of the discharge edge shall bc not le-s than the minivn urn aggregute urea, A in Reg. 293

305. High and Low Water Alarmg.—High and low wator a,larmg Nh}ill be a,djustcd so i,hat, the Alarm is sotuuled with the water level visible in the gauges

306. Final Setting.—Each SHIfoty valve shall, beforo loaving the mokor's works be adjusted to blow-off ot the specified pressure. 708 INDIA BX'lnAORDINAR± SPBINGB 307. The springs ghoill be manufactured from 8teel made by the Acid or Open Hearth process and shall show an analygiB the following oom• poeition :— Carbon Manganese Silicon Sulphur . Phosphorus . not less thon O •9 per oent and not more than I *2 per oent. . not legg than O •45 per oent. and not more than O •75 per cent. . not more than O •30 per cent. . not more thgn O •05 per cent. . not more than •05 per cent. The manufacturer shall supply an analysis of eooh oa.Bt when required to do 80. Should independent unolysiB bo required, these Bhall be mode bt the rate of one per cast. (b) All springs shbLl be formed hot and Bhall be hordened in oil ond suitably tempered

808. Dimensions.—The compression or oxtenßion of safety valve springs to load the volves to ilhe set pressure shall not bo less than one quarter of the dio- meter of the valve, due conalderotion being paid in the coae of spring loaded lever safety valves to the ratio of leverage. The proportion of unloaded length to externa,l diameter of the spring shall not excced 4 to 1

309. Determination of Working Peggure.—The maximum working pressure to be bllowcd for steel springs of round, square ot rectmgulor sec+ion shall be de- ternined from tho following formulae : (o) Round section 10,000 d8 DACR (b) Squore section, 33,333 d8 W.P. DACK (o) Rectangular section. ^DACK) Where (all dimensions in inches) Equ. (80) Eqn. (81) Eqn. (82) $D^4 D^4 d^4 \cdot 615 d$ (In oaae of rectangular section gubgtitute B Eqn. (83) W.P.=Working pressure in lb. per square inoh (get pressure). orea of valve. d=diameter of round of Bide of square steel. B=Breadth of wire (radial to spring oxiß). H=Depth of wire (parallel to spring BXiß). D=Mean diameter of ooil. W Congtant= Eqn. (84) Ll=Initial oompregaion Or extenßion of the spring to give the required loading. further compregßion or extension of the spring to give the lift defi- ned in Regg. 293, and 304. BcampZeg•.— where oompreesion or extenßion of spring to give the required loading is diameter of valve. • 5 where compreßion or extension of spring to give the required loading iB diomøter of valve. C— I • 25 where compression or extengion of spring to give the required loading ig full diameter of valve. —The obove formulae are boeed on maximum allowable gofe strou on the aection of the springs of 80,000 lbs. per squBre inch

810. TestB.—Compression springs shall not show any permanent set after being compressed coil to coil six times in a quick setting screw. Extension spring shall not show permanent set after being tested to 25 per cent. in excess the load necessary to lift the valve, 311. Extension springs shall be made from round section wire

312. Number of Effective Coils.—The number of effective or free coils in compression or extension spring shall be determined from the following formulae (i) For Round or Square Wire $K \times C \times d^3 \times r$ (ii) For Rectangular Wire Where N —Number of effective coils. K: Compression or extension in inches at set pressure. C=22 for round, 30 for square section. d^3 =diameter or side of square steel in 16ths of an inch. S=Load on spring in lb. at blow off pressure. D=Mean diameter of coil in inches. B—Breadth of wire in 16th of an inch. H —Depth of wire in 16th of an inch. . Eqn. (85) Eqn. (86) 313. Spacing of Coils.—The space between the coils, when the valve is lifted one-fourth of its diameter shall be not less than 1/16 in. INDIA IIAIHAUHDINA-t The spring shall be coiled in such a manner as to ensure the coils being uniformly spaced and the coils to be parallel to the axis of the spring

814. Finishing of Ends.—Compression springs shall have their ends wound flat and smooth and at right angles to the axis of the spring over the full circumference so that when placed on end the springs will stand perpendicular. STOP VALVE 315. Lever Valve.—Where the valve is operated by means of a lever, whether hand or mechanically controlled, the lever shall be of ample strength and the bearing shall be so designed as to allow of free working of the valve under all conditions of service

816. Steam Stop A steam stop valve shall be fitted between the boiler and the steam pipe and, except in the case in which a superheater forms an integral part of the boiler itself (e.g. in the Babcock and Wilcox water tube boiler) between the boiler and the superheater. Where two or more boilers are connected with steam receiver or any other vessel, a steam stop valve shall be fitted between the boiler and such receiver or vessel. (b) Steam stop valves shall be attached direct to the boiler shell or to suitable pads or stand blocks riveted to the shell, and the neck of the valve chest shall be reasonably short and of strong construction : Provided that in the case of a larger boiler in which it is proposed for the purpose of drainage or owing to obstruction, to connect the steam pipes to the steam stop valve at higher level than would be under this Regulation, a vertical stand pipe not exceeding 5 diameters in height will be permitted between the stop valve and the boiler. Such stand pipes shall be of strong construction, and of wrought iron, mild steel, or cast, steel. The flanges of wrought iron or mild steel pipes shall be riveted or welded to the pipes, and there shall be no branch on the stand pipe for any other connection, Provided also that in the case of a large boiler in which it is desired to fit a tee piece for the purpose of providing branch connection between the stop valve and the boiler, such a tee piece may be so fitted. The tee piece shall be of strong construction, of wrought iron, mild steel, or cast steel and shall not exceed diameter in height. A stop valve shall be fitted direct to each tee piece branch. (c) No stop valve of the wedge type shall be employed for steam service. BLOW-DOWN COCK OR VALVE AND PIECES 817. General.—The blow-down cock or valve shall be of substantial construction. The waste pipe attached to the cock or valve shall not be connected to a pipe to another boiler. The pipe shall not be bound fast in earth or brickwork

318. Blow-down Mountings.—(a) Each boiler shall be fitted with a suitable blowdown valve or cock placed at, or as near as practicable, to the lowest point of the boiler. (b) For locomotive, vertical and marine type boilers, the valve or cock shall be attached direct to the boiler or to suitable pad or stand pipe. For water tube boilers the valve or cock shall be outside the brickwork with a substantial steel pipe between it and the mudbox. Bø. L. . E On DLA unl.RAO. DI. IA- (c) For Cornish and Lancashire boilers the cock or valve may be attached to a cast steel elbow pipe of substantial section bolted to a suitable stand pipe or pad riveted to the boiler. But cast iron elbow pipes shall not be 819. Blow-down Valve or Cook.— (a) Each valve or cock shall be fitted with a device which shall indicate clearly its open and closed position, and any key or handle device for operating the valve or cock shall be such that it cannot be removed unless the valve or cock is fully closed. (b) The locking feather shall be secured by welding. (c) Cooks fitted with taper plugs shall be of the bolted cover type with separate packing glands. WATER GAUGES 320. (u) Every boiler shall have two independent means of indicating the water level in it and have marked on it, when applicable, in a contiguous position easily seen, the level of the highest part of the furnaces, firebox or combustion chamber the case may be. (b) All boilers 3 ft. dia. and over shall be fitted with two glass water gauges. For small boilers where there is difficulty in fitting two glass water

gauges two test cocks may be fitted in place of the second glass water gauge. (c) The lowest visible part of the glass of the water gauge and lower, test cock shall be fixed at safe working level. For locomotive type and vertical boiler this shall not be less than 2 inches above the highest part of the firebox roof plate. (d) Glass water gauges shall be so placed as to be easily seen and reached by the fittings of glass water gauges and test cocks shall be the boiler of substantial make with large passage ways through them to facilitate cleaning. The gauge cocks when open shall have their handles in a vertical direction and each handle at its junction with the plug shall be plainly marked with a cleop line to indicate the direction of the passage way through the plug. When detachable handles are provided arrangement shall be made to prevent incorrect fitting of the handle.

321. Drains.—A drain cock or valve with a suitable (lead) pipe shall be fitted to each water gauge.

322. Protectors.—Where tubular water gauges fitted, substantial protectors shall be provided. The glass shall be suitably treated to prevent splintering.

323. Glass Size.—Tubular or gauge glasses shall be not less than 1 inch and not more than 1½ inch outside diameter.

324. Safety or gauge glass mountings Shall be fitted with self-closing cock in the bottom arm, and it is recommended that a similar device should be fitted in the top arm.

325. Gauge Columns.—Where the gauges are mounted on a column there shall be no connecting passage between the top and bottom arms of the column unless valves or cocks are fitted between the column and the boiler.

326. Isolating Cock.—Where isolating cocks or valves connecting water gauge to the boiler are fitted, they shall be not less than 1 inch bore and of the vented cover type with separate packing gland. **712** **OF INDIA EXTRAORDINARY GAUGES [Part 827.** For pressures up to and including 500 lbs. per sq. in. pressure gauge dial shall be graduated in pounds per square inch from zero to twice the pressure, nearly as may be practicable. (b) For pressures exceeding 500 lbs. per sq. in. the range of graduation shall be from zero to one and one-half times the maximum permissible working pressure, 88 nearly as may be practicable, but in no case shall be maximum graduation on the gauge be less than 1,000 lbs. per sq. in. (c) The scale on the dial shall be clearly and permanently marked "lbs. per sq. in.". (d) The dial of each pressure gauge shall have marked upon it in red the maximum permissible working pressure. (e) Where the gauge is compensated for a head of water between the gauge and the boiler connection, the amount of such compensation shall be marked on the dial. Pressure gauges shall be calibrated within an accuracy of 1 per cent. of the working pressure. Boiler pressure gauges shall be not less than 6 inches in diameter except in the case of small boilers where a gauge not less than 4 inches in diameter may be used. (f) The travel of the pointer of dial gauges shall not exceed 3250

328. Connections.—All pressure gauges shall be fitted with a syphon pipe and a cock or valve integral with, or adjacent to, the gauge in such manner that the gauge may be shut off and removed whilst the boiler is under steam.

329. Gauge Cock.—The handles of the gauge cock shall be parallel to the pipes in which they are located when the cocks are open and marks shall be put on the bank of the cock indicating open position. **330. Inspector's Pressure Gauge Attachment.**—Every boiler shall be fitted with a valve or cock carrying in a vertical position a receiving screw for the attachment of the inspector's pressure gauge. The receiving cock shall be tapped with in. British Standard Whitworth screw thread and shall be fitted with an easily removable cap. **331. General.**—Fusible plugs shall be of sufficient height and fitted in such position as to give early protection to all parts of the boiler liable to damage by the direct application of furnace heat in the event of shortness of water. In Lancashire boiler the fusible plug shall be in the crown of the boiler. —For example : the furnace from 12 inches to 18 inches in front of the brickwork fire bridge.

332. Type.—Fusible plugs shall consist of an outer body with a central conical passage, the smallest part to be not greater than 1 inch for plugs suitable for pressures up to 100 lbs. per sq. in. and not greater than 3/8 inch for plugs for pressures exceeding 100 lbs. per sq. in. The passage shall be closed by a plug secured by an annular lining of fusible alloy so that the plug may drop clear if the lining melts. The portion

of the body carrying the fugible metal should preferably be detachable from the base to allow of easy replacement without removing the whole fitting from the boiler

333. Material.—The non-fusible portions of the plug shall be of bronze except where the nature of the boiler water precludes the use of a non-ferrous material. The fusible metal shall be an alloy melting readily at a temperature not less than 1500 F in excess of the saturated steam temperature at the maximum permissible working pressure of the boiler. OF INDIA EXTRAORDINARY 718 884. Attachment to Boiler.—Wherever practicable fusible plugs shall be screwed into the boiler plates from the waterside. The screwed portion shall have a thread of Whitworth form not more than 11 per inch. VALVES 885. Feedcheck valves shall be of the non-return type. (b) Where the valve is not of a screw-down non-return type a separate screw-down valve shall be provided. (c) The discharge from the feed check valve or from the internal feed pipe (if provided) shall be above low water level and in the case of Lancashire and Cornish boilers shall be at least 5 ft. beyond the fire bridge

886. Operating position.—Feed check valves or regulating valves shall be so arranged as to enable them to be satisfactorily operated from the boiler floor

CHAPTER V SUPERHEATERS TUBES 337. and Construction—See Reg. 151. 388. (a) The Working Pressure of tubes shall be determined by the following formula :— $WP = \frac{2T}{D} \sqrt{\frac{f}{C}}$ (Eqn. 87). Where T = Minimum thickness of tube in inches. W.P. = Boiler drum working pressure in lb. per sq. in. D = Outside diameter of tube in inches. f = Permissible working stress in lb. per sq. in. at working metal temperature See Table below. C = Constant as follows :— Cold Drawn Tubes. For generating tubes and unprotected furnace wall tubes C = 0.6 The working metal temperature shall be taken as : Hot Drawn Tubes. (a) For boiler tubes, the maximum temperature corresponding to pressure W.P. plus 250 F. (b) For convection superheater tubes, the maximum steam temperature for which the tube is designed plus (c) For radiant superheater tubes the designed maximum steam temperature plus more than 500 F, the amount depending upon the superheater design. THE GAZETTE OF INDIA EXTRAORDINARY Permissible Working Stresses for Tubes. [PART Working metal temperature Up to 6500F 7000F 7500F 8500F 9000F 10000F 10250F 10500F Table. Low carbon steel tube to Reg. 36 and 43 10,000 lbs. sq. in. 9,000 " 8,000 " 6,800 " 5,600 Molybdenum 10/0 chrome 0/0 8 to 12,000 J 1,600 8,400 6,100 4,500 molybdenum tubes 12,000 11,600 9,800 8,400 7,000 5,750 4,500 Intermediate values may be interpolated.— (b) In no case, however, shall the (standard wire gauge) of tube be less than those given in the following table— [Subject to the tolerances Regs. 36 (d), 43 (d), 48 (c) and 53 (c).] Table. Outside diameter in inches Up to and including 2 Over 2, up to and including 3 Over 3, up to and including 4 } Welded tubes Hot finished SWG 10 10 10 9 Cold drawn SWG 13 12 10 9 (c) Where tubes are bent the resulting thickness of the tubes at the thinnest part shall be not less than that required for plain tube. HEADERS AND SIMILAR PRESSURE PARTS 389. Material and Construction. See Regg. 154 & 244(b)

340. Rectangular Headers Symmetrical in Form.— (a) The Working Pressure shall be determined by the following formula : $WP = \frac{2T}{b} \sqrt{\frac{f}{C}}$ (Eqn. (88) Where W.P. = The working pressure in lbs. per sq. in. t = The thickness in 1/32 in. b = The breadth in inches between the supporting sides of the header less one inside corner radius 'r', this being the corner radius of the rectangular box from which the header is pressed or of the header casting, which shall be not less than 1 1/4 in. In no case, however, shall 'b' be taken as less than 0.9 of the breadth between the supporting sides. THE GAZETTE OF INDIA EXTRAORDINARY 715' C = 300 for wrought steel and 350 for steel castings : where the sides are corrugated or otherwise reinforced by substantial supports so that the length of the flat portion between the corrugations or supports does not exceed 'b'. 'C' shall be taken 175 for wrought steel and 200 for steel castings. f = The permissible stress at working metal temperature lbs. per sq. in. see table below. (b) If the faces of the headers are machined locally at the tube holes or hand holes the thickness at that part may be as much as 6/32 in. less than given by Equation 88 but irrespective of the thickness obtained by the use of the formula, the thickness of the headers at the tube holes in 1/32 in. shall be not less than : Eqn. (89). Where diameter of the hole in inches, and in no case shall the thickness be less than 10/32 in. , except that in small patches not exceeding one-half a sq. in. in area, the thickness may be 50 per cent. of the thickness used in Equation 88. (c) The permissible stress at working metal temperature shall be as given in the table below. Working metal temperature 8000F 8500F 9000F TABLE Permissible stress in lb./sq. in.

Wrought steel having an ultimate tensile stress in tons per sq. in. of 24-28 2300 12800 12300 1800 1 0000 9300 7800 26-30 13300 1.3300 13300 12800 1 0000 8300 6.900 28-32 14.300 14300 13800 12300 8500 0300 18,300 10300 15800 14000 11800 9200 6300 84-38 17800 17800 17300 16800 14800 12400 9000 6800 Cut Stool 28-85 tons 10000 9000 8000 7560 7200 6700 0300 4400 Intermediate values may be interpolated. The working metal temperature shall be taken as : (d) For saturated steam, Motor drums, (rums and headers, the saturation temperature corresponding to the pressure WP plus 500 F. (e) For superheater the designed maximum steam temperature for that header plus 500 F. (f) Where headers are adequately protected from the gases of combustion or swept by such gases in the third or subsequent pass of a boiler, the working metal temperature shall be taken as the saturation or designed maximum steam temperature as defined above, whichever applies. A covering of refractory or insulating material which may be liable to become dislodged shall not be deemed adequate for protection.

841. Irregular in Form.—In where the headers are of irregular form as to render impracticable the application of the formula for the determination of thickness, the manufacturer shall show the suitability of the design for the working conditions by indicating practically the maximum internal hydraulic pressure which a header, made to the same design and of similar material will withstand without permanent deformation. The maximum working pressure for similar headers may then be determined by the following formula :—
$$P = \frac{S}{W.P.} \times \frac{1}{1 + \frac{W.P.}{S}}$$
 Where W.P. = The working pressure in lbs. per sq. in. S = The maximum internal hydraulic pressure withstood without permanent deformation. 0.75 for wrought steel and 2 for cast steel, 0.15 for wrought steel of 24 tons per sq. in. stress, —16 500 for wrought steel of 26 tons per sq. in. stress, = 18 000 for wrought steel of 28 tons per sq. in. stress, —21 000 for wrought steel of 32 tons per sq. in. stress, —22 000 for wrought steel of 34 tons per sq. in. stress, and minimum ultimate tensile strength minimum ultimate tensile strength minimum ultimate tensile strength : minimum ultimate tensile strength —15 500 for cast steel of 28 tons per sq. in. minimum ultimate tensile strength

342. Cylindrical Headers.—Where cylindrical headers are provided their working pressure shall be determined by Equation 72. CHAPTER VIII STEAM PIPES AND FITTINGS 343. Steam pipes may be wrought iron, wrought steel, cast steel and in some cases of copper. Steel pipes may be solid drawn (cold or hot finished) or lap welded. Wrought iron pipes may be lap welded. Copper pipes shall be solid drawn and no pipe made from the electrode position of copper on a mandril shall be used for steam delivery. MATERIAL 844. Steel pipes shall be made by the open hearth or an electric process solid or forged. Where the material is used for designed steam temperatures above the specified shall be of non-segregated or fully killed type. (b) The material from which these pipes are made shall conform to the following requirements : see Table 1. Ultimate tensile strength in tons per sq. in. Min. elongation per cent. On 2 in. Kind of pipe Not less than Sulphur Maximum Not more than thickness 1.088 and then over 10k in. thickness over 10k in. Pipe less than 30 80 per cent. maximum Cold drawn Welded steel pipes cut from the pipes and tested in their curved condition. Test length taken from finished pipes (ends of pipes to be plugged for grips) 8 in. from the pipe and tested in their curved condition Test length from finished pipes (ends of pipes to be plugged for grips). 8 in. from the pipe and tested in their curved condition Test length from finished pipes (ends of pipes to be plugged for grips) 23 23 30 30 20 25 18 23 Hot-finished Welded Steel Row Lapwelded steel Pipe 2 22 28 2B 20 25 32 23 0.718 THE GAZETTE OF INDIA EXTRAORDINARY Hydraulic (water gas) Lapwelded Steel Pipe [PART 11 Sulphur Limit] ultimate tensile strength 18 in. tons per sq. in. Not less than 22 Min. Elongation per cent. on 8 in. then Selected samples cut transversely maximum Tensile strength maximum Tensile strength and not over 23 than 4 18 845. Condition of pipes.—All pipes shall be commercially straight free from longitudinal seaming, grooving, blistering or other injurious surface marks. The ends of the pipes shall be cut square. IV CHAN OAL TEST 346.—Flattening test (For pipes up to and including 4-in. nominal bore).—A ring not less than 2" in length cut from one end of each selected pipe shall when cold withstand, without showing either crack or flaw, being flattened between two parallel flat surfaces until when the pressure is released the interior surfaces of the test piece remain at the middle, distance apart equal to 4 times the thickness of the pipe

847. Cold bend test (For pipes over 4-in. nominal) A strip wide out circumferentially from one end of each selected pipe shall when cold withstand, without showing either crack or flaw, being doubled over in

the direction of original curvature round a bar, the diameter of the bar being :— For pipes upto and including 3/8" thick . 3 times the thickness, For pipes over 3/8" thick 4 times the thickness. Bend Test on the Weld.—(b) A rip 1½" wide cut circumferentially from one end of each selected pipe with the weld near the middle of the strip, shall when cold withstand, without showing either crack or flaw, being doubled over in the direction of original curvature round a bar, the diameter of the bar being equal to eight times the thickness of the test piece, the weld being placed at the point of maximum bending. Additional Should a pipe selected for testing fail in any one or more of the tests specified above, two further tests of the same kind may be made from the same or other pipe. Should either of those fail, the pipes represented thereby be reheat treated and then retested. If the repeat test satisfactory, the pipes shall be accepted provided they comply with other requirements but if failure again occurs, the pipes which the test pieces represent shall be rejected. 348. (a) The process of welding lap jointed seams shall be by hammering or rolling the joint. (b) On completion of any work which involves heating, whether for welding the joint, welding on flanges, hot bending the pipe or for any other purpose, the pipe shall be carefully annealed

349. The pressure and temperature limit* within which pipes, tee*, branches etc., shall be used shall be in accordance with Table 2.8] OF INDIA EXTRAORDINARY WORKING PRESSURE OF STEAM PIPES 719 850. Steel and Wrought Iron Pipes.—The maximum working pressure allowed on steel or wrought iron pipes shall be determined by the following formula 2Se. (t—9) W.P. — 100 D t=minimum thickness in hundredths of an inch. W.P.=Working pressure in lbs. per sq. inch. Outside diameter of pipes in inches. Eqn. (91) S=Allowable stress in lbs. per sq. inch 88 specified in Table 3. efficiency factor I for weld-steel pipes, for welded steel or iron pipes for values of t up to and including 7/8", .85 for welded steel pipes for values of t over 7/8" and upto and including 1-1/8", .8 for welded steel pipes for values of t over 1-1/8"

351. Cut steel Pipes.(a) The material shall comply with Regulation 73 to 80, i.e., 28 tons minimum tensile strength. (b) The maximum working pressure allowed on cast steel pipes shall be determined by the following formula : $2S(t-.015d)25$ t=minimum thickness in inches. W.P. =Working pressure in lbs. per sq. in. d—internal diameter of pipe in inches. dl diameter of pipe in inches. Eqn. (92) S = allowable working stress in lbs. per sq. in. as specified in Table (4)

352. Copper Tubes shall comply with Regulation 35.(b) Copper pipes may be used for a working pressure not exceeding 180 lbs. The external diameter shall not exceed 5-in. (c) Copper pipes shall not be used for superheated steam. (d) The maximum working pressure on such pipes shall be determined by the following formula . W.P. D minimum thickness in hundredths of an inch. W. p. working pressure in lbs. per sq in. D outside diameter of pipe in inches. 720 GAZETTE* OF INDIA EXTRAORDINARY TABLE 2 (Maximum permissible W. P. and Temperature) Material Mild Wrought Iron Cast Steel Copper Method of manufacture Cold drawn weld-steel. Hot finished weldless. Hydraulic lap-welded. Roll lap-welded Roll lap-welded Castings Solid drawn Monel metal. Permissible pressure in lbs. No restriction 300 250 No restriction Upto and including 5'..180. Maximum permissible temperature in OF. 426 000 Doan Straight, bends or tees, etc. Straight, bend or tee, etc. Straight Maximum permissible working Stress in lbs. (Values of S) Permissible Working Stress in lbs. per sq. in. for design Pipe Cold Weldless steel, Hot finished weld-steel. Hydraulic (Water-gas) lap-welded Steel Cast lap-welded Steel. 4250 5000 11200 10000 10000 6009 temperature in F. Over 6000 5500 7000 Up to and including 11200 10000 10000 9000 8000 7000 7560 7600 8000 7200 7500 6760 8000 8500 7000 6300 5800 5280 and 8750 880 4400 7500 Not used for these 4 Maximum permissible working stress in lbs. for cast steel (Values of S) Permissible working stress in lbs. per sq. in. for design temperature in OF Over 10000 5500 6000 9000 600 6500 8000 6500 7500 Up to and including 1560 7200 8000 6750 8000 8500 6300 8500 8750 5280 8760 4400 ATTACHMENT OF FLANGES 353. Flanges of Iron and Steel Flanges of iron and steel may be made of cast steel wrought iron or wrought steel made without flange. They may be secured to the pipes by gasketing, riveting or welding. (b) No flange or blank flange of cast iron shall be attached directly to main steam pipe or form part of main steam piping. (c) Blank flange shall be of mild steel or cast steel and shall be not less in thickness than the flange to which they are attached

854. Screwed on flanges.—The pipes may be screwed into flanges with a disappearing thread and expanded. Such screwed and expanded flanges may be used for steam for a maximum pressure of 450 lbs.

358. Flanges Of copper pipes.—Flanges of copper pipes may be made of brass or bronze. When flanges are attached to copper pipes by brazing they shall be secured in such additional way (e.g. by riveting the ends or



forming a conical end so as to fit into conical bore in the flange that the resistance to withdrawal from the flange does not depend wholly on the brazing)

859. Standard Flanges.—The size and thickness of flanges and the number and size of their bolts should be as shown in Appendix E

860. Those Regulations provide for ordinary bolted flange joints. Special types of joints may be used, subject to the approval of the Chief Inspector. (b) All steam pipes with butt welded circumferential joints having a wall thickness $0\frac{3}{8}$ " and above or carrying a pressure of over 50 lbs. shall be effectively stress relieved. (c) Such butt welded joint shall conform to standard specification. STEAM PIPE FITTINGS AND CONNECTIONS 861. Wrought Wherever practicable the radii of bends (on centre line) shall be not less than those given below : Bore up to and including 6 in. over 6 in. up to and including 9" over 9 in. up to and including 12" over 12 in. up to and including 15" over 15 in. up to and including over 18 in. up to and including 20" Where d = the bore of the pipe, R = Radius of bend to centre line of pipe. $R \geq 3d$ $R \geq 5d$ (b) The thickness of plate from which such bends are made shall be not less than per cent. than the minimum thickness required by Equation 91. Where smaller radii are necessary further allowances shall be made for thinning at of the bend. Alternatively some special form of reinforcement shall be adopted to prevent undue thinning

362. Branches, Tees, etc.—Fittings, branches and drain pockets shall be welded to the pipes. Where a branch is of size to the main pipe an approved type of reinforcement shall be employed. For pressure over 350 lb./sq. in. and/or temperatures of 7500 F or over, branches of (i in. bore and larger shall be welded inside as well as outside. Alternatively to the welding on the inside of the pipe, an approved type of reinforcement or mechanical lock may be provided

363. Blow-down pipes. (a) Blow-down which can be subjected to full boiler pressure shall be considered as saturated steam pipes of that pressure. (b) 'Blow-down pipes which cannot be subjected to full boiler pressure shall be considered as saturated steam pipes of half the working pressure of the boiler." 384. Valve Chests. (a) (Heads of stop valves, isolating valves, reducing valves steam traps etc., for fitting ports of wrought iron or wrought steel main steam piping when fitted with natural draft up to a gauge pressure of 160 lbs. per square inch or temperature of 4000 F. may be made of cast iron, cast steel or wrought steel in accordance with the requirements of Regulation 290. (b) When superheated steam is at 1100 F. above 4000 F. or when pressures are above 160 lbs. per sq. in. gauge, (heads shall be made of cast or wrought steel or other approved material in accordance with the requirements of Regulation 290

365. Steam Receivers, separators, etc., for temperature exceeding If such vessels are fusion welded the manufacture and tests shall conform to Chapter V- (b) The working pressure of all parts shall be determined by the appropriate formulae given in Chapter V. (c) All mountings for the above and for connected steam pipe ranges shall be of cast steel or other approved material

866. Steam Receivers, separators, etc. for temperature not exceeding The shells of steam receivers, steam separators, steam driers, catch waters, drop legs, interceptors, etc. may be made of steel plates or steel castings. (b) (i) When fabricated of steel plates the joints may be riveted or welded. (ii) When riveted the working pressure for the parts shall be determined by the formulae prescribed for corresponding parts of boilers and the hydraulic test pressure to which the vessel shall be subjected on completion shall be that prescribed for boilers. (iii) Except where such vessels are fusion welded in accordance with Chapter V the longitudinal weld of vessels exceeding 15" internal diameter be covered by a butt strap. (iv) For such welded seams the standard efficiency of Regulation 176 to be used in determining the working pressure shall be 0.30 for both, welded and welded and strapped seams. The strength percentage to be allowed for the weld shall be 50 and for the strength percentage to be allowed for welded and strapped seams shall be determined in accordance with Regulation 180. (v) , Branches for attachment of steam piping shall be flanged and be either flanged and riveted or welded to the vessel. When welded this shall be done inside as well as outside where practicable. Alternatively to the welding on the inside of the vessel an approved type of reinforcement or mechanical lock may be provided, Where a branch is of equal size to the vessel the opening shall be (vi) All welded vessels shall be stress relieved. (c) (i) Where made of cast steel the shell shall comply with the requirements of Regs. 73 to 80. (ii) The working pressure for flat end plates of cast steel shall be determined by the formulae for flat end plates wrought steel. (d) Suitable arrangements for drainage shall be fitted to all vessels intended for use

in the soporation of condensed stoam. Whore automatic drainoge iB not piovided a glass water gauge of Blibsta,ni iol :moke to indicato the water level in the vessel and substantial drain cook or valvo Bhall Lo fitted

867. Screwed and 800ket6d Jointe.-- Couplings or sockets may bo us-ad on pipe up to 4 in. internal (hamot,cr veil h prossures up to 120 ILA. por square inch guugo and up to 5 in. diani(ter with pressur(-s up to 100 lbs, per yquare inch gouge. 011 other cagoE, flangos w.th bolts uncl nuts Bhall bo used. (a) Valvo riosis of bronze for Biop valvos 368. Other fittings and Mountings. up to 3 In. diarneter of boro may bc uttuehd directly to iron and steel steam pipea when pressurog do not excocd 120 111k". per eq.in. gouge and temporature not exceed- ing 425' F. Tho ottachmont may bc bv direct screwing to tho steam pipe or by meons of flanges. (b) Drain cocks and valves mu.y be attached to stoa,1Y1 pipes eithor by flange and bolts or be screwed into n boss formod on Cho pipe

369. Reducing Valve.- WII(rt rßducing valve is install, '(I in pipe line, the pipe line gnd accessori0N on the low preH,guro side of the reducing valvo shall be protected by u 8bfety valve or vulveg NQ adjusted as to pernnit tho steum to escape us Boon us the safo working pressure iB oxcoodcd or by u, suitable appliance for cutting off automotieal]y the Bu-pply of Bteom as soon as tho sufe working pressure ie exceeded

370. Tho use of sliding expansion joints is prohibit(d. The nooessory degree of flexibility Bhall bo obtained by the 1.160 of special oxpangion jointß, or tho pipes Bhall bo pre-screwed initially Whcn cold by loaving gaps at appropriate ointB und pulling these up when erecting the piping. 'J]he amount of tho cold spring OF INDIA EXTRAORDINAÄ± shall bo not 168B than 500/0 of the total ox-pa,nßion of the length under congidorotion and may be groator than this in cases where it is necessary in order to koop within the permissiblo stress value shown in tables 3 and 4. (b) The ollowanoe for expansion per 100 ft. of piping at various tomperatures 911011. be baged on Table 5. TABLE 5 EXPANSION ALLOWANCE 3•35 5•31 5•83 Rango of temporalure Degreeq Fahrenhoit 60-300 60-360 00-400 60-500 00-600 60-6.50 60-700 60-750 00-800 60-850 60-900 Expansion Inclxey por 100 ft. 7, 44 7•99 371. Pipe work supports.— All pipe work shall bo odoquotßly supported in order to permit froe Illovomeni, for expansion and contraction, and the amount of such movement shall bo proportioned throughout tho whoho of any main by the provision of onohors ot suitable points. Whoro pipcg may be subject to vortical movement, spring support8 detAignod to corry tho load under all conditions shall be provided. It is des-iroble thot pointB of supportN should, far ag practicable, be arranged odjb- cent to the pipo joints. Slings arc in general preferable to roller supports, and these lbttr should bo used only whoro necessary. All pipo supports should, 0B far at' practicable, be of mild stool and pipe anchora cither of mild steel or cast steel

872. In the caxe of steam mains, attention Should bo paid to the adequate provision of drainage points in the forrn of drain pockotB. Drainage pointe oonneotod to Stearn traps, Shall bo provided wherever water can collect under •work- ing condition'l. Hand drains Bhall be provided at all pointN at which water can oollfft in any portion of the Stearn main, by valve leakage or othor rueun-s, when Shut down, or when warming up prior to uge. (b) Where practicable o suitable gradient Bhall be provided in the pipe work to onsure tho passage of condensed water in the direction of flow of Bteurn. towards the drainago point. (c) It iB recomnonded Lhat o by-pass should be fitted at each steam trap. (d) Whero the volume of M'btor deposited is likoly to be of serious proportione, separatorg should bo installed. Each separator shall be furnished with steam trap which Shall be connected to it by means of three-way cock ono ond of which ie connected to a, .manually operated drain

378. Freedom from rust and other foreign matter.—All pipes, valves and fittings Bhall be thoroughly cleaned as far us possiblo of rust ond other foreign matter before erection ond pipe linos shall be blown through with steam or bir before being put into sorvioe. *780' OF INDIA EXTRAORDINÄRY 374. Test Each cornplotad pipo and fitting shall be tested by hydraulic pressure at the Manufacturer'H works to twice the maximum pormisgible working prossure. It is inadvisablo Lo 811 bunt a completed steam pipe installation to any hydraulic test. (b) Pipes and fittings with flanges for steam pressuros exceeding 100 lbs. per sq. in. shall be tosted with blunk flanges bolted or clampod on. All other pipoa, if straight may be tested between the hoods of an ordinary hydraulic pipe teating moohine. (c) Special arrongoment8 shall be mode, oooording to eircumstaneos, for testing bends ond other fittings where not flanged

CHAPTER IX REGULATIONS FOR REGISTRATION AND INSPECTION OF BOILERS 375. *The procedure to be followed in connection with applications for the registration of a boiler and with examinations of boilers under the Act shall be regulated in accordance with the provisions of this Chapter read with the relevant Sections of the Act

876. Preparation for inspection.—(a) At every examination of a boiler for the grant or renewal of a certificate, the boiler shall be empty and thoroughly clean in all its parts. Except, as provided for in sub-regulation (f) all doors of manholes, hand-holes and sight-holes and cleaning plugs and all cocks in the heaters and mud drums of water-tube boiler, all firebars, burners, flues, plates, bridge plates, firebridges, brick arches, oil fuel burners and mechanical stoker fittings shall be all valves and cocks comprising the boiler mounting shall be opened up and taken apart and the valves or cocks ground, when necessary, before the Inspector's visit. (b) Provision shall, if required by the Inspector, be made for the removal of lagging or brick-work or other concealing work and for the drilling of plates, and for verifying the pressure gauge and safety valve dimensions and weights. (c) All smoke tubes, exterior of tubes, smoke boxes, all external flues shall be swept clean. (d) Provision shall be made for the effective disconnection of all bottom and hot water communication with any other boiler under gleam prescribed in Chapter X of these Regulations*, This shall be effected either by the removal of a length of pipe from the steam and feed piping or by the insertion of substantial blank flanges. Where blank flanges employed, they shall be inserted between the flange of the chest and the pipe attached to it. (e) No blank flange shall be inserted between a flange and the chest of the boiler. (f) At alternative annual inspections and subject to of the bottom rows or all tube* subject to the first of heat being opened up for inspection, the Inspector may at his discretion relax the preparation for inspection called for under (a) above in favour of boilers having an evaporative capacity of 200,000 lbs. per hour and over, and fed with water treated to the satisfaction of the Inspector

877. Hydraulic test of boiler for registration.—Every boiler shall be hydraulically tested in the presence of an Inspector or Inspecting Officer. accordance with Regulation 7 and 8 of the Act Inspector or require to examine boilers for registration, to examine boiler for renewal of certificate, to determine subject to the approval of the Chief Inspector, the pressure at which they may be allowed to work, to grant certificate therefor and generally to convey to the owner the order as the Chief Inspector may issue. OF INDIA 878. Preparation for hydraulic The chest of all mounting subject to steam pressure shall be well placed: must shut tight or blank flanged. be renewed and the chest opening (b) The safety valves invariably blank bonneted. (c) The for the Inspector's pressure gauge and the nipple for connecting the test hose shall be in order. (d) All doors shall be properly jointed and tightened up. The boiler shall be completely filled with water, care being taken to allow all air to escape and, if possible, a preliminary test, not exceeding the working pressure of the boiler shall be taken before the Inspector's visit, to test the tightness of the joints. (e) When a boiler is hydraulically tested for the first time, it shall be entirely cleared of lagging or brickwork; in subsequent tests the lagging or brickwork, or portions thereof, shall be removed if required by the Inspector

379. Procedure of hydraulic tests.—(a) Subject to the provisions of sub-regulation (e) of Regulation 381 every boiler shall be hydraulically tested in the presence of an Inspector to not less than the approved working pressure, when such working pressure does not exceed 100 lbs. per square inch; when the approved working pressure is above 100 lbs. per square inch, the hydraulic test pressure shall be times the working pressure plus 50 lbs. per square inch. (b) The boiler shall withstand such pressure without appreciable leakage or undue deflection or distortion of its parts for at least ten consecutive minutes. If the test is satisfactory, the working pressure allowable by calculation shall be sufficiently reduced, unless the owner desires in make such alteration as will enable the boiler to withstand the hydrostatic test; in which case the boiler shall again be examined, after the alterations have been made, the pressure if necessary, and the boiler tested. (c) At the first hydrostatic test of boiler prior to the issue of an original certificate deflection may be noted, during and after test of each furnace length, fire-box and flat, end or other plates. (d) After the application of the hydraulic test the Inspector shall (1) carefully examine the boiler inside and outside and himself that it has satisfactorily withstood the test. (e) In case in which the rated working pressure to be allowed for a boiler cannot, owing to peculiar construction of any of its parts, be determined by calculation in the ordinary way, the Inspector shall, under the direction of the Chief Inspector, subject the boiler to hydraulic test

for the purpose of determining the fitness of such part, B. The amount of the test pressure to be applied in such case shall not exceed the proportion for the load, at working pressure found by calculation for that part* of the boiler or the intended working pressure, whichever (f) Should any part of the boiler show undue deflection or indentation of permanent nature (during the progress of the test, pressure shall be released immediately if such indications are observed. The working pressure for the part shall be per cent. of the test pressure applied when the point of permanent set was reached. This shall apply to any boiler at any test. (g) Hydraulic tests of boilers at subsequent examination: (1) When the Inspector (or other person duly authorized) is satisfied after the inspection, the test pressure to be applied shall be from one and a quarter to one and a half times the working pressure of the boiler. (2) The deformation measurements should be entered in the Memorandum of Inspection Book, before its submission to the Chief Inspector. 1- GAZETTE OF INDIA EXTRAORDINARY (h) When the internal construction of a boiler does not permit of the Inspector getting inside it or of examining closely all its parts, he shall see it tested by hydraulic pressure to one and a half times the working pressure at each inspection for the grant or renewal of a certificate. (i) Water tube, locomotive type and vertical tubular boilers shall be hydraulically tested at each inspection for the grant or renewal of certificate, unless such test is under the orders of the Chief Inspector. (j) The Inspector may, if he considers it necessary, apply a hydraulic test to any boiler at any inspection. (k) Except in the case of small, portable and vehicular boilers which do not require re-erection or building in brickwork, the hydraulic test of all boilers shall be conducted only after the erection of the boiler in situ. (1) All boilers shall after re-erection in position different from that in which they were last examined be hydraulically tested. (l) A hydraulic test shall also be taken before granting or increased pressure certificate and after repairing a boiler, unless the Chief Inspector authorizes the Inspector to waive such test. (m) When carrying out hydraulic test, Inspectors shall use pressure gauges supplied by the Chief Inspector. 380. *Steam Every newly registered boiler and every other boiler of which the working pressure has been altered shall, before the issue of an original or renewal certificate for such boiler, be tested under steam to the satisfaction of the Inspector. (b) At the time of test the safety valves shall be left free and capable of being adjusted to the approved working pressure. (c) After adjustment of the valves to the correct blowing pressure the boiler shall be tried under full steam and firing with the feed water shut off and the stop valve closed, during which time the Inspector shall note the accumulation of pressure and other details of the test as well as the loading and adjustment of the safety valve. In the case of water tube boilers, or boilers fitted with superheaters, the feed water connection and stop valve need not be shut off, and if the total safety valve area and lift are found to be adequate, the requirements of this clause may be assumed to have been satisfied if the valves are so adjusted that each blows at the approved pressure. (d) On completion of the safety valve test the Inspector shall satisfy himself that the water gauges are in working order and that the feed apparatus is capable of supplying the boiler with sufficient water. (e) Where the State Government does not require a person-in-charge of a boiler to hold a certificate of competency, the Inspector may when he thinks fit satisfy himself by questioning or by practical test whether the person-in-charge of the boiler understands the use and purpose of the water gauges, the pressure gauge, the safety valves, the feed water-supply and blowdown. (f) Steam test is primarily intended for the purpose of ascertaining by actual test whether the safety valves are sufficient to relieve the boiler effectively of excess steam and whether they operate at the time when the maximum working pressure is reached. Inspectors should always send to the owner due notice of the date fixed for the steam test. On completion of the test the Inspector enter all details in the Memorandum of Inspection Book. GAZETTE OF INDIA EXTRAORDINARY (f) When witnessing safety valve tests, Inspectors shall use the standard pressure gauges supplied by the Chief Inspector unless the boiler pressure gauge has, since the time of inspection been tested and found correct with an authorized testing machine, (g) NO steam gauge shall be used without a syphon filled with water between it and the boiler. (h) When the accumulation of pressure at steam test exceeds ten per cent. of the maximum working pressure, the area of the safety valves shall be considered insufficient, and certificate shall be refused until the safety valve area is increased. (i) An Inspector may, when visiting a factory for any purpose, verify the correctness of the safety valves and pressure gauge of any boiler under steam by comparison with high standard pressure gauge

381. Procedure for registration.— (a) On receipt of an application for registration under section 7(1) of the Act, the Inspector shall, when the boiler has been properly prepared for examination, proceed to measure in complete detail all its parts, ascertain the working pressure allowed by the Regulations by making series of calculations of the strength of the various parts, such calculations being based on his measurement and if he is satisfied with the correctness of the maker's certificate, on the dimensions and other particulars relating to the material and construction noted therein [vide Section 14(1) (c) of the Act and Regulation 4]. In making his calculations he shall after examination of the material, take due account of the workmanship and detail of the construction of each part. In his examination the Inspector may, if he deems necessary, bore the plates or other parts to ascertain their thickness and in making his calculations he shall be guided by the requirements of Chapter IV and V of these Regulations. (b) If no formulae or coefficient applicable to any part is contained in Chapter IV or V of the Regulations, the Chief Inspector shall in his discretion determine the strength of such part. (c) The strength of the weakest part so calculated or determined, subject to any discretionary power exercised by the Chief Inspector, shall determine the permissible working pressure of the boiler. After inspecting the boiler and ascertaining by the prescribed calculations the maximum pressure at which the boiler may be worked, the Inspector shall hydraulically test and steam-test it in accordance with requirements of Regulations 379 and 380 and may issue provisional order under Section 9 of the Act in



Form V. (d) The Inspector shall enter the above particulars and dimensions of the boiler and calculations of strength of the various parts, together with details of the hydrostatic and of the steam tests, in "Memorandum of Inspection" Book (vide Regulation 386) which, together with all the maker's papers for the boiler, shall be submitted to the Chief Inspector with the Inspector's report under sub-section (3) Of Section 7 of the Act in Form I. (e) Where a certificate in Form 11 and a memorandum of inspection book in Form I are furnished by an Inspecting Authority in accordance with sub-regulation (a) of Regulation 4, the Inspector shall, on receipt of an application for registration under Section 7 (I) of the Act, proceed to make such examination and measurement of the boiler will satisfy him that the boiler is the one certified by the Inspecting Authority and that it has sustained no damage in transit for which purpose he may, if he considers it necessary, subject the boiler to hydraulic test in accordance with Regulation 379. The Inspector shall, if he is satisfied with the condition of the boiler, accept the particular and approved working pressure entered in Form T by the Inspecting Authority or INDIA EXTRAORDINARY Authority if they had been ascertained and entered by himself and shall issue provisional order to enable the boiler to be worked. He shall make such entries in respect of his examination of the boiler in the Memorandum of Inspection Book as may be required and shall submit the book and Inspecting Authority's certificate and drawing of the boiler with his report to the Chief Inspector as prescribed under sub-regulation (d). 882. *Engraving of registry number. (a) The registry number of every boiler shall, within a period of one month after the registration thereof, be cut in the front plate thereof in such position as shall be pointed out by the Inspector. The device for each state shall be distinguished by the following letters : A J Iner A B. or: n Bhopal Bihar Bilaspur Bomb B Y Coorg Himachal Pradesh Kutch Madhya Pradesh M. or: n Monipur Orissa Punjab (India) Tripura Uttar Pradesh Vindhya Pradesh West Bengal B.P.L. B.Y. C. D. K.U. M. M.A. or: T.R. V.P. The distinguishing letters shall be engraved above a number and separated therefrom by a horizontal line two and half inches in length. The letters and figures shall be one inch in height and of suitable breadth, provided that in the case of small boilers the letters and figures, in the discretion of the Chief Inspector, shall be enclosed in a rectangle, the top, be reduced to 3/8" in height. upper and lower sides of which shall be one inch part and one quarter inch clear of the letters and the bottom of the figures respectively as indicated below : The side lines shall be bent, equal distance from the figures. The engraving shall not be than 1/16th inch in depth. (b) The engraving shall be complete and ready for verification within thirty days of the installation of the boiler. (c) Boilers having registry device; differing from those prescribed herein shall be altered or put in conformity with these provisions have such devices obliterated, as prescribed above. The original numbers of such boilers shall be retained in the new device. A number once allotted to a boiler shall not be used again for another boiler, for tracing these devices in the boiler will be supplied by the Chief Inspector. The device shall be put on the part of the boiler pointed out by the Inspector.

888. Measurement of heating surface for the purpose of regulating the area of the safety valves and the amount of registration and inspection fees the heating surface " of a boiler shall be the total surface of all plates and tubes exposed to heat on one side and in contact with water on the other measured on the water side or the fire side, whichever is larger.(b) For Lancashire and Cornish boilers the total heating surface shall include the wetted surface of the furnaces between the end plates, the fire surface of cross tubes where fitted, and the part of the external shell below the side flue covers. In estimating the area of furnaces, they shall be considered plain cylinders ; the area of their wetted surface shall be taken their mean external circumference X the length of the boiler between end plates. For the shell the width of that of the circumference below the flue covers shall be taken $\frac{1}{2} D$, and this width X the length between end plates shall be taken the of shell heating surface. The part of surface of the back-end plate exposed to heat shall be omitted from the calculation. formula, for the total heating surface of Lancashire boiler having plain furnaces without cross tubes is as follows H.S. in square feet $2L (3 + 14d + D)$. L is the length of the boiler between end plates in feet, (d is the mean external diameter of the furnace in feet and D is the internal diameter of the largest, part of shell in feet. (c) For steam and water drums of water tube boilers the heating surface of the drum shall be taken half the external mean circumference multiplied by the length of drum between the outer brick work or centres of cross boxes, the may be. The heating surface of the tubes shall be taken the external surface of the tubes between the tube plates or headers. the heating surface of the headers shall be omitted from the calculation. Integral economiser shall be deemed component heating surface. (d) For marine boilers of

the fire-tube type the heating surface shall include the wetted surface of the furnaces between the tube plates (considered in the same way for Lancashire boilers), the wetted surface of the combustion chamber (less the area of the tube holes) and the wetted surface of the tubes between tube plates. The ports of the front tube plate exposed to heat shall be omitted from the calculation. (e) For locomotive type boilers the heating surface shall include the wetted surface of the fire-box above the foundation ring (less the area of the tube holes the fire-hole and ring) and the wetted surface of the tubes between tube plates. The bottom box tube plate shall be omitted from the calculation. (f) For vertical boilers of ordinary type the heating surface shall include the wetted surface of the fire-box above the foundation ring (less the area of fire-hole and ring and tube holes, if any) and the surface of any horizontal or other tubes and uptake below the lowest water level shown in the gauge glass. (g) For any other heating surface not provided for in the foregoing the same general procedure shall be observed. (h) No deduction shall be made for stays, etc., in calculating the heating surface. 884. Boiler rating.—The boiler rating shall be the number of square feet, (to the whole figure) in the heating surface of the boiler as determined under Regulation 383



385. Registration fee.—The fee required to accompany application under sub-section (1) of section 7 of the Act shall be—
 For Boiler Rating not exceeding 100 Rs. 10
 For Boiler Rating exceeding 100 but not exceeding 300 Rs. 50
 For Boiler Rating exceeding 300 but not exceeding 700 Rs. 100
 For Boiler Rating exceeding 700 but not exceeding 1,100 Rs. 150
 For Boiler Rating exceeding 1,100 but not exceeding 2,000 Rs. 200
 For Boiler Rating exceeding 2,000 but not exceeding 6,000 Rs. 300
 For Boiler Rating exceeding 6,000 but not exceeding 10,000 Rs. 400
 For Boiler Rating exceeding 10,000 Rs. 500
 Provided that the Chief Inspector may direct that no fees shall be payable in respect of fresh application made in pursuance of sub-section (2) of Section 14 of the Act.

386. *Memorandum of Inspection.—A Memorandum of Inspection Book shall be prepared for each boiler in



Form L In [his book the Inspector shall enter in ink all particulars and dimensions of the boiler with the calculations for the various parts in detail, particulars of hydraulic test and steam test and the Inspection note B. (b) At subsequent inspections Inspectors shall enter the dates of the inspections, hydrostatic tests and Steam tests, when such are made with their notes thereon. (c) Inspectors should also enter in the Memorandum of Inspection Book the general condition of the boiler and of repairs, to what extent boilers have been cleared of brick work, etc., a report of all casual visits, visits for inspection of repairs, for inspection of main steam pipes, and reports on accidents, etc., in this way the Memorandum of Inspection Book will provide a useful record of the boiler's history for the information and guidance of Inspectors at subsequent inspections. (d) On submission of the Memorandum Book to the Chief Inspector he will in the case of newly registered boilers, check all particulars and calculations and approve or the working pressure that is to be permitted. In the case of old boilers, the Chief Inspector will examine the Inspector's notes of inspection and proposals made for repair, or reduction of pressure. A pressure once approved for the boiler should not be altered without the written authority of the Chief Inspector.

387. Registration Book.—(a) A Registration Book or copy of Memorandum of Inspection Book containing all the particulars required for registration shall be maintained in the office of the Chief Inspector. In Form I and any orders issued by him regarding the boiler shall be entered in the registration Book under his initials. (b) The Chief Inspector should also see that the notes of subsequent inspections entered in the Memorandum of Inspection Book are copied in the Registration Book.



888. Transfer of Memorandum of Inspection Book and Registration Book.— On a boiler passing from one State to another, the Memorandum of Inspection Book and the Registration Book shall, on the request of the Chief Inspector or of the State to which the boiler has been transferred, be forwarded to that officer who shall take over their custody and maintain them as hereinbefore prescribed. 389. Grant of certificate. (a) A certificate for the use of a boiler shall be granted in



Form V L In t,he certificutc shall be entered the maximum pressure at which the boiler shall be worked, the load to be plneed on the safety volves or the * N0TB.—Tho Meroorendum of Tnapection Book 8hould ulwayß be kept Olean and up to (lute. Inspection Book8, except when actuolly required by the Tngpeotor, Hhould be filed in the ofriro of the ('Inef Inspec t or. Nom —The In8peotor'R remark should brief 13088ibIe. INDIA thickness of wushers or ferrules required os N&feguard against overloading, the (lato uncl pressure of the last hydraulic tost of the boiler and, when applicable, of i he •rnnin Stearn pipes prescribed



390. Procedure for inspection of installed boilers.(o) General Instructions.— is essential have every part of a boiler, that is accessible, open and to properly prepared for examination, internally and externally.

All boilers have openings through which examination may be made and which are open (or closed) • all parts shall be opened whether for access to water (Lees, or heating surfaces. To cool a boiler down for inspection or repairs, the boiler should not be run until setting is sufficiently cooled (or avoid (allow the boiler and when possible allowed to cool (low-pressure). It is not necessary, in order to comply with ordinary prudence, to remove insulation material, internal, or fixed parts of the boiler, unless (except for detection of peculiarities of certain types or in cases of boilers are suspected and where there is moisture or vapour showing through the covering, the covering should be removed at once and complete investigation. Particular attention should be paid to the external parts of boiler in the way of setting blocks, especially when the boiler is clamped and engine fittings of locomotive type boilers should be removed to facilitate the inspection of the underneath the first inspection, and any reasonable period if the Inspector cannot, otherwise satisfy himself as to the condition of (the) ports. Water works, shall be bared at least once in every month. Upon visible evidence or suspicion due to age or causes, every effort shall be made to discover the condition, even (to the removal of insulation material, masonry or fixed parts of a boiler. Sometimes drilling (or) cutting away of parts is justifiable and to positively determine this condition. The Inspector should, whenever (he) is permitted, go inside it and make inspection of all its internal parts. Before doing so, he should ensure, (to) satisfy himself proper provision has been made for disconnecting the boiler from any other boiler under. Should he find that, proper provision for disconnection has not been or that the boiler has not been properly cleaned, or (if) is unreasonably hot, he should decline to proceed with the inspection and should report (to) the Chief Inspector for orders. When boiler is of such size or (of) construction is such that the Inspector cannot, go inside it, there should be sufficient sight-holes or hand-holes provided to enable (him) to see the principal internal parts; if any important part of a boiler is so constructed that the Inspector cannot examine it, he should report, the facts to the Chief Inspector for orders. (b) Scale, Oil, etc.—Upon entering a boiler, the Inspector shall examine all surfaces (of) the exposed (to) observe the action caused by the use of water, oil scale, or other substances which may have intentionally or unintentionally gone in with the boiler. Any evidence of oil is dangerous and steps shall be taken to prevent any further of oil into the boiler. Oil or grease in the (of) water-tube boilers or on plates over the fire of any boiler is particularly harmful, often (causing) them to rupture. (c) Corrosion, Grooving.—A given amount of corrosion along or immediately adjacent to a seam is more serious than a similar amount of corrosion in the solid plate away from the seams. Grooving along longitudinal seams is especially significant as grooving or cracks are likely to occur when the material is highly stressed. Severe corrosion is likely to occur at points where the circulation of the water is poor and such places should be examined most carefully for evidence of corrosive action. If the Inspector decides that a boiler in one or more of its parts is no longer for the pressure approved for it, he must without delay report his proposal for reducing the pressure to the Chief Inspector and at the same time submit his calculation for the wasted parts for check and approval of the Engineer. 738 THE OF INDIA ACT With regard to the pitting and wasting of shell plates; the Inspector should bear in mind that shell plates may become reduced in thickness to an appreciable extent and still be stronger than longitudinal seams. All flanging shall be thoroughly inspected and particularly the flanges of circular end plates that are not stayed, internal grooving in the fillet of such heads and external grooving in the outer surface of heads concave to pressure is very common since there is slight movement in the heads of this character which produces this kind of defect. Some types of boilers have what is known as the OG or reversed flange construction in some of their parts that may be inaccessible to the eye, but the condition shall be determined by the insertion of a mirror which at a proper angle will reflect back to the eye the condition of such a place, or any other feasible manner. (d) Stays.—All stays, whether diagonal or through, shall be examined to note that they are in even tension. All fastened ends shall be examined to note whether cracks exist where the stays are punched or drilled for rivets or bolts and, if not found in proper tension, the inspector should recommend their proper adjustment. (e) Manhole and other Openings.—The manhole and other reinforcing plates, as well as nozzles or other connections flanged or screwed into a boiler, shall be examined internally as well as externally to see that they are not cracked or deformed, and wherever possible observation shall be made from the inside of the boiler as to the thoroughness with which its pipe connections are made to the boiler. All

openings to external attachments, such as water column connections, openings in dry pipes and openings to safety valves, shall be noted to see that they are free from obstructions. (f) Fire Surfaces—Bulging, Blistering, Leaks.—Particular attention shall be given to the plates or tubes exposed to the fire.

The Inspector shall observe whether any part of the boiler has become deformed during operation by bulging or blistering; the former is a distortion of the entire thickness of the plate or tube where it takes place, while the latter is a lamination or separation of the plate due to foreign material being embedded in the metal before the plate is rolled. If bulges or blisters are of such size as would seriously weaken the plate or tube, and especially when a leakage is noted coming from those defects, the boiler shall be discontinued from service until the defective part or parts have received proper careful observation. It shall be made to detect leakage from any portion of the boiler structures—particularly in the vicinity

of seams and tube ends. Fire tubes sometimes blister but rarely collapse; the Inspector should look through the tubes for such defects and if they are found with a sufficient degree of distortion they should be removed. (g) Lap Joints, Fire boiler are apt to crack where the plates lap in the longitudinal or straight seam; if there is any evidence of leakage or other stress at this point, it shall be thoroughly investigated and, if necessary rivets removed or the plate slotted in order to determine whether cracks exist in the seam.

Any cracks noted in shell plates are usually dangerous except fire cracks that run from the edge of the plate into the rivet hole of girth bearing. A limited number of such fire cracks is not usually very serious matter. (h) Testing Staybolts.—The Inspector shall test staybolts by tapping one end of each bolt with a hammer and when practicable a hammer or other heavy tool should be held on the opposite end to make the test more effective. (i) Tubes—Their Defects etc.—(i) Tubes in horizontal fire-tube boilers do

terminate more rapidly at the end forward the fire, and they should be carefully peeped with a hammer on their surface to ascertain whether there has been THE GAZETTE OF INDIA EXTRAORDINARY 735 The tubes of vertical tubular boilers are more serious reduction in thickness, susceptible to deterioration at the upper ends when exposed to the products of combustion without water protection. They should be reached

far as possible either through the handholes, if any, or inspected at the ends. (ii) The surfaces should be carefully examined to detect bulges or cracks, or any evidences of defective welds. Where there is a strong draft the tubes may become thinned by corrosion produced by the impingement of particles of fuel and ash, or the improper use of soot blowers. A leak from a tube frequently causes serious corrosive action on a number of tubes in its immediate vicinity. (iii) Where short tubes or nipples are in joining drums or headers, there is a tendency for waste products of the furnace to lodge in the junction points and such deposits are likely to encourage corrosion if moisture is present. All such places should be thoroughly cleaned and examined. (j) Ligaments between tube holes.—The ligaments between tube holes in the head of all types of fire-tube boilers and in shells of water-tube boilers should be examined. If leakage is noted, it may denote a broken ligament. (k) Steam Pockets.—Steam pockets on fire surfaces are

sometimes found in new or replacement work, and wherever this is possible or likely the Inspector should make observation and, if any are found, recommend the necessary changes, (l) Pipe connections and Fittings.—The steam and water pipes, including connections to the water column, shall be examined for leaks, and if any are found it should be determined whether they are the result of excessive strains due to expansion and contraction, or other causes. The general arrangement of the piping in regard to the provisions for expansion and contraction, as well as adequate support at the proper points, shall be carefully noted. The location of the various stop valves shall be observed to see that water will not be pocketed when the valves are closed and thereby establish cause for water-hammer action. The arrangement of

connections between individual boilers and the main steam pipes shall be especially noted to see that any change of position of the boiler, due to setting or other cause, will not produce an undue strain on the piping. It shall be ascertained whether all pipe connections to the boiler possess the proper strength in their fastenings, whether tapped into the boiler, a fitting, or flange riveted to the boiler. The Inspector shall determine whether there is proper provision for the expansion and contraction of such piping, and that there is no undue vibration tending to crystallize the parts subjected to it. This includes all steam and water pipe, and especial attention should be given to the blowoff pipes with their connections and fittings,

because the expansion and contraction due to rapid changes in temperature and water-hammer action create a great strain upon the entire blowoff system, which is more pronounced when a number of blowoff pipes are joined in one common discharge. If the freedom of the blowoff connection on each boiler shall be tested whenever possible by opening the valve for a few seconds, at which time it can be determined

whether there is excessive vibration. Blowoff pipes should be free from external dampness to prevent corrosion. (m) Water column.—The piping to the water column shall be carefully noted to see that there is no chance of water being pocketed in the piping



forming the steam connection to the water column. The steam pipe should preferably drain towards the water column. The water-pipe connection to the water column must drain toward the boiler. The relative position of the water column to the fire surface of the boiler shall be observed to determine whether the column is placed in accordance with the 740 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 regulations. The attachments shall condition be examined to determine their operating (n) Baffling—Water-Tube Boilers.—In water-tube boilers, it should be noted, as far as possible, whether or not the proper baffling is in place. In many types of boilers the absence of baffling often causes high temperatures on portions of the boiler structure which are not intended to be exposed to such temperature, from which dangerous condition may result. The location of combustion arches with respect to tube surface shall be carefully noted. These are sometimes arranged so as to cause the flame to impinge on a particular part of a boiler and produces overheating of the material and consequent danger of the rupture of the part. (o) Localization of Heat.—Localization of heat brought about by improper or defective burner or stoker installation or operation creating a blowpipe effect upon the boiler, shall be condemned. (p) Suspended Boilers—Freedom of Expansion.—Where boilers are suspended the supports and setting shall be carefully examined especially at points where the boiler structure comes near the setting wall or floor. Often accumulation of ash and soot will bind the boiler structure at such points and produce excessive strain on the structure owing to the expansion of the parts under operating conditions. (q) Safety Valves.—As the safety valves are the most important attachment on the boiler, they shall be inspected with the utmost caution. There should be no accumulations of rust, scale, or other foreign substances located in the vicinity so as to interfere with the free operation of the valves. The Netting and freedom of the safety valves should be tested properly by raising the steam pressure to the blowing-off point, or if this cannot be done, the valves shall be tested by means of the test levers to ascertain if they are free. Where the steam discharged from a safety valve is led through a pipe the Inspector shall determine at the time the valve is operating whether or not the drain opening in the discharge pipe is free and in accordance with the Regulations. If the Inspector is necessary, in order to determine the freedom of discharge from safety valve, the discharge connections should be removed. Under no circumstances should a stop valve be permitted between the boiler and its safety (r) Steam Gauges.—The steam gauges on all boilers shall be removed and the Inspector shall test them and compare their readings with standard test gauge. The readings of the steam gauges shall be observed and compared when making an inspection with steam on the boiler, where several boilers are in service connected to a common main. The location of the steam gauges shall be noted to see whether or not it is exposed to high temperature either externally, as would be the case if placed close to the smoke flue or other highly heated part of the boiler or setting, or exposed to heat internally due to lack of protection of the gauge spring with proper syphon or trap to prevent them from coming in contact with the spring. The Inspector shall see that the provisions are made for blowing out the pipe leading to the steam gauge

391. Calculation of Wasted When any part is wasted and Inspector is doubtful of Its fitness for the pressure, he shall make one or more small holes to be bored and from them ascertain the average thickness of the parts from which he can satisfy himself by calculation in accordance with the formula applicable to the part. Such gauging and calculation he shall enter in the Memorandum of Inspection Book. •SAO. 8] THE GAZETTE OF INDIA EXTRAORDINARY 741 (b) In making calculations for or welded part of a boiler shell, e.g., along the line of seating blocks of Lancashire boiler, the Inspector shall use the following formula: $W.P. \times D \times t \times \frac{1}{4} = \text{thickness of wasted plate, where } t = \text{thinnest, } \dots \text{Eqn. (96) } S = \text{Minimum tensile strength of material of shell in lbs. per sq. in. } D = \text{internal diameter of shell in inches. Factor, or of safety, which shall not be less than 4}$

392. Repairs to Extensive repairs such as, fusion welded or riveted patches to girths, fire boxes and end plates of boilers and extensive building up of wasted parts of boiler require permit issued under these Regulations, the renewal of furnace and end plates, pressure of Shell, fire boxes, girders etc., shall only be entrusted to a Repairer who can satisfy the Chief Inspector regarding the quality of and other repair done by his Organization. Welding (b) TIG -Repairer shall satisfy the Chief Inspector, (i) that the electric arc or oxy welding sets and other tools and plant in his possession for carrying out repairs are suitable for the work undertaken, (ii) that the quality of material used to the specification that are prescribed, (iii) that the supervisory and operative staff employed by him possess the necessary training and experience for the work undertaken, (iv) that welding Operators by the

Repaired or shall be required to possess the tests in regard to vertical, horizontal, overhead and 6110t welding
 (b) Repairs shall be made by the Chief Inspector, (c) standard of work should be of high order and comply with all the requirements and tests that may be prescribed by the Chief Inspector. Riveting and other repairs (c.) The Repairer shall notify (The Chief Inspector, - (i) that he possesses the necessary equipment and tools and engages trained and experienced workmen and staff for the work under (ii) standard of work should be of a high order and comply with all the requirements and tests that may be prescribed by the Chief Inspector, and all material used shall be of boiler quality. Minor repairs. (d) Notwithstanding anything contained in (a) above, minor repairs as determined at the discretion of the Chief Inspector may be entrusted to any Repairer. (e) The Repairer should be subordinated, BO for his other duties permitted by the Inspector when the firebox and smoke tubes of locomotive tube boiler are withdrawn, the opportunity should be taken to inspect the internal parts which are otherwise inaccessible for close inspection. (f) Repairs to boiler shells shall be effected either by patching or by removing a strip of worn or damaged plate and inserting the new strip with covering strips over the longitudinal butt joint, the strength of the riveted joints to be not less than that of the longitudinal joints of the shell. 742 GAZETTE OF INDIA EXTRAORDINARY [PART (g) Patches for fire-exposed plates shall be fitted metal to metal without joint of any description. The affected part shall be cut out, leaving the corner of the hole. Patches shall be secured, wherever possible, by properly spaced rivets. With a width of plate at least equal to the diameter of rivet between the edge of the rivet hole and the edge of the plate. Where riveting is impracticable, the plate shall be covered by well pointed sunk headed pins. (h) The thickness of a patch plate shall not be less than the original thickness of the plate which it is used to patch. (i) Bulged or distorted furnace of circular section may, if the bulge or distortion is not too great, be pressed back to shape. (j) Circular furnaces of horizontal boilers that have become distorted, may be suitably reinforced. (k) Anti-collapse rings shall be of substantial section either of single or double angles bolted back to back. With diameter not less than 7/8th inch in diameter and about 7 inches in pitch passed through flat of angle and screwed into the furnace, the ends being here rounded or riveted over on the fire side and fitted with nut at the other. The stay bolt shall be fitted with ferrules not less than 1 inch in depth between furnace and angle ring. (l) Welding shall not be accepted for the repair of any part of a boiler for which welding is forbidden for a new boiler under these regulations. Boiler shells shall not be repaired by welding beyond the filling up of a small isolated corroded or pitted part or the making up of jagged edges of opening. (m) Cracks or grooving in shell or flat end plate of cylindrical shells or in the bends of furnace flanges in a circumferential direction may be cut out and butt welded of "smoke tubes.—Smoke tube may be butt welded either by fusion welding, flash welding or oxy-acetylene welding, and these should be tested hydraulically at the discretion of the Chief Inspector. (n) Worn parts of circular furnace and fire-boxes and fire exposed flat, plates in rectangular fire-boxes and combustion chambers may be cut out and be replaced by new pieces welded in or they may be built up by welding. Longitudinal cracks in circular and fire-boxes and rectangular fire-boxes and combustion chambers may be welded. (o) No plate shall be welded. (p) For the purpose of these regulations renewed parts shall be deemed to be parts of a new boiler intended for use at the pressure at which the boiler is now used, 393. Submission of plans of In the case of land boiler made in India or outside India for use in the States the Chief Inspector may, on receipt of a Treasury acknowledgment of the prescribed fee, receive for examination in advance the plans and particulars of material, design and construction of boiler so as to avoid questions arising at the examination of the finished boilers. (b) The fee required under sub-regulation (a) shall be half the fee which would be required to accompany an application for the registration of the boiler (vide Regulation 385). (c) The Chief Inspector shall, after examination of the plans and particulars intimate to the proprietors whether he is satisfied with the design and fitness of the parts for the intended purpose and, if not, what modification is necessary therein. When plans and particulars of boiler have been approved, the Inspector in making his examination shall see that the design as approved have been carefully followed out and that the material corresponds with the approved particulars. THE GAZETTE OF INDIA EXTRAORDINARY 743 (d) The above procedure shall be followed in the case of extensive repairs or alterations to boilers, but no fee be leviable for the examination of such plans and particulars. STEAM PIPES 394. Inspections of steam pipe shall be inspected and by hydraulically tested before erection in place, the test pressure to be that prescribed in the Standard Conditions for steam pipes, A certificate from an inspecting Authority of a recognized

mokor stating that this been dono may bo accepCed. If tho Ingpoctor is stigfied with the test,, the pipeB may be orectod in position , at, the Btoom teyt of the boiler ho Bhull examine thom under steam pressure. No separate certi- fieufe for the stoam pipes Bhall be nwued, nor Bhall o separato foe be charged for their ingpection. (b) At subsequent inspootiong of tho boiler or at any other time, tho Inspector may make external inspection of the steam pipes and for this purpoge may require a part of the lagging at the flangcg to be removod, and the pipe Inodo bare. If as a result of this inBpection tho Inspector is of opinion that tho pipes or any portions of thorn are in on umatisfactory condition he Bhall report the matter to the Ch ief Impoctor, who may require the whole of the logging to bo removed and may require any pipo or pipen to bo hydraulically td8tod. The tet-It prossuro at such hydraulic tost shall be not legg thon twi(e the working prossuro of the boiler. (c) The dute ond hydraulic pressure to which stoam pipe8 were gub.iectod Shalli be e ntered in the eortificate for the boiler and such entrios shall be continued from time to time in the renewal certificate» for the boiler

395. Submi88ion of plans of 8team of steam pipes Bhull bo subniitted to the Chief Ingpoctor before construction or tho t)Jno of registration of the boiler for his dooi8ion whether the pipes and their arrangement cornp]y with [he regula- tions.CHAPIQER X SAFETY op PERSONS mSIDBB01L.ERB

396. Safety of persons working inside boilers.— (a) No person shall bc compol- or allowed, by the owner or person in charge, to go inBide o steam boiler for any purpoH0 whatsover unlosg tho boi]er is effectively diuonected in the manner horo- inafter prescribed from any steam or hot water communication with any other boiler. (b) Effective dißcon-nection Shall be mudfl either by the removal of tho boiler 8top valve or of o length of piping from *toom and hot water connections •with ony other boiler, vessel or pipe containing steam or hot water or by tho inaertion of subBtantal blunk flanges between the boiler stop valves und piping. The Shutting of b etop va,lvo, stop cock or automatic isolating vulvo alone Bhall not be dccmed ti(» constitute compliance with thiN regulation. (c) Tho owner of o boiler to which tbi8 regulation iB applicable shall obtain the approval of the Chief Inspector in Wl'iting to the method of disconnection which he propose" to use and shall be resposnible för enguring that the method BO approved is followed in pruotioe

CHAPTER XI ECONOMISERS

1. An economiser shall not be registered under sub-section (4) of section 7 of the Act and certificate shall not be issued under sub-section (5) of that section.

2. THE GAZETTE OF INDIA EXTRAORDINARY [PART II with reference to an economiser, unless the standard conditions in respect of material, design and construction, which are specified in this Chapter are satisfied in respect, of such economiser. Where the heating surface is designed to permit the generation of steam and there are no valves interposed between the heating surface and the boiler drum, then the economiser shall be designed in accordance with Chapters I to VIII of the Regulations where they apply: Provided that an economiser in at the time Chapter XI of these come into force, may be so registered and such Certificate may be issued in respect thereof notwithstanding that such standard conditions are not satisfied in respect of such economiser. (b) Notwithstanding anything contained in sub-regulation (a) the Chief Inspector may, subject to the provisions of Regulation 502, register an economiser and order the issue of a certificate authorising the use thereof, although the standard conditions are not fully satisfied in respect of such economiser. GENERAL REQUIREMENTS The part used in the assembly of 501.—

(a) All cast iron and headers and an economiser conform with the requirements of this Chapter in respect of material, design and construction, workmanship and structural requirements. (b) All economisers under construction shall be under the supervision of an Inspecting Authority and must be so certified by that Authority. (c) For economisers imported into the States to which these Regulations extend, a certificate from the Inspecting Authority in Form VII certifying that the material tested and the economiser built under its supervision shall be furnished to the Chief Inspector before or with the first application for registration. (d) In advance of registration along with an application for registration, the following shall be furnished : (i) a certificate in

Form VIII of manufacture and test signed by the Maker or by a responsible representative of the Maker, containing the description of the economiser, particulars of the material used in its construction, and the dimensions of the several parts with the declaration that the limits of tensile breaking strength and the dimensions comply with the standard conditions; (ii) a certificate from the Maker of the material, stating the tensile breaking strength and the elongation provided that if the Maker and Manufacturer be the same, the Manufacturer's precise statement showing the above information shall be accepted. (e) To suit owners convenience where possible it is recommended that economisers be installed in two or more sections

502. Where no certificates are produced, the working pressure as found by formula will be reduced by 1000 When the workmanship is however in any way doubtful and (the Chief Inspector is not satisfied that any of the foregoing conditions would be sufficient to meet the circumstances, he may at his discretion reduce the working pressure by such percentage as he deems fit

503. Makers' certificates for steel economisers.—The Maker shall furnish the Inspecting Officer with a certificate in the following form:— "We hereby certify that the material described below has been made by the Open Hearth or an Electric process acid/basic and has been satisfactorily tested in the presence of the Inspecting Officer/our Test House Manager in accordance with the Standard Test. " of below : On components before being used. Oost iron tubes, headers & Bend. THE GAZETTE OF INDIA EXTRAORDINARY 504. For all new economisers the hydraulic test must be applied as shown in Table 1, 20 to 100 lbs. test pressure. Working pressure; Minimum 500 lb./sq. in. working pressure. Minimum bursting pressure 1000 lb./sq. in. Maximum 1000 lb./sq. in. plus working pressure. "Work" shall be the highest of which the economiser shall be tested. NOTED. The above test shall be held for a period of ten minutes.

505. Material of construction, workmanship and material used in the construction of pressure parts shall be tested and shall conform with the following requirements. (a) The workmanship throughout shall be of the highest standard. All castings shall be well finished, free from defects, porous places and blow holes, and true to dimensions without warping. Where chaplets are used, there must be satisfactory fusion with the metal. Chaplets must be properly tinned with metal free from lead. (b) The screw threads of all bolts must be of British Standard Whitworth forms. (c) All component parts shall where necessary be manufactured to limit gauge to secure interchangeability throughout. CAST IRON TUBES AND HEADERS 506. Process of minimum tensile strength shall be in accordance with the following table: Main tubes or headers of 5/8 inch and over 5/8 inch and not exceeding 1 1/8 inch diameter of test piece. LEI. 504 to 708 Minimum tensile strength in tons per square inch. On analysis, the sulphur and phosphorus content of the iron shall not exceed the following percentages: Component Tubes Headers Sulphur 0.01 per cent. Phosphorus 0.01 per cent. THE GAZETTE OF INDIA EXTRAORDINARY [PART 507. Test bars 1/8 inch. (a) When the test bars are cast separately, they shall be poured at the same time and from the same ladle of metal as the casting or castings they represent. The number of test bars specified in Regulation 508 shall be applicable to all castings of each melt. (b) When the bars are cast in the mould for the casting and the mould for the test piece shall be joined together in such a manner that the liquid metal fills both moulds at the same operation. (c) All test bars shall be cast in green sand or dry sand moulds according as to whether the casting or castings they represent are moulded in green sand, or in loam or dry sand respectively. (d) The test bars shall not be subjected to any heat treatment after leaving the moulds except where the castings are heat treated. (a) The number of tests required for each batch 508. Number of tensile tests of castings shall be in accordance with the following table: The various classes of castings being divided into 4 representative groups: Group 1 Weight of casting Up to 28 lbs. Over 28 lbs. up to 1 cwt. 3 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. One test for each 30 cwt. of casting or part thereof. One test for each 2 tons of casting or part thereof. One test for each 4 tons of casting or part thereof. In the above Groups 1, 2 and 3, the casting or castings represented by one must be poured from the same ladle of metal as the casting or castings they represent. 4 Over 10 tons and up to 100 tons. One test for each 4 tons of casting or part thereof or for each casting weighing 4 tons or more. (b) The additional tests to be carried out before casting or casting is rejected shall be in accordance with the following table: 1st test piece. If this fails, the 2nd test piece shall be cast. If this fails, the 3rd test piece shall be cast. If this fails, the casting shall be rejected. (c) Provided always that in the case of failure of both test pieces if either show obvious defects on third test, piece shall be taken from the casting or broken casting or 84 piece may be cut from the usable casting for further testing as

followa•. 3rd best meco If this If thig failg The batch or separato costings repreNentacl Shall be aoccepted. The betch or gepureto coeting represented may be rejected

509. Standard test piece.—The tensile test bar shall conform to the dimensions shown in the following. Bars may be tested with either plain or screwed ends. (SAU. SCREWED) Ddi AREA D 111. SCREWED) Main cross section of casting represent%l. in. 0.875 11 in. 0.25 (NRALLEL) C m. in. 2 in. 3} 111, (BSW) ILL. in. 7-1/16 in. 4-13/18 Up to 5/8 Over 5/8 and not exceeding 1-1/8 The test bar shall be a cylindrical bar of the diameter, given in Col. B and to the dimensions given in COIN. D & P in the above Table. CONSTRUCTIONAL REQUIREMENTS CAST IRON ECONOMISERS 510. (a) The Manufacturer shall, on the basis of design details, satisfy the Inspecting Authority regarding the design and strength of all parts of Cast Iron Economiser for which, under these Regulations, specific design and stress limitation have not been imposed, subject to the following maximum working pressures (1) (2) Max. W.P. Ordinary Vertical Tube 250 lb./ sq. in. Ordinary Vertical Tube with Strengthened tubes . 300 lb./ sq. in. Ring Stay Vertical Tube 350 lb./ sq. in. Gill tube type of approved design . 450 lb./ sq. in. (b) A certificate from the Inspecting Authority regarding the safe working pressure of such parts of Cast Iron Economisers for which design and stress limitations have not been imposed under these Regulations, should be furnished to the Chief Inspector. 511. "Joint bolts and studs for cast iron economisers— (a) The maximum working pressure for the bolts and studs shall be calculated by Regulation 518. (b) The use of studs tapped into cast iron is permissible where:— (i) The studs and nuts are not in the path of the flue gases. (ii) The studs are securely threaded to gauge and fitted into tapped holes of ample depth", 512. Use of cast iron.—Where the water temperature is expected to exceed 4250 F. the use of cast iron for pressure parts is prohibited. STEEL ECONOMISERS WITH OR WITHOUT CAST IRON SLEEVES ON THE TUBES 513. Tubes, The tubes shall be manufactured in accordance (b) Suitable provision shall be made for supporting horizontal with Regulation 151. tubes at one or at more intervals in their length to relieve bending stresses, and these supports as well as the end connections must permit free expansion

514. Tubes Working pressure.—The working pressure of the tubes shall be calculated according to With Regulation 338

515. Headers: The headers shall be constructed in accordance with Regulation 154.(b) Branches shall be secured by one of the following methods: (1) Expanded, belled and welded. (2) Strength welded with additional securing means. (3) Full depth. strength weld. (4) Branches less than 2 inch may be screwed and seal welded. (c) Open end of forged or seamless, steel tube headers may be closed by forging, or the ends may be secured by bolting, screwing, or welding in an approved manner

516. Headers: Working pressure.(a) Rectangular headers. The working pressure shall be calculated in accordance with Regulation 340, (b) Cylindrical The working pressure shall be calculated in accordance with Regulation 270 and 271

517. Attachment of tube to headers (a) Tube shall be connected to the tube plate by one of the following methods:— (1) Expanding with bell mouth or Roll welding. (2) Strength welding. (3) Mechanical bolted joint. (b) Roller expanded tubes shall project through the neck or bearing part in the holes by not less than, quarter of an inch and shall be secured from pulling out by being bellmouthed to the extent of 1132" for each inch in diameter plus 21.32M (c) Tubes expanded into headers may be seal-welded inside or outside the header. Where a, small weld is provided inside the header, the tube end projection and bolt head specified (b) not required. (d) In the case of roller expanded tubes the tube holes in the headers shall be formed in such a way that the tubes can be effectively tightened in them. There shall be a neck or bell mouth of at least, inch. (e) Where the tubes are strength welded directly to the header, the technique for the same shall be approved by the Inspecting and all welds shall be suitably heat treated. (f) Bolted joints shall be designed in accordance with Regulation 518. (g) Tube supports supporting clips and lugs may be welded to the tubes. (h) The tubes shall be so arranged that they are accessible for cleaning internally and externally. BOLTS AND STUDS 518. Joint bolts.—The maximum working pressure for the bolts shall be determined by the following formula: $N \times C \times D \times n^2$ Eqn. (121). N = No. of bolts securing the ports. No. of screw threads per inch. Bolt diameter in inches measured over the threads. the area exposed to pressure which is assumed to be bounded by line midway between the pitch line of the bolts and the inner edge of (When flange joints are used with joint rings. Where

conical joint flange used with joint rings of curvilinear cross section, the area exposed to pressure shall be assumed to extend to the root of the thread where the tube end is screwed, or to boundary if the flanges are attached by other appropriate means. For steel bolts or studs of 28 tons/sq. in. ultimate tensile stress where the diameter over thread is less than 3/4 inch. For steel bolts or studs of 30 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than 3/4 inch. For steel bolts or studs of 35 tons/sq. in. minimum ultimate tensile stress where the thread is less than 3/4 inch. For steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is not less than 3/4 inch and not greater than 7/8 inch. For steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is greater than 7/8 inch. VALVES AND MOUNTINGS 519. (a) Thermometers.—All economisers shall be provided with thermometer or measuring instrument adjacent to the inlet and outlet connections. (b) Relief valve which shall prevent increase of pressure beyond 8 per cent above the design pressure shall be fitted to every economiser (except where economisers are designed to permit steam generation and have open connections to the boiler drum) and the design shall provide against unauthorised interference with the working. Economisers with pressure parts of cast iron and arranged in groups of tiers connected by circular piping shall have a relief valve fixed on each group or tier. Relief valves should have a minimum diameter of 2". (c) Pressure Gauge.—Means for indicating the pressure in the economiser shall be provided by a Pressure Gauge constructed on the lines of Regulation 327. (d) Air release must be provided for the release of air at all points where air accumulation may occur. (e) Blow off drain valve.—Means must be provided for draining the economiser completely of water. (f) Non-return valve.—Economiser provided with means for heating the incoming feed water mixing it with hot water from the economiser outlet must have non-return valve in the hot water return line. (g) Reserve Flues.—In every case a reserve flue shall be provided for by-passing the flue gases when no water is being fed to the boiler through the economiser. (h) Explosion Doors.—To relieve the economiser of excessive pressure due to internal explosions doors preferably of horizontally hinged "self-sealing" type shall be fitted. (i) Hydraulic Tests.—All valves and fittings shall be tested by hydraulic pressure to not less than twice the working pressure subject to a maximum of 1000 lb./sq. in. the working pressure. NOTE.—The working pressure shall be the highest pressure at which the economiser relief valve is to be set. FEED PIPES 520. General.—Feed pipes may be made of cast iron or copper but wrought iron pipes will not be accepted for working pressure over 200 lbs per sq. in. or 4250 F. Copper feed pipes shall be solid drawn and not exceed 8" external diameter and may be used for working pressure not exceeding 350 lbs. or 3000 F. Design pressure for feed piping.—The design pressure shall be the maximum pressure generated in overcoming friction and other losses in the feed piping under ordinary working conditions, or the maximum pressure which can be generated by the boiler feed pumps unless special provision is made to prevent the pressure being communicated to the pipe line

521. Steel feed pipes.—Steel feed pipes shall be in accordance with Chapter IV

522. Cast iron feed pipes. The standard conditions for material of construction and tests for cast iron pipes shall comply with Regulations 505 to 509. (b) The maximum working pressure shall be determined by the following formula:— $1.30(t-6) \text{ Eqn. (122)}$ Thickness in thirty-seconds of an inch. d the external diameter of the pipe in inches

523. Copper feed pipes. The standard conditions for material of construction and tests for copper pipes shall comply with Regulation 35. (b) The maximum working pressure shall be determined by the following formulas: W.P. = Eqn. (123) Thickness in hundredths of an inch. d external diameter of the pipe in inches. REGULATIONS FOR REGISTRATION AND INSPECTION OF ECONOMISERS

524. Preparation for inspection.—(a) At each inspection the economiser shall be emptied and thoroughly cleaned internally and externally and in the flues. All mountings shall be opened up and cap removed to permit adequate inspection. (b) The owner of an economiser to which this Regulation is applicable shall obtain the approval of the Chief Inspector in writing to the method of disconnection which he proposes to use and shall be responsible for ensuring that the method so approved is followed in practice

525. Procedure for registration.— (a) On receipt of an application for registration the Inspector, shall, after the economiser has been prepared for, take full particulars of the design and ascertain the working pressure allowed by the Regulations. (b) If required under Regulation 510(a), certificate from the Inspecting Authority has not been furnished, the Chief Inspector shall determine the fitness of such part! as per the following formulae subject to the limitation prescribed under Reg. 510(a) :— (i) Economisers with pressed socket joints not reinforced, — Area of Socket in contact, (width inside Header) (Pitch of tubes in Header) Friction Factor. $W.P. = \text{Working pressure in lbs. per sq in} \times \text{Friction Factor} \times 300$. (ii) Headers for above Economisers :— $20 \times \text{Thickness of flat sides in thirty second-B of an inch}$, (iii) Economisers with pressed socket joints reinforced, Area of Socket in contact, (width inside Header) (Pitch of tubes in Header) Eqn. (124) Eqn. (125) $\times$ Eqn. (126) Friction Factor $4k$ No. of stays per header Where k — No. of sockets per header Where friction factor 300. and $P = 300$ for approved design of reinforcing stay. be considered greater than 150. (iv) Tubes for above Economisers : $200 \times (t - 6)$ Where t Thickness in thirty second of an inch, d External diameter in inch. In no case value of K shall (127) INDIA, (v) Header for Economiser with reinforced socket joint 1 — $200 \times (t - 9)$ t thickness in thirty second of an inch. d = External diameter in inches. (vi) Manifold Pipes for above Economiser :— $200 \times (t - 7)$ $D \times t$ — Thickness in thirty second of an inch, d External diameter in inches. Eqn. (128) (129) (vii) Cast iron Economiser with gills or other extended surface Tubes $500 \times (t - C)$ t = Thickness in thirty seconds of an inch. $C = 8$ for portion where gills act as reinforcement ; reinforced. d = External diameter in inches. (viii) Bends and Manifold Pipes for above Economiser $d \times t$ — Thickness in thirty seconds of an inch. d — External diameter in inches. Eqn. (130) IO for portion not re. Eqn. (131) (c) The Inspector shall enter full particulars of the economiser together with the required calculations of various parts in a Memorandum of the Inspection Book (

Form IX) and submit it to the Chief Inspector. (d) If no formula or coefficient applicable to any part, other than what is mentioned above, is contained in the Regulations, the Chief Inspector shall at his discretion determine the fitness of the part. (e) After inspecting the economiser and ascertaining, as required, the maximum working pressure to which it may be worked, the Inspector shall witness the hydrostatic test in accordance with Regulation No. 527 and may issue a Provisional Order in Form X

526. Procedure at subsequent After the economiser has been cleaned the Inspector shall make a thorough examination before its reconstruction. The external condition of the tubes should be carefully noted for sagging especially at the feed inlet end and all accessible tubes should be calipered. The internal surface of cast iron tubes should be closely observed for graphitic staining so far as it is possible and in the event of any tube failure these should be broken up for scrutiny so that the general internal condition of the other tubes may be estimated. (b) Where tubes or other parts are wasted, the strength should be re-calculated. (c) The scraper gear should be examined to note if any parts are missing and if the length of travel is adequate and if the scrapers are correctly adjusted. (d) All cap bolts are to be inspected, also the condition and position of the dampers and baffles. (e) The record of each inspection and calculations will be entered in the Memorandum of Inspection Book

527. Procedure for Hydraulic test.—Every economiser for registration shall be hydraulically tested in the presence of an Inspector to at least twice the working pressure. Subsequent hydrostatic test may be confined to after repairs or when the Inspector considers it necessary. During the test all parts externally and in the flue gas passages shall be noted for leakage. 528. Memorandum of inspection book.—In this book the Inspector shall enter all particulars and dimensions of the economiser with the required calculations for the various parts together with details of hydraulic test. At subsequent inspection the Inspector shall enter all notes pertaining to the condition of the various parts

529. Registration Books will be maintained on the lines of Regulation 387

530. Grant Of certifiacte.—A cortificate for the use of an oonomiger shall be granted in



Form XI

531. Casual Tho Inspector shall note if the economi*m is working uthfaotorily, and if the relief valves, are oorrectly bdjusted, ff the scraper gear operating and if the external brickwork ig froe from cracks.(b) He ghall LIBO ascertain that the makers' instructions for working are" being 5triotly followed by the owner. N0TB.—Tt, iB rerornmonded that the d inlet tcmperature to the should not be legg thon I ()OOF to prevont sweating nnd congeqnent external oorrogion of tho tubo and bottom headere



532. Economiser rating.—The rating shall be equivalent to the area of the heating surface in square feet which shall be computed from the tubes and 533. Registration fee. —An application for registration

shall be accompanied by appropriate fee. For Economiser rating not exceeding 500 For Economiser rating exceeding 500 For Economiser rating exceeding 1,000 For Economiser rating exceeding 1,500 For Economiser rating exceeding 2,000 For Economiser rating exceeding 2,500 For Economiser rating exceeding 3,000 For Economiser rating exceeding 3,600 For Economiser rating exceeding 4,000 For Economiser rating exceeding 4,500 For Economiser rating exceeding 5,000 but not exceeding 1,000 but not exceeding 1,600 but not exceeding 2,000 but not exceeding 2,500 but not exceeding 3,000 but not exceeding 3,500 but not exceeding 4,000 but not exceeding 4,500 but not exceeding 5,000 50 70 80 90 100 110 120 130 140 150 534. Engraving of Registry Number.— (a) Each ion, branch pipe or detachable part subject to the foregoing regulations shall be marked for identification with Registry Number and also the appropriate device as shown in Regulation 882. (b) In the case of the ordinary vertical type of cast, iron economisers, the device and number shall be stamped on the header flange connected to the top branch pipe. In each case the stamping shall be on some conspicuous part not affected by the gases or other corroding influence. The letter "F," shall be prefixed to the number in the denominator. Example :

r.L.H.N.1 Or -LINDIA



FORM 1 (Regulation 386 and 887) INDIAN BOILERS ACT, 1923 BOILER INSPECTION
DEPARTMENT BOILER REGISTRY NUMBER Memorandum of Inspection OR Registration Book 1.4
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Do. do. Do. rivet to edge Outer but* strap, width X . do. do. X do. Inner do. Cöwmfrerz*u seams. No. of
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Authority. 19 810. 8] GAZETTE OF INDIA EXTRAORDINARY FORM Worke Addre88
CONSTRUCTOR'S CERTIFICATE OF MANUFAOTURE AND TEST [REGULATION (d)) Des- orip
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number of boiler eq. ft. Grote area sq. ft. Yeur of Mmufoature Description of boiler. Totol Evoporotåon
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The shell and no per pitch of and number Detail of gauge in drawing No. Furnace Seamw. —The longitudinal joining rings are of type inches. The oroga seam riveted. 8 rivet holes in shell and furnace flueg drilled in plates were bent, in place afterwards to be aput, burr removed and rough edges of hole cleaned before riveting. Riveting wherever practicable done by machine. All fire-worked plates (mainly annealed after completion of operation). Welded parts of boiler are welding process. No part of boiler proper including mountings and stand blocks, is made of iron or malleable cast iron. Fusion welded drums.—The construction is in accordance with Chapter V of Indian Boiler Regulations. Number of longitudinal girths in each ring. Number of defects repaired to sound during construction, if any. Deüzila of heat treatment GAZETTE OF INDIA EXTRAORDINARY 4 FORM Motorial continued. Smelter Boiler parts and fittings. Do. Rivet bolts. Boiler Tubes Girders Manhole frames. Manhole door Manhole Compn. ring. Sight hole door. Stand block Stop Valve Check Valve Chests Feed Valve Chests Blow down Blow down elbow plate Water gauge mount Make Inspooling Remarks On No. N0TB.—Under 'Motorial' enter against appropriate item Siemens Martin, open hearth acid (or basic) process"; "Wrought Iron, Branch. ... , ... " "(Jogt Station, Process. ... " etc., etc., and under age. "Solid drawn", lbs. per square inch, "Remarks" a brief explanation of process or manufacture where necessary. "Lap welded"} "Solid pressed": Toggled by maker. ... etc. THICKNESS OF PLATES, ETC., AND TENSILE TEST RESULTS Part of boiler shall. Butt Joints. Steam and water drawn Barrel (Loco) Firebox Casing Crown, (Loco), Dome Mud drum Front End. Back End Shell Crown Dome End. Mud Drum End • Saddle (Loco) Firebox casing Bideg (loco) Doubling Thick-ness. 8% of plates in 82nd or Diameter in inches Tensile strength limit to tons Elongation Gauge Brand and limit to length in inches. number on plate end. THICKNESS OF PLATES ETC. AND TENSILE TEST LIMITS—continued. 5 • u 8 8] of INDIA FORM m.—continued. Tensile Elongation Part of boiler Furnace, Circular (plain) Furnace, Circular (corrugated) Firebox, Crown. Firebox Side. Firebox Front. Firebox Tube. Uptake. Smokebox tube. Tube. Water Tubog. Smoke Tubog, (plate) Synchro Tubog (atoy) Superheater. Casing borog. Mud boxog. Gusset Stoy (plate B) Longitudinal. Scroy. Firebox Roof slings. Firebox Roof Pins. Girder Bolts. Shell Anglo Bolt. Uptake Anglo Bolt. Manhole Bolts. Sight hole Bolt. Firebox Girder. End plate Stiffener. Shell Anglo, Furnace An Io. Uptake An Manhole compn. Ring. Manhole Frame. Cover. Sight hole Compn. Ring. Sight hole Doors. Stand Blocky. of plates in 32nd or Diameter in inches strength limit to tons limits to Gauge length in inches Brand and number on plate or DIA LA 1 tsAOHDINA_kÖx [-xAB'R (6) Certificate that the particulars entered herein in manuscript by you are correct and that arts and fittings in sections 4 and 5, against the number of which entries are made, have been used in the construction and fitting of the boiler, The particulars shown against the various parts used in accordance with the maker" In our possession. The design of boiler in section and end view with principal parts fully dimensioned is shown in drawing No. The boiler has been designed and constructed to comply with the Regulations under the Indian Boiler Act, 1923, for a working pressure of lbs. per square inch But our works above named and 88th foot or less withstood wet test of lbs. per square inch on the day of 19 In the of our responsible representative whose signature appended hereunder. Maker. Signature of Engineer. Signature of Maker or who witnessed test. Secretary of Firm. Dated at Signature of Inspecting Authority. the day of Nory.—The drawing of the boiler and maker" certificate of manufacture and results of plate tests for tensile strength elongation and bending must accompany this and If boiler has been built under the supervision of an Authority their Form 11 must be attached. FORM IV STEEL MAKERS CERTIFICATE OF MANUFACTURE AND RESULTS OF TESTS [REGULATION 4 DESIGNATION OF ROLLING MILL We hereby certify that the material described made by the acid, basic and rolled by us and last tested in the Office of your Office, or Test in with the tests. Date of Test Overruled by Boiler No. znk:zr Charge Number 19 Part of boiler Signature or Initials, House Order Number of plate RESULTS OF TESTS SIZE or PLATE Length Tensile strength in tons square inch Date in inches cent. B end Thickness in 32nds in. Counterfoil No. Be hereby permitted to the Rating made by number of lbs. of No. Boiler (Registry at maximum Pressure pending issue or renewal of a certificate within six months from the date which this order will become void. Dated In. 81H3tor of H)ikrs. FORM V 381 (C) PROVISIONAL ORDER UNDER SECTION 9 OF THE INDIAN BOILERS ACT OF 1923. b.r.e hereby to the (Rating & No.) Boiler Rating by Boiler Maker* maximum of square inch issue or of a (Rating) within six months from the date after which this order becomes void. Dated r-n.sfb3t.or of Boiler-læs.

4. Eoonomi. Ber and fittingn All castinge are well finished, free from external defectp, poroua placeg and blow-holes and true to d.imønson.B without smrp{ng. Whoro chaplete aro used, thero is gatßfactory fusion with tho Chaplets ore properly tinned with metal free from load. All acrow throodg are of Britißh Standtk.rd Whitworth forrn. All component parts manufactured to limit gougoß to woure intorchangeability throughout. Parts Material Tubes end or Valvo ohost3 Makor Inspecting P articularB of motorial THICKNESS OF PARTS AND TENSILE TEST LIMITS Remgrk* Brand and No

5. Part of Economiser Hoaderg Tuboe BoltB Thick-nose in 32ndB Tensile strength limits to tong Elongation limitB Gauge length Cortified that the particularB ontored horoin are correct that the parta ond Bttinge men• tioned obovo hove t:xxm ugod in the construction and Bttingg of the EconomisB.or. The particulory Bhown ogaingt the vurious aro fn accordance with the Maker'a cerii.

flcate3 m our poggeggion. Tho depign of the oconorn.igor in section ond ond view wH,h principol parts fully dimensioned is that shown in drowing No. Tho Economiser has been designed and oono- truct,ed to comply with the Indian Boiler Rogi-dations for a working of lbs. por sq. in. , at our Workfi abovemontionad and the sections Jbtisfactorlly with8tood 8 water text lbs. por sq. in. for of in the prosenco Of our Nignoture is appended horoundor. Signature of who witneyeed bho test. Dated at day of minutos on rosponsiblo repreænbe.tÅve who* Dosignotion of Mokor day of 19 Slnature of the Inspecting Authority. Nom.—The drawing of the Economiser and Mokor'8 oortificote of manuftM)ture ahowng tegula of teste for strength ond elongation must accompany thie oortifioete and ff the economfger boon built undor the supervision of on I.n.gpoe ting Authority thoir in



Form VI-I must accompany. FORM IX (REGULATION 528) INDIAN BOILERS ACT, 1923 BOILER INSPECTION DEPARTMENT ECONOMISER REGISTRY NUMBER Memorandum of Inspection OR Registration Book SEO. B] District Owners Address of Factory Nearest Railway Station Economiser Register at Register Book No. Registry Number Approved Working Pressure Economiser Rating Register book filed at Romark on transfer etc. OF INDIA EXTRAORDINARY THE GAZETTE MISCELLANEOUS on page verified on lbs. Inspection fee on PROVISIONAL ORDER AND CERTIFICATE RECORD Fee Date of payment Date of Inspection Certificate No. and date Period of Working Certificate pressure Economiser Rating 79b Remark g and Inspector's initial Type of Economiser Makers. Intended Working Pressure Place and year of Make....., Makers' No. Description of Economiser THE OF INDIA EXTRAORDINARY 196 No. of tubes. ., Length. Dia. Thickness Internal diameters. No. of Headers Thickness of Headers. Length of Top Branch Pipe....., Length of Bottom Branch Pipe Dimensions of cap opening of cap bolts No. Relief valve Stop Valve. Blow Down Thermometers Pressure Gauge Additional Fittings Position 11 M boiler Diameter mm: 10ATB8 r Type MAKERS, Name of Maker Maker's Hydraulic Pressure, ., Maker's Drawing No...., Name of Inspecting Authority Name of Maker of Material. Pressure Pipes Bolts Tubes. Headers. 0? Sulphur. % Phosphorus Total Reculter, Mark on Identification Marks Position BEC. GAZETTE OF INDIA EXTRAORDINARY CALCULATIONS HEADERS TUBES BRANCH PIPE* BOLTS 197 798 GAZETTE OF INDIA EXTRAORDINARY SURFACE [PART n Total Heating Surface. Economiser Rating Calculations made by Calculations checked by Leut pressure, that for Approved working pressure Chief Inspector's remarks and signature INSPECTOR'S submitted on on lbs, lbs. NOTES SEO. 8] Counter foil No. GAZETTE OF INDIA EXTRAORDINARY FORM X [Regulation 525(e)] 079 Name of person or firm to which provisional order is granted. Description of Economiser Makers No. Rating. Pressure permitted Period Date Inspector PROVISIONAL ORDER UNDER THE INDIAN BOILERS ACT, 1923 are hereby permitted to use the Economiser RY No. and Economiser Rating by maker and boiler makers' No. of maximum pressure of lbs. per sq. in./maximum temperature of OF. pending the issue or refusal of 8, certificate shall within six months from the date hereof after which period this order will become void. Dated FORM on this day INSPECTOR. -Boiler Inspection Department. CERTIFICATE FOR THE USE OF AN ECONOMISER Registry Number of Economiser No. of tubes. Number of Headers. Economiser Rating. (Regulation 530) Type. Place and year of manufacture GAZETTE OF INDIA EXTRAORDINARY Name of Owner. Situation of Repairs. Remarks. I/We hereby certify that the above described Economiser is permitted by me/Chief [PART under the provisions of Section worked at a maximum pressure of for the period from the 10th day of the relief Valve is not to of the Indian boiler "A", 1028 (V of 1928) to be lbs. per sq. in. of Fee Dated on page {d on of INSPECTOR REVERSE or FORM CONDITIONB CHIEF INSPECTOR (1) No structural alteration, addition or renewal shall be made to the Economiser without a written permission from the Chief Inspector. (2) This certificate shall cease to be in force — (a) on the expiry of the period for which it was granted, or (b) when any accident occurs to the Economiser, or (c) when any structural alteration, addition or renewal made in or to the Economiser, or, (d) if the Chief Inspector in any particular so directs when any structural alteration, addition or renewal is made in or to the Economiser, or (e) on the communication to the owner of the Economiser of an order of the Chief Inspector or Inspector prohibiting its use on the ground that it is in a dangerous condition. (3) The Economiser shall not be used at a pressure greater than the entered in the certificate maximum pressure/temperature nor with the relief valve set to pressure temperature exceeding such maximum pressure/temperature. (4) The Economiser shall not be used otherwise than in a condition which the owner reasonably believes to be compatible with safe working. N.B.—Details regarding this are recorded in a Book No. Of which copy may be obtained on payment on application to the Chief Inspector. N. P. DUBE, Secretary, Central Boiler Board. THE GAZETTE OF INDIA EXTRAORDINARY 801 APPENDIX A DIAGRAMS OF RIVETED JOINTS WITH FORMULÆ RIVETED JOINTS LAP JOINT. ONE RIVET PER PITCH ONE RIVET PER PITCH Max. Pitch $xT+1-625$ 100 (P—D) Plate 0/0 $IOO \times AxS1$ Rivet 0/0 Eqn. (11) (2) (8) Reg. 184 SINGLE STRAP. ONE RIVET PER PITCH Max. Pitch O Rivet 0/0 — $1-53xT+1-625$ 100 (P—D) $IOO \times AxS1$ $PxTxS$ Eqn. (11) (2) (3) Reg. 184 Eqn. (5) BUTT STRAP — $1-125xT$ DOUBLE BUTT STRAP. Max. Pitch Plate 0/0 $xT+1-025$ 100 (P—D) $X AXI 875^*$ Eqn. Reg. 625 xT BUTT STRAPS • (11) (2) (3) 184 (7) 802 GAZETTE OF INDIA EXTRAORDINARY DOUBLE RIVETED JOINTS [PART 11 LAP JOINT. TWO RIVETS PER PITCH Max. Pitch Plate o

Rivet 0 • 625 100 (P—D) IOOxAx2XS1 PxTxS - .67D Eqn. (11) (2) (3) Reg. 184 LAP JOINT. TWO RIVETS PER PITCH Max. Pitch = 2-62xT+1-625 100 (P—D) 100 x Ax2xS1 Rivet 0 o Eqn. (11) (2) (3) Reg. 184 SINGLE BUTT STRAP. Two RIVETS PER PITCH Max. Pitch Plate 0/0 Rivet 0/0 Bum STRAP Eqn. (11) 100 (P—D) IOOxAx2xS1 — • 671) —1-125xT Roe. Eqn. (2) (3)] 84 (5) .11 DOUBLE RIVETED JOINTS SINGLE BUTT STRAP. TWO RIVETS PER PITCH P FIG. Mnx, Pitch Rivet BUTT STRAP —3-06XT+1-625 100 (P—D) IOOxAx2xS1 —1-125xT Enq. Reg. Eqn. (1) (2) (3) 184 (5) SINGLE BUTT STRAP. THREE RIVETS PER PITCH Max. Pitch Plate 0/0 Rivet 0/0 Combined 0 o —4-05 xT+1,625 100 IOOxAx3xS1 100 (P—2 D) IOOxAxS1 4 .2P+1-15D —1-125 Tx (P—2D) Eqn. (11) (2) (3) Reg. 184 STRAP DOUBLE Jonas SNGLE STRAP. THREE RIVETS PER PITCH Max. Pitch 100 (P—D) Plate % Rivet 9/0 100 (P—2D) IOOxAxS1 Combined 0/0 PxTxS = .33 P+.67D . or 2 x D whichever is greater Bum STEAP 125Tx Eqn. Reg. Eqn. (11) (2) (3) (4) 184 (6) DOUBLE STRAPS. TWO RIVETS PER PITCH FIG. 10 Pitch Max. Plate 0/ Rivet 0/0 BUTT STRAP 100 (P—D) IOOxAx2x1-875xS1 PxTxS = .33P+.67D —1.5xD Equ. Reg. (11) (2) (3) 184 (7) grvrn jomrs DOUBLE BUTT STRAPS. TWO mvms PER PITCH FIG. 11 FIG. 12 Max. Pitch Plate 0/0 BUTT STRA2B • x • 625 100 (P—D) 100xAx2x1•875xS1 PxTxS —•625XT Eqn. Rog. Eqn. (11) (2) (3) (184) (7) DOUBLE BUTT STRAPS. THREE RIVETS PER PITCH Max. Pitch Plate % Rivet 0/0 Combined 0/0 BUTT S 100 (ED) PxTxS Eqnp (11) (2) (3) loo (P—2D) 100xAx1•875xS1 PxTxS —•2P+1•15D. Reg. 184 Eqn.' (8) (PAD) DOUBLE RIVETED Jonas DOUBLE BUTT STRAPS. THREE RIVETS PER PITCH FIG. 13 14 Mux. Pitch Plato o Rivet o Combined 0/0 BUTT STRAPS DOUB LE Max. Pitch Plate o Rivet 0 o BUTT STRAP (WIDE) BüTT STRA;p (NARROW) 100 (P—D) IOOYAx3x1•875XS1 PxTxS 100 (P—2D) Eqn. (11) (2) (3) (4) or 2 X D whichever is greater 625TX TWO RIVETS PER PITCH 100 (P—D) 100xAx1•875xS1 PxTxS •33 67 D —1.5xD = •625 T Reg. 184 Eqn. (8) Eqn. (11) Reg. Eqn. (2) (3) 184 (9) FIG. 15 DOOLE RIVE'ID jonnS DOUBLE BLITT STRAPS OF UNEQUAL WIDTH TWO RIVETS PER PITCH Max , Pitch Plate o BUTT STRAP (WIDE) BUTT STRAP (NARROW) 100 (P—D) 100 PxTxS — •625 T Eqn. Eqn. FIG. 18 DOUBLE BUTT STRAPS OF UNEQUAL WIDTH THREE RIVETS PER PITCH 01) (3) 184 (9) (11) (2) Max. Pitch Plate 00 Pulvot 0 Combined 0 BUTT STRAP (wrnn) B (JTT STRAP (NARROW) Eqn. 100 (P--D) PxTxS 100 (P •625T 100 x A x S1 PxTxS 1 •15D Reg. Eqn. (3) (4) 184 (9) FIG. 17 BIVEÆD Jomn DOUBLE BUTT STRAPS OF UNEQUAL WIDTH THREE RIVETS PER PITCH Max. Pitch Plate % Rivet Q/'ø Combined % Bore STEAP (WIDB) Bumm STBA-P (NARROW) —4 •63 xT+1 •625 100 (P—D) IOOxAx4-75xS1 PxTxS IOOxAxS1 PxTxS or 2 x D whichever is greater Eqn. (11) (2) (3) (4) =1-5xD —625 T . Rtvmo JOIN'N Rag. Eqn. Ere. 18 LAP JOINT. THREE RIVETS PER PITCH Max. Pitch Plato 0/0 Rivet 0/0 100 (P—D) PxTxS —33Px•67D Eqn. Reg. (13) 184 (9) (11) (2) (3) 184 Blv•rrmD jomz LAP JOINT. THREE RIVETS PER PITCH FIG. 19 FIG. 20 Max. Pitch Platz % Rivet y, —3,47xT+1-625 100 (P—D) IOOxAx3xS1 PxTxS Eqn. . Reg. LAP JOINT. FOUR RIVETS PER PITCH Max. Pitch Plato 0/0 Rivet % Combined 14 x ' 625 100 (P—D) IOOxAx4XS1 PxTxS Eqn. 100 (P—2 D) IOOxAxS1 PxTxS Reg. (11) (2) (3) 184 (11) (2) (3) (4) 184 TREBLE RIVETED ronvrs FIG. 21 LAP JOINT. FOUR RIVETS PER PITCH! Mux Pitch Eqn. (11) 1 Plute o Combined 0 o tot) x A x 4 x S1 100 (P 21)) IOOxAxS1 or 2 D whichever is grebter Rog. (2) (3) (4) 184 FIG. 22 DOUBLE BUTT STRAPS. THREE RIVETS Max. Plate o O Rivet, 0 o BUTT STRAPS PER PITCH. •625 100 (P D) 100 x A rxTxS .67 D. Reg. (2) 184 SEO 8] THE GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED JOINTS DOUBLE PS. THREE RIVETS PER PITCH. Max. Pitch Rivet BOTT STRAPS - 4 6.3 (T+1 . 100 (P—f)) —2xD . Eqn. Reg. Eqn. 811 (11) (2) (3) 184 (7) DOUBLE BUTT STRAPS. FOUR RIVETS PER Mux. Pitch Plate RI vot Combined 0/0 BUTT STRAPS —5,52xT+1-625. Eqn. (11) IOOxAx4x1,875xS1 (3) 100 xS1 • 2P+1•15D PxTxS Reg. Eqn (4) 184 (7) 812 FIG. 26 GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED JOINTS DOUBLE STRAPS. TOUR RIVETS PER PITCH [PART n Max. Pitch Plate 0/0 Rivet 0/0 (hmbined 0/0 BUTT STRAPS Eqn. (11) (2) (3) 100xAx4x1•875xS1 PxTxS 100xAx1-875xS2 PxTxS (4) — .33P+.67D •r 2 D whichever greater Eqn. (7) DOUBLE BUTT STRAYS. FIVE RIVETS PER PITCH Max. Pitch . Eqn. (11) (2) Plate 0/0 IOOxAx5x1•875xS1 Rivet % (3) 100 x Ax1 Combined 0/0 RI BETT STRAPS = = •671) .625 Tx (P—2D) PxTxS R". 184 Eqn. (8) GAZETTE OF INDIA EXTRAORDINA-R± TREBLE RIVETED Jonrrs DOUBLE Bum STRAPS. rrvn RIVETS PER PITCH FIG. 27 Max. Pitch X T + 1. • 626 (P—2D) 818 Eqn. (11) (2) (3) o Rivet 0/0 Combined 0/0 RI 100xAx5x1-875xS1 PxTxS 100xAx1-875xS, PxTxS (4) or 2 D whichever greater BUTT STRAYS — •625T X R eg. 184 Eqn.(8) RIO. 28 DOUBLE STRAPS OF

UNEQUAL WIDTH THREE RIVETS PER PITCH Max. Pitch o Rivet 0/0* STRAP (WIDB) BUTT STRAP (NARROW) $=4i63xT+1-625$. IOOXAx4.75xS1 = .625 T Eqn. (11) (2) (3) Reg. 184 Eqn. (9) (10) GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED JONRRS DOUBLE BUTT STRAPS OF UNEQUAL WIDTH FIG. 29 THREE RIVETS PER PITCH Reg. 184 Max. Pitch $=4-63 xT+1-625$. 1 1 Plate 0/0 Rivet o R IOOXAx4-75xS1 $=2xD$ Eqn. (11) (3) Eqn. (9) BUTT STRAP (WIDE) BUTT STRAP (NARROW) 625T. DOUBLE BUTT STRAPS OF UNEQUAL WIDTH FIVE RIVETS PER PITCH Max. Pitch Plate o Combined 0/0 BUTT STRAP (WIDE) BIJTT STEAP (NARROW) IOOXAX8•5XS1 Eqn. (11) (2) (3) IOOXAxSi • 165 P+ D • 625T. Reg. 184 Eqn. (9) Nominal thiQkne•n oc tent picco Width Gauge length Pbmlol length (minimum) at Bshouldor (minirnum) Approximate total length ('61 Not' 8) Up 'o but not, Including 818 in. 8/8 in. •nd t hicker m. 8 111. 1 12 m. li (mex.) I I(max.) 9 18 9 1 18 When the width of the material to be tested IS insufficient to permit of (he pre- paration of the Ntandard tensile test piece, a piece of the full width of the material may be ueød. Nori". l. For some matoriolg it convenu-nt to use straight parallol t'8t paoeoa

2. For certam non-forrou• nnettd* it is sometimes convenient to use the scandal'd tent picee that, hoa a width of i m. and a gouge length of 2 in. for thickness exceeding in

3. A t0Nt piece of the dimensione given Col, (jiz) for material under 318 in, nmnmal thick- ia intended for ferrous metelg only. Piece A1 2. In tensile tests on special shoot and strip materialg (e.g., steel uBed for deep pressing operations) the follöwing alternativo tegt piece may be used. nn Nd in 9in mn length t5it., BRITISH STANDARD ROUND TEST PIECES Piece B ined rods and noi exceeding 1 in. diuneter (exclud- Ing rnet u Is), P Length G=8D between gr•pg P to be not than 9 D All pieces of form B ore tly nnlar and for the same material give the eomo percentage elongat •on. They give elongation figures nearly tho same as those ot' dttandard flat, test ex 8 in gange lengi)), in. Wide and iu. thick. N0TE. —When tensile toys n re on unmachuzod square 't,nrl hexagonal bat'S (oxrludlnx caat metals) the g»uge length *hall he 8 tnnca the distan(e between the flatg and the lengt bo,lwcen the gl'lÆ»-J Nhall bc not thnn times tho dLBtnuce between the flats. Test Piece B1 4. For rods -l]ld bars over I in. clm,lncter (exclud)ng cost metals). Ga.ngc• 102111th (A Lcngth between gr P to be 110t less thnn 4 •5 Piece C 5. Round TeNt G u uge length G=2 ID. Purallcl lengQ1 P to be not 1649 than in Diameter 504 In. Cross-8tÅ'fiona,] oreo square Radius at nuntmurn for wrought meta]B and In. nnnimum for cast metals. Subsidiary Standard Round Test Pieces d. Machined Test Pieces for general purpogos (excluding cast iron). V] teel couforming tn the above d I u re snnilar to Standard Teat Piece (7 With e orre91)011ding shoulder rud ; us, and the sanie pereontlbge elongation 'Tt-*t Piece C for the same lna,tcruil. Reeonnnndcd diinenBions for Suhsl(liar.x, Standard '1108t Pieces are tabu• lot ad below. Standard Piece (I) •.3ß4 in (limneter) 1B [Il'•luded for comparison. Any t08t picec, however, in which the (lillinct01' noi lew thun • 125 in. , und the di,nengions of which conform to the Ht andurd forn , is recouniN0d us sub- Mdilll',v standard test c. ot, Bhoul R (nunnnu-l.n) Ie,igtll P metol THE GAZETTI\$u OF EXTRAORDINARY Cross. *ectlonal Arc•u A 4 Gauge length G •54K). --3 •9S D nuninnun. Parallel xth P=9J8 G In 14 (Millijnuy. Radius ut shoulder for wroug.,rht Illeta18- •88 1) 'nint tn). 4.30 18 .85 1.75 0•35 1.55 O • 14 Radius at Hhou[der for eaHt — Ininirnum. 4 (4 •40 1) milli Ilium). 111. O, 70b 10. o, 7,100 2500 o, 012' Ill. 1.25 1.00 818 THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX C List of Inspecting Authorities recognised uy cornpetent under Regulation 2 (h) of the Indian Boiler Regulations, 1950. No. 1. 2. a. 4. 5. U. 7. 8. 9. 10. 11. 14. 15. 16. 17. 19. 20. 20 23. 24. 25. 26. 27. '8. 30, 31. 32. 33. 84. 35. 86. 37 r, 38 Name' Lloyd's Regietor of Shipping, .Londou. The (Jcöan Accident ond Guarantoe Corporation Ltd., London, *I'he Authorized Boiler 'Tegting and Inspect ion -iggociation, (Czecho. alovüia). Dhe ScottiBh Boiler and Genoral -Lnsuru,nce Co., Glasgow. Magarg. Kennedy and Donkin. Consulting Engrn., London. The Notional Boiler and (-kneral Lnsuranc,ü Co., Monohegter. 1'h8 Vulcan Boiler and Genc rol Lnsurance Co., Ltd., Monchester. Tho British Engine Boilor uncl Electrical Insuranc»e (NO. , Ltd., MnnehßAter. Megrß. Preece Cardew & Hider, London. Messrß, Eagle Star Inguranco Co., Ltd., London. Bureau Veritas, Internetionol Registor of Shippmg, Paris. Inßurance Engineers, Ltd., London. 'The (Accident and Guerantoe Corporation, 14td., U.S.A., New York. India Store l)ept., London. MGB81'ß. Merz and Mclellan, Consulting Engmeerg, Englund. Messrs. Rendel Palmer and 'Ilritton. Consulting EngintRTN, England. "L'118 London Lancashire Co., Ltd., England. Chief Inspector Chief Inspector Chief Inspector Chiof Inspector Chief Inspector Chief Chief' IMVeetor Chief -Inspector Chief I napector of Boilers, Asgarn. of Boilers, Wogt Bengt•l. of Boilere, Bihar and (of S teenm B011erg, Bombay. of Boilers,

Madhye L P rB(ltHh. of Boil101'N, Delhi md A.J1ner. of Stemn Boderge, and Coorg. of Boilers, (I) of Boilers, Uttar Tru,d08h. Chisf Inspector or Boilerg, Department of I,obonr, Sydney, New South W 8168, A ustralia. Chief Inspector of Boilers, Mineg Department, Melbourne, Victori», Auetralia. Chief Inapector of Machinery, Brisbano, Queen51and, Augtr•lia. Chief Jn8pector of Machinery, Mines Department, Perth we8t Austrelia. Chief Inapeetor of Machinery, Hobart, Tasmanib, Chief IrwpocLor for Foetorios & Boilers Department, Adelaide, South Australia. American Employers Insurance Company, Mass. Employerg Liability AqsurH,nee Corporation Limited, M&8B. Mutual Boiler Ineurnee Company of Bogton, Mau. Colum bia Oagualty Company, New York. London Guaranteø and Arrident OompB,ny Limited, New York. T)hanix Indemnity Compbny, New York. THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX D 1819 Proof Test for Creep Quality of Carbon Steel plate of Boiler Plate Qaality SPECIFICATION NATURE or TE5T 1. The test shall consiBt of a, tensile creep tost carried out over period of at least 48 hours Ut, a, temperat,urc of 4500C. und with Stress of 8 tong per eq. in. Under these conditiona the slope of the ohord to the creep curve between the 24th and 48th hour shall not exceed 5() X 10-8 strain por hour. CONDITION or MATERIAL 2. The tegi, shall bc modc on the material in the normalised conclition. The normalismg temperature shall be bewteen 8750C.—9250C., and the plate sample shall be Binta,inod the normalising temperoture for one hour per inch of thickneNN ænd cooled freely in still a,ir. TDMPØRATURB or Tswr 3. (b) Temperature measurement.—The temperature of the apccimen Bhall be measured by thermocouples suitable for the temperature xpecified. Two thermo- couples situated one at ea,eh end of the gouge length shall be used in the cusc of test pieces having gouge lengths up to 2 in. , and for longer gouge length* on add itional thermocouple sit,uuted at the middle of the gauge length 8hall be used. Thermocou ples shall make good thermol contact with the test piece oncl be protected from the direct heat of the furnace by being covered with asbestos tape or equivnlent insulu,tion. 'Ilhc cold junction shul-I be Ina,intoined a known tempermture which *hall bc regl*tcrccl by a mercury thermometer. Alternatively, a suitbb)e means shall be provided for correcting biltomuticolly error* in reading duo to changeH m tempern- ture of the ool(l junction. (b) Temperature control—The two (or three) thermocouples speclied in clausc 3 (a) Bhall ogrce with one Bnot,hcr within 30 C. a,nd the overage of these readings 8ball be taken the test temperu ture which shall not vory from by more 20C. throughout the test. Either u cont,inuoues record or gumcicnt, readings of the temperature shall bc made indicate that the temperature cona !tions have been gutisfuctory. (c) Heating rcriod before Loading specimen Bhall be ynaintained at the specified tempernttue for ot least an hour prior to the applicat ion of the load, STRn,SS 4. The load required to produce the ypecified stres» ghall be gradually applied hout shook during a period not exce(ding five rminutes and the Hi rcss Shall be occur te per cent. SENSITIVITY or STRAIN- MEARURING 5. 'l'ho sensitivity of the extensometer must bc such that struins can bc mea- guredcl to the nearest READLNas 6. A gufficient number of st,rnin readings shall be tukcn cleurly to define the creep curve up to 48 hourg, and [he chörd slope Bhall be ed from u, chord drown between points on the curve of the 24th ond 48th hours. THE GAZETTE OF INDIA EXTRAORDINARY REPEAT [PART 7. if the Inatterial fail* to the test, but (ho chor d slope does not exceed 10.8 dt,ruin per hour, shall be n,cccepted if sati8fuctory, or ot the Inspector't* (ltgetetlon u, puss tog(ut a, stress o per cent less thun that Fpccified may be accepted. APPENDIX E STANDARD PIPE FLANGES. Pipe FlangeB (For La•nd ugr) TABLE WORKING STEAM PRESSURES UP TO LBS. (Thig tablo does not apply to boiler feed I) pes, 01 to ot nel er pipes subject to exceptional shocks.) TABLE E.—FOR WORKING STEAM PRESSURE ABOVE 50 LBS. UP TO IOO LBS. PER SQUARIO INCH. Number and 1 hameter Normnal of Diameter Diameter of Flange Did. of 100 lb. of Bolt Up to lb. 100 lb. Bolt' (Off centre Up to [q lunge . Cugt St '81 and Bronze Up to Sturm or Forge I or Iron or Steel Notes) 50 lb. 4—5/8 4 5/8 *See Notes ut end of T blos regard-mg thege, algo for other partnenlarg. Pip. (Land use) FOR WORKING STEAM ABOVE 100 LBS. AND UP '10 150 LBS. INCH, TARI-E -FOR WORRI STEAM ABOVE 15() AND UP TO 25() LBS. PER SQUARE, INCH. Diameter I Nnmber and Diblnetpr 'l'hicknoßß of F longc (must COBI. Steel und Bronze N01ninal Inll. 150 lb. only 25() lb. only of FNInnge 04 Boll lb. o? BoltB (off eent re 150 lb, Up to 260 lb. Up to 150 lb. Støel (Btmmpocl or forged) (See Noten) Up to Up to 160 lb. 250 lb. *Soo Note* end of YINuhleH regurding thQNe, o]go for flonges for pipe lines •nd other parti• TABLE J Pipe Plangeø (For Land —FOR WORKING STHAM ABOVE 250 LBS. AND UP TO 350 LB8. SQUARE INOM. 'Thickne•sa of Flange Diameter of Diurnetor of Nt-unbor ond CBBt Steel end Bron- Nominol Intl. Act Extl. Dia. of Pipe Dia. of W rot, 1-29/32 Flange Bolt (hrclc Diameter of Bolts (off centre lines) ze.• Støel

(stamped or forged) (See Notes) *See Notes end of Tbb10ß regarding theae, also for flanges for Pipe linog and other parti- The actual externl'l diameters of wrought pipeq given ebove apply equally to all tables, TABLE K. Nominel Intl. Dia. of Pipo GAZETTE OF INDIA Pipe (For Land FOR WORKING STEAM PRßSSURE8 ABOVE 350 LBS. AND UP TO 450 LBS. PER SQUARE Thiok.neBß of flulge DiblDBter of Dizrnater of Numtm and Steel and Flange Bolt Circle Dibmeter Of Bronze Steel (ßt&mpad Bolts (off oentre Ifnøe) or forged) (Seo Notes.) iy recommended i,hAt Che urge of rn»rkod * should be ovoid&l. 'The of Hunge givon m tho include l'l'bised faro Df not more than 1/16 in. high if guoh be used. E'or Fin. 5/8 in. bolt,g tho diumotorg of tho h010R to bo 1/ ld in. Itsrger thBNh tho diameterg the bolts, and for Inrgor of boltH 1 18 in. Iron or Stf-BI flougeg (gturped or förgod) may bo grrewod or riveted on with bogs, or welded with fillot, tho 11 ».ngos boing of Ht•eol för prouuros "bove 15() lb. inch. Speciol {l»ngos (atamped or lbrged) For pipe linos 2-i-n. nominal diameter of pipo and upward* (without valveg or fittmgs) oro made stated below, the flange 38leot6d in all being thot givon for the next arnal.ler Bize of pipo in the corosponding table Btotedt— table F modified "bovo. —For Working Stoun above 150 lb. up 250 lb. por moh. Tobie M gorre»pond.ß with Tub19 mcx:lifiod above. Toble P.- -For Working *tenm P roBsul'(N 25() lb. and 1 up to 850 lb. per qqware inch, corre»pond8 with 'l"ublo J modiflod ag above. THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX Transverse rupture Btress (Modulus oi Rupture). 11 The t,tansverse strength of cast iron may be expressed by a figure known as the Transverse Rupture Stress; this figure IS obtained by dividing the maximum bending moment at failure by the modulus 01' tho soefion. Thus, the Transverso Rupture Stresa is the maximum stress which would huve exigited if the materibl hod behaved in ocoordanee with the assumptiong Inade in the ordinary theory of bonding, ond in that event it would be independent of the size and shupe of 1,110 aection. Bars fractured in transverse, however, urc stressed beyond the elastic limit, and under those conditions the theory of bending no longer holds good. Furthermore, the influence of rote of cooling in cast metal* is such that the Transverse Rupture Stress of thick bar is less thon that, of u thinner bur of tho sa,me metol. The Rupturo Scress, therefore, i I not Atriotly independent of the size and shape of the section, but nevertheless forms u convenient way of expressing the results of tran- verse tests without the nerossit.y for giving full details of bar dimensron.B. The formula required is obtained follows : A bar supported at both ends und centrally looded with a loud W is subject to bending moment WL L being the cliqtanc•c• between supports. The resistance offered by tho bar bc, expressed fZ f bemg tho stross und Z the modulus of the sector. At brea,kinu stress or Trane•verse Rupture in tons and L m inches, f is in tong S tresg, and 4z per square inch. For a round bar, where d— diometey in inches. is fixed, Since for Standard f onnrl L and Z are constant, the va,luo and hence [Ile Trang verse Rnpfur• St f -E K W, where k a conBtant. The fnotors k for converting actual breaking loads into Transverse Rupture Stresses orc givon in the follow inu both for the Stnndard test barg n,nd test bbl'S varying within the lunit* of Regulation 88. In the game table arc given hpea,king into equivalent, break in" load* on the factors for converting borg of Stunda,rđ Factors X fck Actual Breaking Log.dg into Equivalent Breakina Loads on Bare of Standard (Equivoknt Bre&ing uoad on Bæ of Standard Did-meter = X X Actual Breaking load,) æ:ıd Factors K for converting Actual Loads into T-rønsvaæ Rupture Stræs. (Trumgver* Ruptnæ in tons in.=K Aetnal BTB8king Load in lb.) o •6 Tet 1 .12 .81 1 .13 0-82 o .83 1-17 o .58 o .59 I .20 2-10 0 •61 0-62 Bar o •0582 0 0552 o •0524 o 0429 0 •875 in. Bar x 1 Test Bar x 1 .6 Bar 2 2 .02 2 .04 2-05 2 07 2-09 2-11 2-12 2-13 2-14 2-15 2-17 2-18 •1 in. .86 o .87 o •875 o 0 0-91 92 0 93 0 94 o •0146 o •0142 o •0138 o .0135 0 0128 0 10113 o .0110 •0095 Dia. in. .52 I •56 1 .59 1 .61 1 .63 1 .66 I •68 .69 1 .70 x • 214 1 1 •144 1 1 .079 1 1 •946 o .929 o • 895 o •00606 o •00594 o .0058..3 o .00519 o .005Ü9 0 00490 o .00405 0 00447 o .00424 in. Test Bar x 1 .124 1 .075 •059 029 o •00336 o .0-0331 o •00317 0 0312 O O o o .56 • 63 64 x 1 •166 1 1 •107 0•952 o •864 .S24 1 •261 1 •215 1 •172 1 091 •053 •000 0 983 o •950 919 889 o o .833 o •0257 o •0247 o -0239 o •0230 o •0222 o •0214 o o•-07 o .0204 o .0193 O .018fi 0-0175 0-0170 .21 .22 i .23 1-24 t .25 .27 1 .28 1-29 1 •052 o .902 •929 o o •885 o 884 •844 O o 824 • S05 1 0-906 0-894 o -882 0 0)295 0 0290 O .(D282 o •00274 [No. E 1-11/304(40).] N. P, DBEJ Dy. PRINTED m INDIA BY THE MANAGER GOVT. or INDIA PREBS, NEW DELHI AND PUBLISHED BY THE MANAGER OF PUBLICATIONO DELHI 1950