10

Boiler Mountings and Accessories

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10.1. BOILER MOUNTINGS AND THEIR FUNCTIONS

Different fittings and devices necessary for the operation and safety of a boiler are known as boiler mountings. The safety valve, water level indicator, and the fusible plug are the devices used for the safety operation of the boiler. The pressure gauge, feed check valve, blow-off cock and steam stop valve fall under the category of fittings and these are essential for the operation of the boiler.

Safety Valves. When there is a sudden drop in steam requirements, the steam pressure in the boiler will increase. The main function of a safety valve is to prevent under such a condition, an increase in the steam pressure in the boiler exceeding a predetermined maximum pressure for which the boiler is designed. This is automatically done by opening of the valve and discharging of the steam to the atmosphere as soon as the pressure inside the boiler increases above the predetermined value. The safety valves are directly placed on the top of the boiler shell. The different types of the safety valves which are commonly used are discussed below.

10.2. SPRING-LOADED SAFETY VALVE

This type of safety valve is commonly used now-a-days for stationary as well as mobile boilers. It is loaded with spring instead of weights. The spring is made from a square steel rod in helical form.

A spring loaded safety valve commonly used on Locomotive boiler is shown in Fig. 10.1. It consists of two valves, each of which is placed over a valve seat fixed over a branch pipe as shown in the figure. The two branch pipes are connected to a common block which is fixed on the shell of the boiler. The level has two pivots each of which is placed over each respective valve. The lever is attached with a spring at its middle which pulls the lever in downward direction. The lower end of the spring is attached to the back as shown in the figure. Thus the valves are held tight to their seats by the spring force.

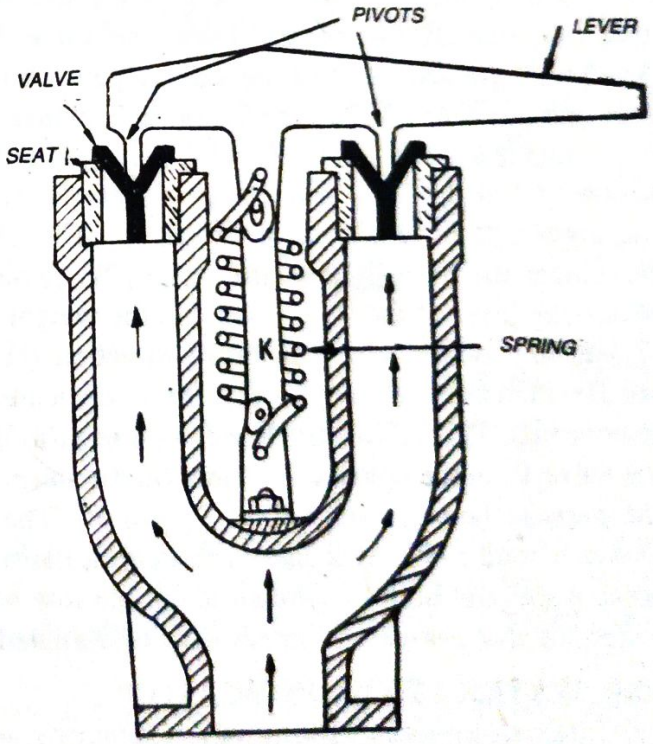


Fig. 10.1. Spring loaded safety valve.

These valves are lifted against the spring when the steam pressure is greater than the working pressure and allows the steam to escape from the boiler till the pressure in the boiler reaches its working pressure. The lever has an extension which projects into the driver's cabin. The driver can release the pressure if required just by raising the lever. The lever is connected loosely by a link to the block. This limits the valve opening and prevents the lever blowing off in case of spring failure.

The valve is much lighter and compact compared with other safety valves; therefore, they are preferred on all stationary and mobile boilers.

10.3. HIGH STEAM LOW WATER SAFETY VALVE

It is a combined safety arrangement against high steam pressure and low water level in the boiler. This is generally used in Lancashire boiler. It is actually a combination of two valves, one of which is lever safety valve which blows off steam when the working pressure of steam exceeds the preset value. The second valve operates by blowing off the steam when the water level in the boiler falls below predetermined level. This raises an alarm, so that corrective action can be taken by pump , in water.

A commonly used high steam low water safety valve is shown in Fig.10.2. It consists of two valves V_1 and V_2 of which the valve V_1 rests upon the valve seat and valve V_2 is placed over the valve V_1 which acts as valve seat for valve V_2.

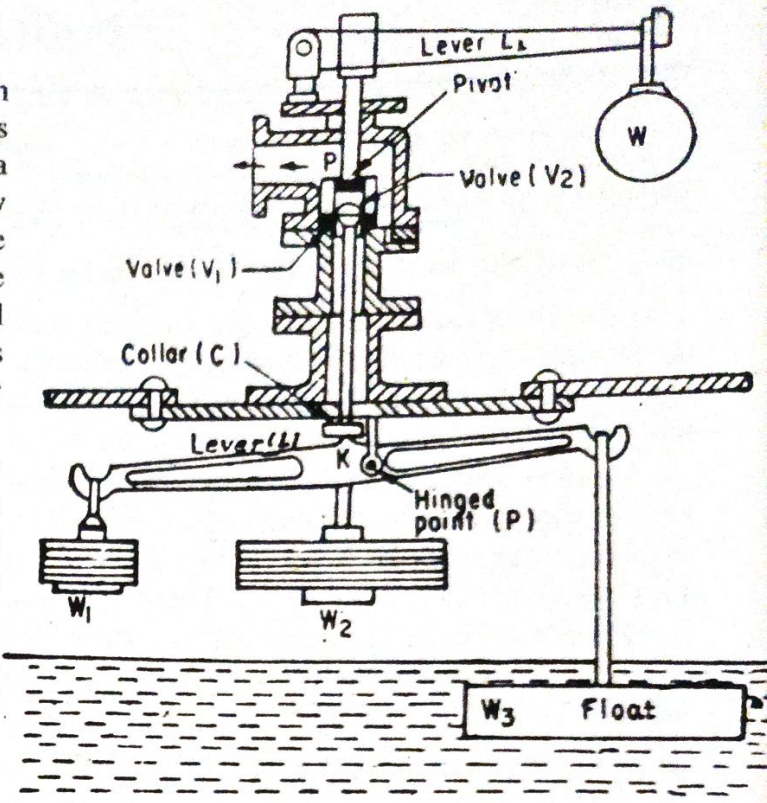


Fig. 10.2. High steam and low water safety valve.

To maintain the pressure of the steam in the boiler, it acts like a simple lever safety valve. The lever L_1 is hinged at its one end and a weight W is hung from the other end as shown in the figure. The pivot P is placed over a valve V_1 and when the steam pressure exceeds the normal limit, the valve V_1 is lifted with the lever L_1 and the valve V_2 also. So the steam escapes through the passage between the valve seat and the valve V_1 till the pressure becomes normal.

Inside a boiler shell a lever L is hinged at the point P as shown in figure. A weight W_2 is connected to one end of the lever and a large weight W_3 to the other end. The valve V_2 is connected with a spindle, the lower end of which has a weight W_2. The knife edge K touches a collar C of the spindle of the valve V_2. Under the normal level, the weight W_3 remains in water and whole system with weights is balanced. When the level of the water falls and the weight W_3 is uncovered, the system becomes unbalanced and the weight W_3 moves in a downward direction (because its acting weight increases as buoyancy force is decreased as it is partly uncovered). This causes the knife edge to push the collar C with the valve V_2 in the upward direction. So the steam escapes through the passage between the valves V_1 and V_2. The escaping steam causes a loud noise as it passes through a narrow passage. This noise warns the boiler attendant about the low water level of the boiler, so that corrective action may be initiated.

10.4. WATER LEVEL INDICATOR

It is an important fitting which indicates water level inside the boiler to the observer. Usually two water level indicators are fitted in front of the boiler. The water indicator shows the level or water in the boiler drum and warns the operator if by chance the water level goes below a fixed mark, so that corrective action may be taken in time to avoid any accident.

A water level indicator used in low pressure boilers is shown is Fig. 10.3. It consists of three cocks and a glass tube. The steam cock 1 keeps the glass tube in connection with the steam space

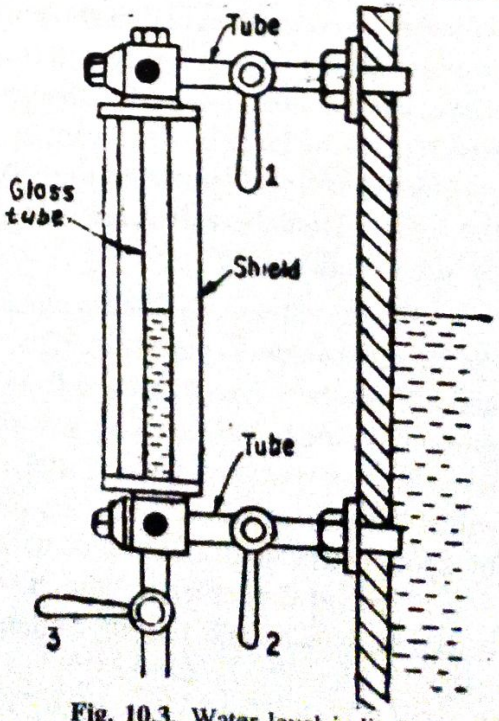


Fig. 10.3. Water level indicator.

and cock 2 puts the glass tube in connection with the water space in the boiler. The drain cock '3' is used to drain out the water from the glass tube at intervals to ascertain that the steam and water cocks are clear in operation. The glass tube is generally protected with a shield.

For the observation of the water level in the boiler, the steam and water cocks are opened and drain cock is closed. In this case, the handles are placed in vertical position as shown in Fig. 10.3. The steam enters from the upper end of the glass tube and water enters from the lower end of the tube. So the water level inside the boiler will be same as seen in the glass tube.

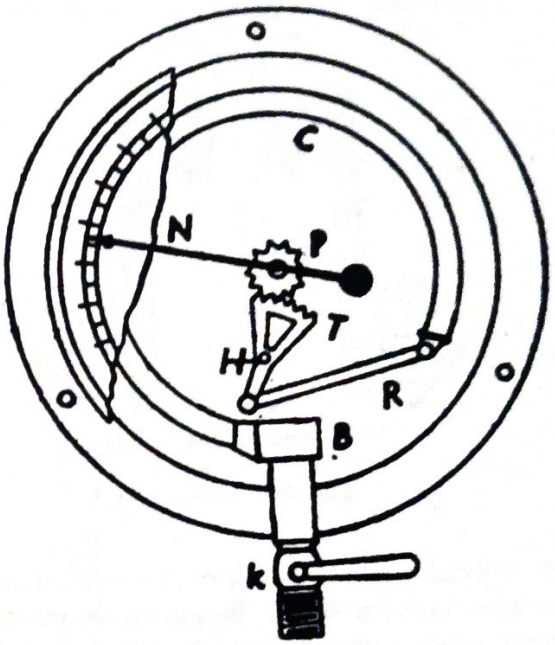
The rectangular passage at the ends of the glass tube contains two balls. In case, the glass tube is broken, the balls are carried along its passage to the ends of glass tube and flow of water and steam out of the boiler is prevented.

The water level indicator can be taken out from boiler for cleaning purposes by removing the bolts when the boiler is not working.

10.5. PRESSURE GAUGE

A pressure gauge is used to measure the pressure of the steam inside the boiler. The commonly used pressure gauge known as Bourdon type pressure gauge, is shown in Fig. 10.4. It consists of an elastic metallic type of elliptical cross-section and is bent in the form of circular arc. One end of the tube is fixed and connected to the steam space of the boiler and other end is connected to a sector wheel through a link. The sector remains in mesh with a pinion fixed on a spindle. A pointer as shown in the figure is attached to the spindle to read the pressure on a dial gauge.

When high pressure steam enters the elliptical tube, the tube section tries to become circular which causes the other end of the tube to move outward. The movement of the closed end of the tube (other end) is transmitted and magnified by the link and sector as shown in the figure. The sector is hinged at the point *H* as shown in the figure. The magnitude of the movement is indicated by the pointer on the dial.



C–Spring tube, *B*–Block, *R*–Road, *H*–Hinged point, *T*–Toothed sector, *P*–Pinion, *N*–Pointer, *K*–Cock.

Fig. 10.4. Bourdon pressure gauge.

10.6. FUSIBLE PLUG

The main object of the fusible plug is to put off the fire in the furnace of the boiler when the water level in the boiler falls below an unsafe level and thus avoid the explosion which may take place due to overheating of the tubes and shell. This plug is generally fitted over the crown of the furnace or over the combustion chamber.

A fusible plug which is commonly used is shown in Fig.10.5. *A* is a hollow gun metal body screwed into the crown of the boiler grate. *B* is a second hollow gunmetal plug screwed into the plug *A*. The third plug *C* is locked with plug *B* by pouring a low melting point metal into groove provided for the same.

Under normal water level condition in the boiler, this plug is covered with water which keeps the temperature of the fusible metal below its melting point. But when the water level in the boiler falls low enough to uncover the plug; the fusible metal between the plug *B* and *C* quickly melts and the plug *C* drops out. The opening so made allows the steam to rush the water into the furnace and extinguish the fire. The steam rushing out puts out the fire and gives warning that the crown of the furnace is in danger of being overheated.

10.7. FEED CHECK VALVE

The function of the feed check valve is to allow the supply of water to the boiler at high pressure continuously and to prevent the back flow of water from the boiler when the pump pressure is less than boiler pressure or when pump fails.

A commonly used feed check valve is shown in Fig. 10.6. It is fitted to the shell slightly below the normal water level of the boiler. The lift of the non return valve is regulated by the end portion of the spindle (*E*) which is attached with the hand wheel. The spindle can be moved upward or downward with the help of hand wheel as the upper portion of the spindle is screwed to a nut.

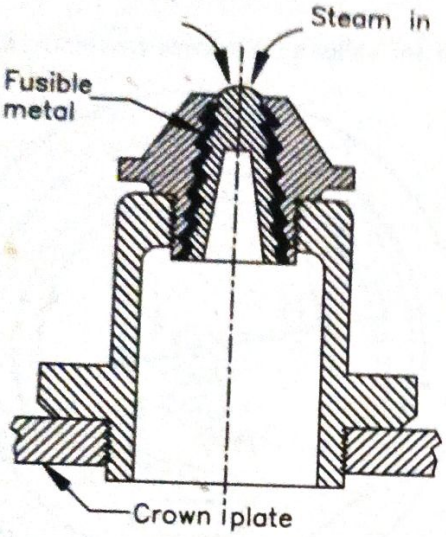


Fig. 10.5. Fusible plug.

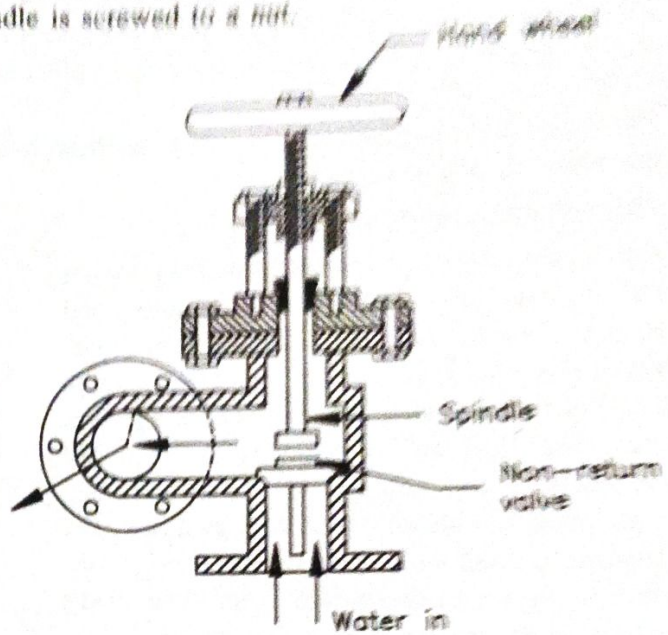


Fig. 10.6. Feed check valve.

At normal working condition, the non-return valve is lifted due to the pressure of water from the pump and the water is fed to boiler. But when the pump pressure falls below boiler pressure or if the pump stops, non-return valve is closed automatically due to the pressure of the water from the boiler and prevents the escape of water from the boiler.

10.8. BLOW-OFF COCK

The blow-off cock is used for dual functions :

1. To empty the boiler when neccessary for cleaning, repair and inspection.
2. To discharge the mud and sediments carried with the feed water and accumulated at the bottom of the boiler.

By periodic blow-off, the salt concentration in the boiler is also reduced. Even with a small amount of dissolved salt, over a period of time, due to the evaporation of water, the salt accumulates in the boiler, raising the salt concentration.

It is fitted to the lowest part of the boiler either directly with the boiler shell or to a pipe connected with the boiler.

A commonly used type of blow-off cock is shown in Fig. 10.7. It consists of a conical plug fitted accurately into a similar casing. The plug has a rectangular opening which may be brought with the line

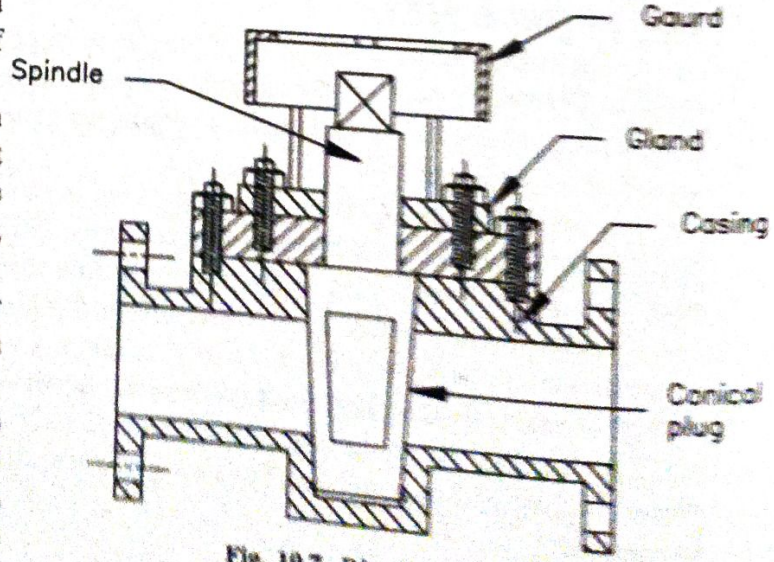


Fig. 10.7. Blow-off cock.

of the passage of the casing by rotating the plug. This causes the water to be discharged from the boiler. The discharging of water may be stopped by rotating the plug again.

The blow-off cock should be operated only when the boiler is on if the sediments are to be removed. This is because, the sediments are forced out quickly due to the high steam pressure in the boiler.

10.9. STEAM STOP VALVE

It is the largest valve on the steam boiler and usually fitted to the highest part of the boiler shell. The function of the stop valve is to regulate the flow of steam from the boiler to the engine as per requirement and shut off the steam flow when not required.

A commonly used steam stop valve is shown in Fig. 10.8. The main body is made of cast steel. The valve, valve seat and the nut through which the valve spindle works, are made of brass for smooth working. The spindle is passed through a gland to prevent the leakage of steam. The spindle is rotated by means

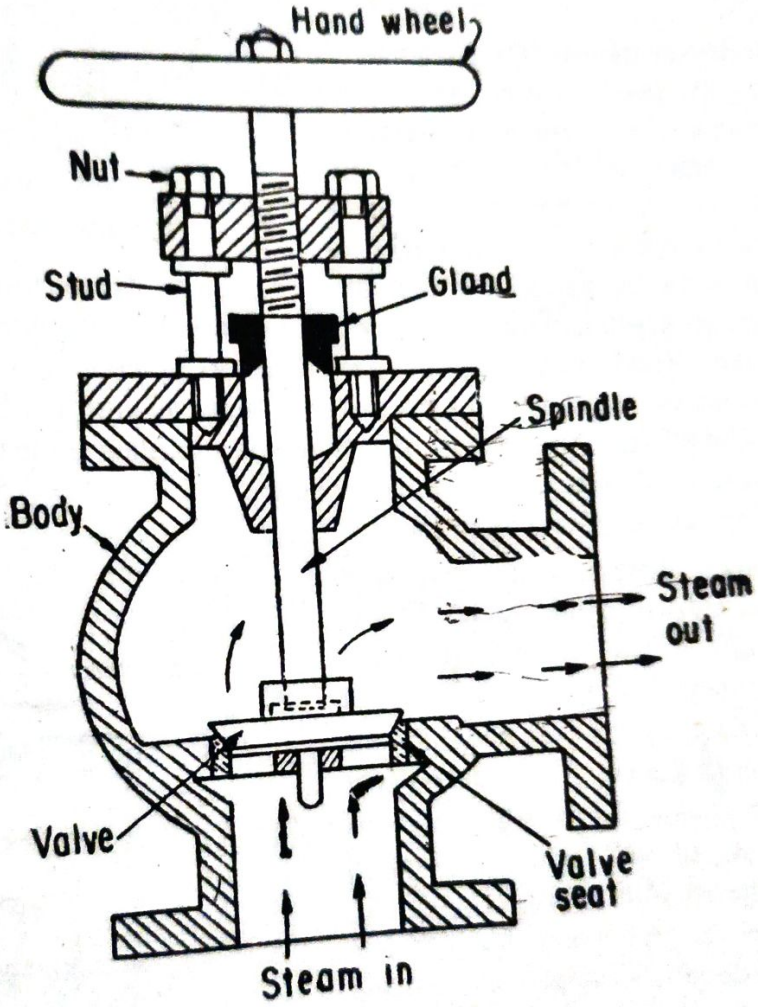


Fig. 10.8. Steam stop valve.

of a hand wheel. Due to the rotation of hand-wheel, the valve may move up or down and it may close or open the passage fully or partially for the flow of the steam. In locomotive boiler the flow of steam is controlled by means of a regulator (as discussed in previous chapter) which is placed inside the boiler shell and operated by a handle from the driver's cabin.

10.10. BOILER ACCESSORIES AND THEIR FUNCTIONS

Boiler accessories are auxiliary parts required to increase the overall efficiency of the plant. Water feeding equipments, air-preheaters, economisers and superheaters are some of the essential accessories of the boiler.

10.11. ECONOMISER

The economiser usefully extracts the waste heat of the chimney gases to preheat the water before it is fed into the boiler. Preheating of the boiler feed water has the following advantages:

(1) There is a saving of fuel as waste heat from the flue gases is used for heating the feed water.

(2) Dissolved gases as air and CO_2 are removed by preheating the feed water, reducing corrosion and pitting.

(3) There will be less temperature strain in the boiler plates as the feed water enters the boiler at a higher temperature.

(4) Circulation of the water is very well maintained as quick evaporation is possible because of hot feed water.

(5) This unit improves the overall efficiency of the boiler by reducing the fuel consumption.

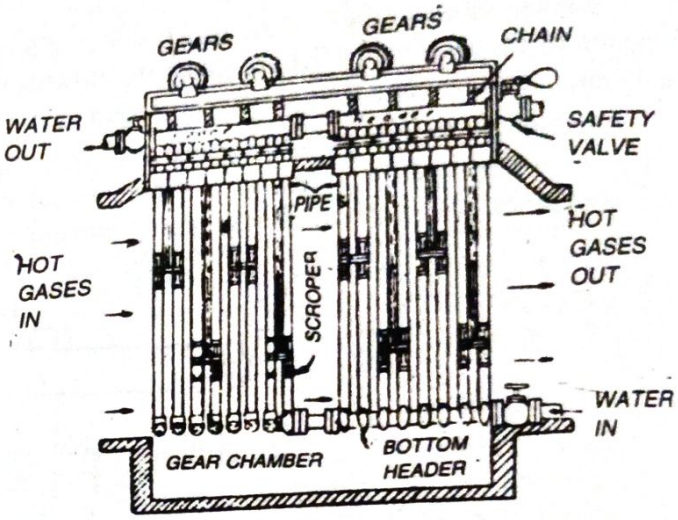


Fig. 10.9. (*a*) Green Economiser.

A Green's economiser commonly used in Lancashire boiler is shown in Fig. 10.9 (*a*) The economiser consists of vertical cast iron pipes which are fitted with two headers, one at the bottom and other at the top. The feed water is passed through the bottom header, economiser pipes and top header and on to the boiler. The hot gases pass over the external surface of the water tubes. The heat from the hot gases is given to the feed water through the tube surface. A safety valve is fitted on the top header for the safety of pipes against any highest pressure of water that may be developed. A blow-off valve (not shown in the figure) is also fitted at the lowest point of the economiser to discharge the sediments collected from the feed water.

To prevent the deposition of soot from the flue gases over the economiser tubes, a set of scrapers is fitted over the pipes as shown in the figure. This is necessary as the deposition of soot reduces drastically the heat flow rate from the gases to the water. The soot is removed by moving the scrapers over the pipes up and down continuously with the help of chain and gear arrangement. The soot removed from the pipes is collected in soot chamber situated below the bottom header and removed periodically.

The temperature of the feed water should not be less than 35°C because there is a danger of corrosion of the cold pipe outer surfaces due to the condensation of moisture and SO_2 contained in the flue gases.

By-pass arrangement for the furnace gases must always be provided so that the economiser may be put out of action when necessary (for repair or inspection). Fig.10.9 (*b*) shows such an arrangement used with Lancashire boiler.

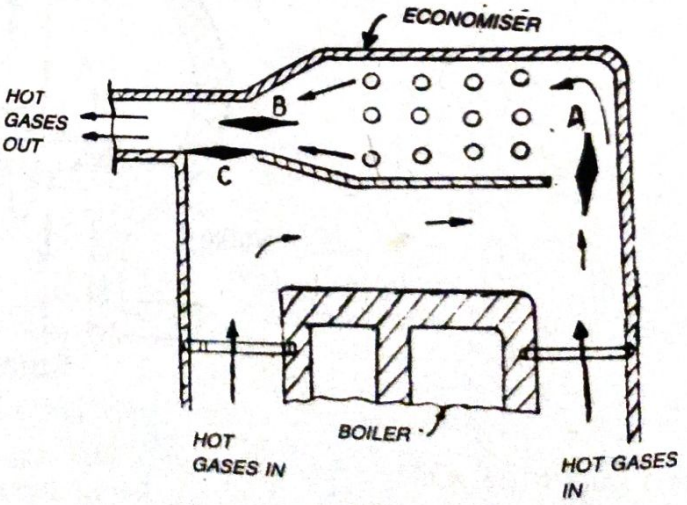


Fig. 10.9. (*b*) Bypass arrangement.

(*a*) When hot gases are used for heating the feed water, the dampers *A* and *B* are kept open and damper *C* is closed.

(*b*) When hot gases are to be bypassed for economiser inspection, the dampers *A* and *B* are closed and damper *C* is kept open.

10.12. AIR PREHEATER

Air preheater, like economiser, recovers some portion of the waste heat of the flue gases. Air supplied to the combustion chamber is preheated by using the heat in the waste flue gases. Air preheaters are placed after the economiser and before the gases enter the chimney.

The preheating of air offers the following advantages :

(1) Waste heat from the flue gases is recovered for heating air and reduces the fuel consumption by about 1.5% for each 100°C drop in gas temperature.

(2) Inferior grades of coal can be burnt efficiently with preheated air.

(3) Combustion can be more efficient and an intense flame can be achieved in the furnace. This increases the evaporation rate of the boiler.

Air-preheaters can be classified as tubular type, plate type and generative type. In tubular type, the hot flue gases pass through the tubes and air is forced to flow over the tubes. The plate type consists of a number of parallel plates. Air flows through the alternate spaces of the plates and flue gas passes through the remaining passages. In regenerative type, a wire mesh rotor is alternately heated by the flue gases and then cooled by the air and as a result the air is heated.

A tubular type commonly used in smaller boiler plants is shown in Fig. 10.10. The hot gases are passed through the tubes and air circulates around them. Air is forced to deflect by using baffles as shown in the figure and compelled to move in a zigzag path for a number of times. This increases the period of contact between the air and hot surface and air is effectively heated. The soot and other material carried with gases are collected in the hopper at the bottom and removed periodically through the soot gate.

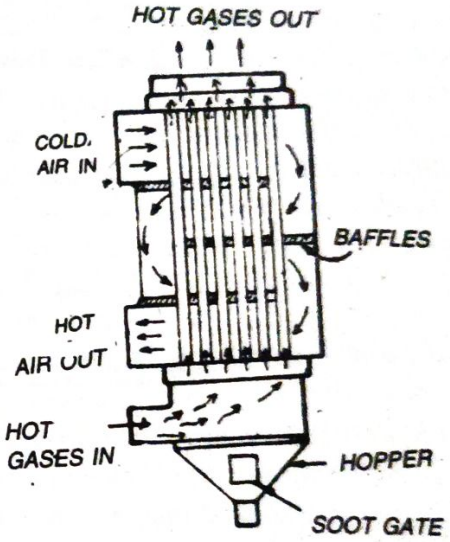


Fig. 10.10. Air preheater.

10.13. SUPERHEATER

Superheaters are used in boilers to increase the temperature of the steam above its saturation temperature. This is done by passing the steam through a small set of tubes and hot gases over them. Superheated steam is absolutely essential for power generation.

The advantages of superheated steam are listed below :

(1) It reduces the specific steam consumption of engines and turbines.

(2) It reduces the condensation losses in the pipes and engine cylinder.

(3) It eliminates the erosion of the turbine blades in the last stages.

(4) The efficiency of the steam plant is higher with the use of superheated steam.

The superheaters used in locomotive boilers and Babcox and Wilcox boilers have already been described.

The superheater commonly used in Lancashire boiler is shown in Fig. 10.11. This superheater consists of two headers and a set of superheater tubes made of high quality steel in the form of U-tube. Superheater is located in the path of furnace gases where the temperature of the gases is not less than 550°C. The superheater is located just before the gases enter the bottom flue.

The amount of hot gases passed over the superheater tubes should be in proportion to the amount of superheated steam passing through the tubes. Otherwise, the tubes would be overheated. To avoid this, the amounts of hot gases are diverted as shown in the figure. The superheater is put out of action by turning the damper upward to the vertical position. In this position of the damper, the gases coming out from the central flue pass directly into the bottom flue without passing over the superheater tubes.

The arrangement for getting superheated or wet steam is shown in the figure. For getting superheated steam, the valves *A* and *B* are opened and valve *C* is closed. And the damper is kept open as per the quantity of steam flowing through the pipe. For this position, the flow direction of the steam is shown in the figure. If wet steam in required, then the valves *A*, *B* and gas damper are kept closed, and valve *C* is kept open. In this case, the steam directly comes out from the boiler through the valve *C*. By adjusting the gas damper,