CHAPTER VI

VALVES, GAUGES AND AUXILIARIES

281. *Requisite Mountings, Fittings and Auxiliaries.—Every boiler shall be provided at least with the following:—

* Two safety valves (Minimum diameter 3/4");

Two means of indicating the water level;

A steam pressure gauge;

A steam stop valve;

A feed check valve;

One feed apparatus. When the heating surface exceeds 200 square feet-two independent feed apparatus, each such apparatus shall have a capacity of not less the maximum continuous rating of the boiler. (For boilers in battery *see* regulation 336A), and

A blow-down cock or valve.

A fusible plug when boiler has internal furnaces;

An attachment for Inspector's test gauge;

A manhole, where size and construction permit, and such mudholes or sightholes as are necessary for effectively c eaning the boiler.

In the case of boilers fitted with integral superheaters, an additional safety valve shall be fitted at the end of the superheater outlet header.

In the case of boilers with no fixed steam and waterline, the fitting of such accessories that are manifestly not needed or used, such as water gauges, water columns and gauge cocks, may not be insisted upon.

* Two independent feed apparatus mean feed apparatus to which power is supplied from two independent sources or from a main or mains to which two sources of generation are connected or from a common steam main fed by two or more active boilers or, a combination of any of the above.

In the case of miniature boilers coming under Chapter XIV the Steam pressure gauge may be connected to the steam space or to a steam connection to the water column by a syphon tube or equivalent device that will keep the guage tube filled with water. If brass or bronze composition is used the minimum size of the syphon tube shall be 6 mm. ($\frac{1}{4}$ in.) standard pipe size; for other materials the minimum inside diameter of the pipe or tube shall be 13 mm. ($\frac{1}{2}$ in.)

For Electrode Boilers, *see* Regulation 437;

---

*NOTE.—It is recmmended that in Lancashire and Cornish Boilers one of the safety valves should be of high steam and low water type. In Water Tube and Horizontal Multi-tubular Boilers, a low water alarm directly operated by steam should be fitted. Ramsbottom type safety valves consisting of two valves and with spring and lever in common may be considered as two safety valves for the purpose of this Regulation.

In the case of Marine Type boilers low water alarm may be fitted in place of a fusible plug.

GENERAL REQUIREMENTS

* **282. Materials, Temperature and Pressure Limits—(*a*) Materials.**—The materials used in the manufacture of the bodies of the fittings shall comply with the following requirements:—

(*i*) *Steel castings shall comply with 28 tons grade I *see* Regulations 73 to 80.

(*ii*) Steel forgings shall comply with Regulations 81 to 85.

(*iii*) Iron casting shall comply with Regulations 86 to 93.

(*iv*) Bronze Castings shall comply with the following requirements, namely:—

Chemical Composition

Tin	5.5 to 8 per cent.
Lead	2 per cent maximum.
Zinc	3 to 5 per cem.
Nickel	1 per cent.
Total of all elements other than copper and those set out above	0.3 per cent maximum.
Copper	Balance.

Physical Properties

Sand Cast (Cast on)	Ultimate tensile strength—Minimum 22 Kg/mm² (14 tons/Sq. in.)	
	Elongation per cent minimum on standard test piece C	8
Sand cast (separately cast)	Ultimate tensile Strength 23 Kg/mm² (14.5 tons/sq. in.)	
	Elongation per cent minimum on standard test piece C	12

(*v*) The seats and discs of valves shall be made of non-corrodible metal†.

(*b*) **Limits of Cast Iron.**—Cast iron shall not be used for:—

(*i*) Temperatures above 400° F.

(*ii*) Steam pressures exceeding 160 lbs. per sq. in. (gauge).

(*iii*) Feed valves and scum valves directly attached to boilers for pressures above 160 lbs. per sq. in. (gauge).

(*iv*) Blow-down fittings.

(*c*) **Limits of Bronze Fittings.**—Bronze shall not be used for steam temperature above 435° F.

---

*NOTE.—Steel castings which will be subject to the action of feed water shall be made of steel of which the manganese content does not exceed 0·8 per cent.

†By non-corrodible metal is meant metal specially resistent to corrosion and/or erosion.

134/2/M. of Industry/69-70-11

METHOD OF CONSTRUCTION

283. Castings.—(*a*) All castings shall be smooth, sound and free from flaws cracks or other injurious defects. Variations in thickness at any part shall be gradual and substantial fillets shall be provided.

(*b*) The body of a boiler mounting shall be connected to the boiler flange by a strong and stiff neck. In no case shall the thickness of the neck of bonze mounting 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.—(*a*) Valves of 1½ inch bore and over directly connected to boilers, and other valves of 2½ inch bore and over where fitted with a cover shall have such cover secured by bolts 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 valves are secured by studs, the studs shall be screwed into the b dy with full thread for a length of at least one diameter. The stud holes shall not penetrate into the pressure space of any casting.

(*c*) Valves with screwed covers shall be fitted with 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.—(*a*) Flanges shall be in accordance with the tables for the appropriate pressure (Appx. 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 material 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 be efficiently secured. Means shall be provided in every case to prevent the valves leaving their guides.

290. Chests etc., in General.—(*a*) All chest and fittings shall be smooth, sound and free from flaws, cracks or to other injurious defects. After completion they shall withstand satisfactorily a hydraulic test o to at least twice the working pressure of the boiler for which they are intended.

(*b*) Valves may be fabricated from seamless steel pipes for pressures not exceeding 250 pounds per square inch and temperatures not exceeding 800° F. The welding should conform to Regulation 125 and valve chest should be stress relieved after fabrication. Valves meant for use in pipe work may also be fabricated by welding from seamless steel pipes but no restriction as above regarding pressure and temperature shall apply to them provided the welding complies with all the relevant requirements of fusion welding such as stress relieving and radio-graphic inspection of the weld and the like prescribed in Chapter V of these Regulations.

* The working pressure of the valves shall be determined from equation 91 where 2Se shall be substituted by 1.85. The wall thickness shall not be less than 3/8". The fabricated valves with their assembled fittings shall withstand satisfactorily a hydraulic test to the same pressure as will be applied to the drum during its registration.

* (*c*) The working pressure and thickness of the chest shall be determined by the following formula [subject to the minimum thickness in Regulation 283(*b*)].

$$W.P. = \frac{C\,(t-x)}{D} \qquad \text{Eqn. (76)}$$

$$t = \frac{W.P. \times D}{C} + X \qquad \text{Eqn. (77)}$$

where D is the internal diameter of the chest in inches,

t is the thickness of the chest in 32nds of an inch,

C is a co-efficient from the following table,

X is a provision for tolerance, etc. from the following table:—

Table of Valves C & X

Material of Casting	C	X
Cast iron, at least 10 tons tensile strength	160	6
Bronze, at least 16 tons tensile strength	175	4
Cast steel, 28/35 tons tensile strength—		
For temperature up to 550° F	350	8
For temperature 600° F	315	8
For temperature 650° F	280	8
For temperature 700° F	265	8
For temperature 750° F	252	8
For temperature 800° F	236	8
For temperature 850° F	220	8
For temperature 900° F	154	8

Intermediate values may be interpolated.

SPECIAL REQUIREMENTS

Safety Valves

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. Definitions.—(*a*) An ordinary safety valve is a valve which lifts automatically at least D/24, where D = diameter of valve seating.

(*b*) A high lift safety valve is a valve which lifts automatically at least D/12 where D = diameter of valve seating.

(*c*) A full lift safety valve is a valve which lifts automatically a distance giving a discharge area round the edge of the valve seating equal to the area through the valve orifice, when the valve is fully lifted, after deducting the area of guides or other obstructions.

293. Minimum Aggregate Area.—(*a*) **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:—

$$A = \frac{E}{CP} \qquad \text{Eqn. (78)}$$

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 nett area in square inches through the seats 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 walls, steaming economiser, and other heating surface in direct communications 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).

P = absolute pressure in lbs. per sq. in. to which the safety valve is set.

C = a constant as follows:—

Type of Valve	Spring loaded Valves, Direct and Lever C.	Weight loaded Valves, Direct or Lever C.
Ordinary Valves	4	4·8
High Lift Valves	8	9·6
Full Lift Valves	16	16

*Subject to the application of Eqn. 79 the term "boiler" shall include any superheater fitted to the boiler without an intervening stop valve.

For water tube boilers of evaporative capacity greater than 10,000 lbs. of water per hour C may be increased as follows:—

Type of Valve	Spring Loaded Valves, Direct and Lever C.	Weight Loaded Valves, Direct or Lever C.
Ordinary Valves	4·8	4·8
High Lift Valves	9·6	9·6
Full Lift Valves	20	20

In the case of Water tube Boilers whose evaporative capacity is greater than 4536 Kilograms (10,000 lbs.) of water per hour, where relieving capacity tests have been carried out to the satisfaction of the Inspecting Authority or Chief Inspector of Boilers, higher constants than those given above may be accepted.

Where two valves are loaded by a single spring the above areas shall be increased by 50 per cent. If a part of the total area 'A' as determined by the above equation is provided in the valves fitted to integral superheaters, this part of the area shall be increased as provided for in equation 79.

(*b*) **Superheated Steam.**—If the valves have to pass superheated steam the area shall be determined in accordance with the following formula:—

$$As = A\sqrt{\left(+\frac{1.5T}{1000}\right)} \qquad \text{Eqn. (79)}$$

where As = area in sq. inch for superheated steam.

A = Area in sq. inch for saturated steam.

T = degree of superheat in deg. Fahr.

(*c*) In the case of Waste Heat Boilers, where the evaporation per square foot of heating surface is certified by the manufacturers to be less than 6 pounds, the minimum safety valve area may be calculated on the basis of the actual maximum evaporation of the boiler.

294. Over Pressure.—The valves shall be so designed that the maximum peak load evaporation for which the boiler is specified will be completely discharged with a rise in 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 (*a*) not more than 5 per cent. and (*b*) not less than 2½ per cent. below the safety valve blow off pressure. For valves less than 1¼ inch diameter the limits shall be increased to (*a*) 10 and (*b*) 5 per cent. respectively. Valves for superheated steam and for water tube boilers of an evaporative capacity greater than 10,000 lbs. of water per hour shall be exempt from the minimum requirements (*b*).

296. Attachment to Boiler.—(*a*) All the safety valves of a 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 casting, provided that the passage way to the valve complies with the above rules.

(*b*) The chest shall be connected to the seating 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 of 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 Appx. E for the diameters of flanges adopted.

297. Openings in Shell.—No accessories other than those integral with the Safety Valve shall obstruct the openings in the boiler shell. Discharging steam shall have direct access to the safety valve without flowing through internal pipes.

298. Discharge Passage.—The safety valve discharge pipes shall comply with the requirements of clauses (*a*) and (*b*) of this regulation. The discharge pipe shall be as short and straight as possible and be fitted with open drain to prevent accumulation of water in the pipe. Suitable arrangement shall be provided in the discharge pipe system so that the discharge can readily be heard by the Boiler Attendant.

(*a*) Steam safety valves.

(*i*) Ordinary and high lift valves. Where a waste steam-pipe is fitted the pipe and the passage leading to it shall have a cross-sectional area not less than the minimum combined area of the safety valves required by Regulation 293.

(*ii*) Full lift valves. For full lift valves the area of waste steam-pipe and passages leading to it shall have a cross-sectional area not less than twice A, or such area above this minimum as may be required for valves having a higher approved constant, where A, E and P are as defined in regulation 293.

(*b*) Economiser safety valves. The area of the discharge pipe from an economiser safety valve shall be at least twice the area of the valve seating.

Where the discharge from several economiser safety valves is connected to the main discharge pipe, the diameter of the main discharge pipe shall be designed to prevent accumulation of pressure due to the formation of steam under the particular conditions of temperature and pressure which may be applicable.

299. Drainage.—For each enclosed safety valve chest a means of draining shall be provided. The drain pipe shall be laid with a continuous downward gradient clear of the boiler to a place where the discharge is visible and cannot do injury to any person.

300. Moving Parts.—The valves and spindles shall be efficiently guided and means shall be provided in every case to prevent their lifting out of their guides. The working parts shall have sufficient clearance to ensure freedom

of movement under all conditions of service. The spindle shall not be fitted with a stuffing box.

301. Bearings for Levers.—The bearings of the levers of lever valves shall be so designed as to allow of free working of the valve under all conditions of service. Where the lever is mounted on pin bearings, the holes in the lever shall be bushed with non-corridible metal, or the pins shall be of non-corrodible metal.

302. Attachments of Weights and Springs.—(*a*) In a lever and weight safety valve the weight shall be in one piece and attached to the lever in such a way that the safety valve cannot be overloaded.

(*b*) In the case of spring loaded safety valves, washers or ferrules shall be fitted under the adjusting screws so that the valves cannot be overloaded when under steam. Where springs are in tension, links or other suitable stops shall be fitted to prevent the spring being extended a greater amount than that corresponding to a valve lift of D/4,

where D = diameter of valve seating.

303. Easing Gear.—Safety valves shall be so arranged that they can be eased off their seats when under pressure and the easing lever shall positively lift the valve.

304. Lift.—Safety valves shall be capable of being lifted a distance such that the area of the discharge edge shall not be less than the minimum aggregate area, A in Reg. 293.

305. High and Low water Alarms.—High and low water alarms shall be adjusted so that the alarm is sounded with the water level visible in the gauges.

306. Final Settings.—Each safety valve shall, before leaving the maker's works be adjusted to blow-off at the specified pressure.

SPRINGS AND TORSION BARS

* **307. Materials**—(*a*) **Springs.**—The springs shall be manufactured from steel made by the Acid Open Hearth or Electric process and shall show on analysis the following composition:—

Carbon	not less than 0·9 per cent. and not more than 1·2 per cent.
Manganese . .	not less than 0·45 per cent. and not more than 0·75 per cent.
Silicon	not more than 0·30 per cent.
Sulphur	not more than 0·05 per cent.
Phosphorus	not more than 0·05 per cent.

The manufacturer shall supply an analysis of each cast when required to do so. Should independent analysis be required, these shall be made at the rate of one per cast.

All springs shall be formed hot and shall be hardened in oil and suitably tempered.

* (*b*) **Torsion Bars.**—Torsion bars shall be manufactured from steel which shall have a yield point of not less than 141 Kg/mm². (90 tons/Sq. in.).

* **308 Dimensions.**—The compression or extension of safety valve spring required to load the valves to the set pressure shall not be less than one quarter of the diameter of the value, due consideration being paid in the case of spring loaded lever safety valves to the ratio of leverage.

The proportion of unloaded length of external diameter of the spring shall not exceed 4 to 1.

* **309. Determination of Working Pressure.**—(1) The maximum working pressure to be allowed for steel springs of round, square or rectangular section shall be determined from the following formulae:—

(*a*) Round section—

$$W.P. = \frac{10{,}000\ \pi\ d^3}{DACK} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (80)}$$

(*b*) Square section—

$$W.P. = \frac{33{,}333\ d^3}{DACK} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (81)}$$

(*c*) Rectangular section—

$$W.P. = \frac{160{,}000\ B^2\ H^2}{DACK(3B+1{\cdot}8H)} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (82)}$$

where (all dimensions in inches):—

$$K = \frac{4\frac{D}{d} - 1}{4\frac{D}{d} + \cdot 615 - 4\frac{D}{d}} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (83)}$$

(In n case of rectangular section substitute B ford

W.P.=Working pressure in lb. per square inch (set pressure).

A=Loading area of valve.

d=diameter of round or side of square steel.

B=Breadth of wire (radial to spring axis).

H=Depth of wire (parallel to spring axis).

D=Mean diameter of coil.

$$C = \text{Constant} = \frac{L_1 + L_2}{L_1} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (84)}$$

L_1=Initial compression or extension of the spring to give the required loading (W.P.×A).

L_2=The further compression or extension of the spring to give the lift as defined in Regs. 292 and 304.

Examples:—

C=2 where compression or extension of spring to give the required loading is ½ diameter of valve.

C=1·5 where compression or extension of spring to give the required loading is ⅓ diameter of valve.

C=1·25 where compression or extension of spring to give the required loading is full diameter of valve.

* NOTE.—The above formulae are based on a maximum allowable safe stress on the section of the springs of 80,000 lbs. per square inch.

(2) In the case of torsion bars the maximum shear stress as calculated from the following formula shall not exceed 55 Kg/mm² (80,000 lbs per square inch):—

$$fs = \frac{TDC}{2\ J}$$

where—

fs=Shear stress.

T=Torque at set pressure.

D=Outside diameter of the bar.

J=Polar moment of inertia of the section of the bar, and

$$C = \frac{\text{Angle of twist at full lift of valve}}{\text{Angle of twist at set pressure}}$$

(as furnished by the manufacturer)

The dimensions of sleeve transmitting the torque shall be of substantial proportions for the material used.

310. Tests (1)—Compression springs shall not show any permanent set after being compressed coil to coil six times in a quick acting scrag. Extension spring shall not show a permanent set after being tested to 25 per cent. in excess the load necessary under working conditions to lift the valve.

(2) Torsion bars shall not show a permanent distortion after being twisted to an angle fifty per cent in excess of the working angle.

311. Extension Springs.—Extension springs shall be made from round section wire.

312. Number of Effective Coils.—The number of effective or free coils in a compression or extension spring shall be determined from the following formulae:—

(*i*) For Round or Square Wire—

$$N = \frac{KCd^4}{SD^3} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (85)}$$

(*ii*) For Rectangular Wire—

$$N = \frac{66\ B^3\ H^3\ K}{(B^2+H^2)\ SD^2} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (86)}$$

where N=Number of effective coils.

K=Compression or tension in inches at set pressure.

C=22 for round, 30 for square steel.

d=diameter or side of square steel in 16th of an inch.

* (*b*) **Torsion Bars.**—Torsion bars shall be manufactured from steel which shall have a yield point of not less than 141 Kg/mm². (90 tons/Sq. in.).

* **308 Dimensions.**—The compression or extension of safety valve spring required to load the valves to the set pressure shall not be less than one quarter of the diameter of the value, due consideration being paid in the case of spring loaded lever safety valves to the ratio of leverage.

The proportion of unloaded length of external diameter of the spring shall not exceed 4 to 1.

* **309. Determination of Working Pressure.**—(1) The maximum working pressure to be allowed for steel springs of round, square or rectangular section shall be determined from the following formulae:—

(*a*) Round section—

$$W.P. = \frac{10{,}000\ \pi\ d^3}{DACK} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (80)}$$

(*b*) Square section—

$$W.P. = \frac{33{,}333\ d^3}{DACK} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (81)}$$

(*c*) Rectangular section—

$$W.P. = \frac{160{,}000\ B^2\ H^2}{DACK(3B+1{\cdot}8H)} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (82)}$$

where (all dimensions in inches):—

$$K = \frac{4\frac{D}{d} - 1}{4\frac{D}{d} + 4\frac{D}{d}} \cdot 615 \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (83)}$$

(In n case of rectangular section substitute B ford

W.P.=Working pressure in lb. per square inch (set pressure).

A=Loading area of valve.

d=diameter of round or side of square steel.

B=Breadth of wire (radial to spring axis).

H=Depth of wire (parallel to spring axis).

D=Mean diameter of coil.

$$C = \text{Constant} = \frac{L_1 + L_2}{L_1} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (84)}$$

L_1=Initial compression or extension of the spring to give the required loading (W.P.×A).

L_2=The further compression or extension of the spring to give the lift as defined in Regs. 292 and 304.

Examples:—

C=2 where compression or extension of spring to give the required loading is ¼ diameter of valve.

C=1·5 where compression or extension of spring to give the required loading is ⅓ diameter of valve.

C=1·25 where compression or extension of spring to give the required loading is full diameter of valve.

* NOTE.—The above formulae are based on a maximum allowable safe stress on the section of the springs of 80,000 lbs. per square inch.

(2) In the case of torsion bars the maximum shear stress as calculated from the following formula shall not exceed 55 Kg/mm² (80,000 lbs per square inch):—

$$fs = \frac{TDC}{2\ J}$$

where—

fs=Shear stress.

T=Torque at set pressure.

D=Outside diameter of the bar.

J=Polar moment of inertia of the section of the bar, and

$$C = \frac{\text{Angle of twist at full lift of valve}}{\text{Angle of twist at set pressure}}$$

(as furnished by the manufacturer)

The dimensions of sleeve transmitting the torque shall be of substantial proportions for the material used.

310. Tests (1)—Compression springs shall not show any permanent set after being compressed coil to coil six times in a quick acting scrag. Extension spring shall not show a permanent set after being tested to 25 per cent. in excess the load necessary under working conditions to lift the valve.

(2) Torsion bars shall not show a permanent distortion after being twisted to an angle fifty per cent in excess of the working angle.

311. Extension Springs.—Extension springs shall be made from round section wire.

312. Number of Effective Coils.—The number of effective or free coils in a compression or extension spring shall be determined from the following formulae:—

(*i*) For Round or Square Wire—

$$N = \frac{KCd^4}{SD^3} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (85)}$$

(*ii*) For Rectangular Wire—

$$N = \frac{66\ B^3\ H^3\ K}{(B^2+H^2)\ SD^2} \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (86)}$$

where N=Number of effective coils.

K=Compression or tension in inches at set pressure.

C=22 for round, 30 for square steel.

d=diameter or side of square steel in 16th of an inch.

S = Load on spring in lbs. 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.

* **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.

The springs shall be coiled in such a manner as ensures the coils being uniformly spaced and the sides to be parallel to the axis of the spring.

314. Finishing of Ends.—Compression springs shall have their ends ground flat and smooth and at right angles to the axis of the springs over the full circumference so that when placed on end on a horizontal plane the springs will stand perpendicular.

STOP VALVES

315. Lever Valves.—Where the valve is operated by means of a lever, whether hand or mechanically controlled, the lever shall be of ample strength and the bearings shall be so designed as to allow of free working of the valve under all conditions of service.

316. Steam Stop Valve.—(*a*) 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 between the boiler and the superheater. Where two or more boilers are connected with a 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 and the neck or the valve chest shall be reasonably short and of strong construction. The steam stop valve may also be attached to a stand pipe, a connecting pipe or the superheater header. The attachment may be made by bolted flanges or butt-welded joints. Such butt-welded joints shall be suitably stress relieved, where necessary.

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 a higher level than would be obtained under this Regulation, a vertical stand pipe not exceeding 5 diameters in height will be permitted between the step 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 large boiler in which it is desired to fit a tee piece for the purpose of providing a 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 2½ diameters in height. A stop valve shall be fitted direct to each tee piece branch.

* (*c*) Wedge type valves the sealing surfaces of which are solidly connected with the wedge, shall not be permitted for steam service.

(*d*) When two or more boilers are connected to a common steam main and there are no combined stop and isolating valves fitted to them, an automatic isolating valve shall be compulsory. In the case of boilers fitted with welded pipes, fitting of an independent automatic isolating valve shall be compulsory.

BLOW-DOWN COCK OR VALVE AND PIPES

317. General.—The blow down cock or valve shall be of substantial construction. The waste pipe attached to the cock or valve shall not be bound fast in earth or brick work and shall discharge at a point where there is no danger of injury to any person. These pipes shall not be connected to a pipe common to another boiler. The continuous blow-downs may, however, be connected to a common header discharging freely to an adequately vented tank or sump. The headers shall be of sufficiently large cross section and the blow-off tank shall be provided with a vent pipe free from valves and of sufficient size to prevent accumulation of pressure. If, however, the tank is intended for collecting flash steam, a saftey valve of adequate capacity shall be provided. The tank shall be so located that all parts will be accessible for inspection.

318. Blow-down Mountings.—(*a*) Each boiler shall be fitted with a suitable blow-down 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 a 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.

(*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 permitted.

319. Blow-down Valve or Cock.—(*a*) Each valve or cock shall be fitted with a device which shall indicate clearly its open and closed positions, and any key or similar 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*) Cocks fitted with taper plugs shall be of the bolted cover type with separate packing glands.

WATER GAUGES

320. (*a*) Every boiler shall have two 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 as the case may be:

Provided that in the case of boiler drums below 3 ft. diameter where there is difficulty in fitting two water gauges, two test cocks and a glass water gauge may be fitted.

(*b*) For boilers having evaporating capacity greater than 10,000 lb. of water per hour, one of the water-gauges may be of the remote water level indicator type.

(*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 boilers 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 boiler attendant. The fittings of glass water gauges and test cocks shall be 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 deep line to indicate the direction of the passage way through the plug When detachable handle are provided arrangement shall be made to prevent incorrect fitting of the handles.

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

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

323. Glass size.—Tubular water gauge glasses shall be not less than ½ inch and not more than 3/4 inch outside diameter.

324. Safety Devices.—Water guage glass mountings shall be fitted with self-closing devices 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 columns and the boiler.

326. Isolating Cocks.—Where isolating cocks or valves connecting water gauge pipes to the boiler are fitted, they shall be not less than 1 inch bore and of the bolted cover type with separate packing gland.

PRESSURE GAUGES

327. Dials.—(*a*) For pressures up to and including 500 lbs. per sq. in., pressure gauge dials shall be graduated in pounds per square inch from zero to twice the pressure, as nearly as may be practicable.

(*b*) For pressure exceeding 500 lbs. per sq. in the range of graduation shall be from zero to one and a half times the maximum permissible working pressure, as nearly as may be practicable, but in no case shall the 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 guage not less than 4 inches in diameter may be used.

(*f*) The travel of the pointer of dial gauges shall not exceed 325.

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 Cocks.—The handles of the gauge cocks shall be parallel to the pipes in which they are located when the cocks are open and marks shall be cut on the shank of the cock indicating open position.

330. Test Connections—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 socket shall be tapped with 3/4 in. Whitworth screw thread and shall be fitted with an easily removable cap.

FUSIBLE PLUGS

331. General.—Fusible plugs shall be of sufficient height and fitted in such a 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.

NOTE.—For example : In Lancashire Boilers the fusible plugs should be in the crowns of the furnaces 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 1/2 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 annual lining of fusible alloy so that the plug may drop clear if the lining melts.

The portion of the body carrying the fusible 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 150° F in excess of the saturated steam temperature at the maximum permissible working pressure of the boiler.

334. Attachment to Boiler.—Wherever practicable fusible plugs shall be screwed into the boiler plates from the waterside. The screwed portion shall have threads of Whitworth form not more than 11 per inch.

FEED VALVES

335. General.—(*a*) Feed check valves shall be of the non-return type.

(*b*) Where the valve is not of 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. Provided that the restriction aforesaid regarding the position of feed discharge level would not apply in the case of water tube boilers.

(*d*) The discharge end of feed pipe shall be so located that it is not close to any riveted joint of the furnace plates or of the shell.

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

336A.—Requirements as to feed apparatus in certain cases—In the case of a battery of boilers connected to a common feed range, the requirements of regulation 281 in respect of the number of feed apparatus shall be considered to have been fulfilled provided a total supply of feed water, not less than the combined maximum continuous rating of all active boilers can be maintained even if any one of the sources of power supply should fail.
