

# **DEFINATION OF A BOILER**

- A Boiler is a device use for generating stream from water.
- This stream is utilize for the power generation, for the process heating, for the space heating.
- Only hot water is produced in a boiler and utilize for the heating purpose sometime.
- According to IBR (Indian Boiler Regulations), a boiler is a close pressure vessel with the capacity exceed 22.75 liters use for generating stream under pressure.

It includes all the mountings fit to such that vessels which remain wholly or partly under pressure when stream is shut-off.

Capacity of the boiler use for power generation is larger.

The stream is produce at high pressure due to requirement of high efficiency.

The boiler use for the process heating are generally smaller in the size, simpler in the design, generate a stream at a much lower pressure.

# APPLICATION OF STEAM

- To drive the Prime Movers like Steam Turbine in Thermal Power Plant, Steam Engine in Train etc.
- In Industry as Process Heating.

## Essential Qualities of the Good Boiler:-

It should produce maximum steam with minimum fuel consumption, it should have high efficiency.

It should be able to deliver desired quantity of the steam quickly after starting.

It should be able to meet larger load fluctuations.

It should be able to vary steam production rate as per the requirement in a wide range.

It should be light and simple in to the construction.

It should occupy less space.

It should be easy to maintain and inspect.

The velocity of the water and that of the flue gases should be minimum.

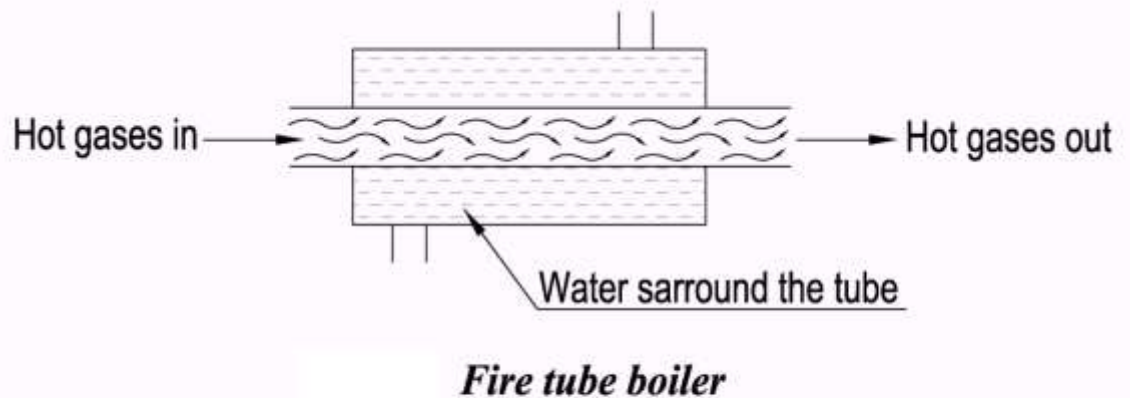
# CLASSIFICATION OF BOILERS.

- **According to Position of Boiler.**
  - Horizontal Boiler.
  - Vertical Boiler.
  - Inclined Boiler.
- **According to Number of Tubes in Boiler.**
  - Single Tube Boiler.
  - Multi Tube Boiler.

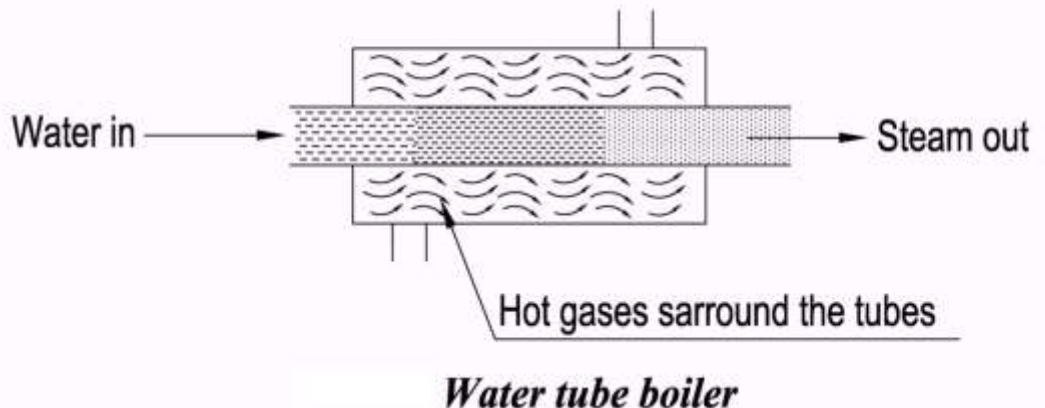
# CLASSIFICATION OF BOILERS.

- According to the Fluid Passing through the Tubes.

- Fire Tube Boiler.



- Water Tube Boiler.

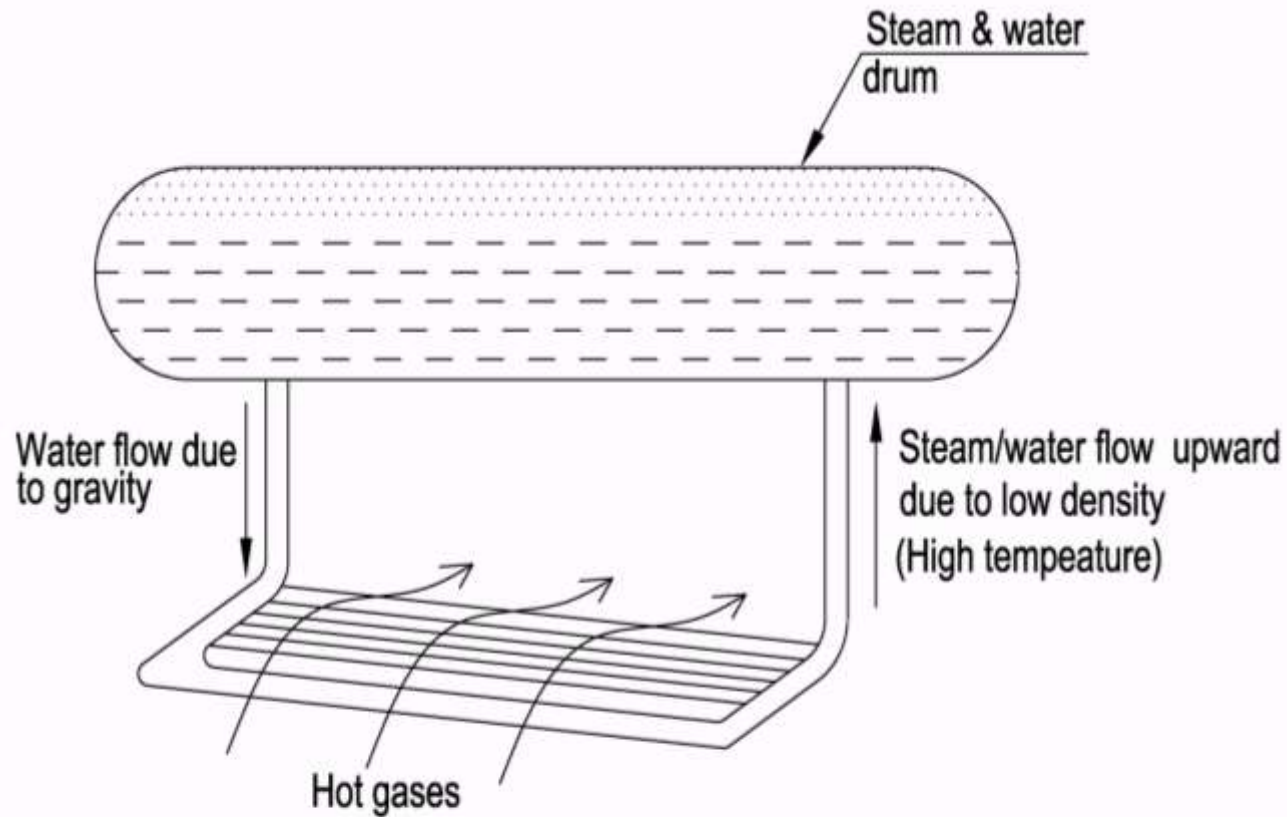


# CLASSIFICATION OF BOILERS.

- **According to the Method of Water Circulation.**
  - Natural Circulation Boiler.
  - Forced Circulation Boiler.

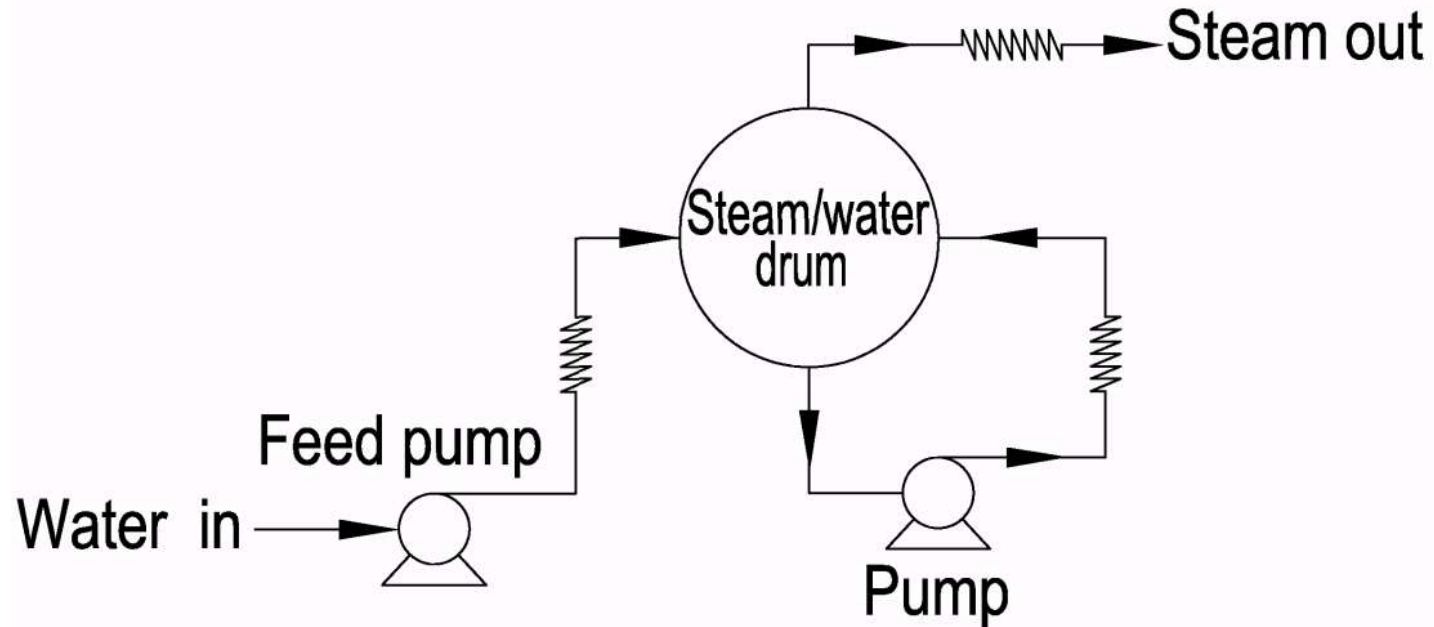


# CLASSIFICATION OF BOILERS.



***Natural circulation boiler***

# CLASSIFICATION OF BOILERS.

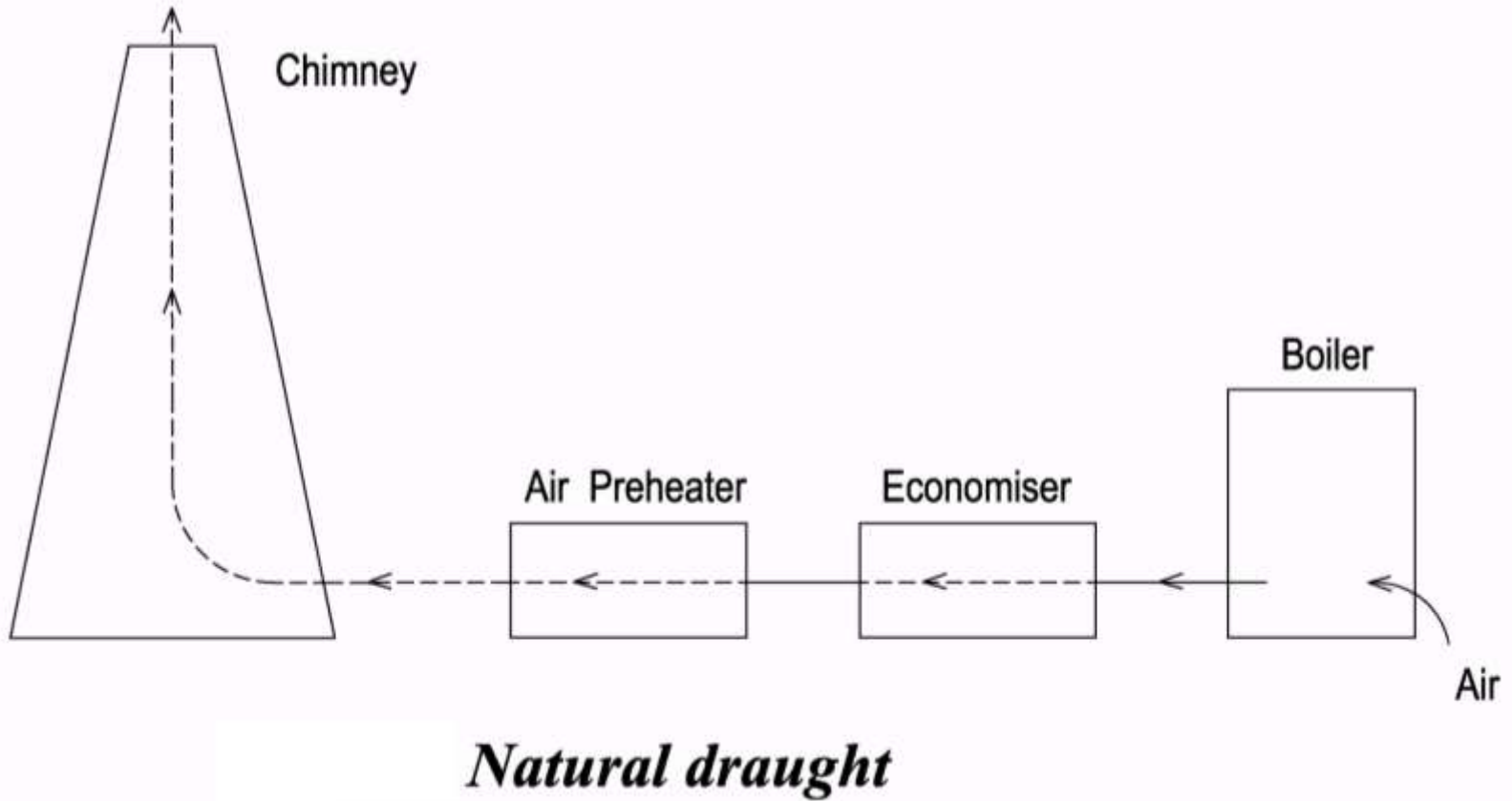


***Forced circulation boiler***

# CLASSIFICATION OF BOILERS.

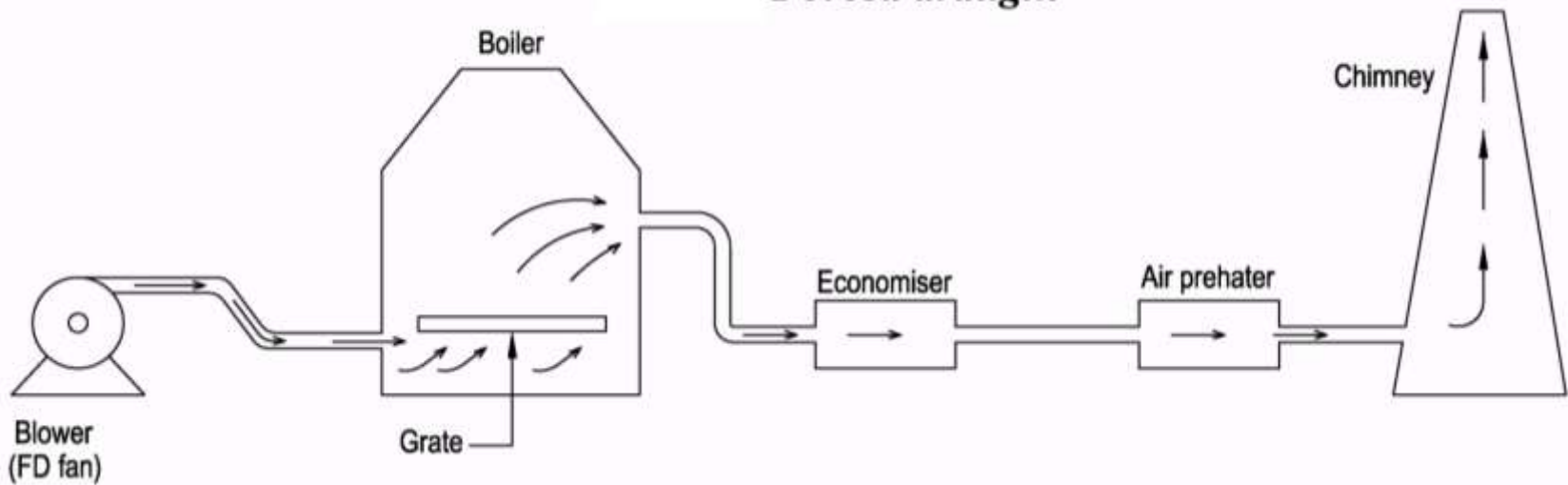
- **According to the Method of Air and Hot Gases Circulation.**
  - Natural Draught Boiler.
  - Artificial Draught Boiler.
    - Steam Jet Draught.
    - Mechanical Draught.
      - Induced Draught Fan.
      - Forced Draught Fan.
      - Balanced Draught Fan.

# CLASSIFICATION OF BOILERS.

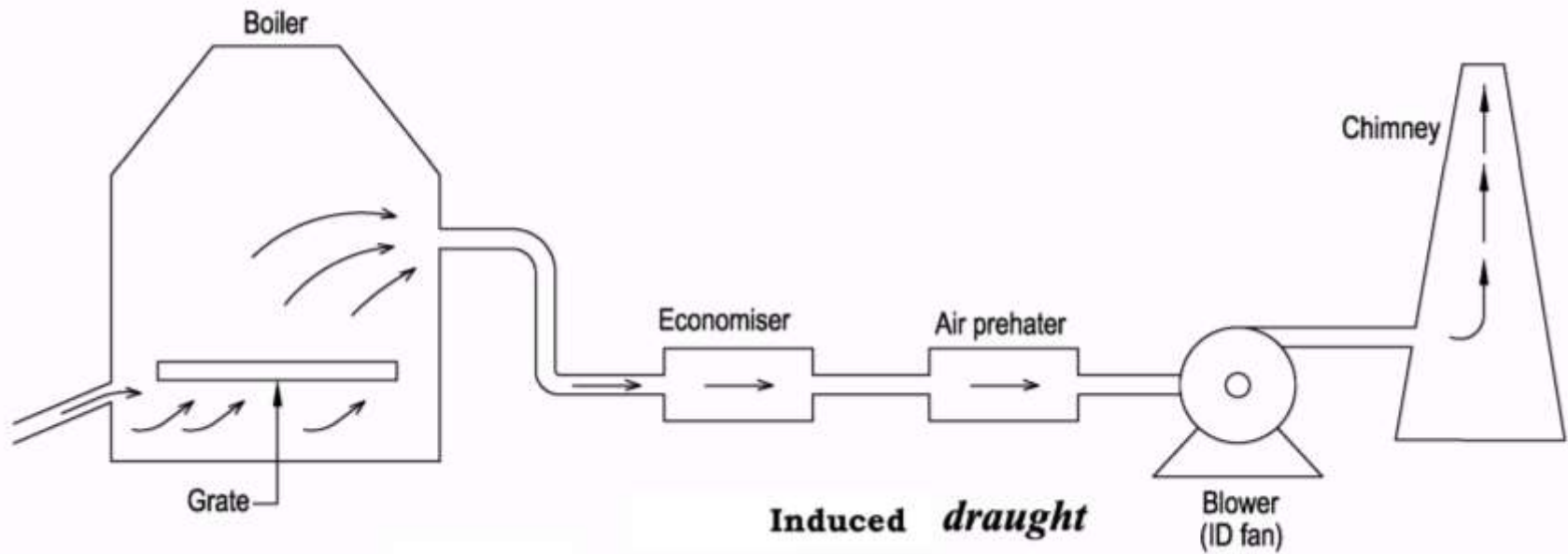


# CLASSIFICATION OF BOILERS.

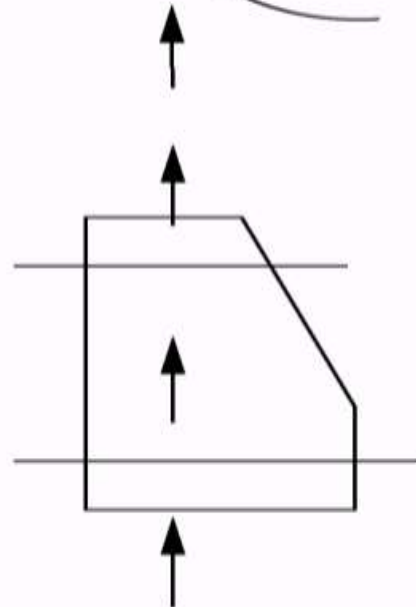
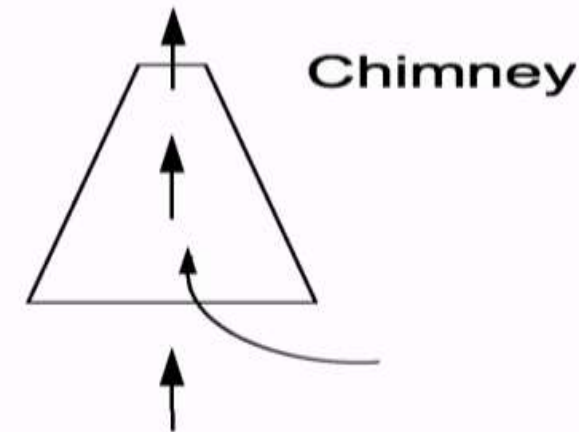
## *Forced draught*



# CLASSIFICATION OF BOILERS.



# CLASSIFICATION OF BOILERS.



Steam supply

***Steam jet draught***

# CLASSIFICATION OF BOILERS.

- **According to the Location of Furnace.**
  - Internally Fired Boiler.
  - Externally Fired Boiler.
- **According to the Boiler Pressure.**
  - Low Pressure Boiler.
    - Pressure Range : 3.5 to 10 bar.
  - Medium Pressure Boiler.
    - Pressure Range : 10 to 25 bar.
  - High Pressure Boiler.
    - Pressure Range : More than 25 bar.



# CLASSIFICATION OF BOILERS.

- **According to the Application.**
  - Stationary Boiler.
  - Mobile Boiler.
  - Marine Boiler.

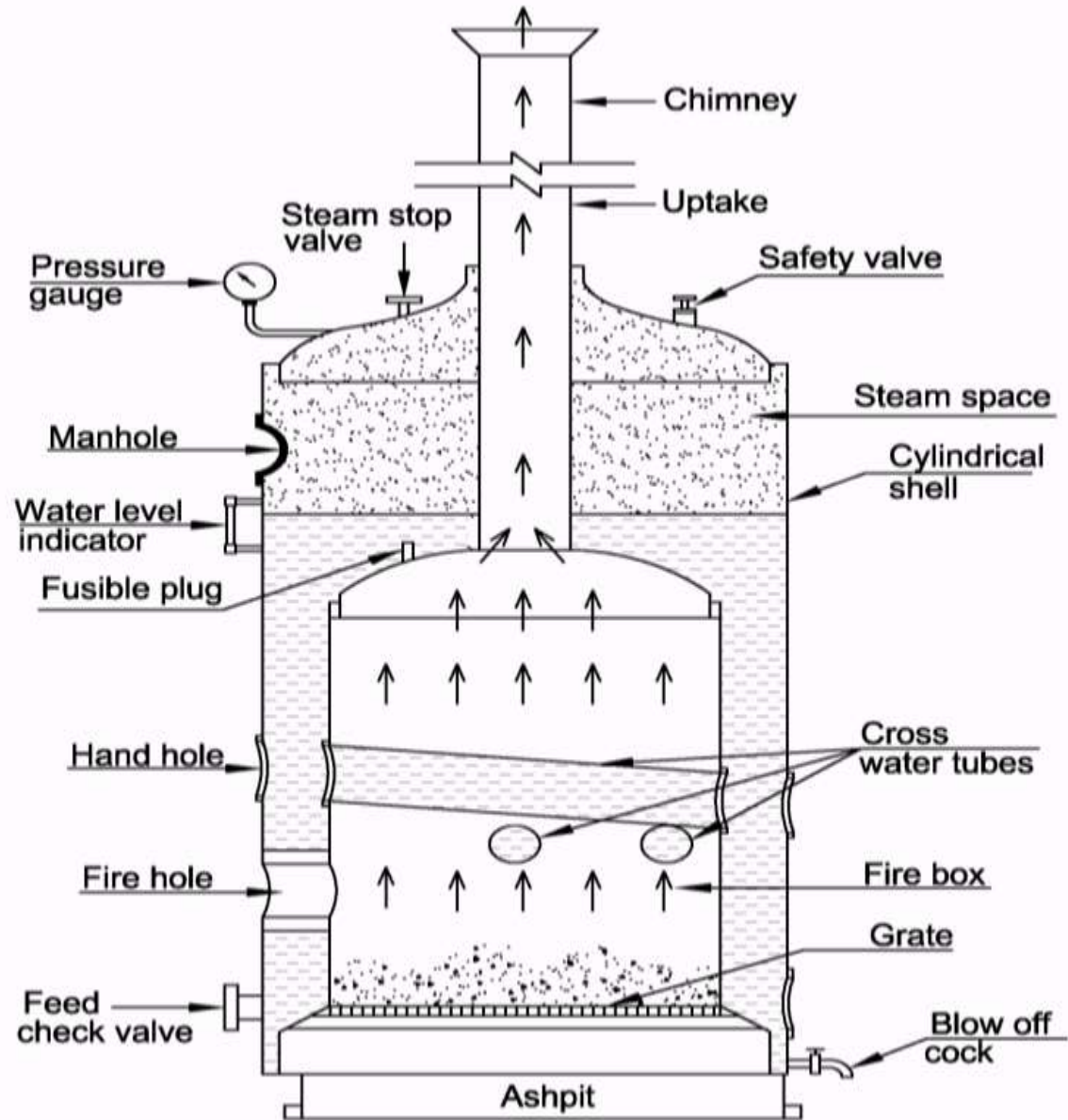
<b>Main Part</b>	<b>Working</b>
Cylindrical shell (boiler drum, closed vessel)	<ul style="list-style-type: none"> <li>• It is a closed vessel in which water is filled and heated. Lower half of drum is filled with water and upper half is for steam.</li> </ul>
Combustion chamber (furnace, fire box)	<ul style="list-style-type: none"> <li>• It is the place in boiler where fuel is burnt and hot gases (smokes) are generated.</li> </ul>
Grate	<ul style="list-style-type: none"> <li>• It is the platform provided in the combustion chamber on which fuel is burnt.</li> </ul>

Ash pit (ash pan)	<ul style="list-style-type: none"> <li>• It is the place where ash is collected.</li> </ul>
Fire Hole	<ul style="list-style-type: none"> <li>• It is the hole provided in combustion chamber through which fuel is added into combustion chamber.</li> </ul>
Smoke Chamber (smoke box)	<ul style="list-style-type: none"> <li>• It is the place where, hot gases are collected.</li> </ul>

<b>Main Part</b>	<b>Working</b>
<p>Anti priming pipe (steam collecting pipe)</p>	<ul style="list-style-type: none"> <li>• When the steam is leaving the boiler, it always contains some amount of water (moisture). It is necessary to remove water particles from steam.</li> <li>• Anti priming pipe is used to separate water particles from steam.</li> <li>• When wet steam (steam containing some amount of water) from boiler, enters the anti priming pipe, its direction is changed suddenly. Due to the direction change, dry steam moves in upward direction, but water having more weight is collected at the bottom of the priming pipe. Dry steam is taken out from top.</li> </ul>

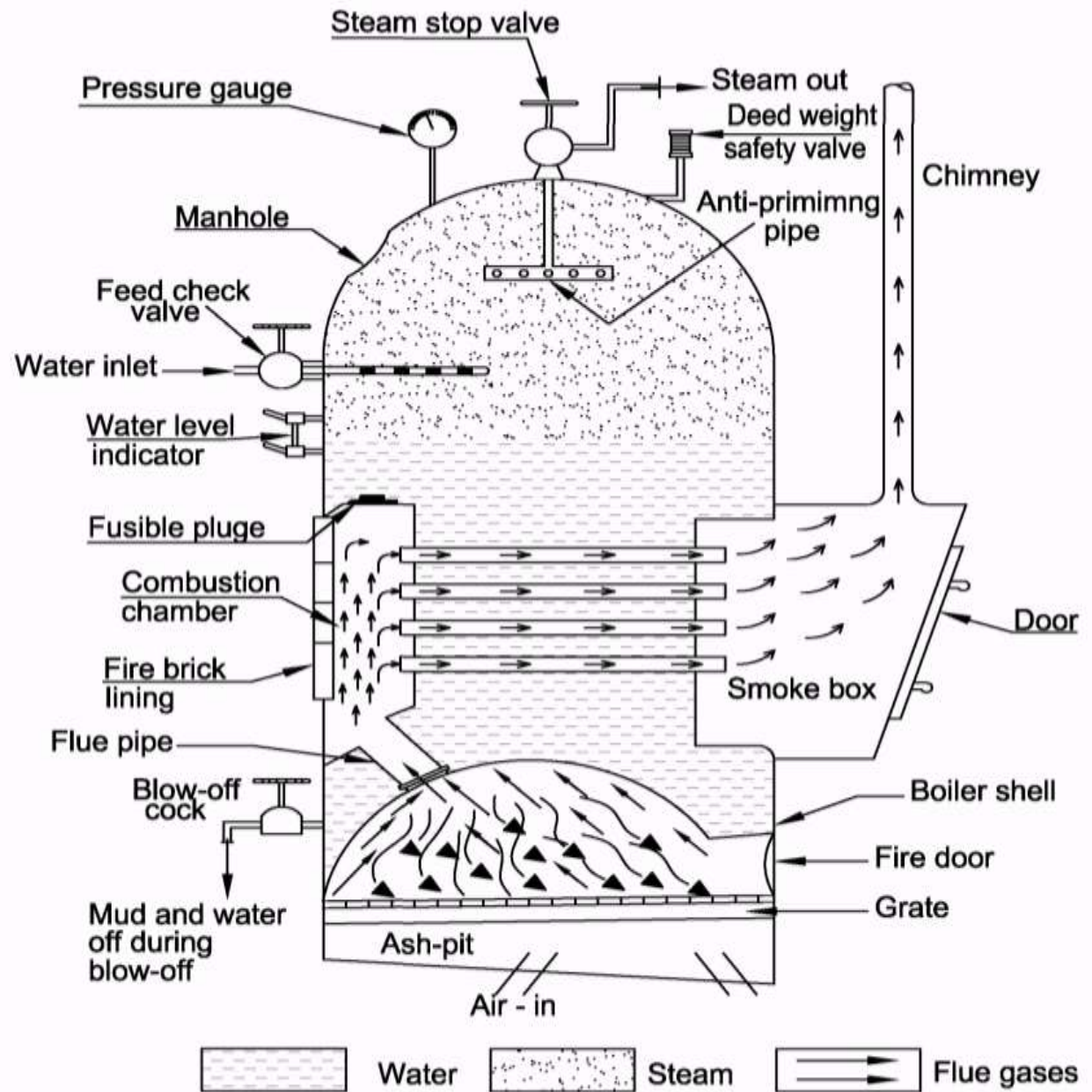
Baffle plates	<ul style="list-style-type: none"> <li>• Baffle plates are provided in the path of hot gases movement.</li> <li>• Due to baffle plate, hot gases move in zigzag (sine wave form) path.</li> <li>• It increases the time of contact between water and hot gases.</li> </ul>
Damper	<ul style="list-style-type: none"> <li>• Generally Dampers are provided at the bottom of the chimney.</li> <li>• Dampers are used to regulate the flow of hot gases.</li> <li>• If the hot gases are sufficiently hot, damper is closed and hot gases are stopped to enter in the chimney until hot gases cool sufficiently.</li> </ul>

# SIMPLE VERTICAL BOILER



*Simple vertical boiler*

# COCHRAN BOILER



*Cochran boiler*

Cochran boiler is a vertical, multi fire- tube boiler use for the low rate steam generation.

Made in different sizes with the steam evaporation capacity range from 150 to 3000 kg per hour and working pressure range is up to 20 bar.



## Construction and Working:-

Boiler consists of a cylindrical shell with the hemispherical shape crown.

Fire- box is also hemispherical in the shape.

The hemispherical crown of boiler gives good strength to withstand pressure of the steam inside the boiler.

The hemispherical shape of the furnace can withstand intense heat and is also advantageous for the absorption of the radiant heat from the furnace.

The grate is placed at the bottom of the furnace and is located below the grate.

The coal is fed to the grate through the fire door and ash formed is collected in to the ash-pit.

The furnace and the combustion chamber are connected by the short flue pipe.

The back of the combustion chamber is lined with the fire bricks.

The hot gases enter the combustion chamber through flue pipe with the considerable velocity.

The hot gases in to the combustion chamber flow through the rest of the horizontal fire tubes.

The gases pass through the fire tubes transfer a large portion of the heat to the water by the convection mode of heat transfer.

The flue gases coming out of the fire tubes enters in to the smoke box.

They are then discharge to the atmosphere through a chimney.

A man hole is provide near the top of the crown of the shell for cleaning.

A number of hand holes are also provide around the outer shell for cleaning purposes.

The smoke box is provide with the doors for the cleaning of the interior of the fire tubes.

The air flow through the grate is caused by means of the draught produced by the chimney.

A damper is placed inside the chimney to control the discharge of the hot gases and thus the flow of the air through grate.

Oil is also use in some boiler as a fuel in place of the coal.

# Advantages and Disadvantages of the Boiler:-

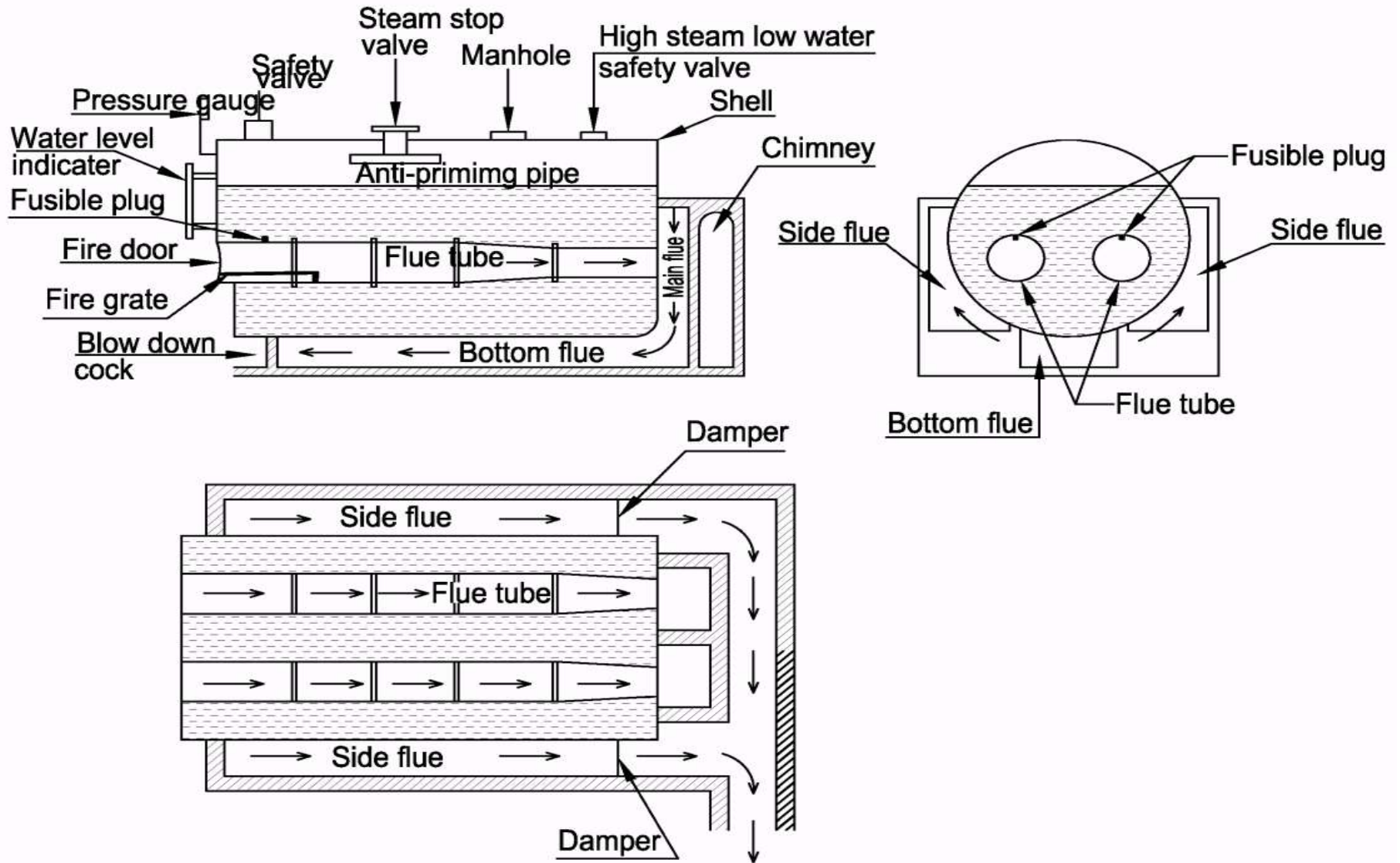
## Advantages:-

- (1) Compactness and portability
- (2) Lower first cost
- (3) Quick and easy installation

## Disadvantages:-

- (1) The interior is not easily accessible for cleaning inspection and repair.
- (2) Efficiency is lower in smaller sizes.
- (3) Water capacity is small, making it difficult to keep a steady stream pressure.

# LANCASHIRE BOILER



***Lancashire boiler***

## Construction and Working:-

Lancashire boiler is one of the most common use stationary boilers.

The boiler is internally fired and flue gases have three passes-one from inside of the boiler, second from below, and third from the side of the boiler shell.

The boiler has good streaming quality as it is heated from the three sides.

It can burn inferior quality coal also.

The boilers have a cylindrical shell of 2 m diameter and the length of 8 m to 10 m.

The cylindrical shell is place over the brick structure.

The brick work also forms one bottom flue, and two side flues as shown in the figure.

The grates G are provide at the front end of the two main flue tubes inside the boiler.

A fire brick bridge B is provide at the end of the grate to prevent coal and ash particles enters in to the injector of the furnace tubes.

The got gases leaves the grate pass up to the back end of the tubes and then in to the downward direction.



They move by the bottom flue to the front of the boiler where they are divided in to two streams and pass into the side flues.

They move along two side flues and enters the chimney flue.

Ultimately they are the discharging to the atmosphere from the chimney.

The water level in the boiler shell is always above the main flue tubes.

The water in the shell is also heated from the bottom by the bottom flue and from sides by the side flue.

When provide the superheater is at the end of the main flue tubes in the passage of the flue gases.

While an economizer is at the end of the side flues, before exhausting the gases to the chimney.

Dampers D in the form of sliding door are place at the end of the side flues to control the flow of the gases.

This regulates the flue combustion rate as well as steam generation rate.

The dampers are operated by the chains pass over a pulley outside the boiler.

## Mountings:-

The steam collecting pipe P, safety valve S, low water and high stream safety valve L and man hole M are provide on to the top of the boiler shell.

The pressure gauge and water level indicator and feed check valve are provide at the front of the boiler.

The blow off cock C is at the bottom of the shell on front side.

The fusible plugs are mount on to the top of the main flues just over the grates.

## Advantages and Disadvantages:-

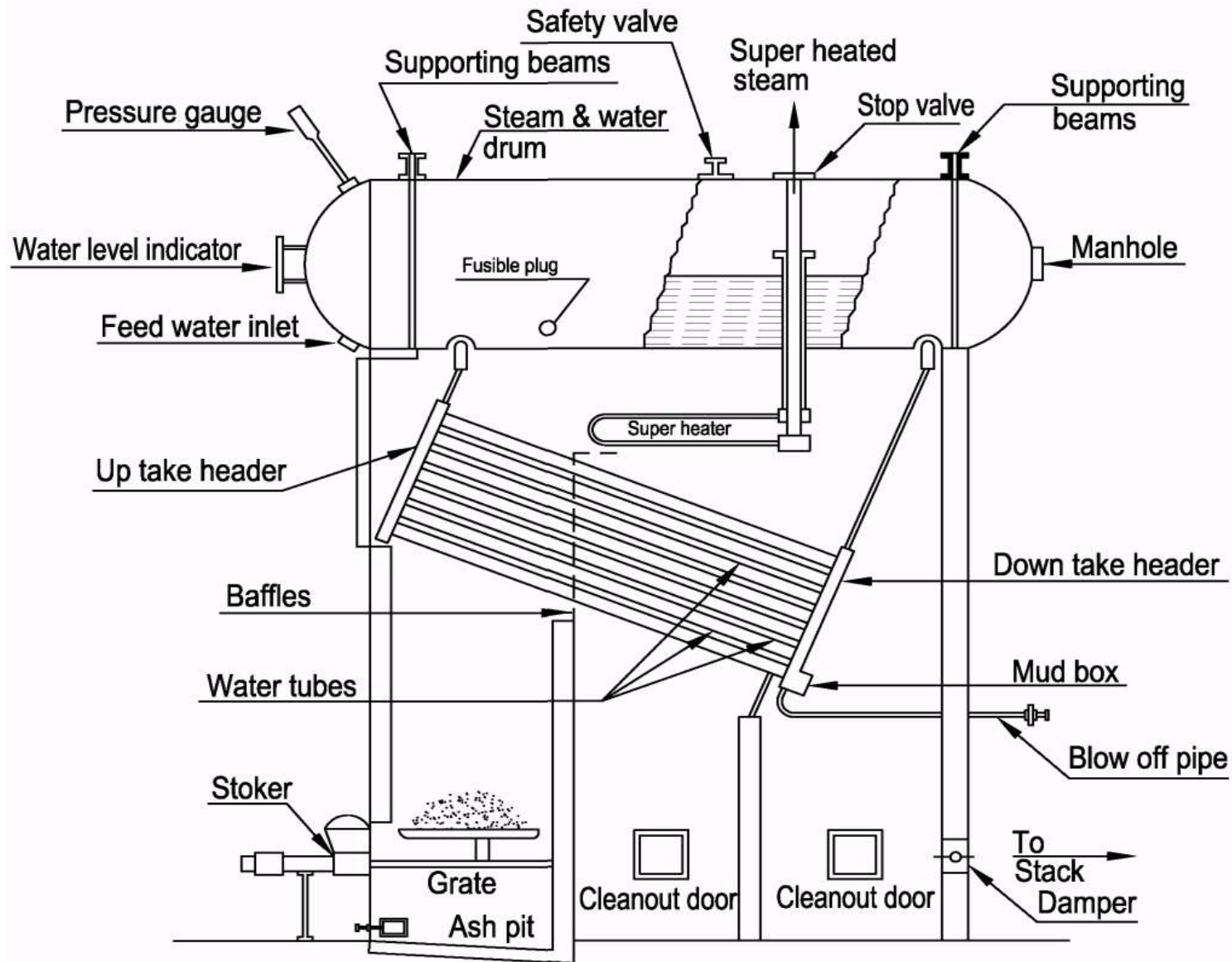
### Advantages:-

- (1) The heating surface area per unit volume of the boiler is considerably large.
- (2) Its maintenance is easy.
- (3) Load fluctuation can be easily met by this boiler due to large reserve capacity for the water.

### Disadvantages:-

- (1) It occupy large floor space due to brick work.
- (2) Takes more time to deliver steam at required pressure and rate.

# BABCOCK AND WILCOX BOILER



*Babcock and wilcox boiler*

## Construction and Working:-

This is a water tube boiler, water flows inside the tubes and hot gases flow over the tubes.

The steam and water drum run from front to rear of the boiler.

It is made of high quality steel.

The inclined steel tubes of around 4 inches diameter are connected with pressed steel headers on the either side.

A short pipe connect the front header while a long pipe connect the back header with the drum.

The headers are provide with hand holes which are cover with the caps.

The hand holes are useful to clean the tubes.

The mud box collects sediments which are blown away frequently through blowoff valve.

The furnace is kept below the front header.

Coal is fed to grate through fire hole.

The fire brick baffles are oriented such that the hot gases from furnace are first force to move up then down and again upward over the water tubes.

The dampers control the flow of the air in to the furnace.

Water in the drum comes down through downcomer and enter the tubes.

They get heat from the gases.

The water of decreased density and part of the water converted to the steam enter the drum through riser.

Thus a continuous circulation of the water from drum to water tubes and water tubes to drum is maintain.

Saturated steam from the upper part of the drum pass downward to the superheater.

The superheater is a set of U tube and is situated below the drum.



The superheated stream is taken from main stop valve through superheater header.

The access to the interior of the boiler is provided by the cleanout doors.

The boiler contains the standard mounting like steam gauge, water level indicator, feed check valve, safety valve etc.

## Advantages and Features:-

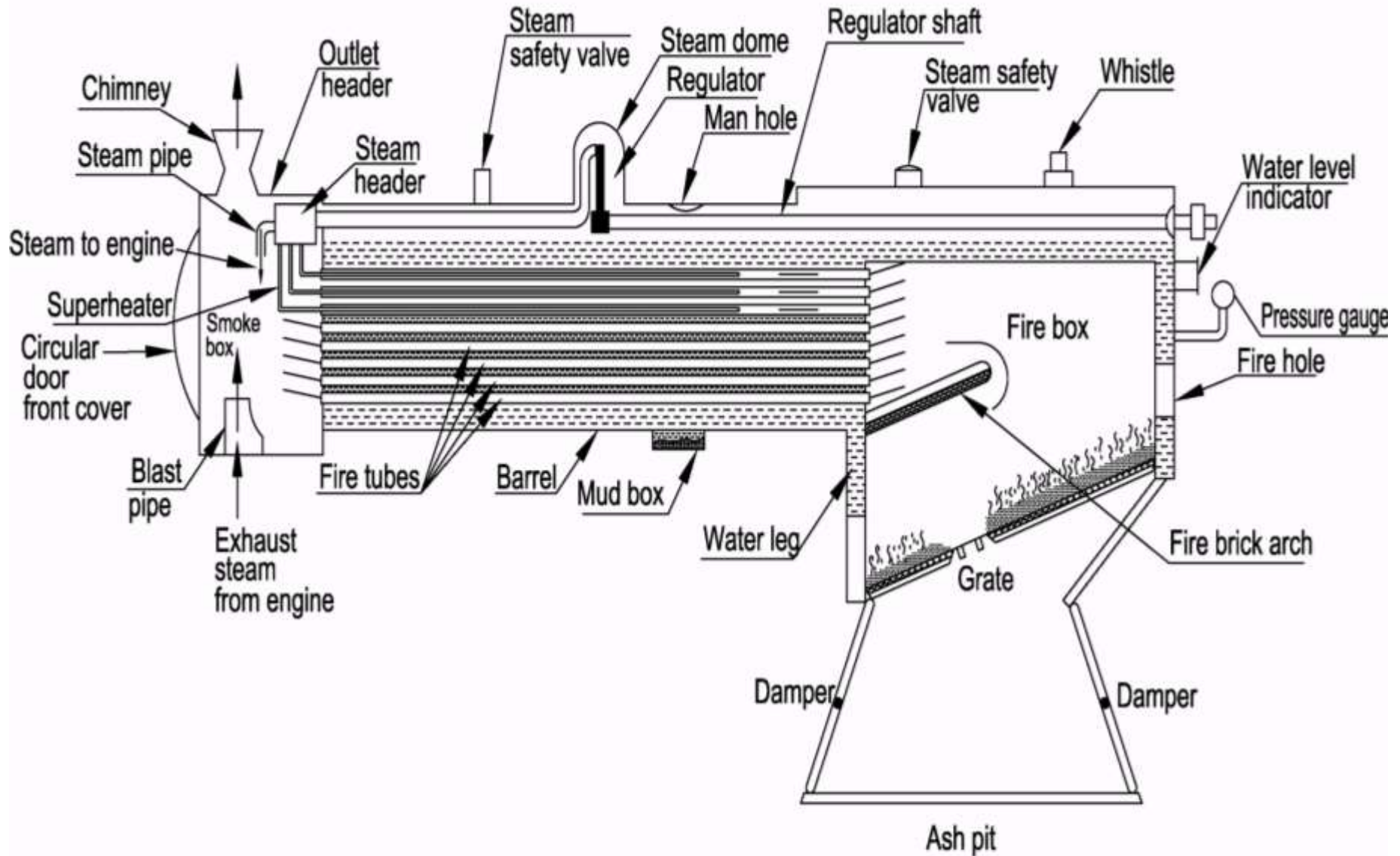
### Advantages:-

- (1) The steam generation capacity of the boiler is very high.
- (2) The defective tubes can be easily replaced.
- (3) The draught loss is much less

### Features:-

- (1) Boiler can generate high quality steam in the large amount.
- (2) Use in to the power stations.
- (3) Occupy lesser amount of floor space area.
- (4) Offers great operational safety.

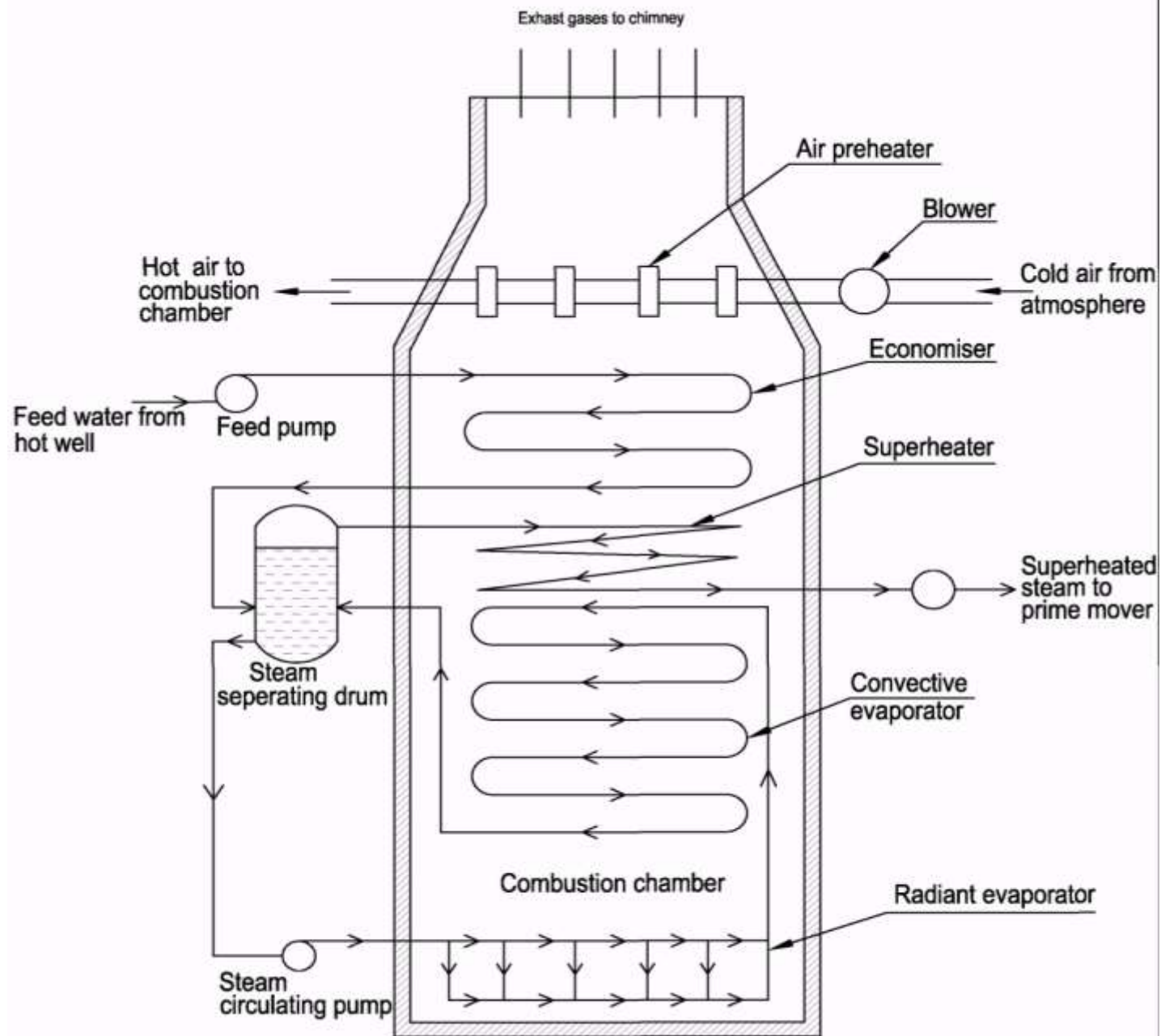
# LOCOMOTIVE BOILER



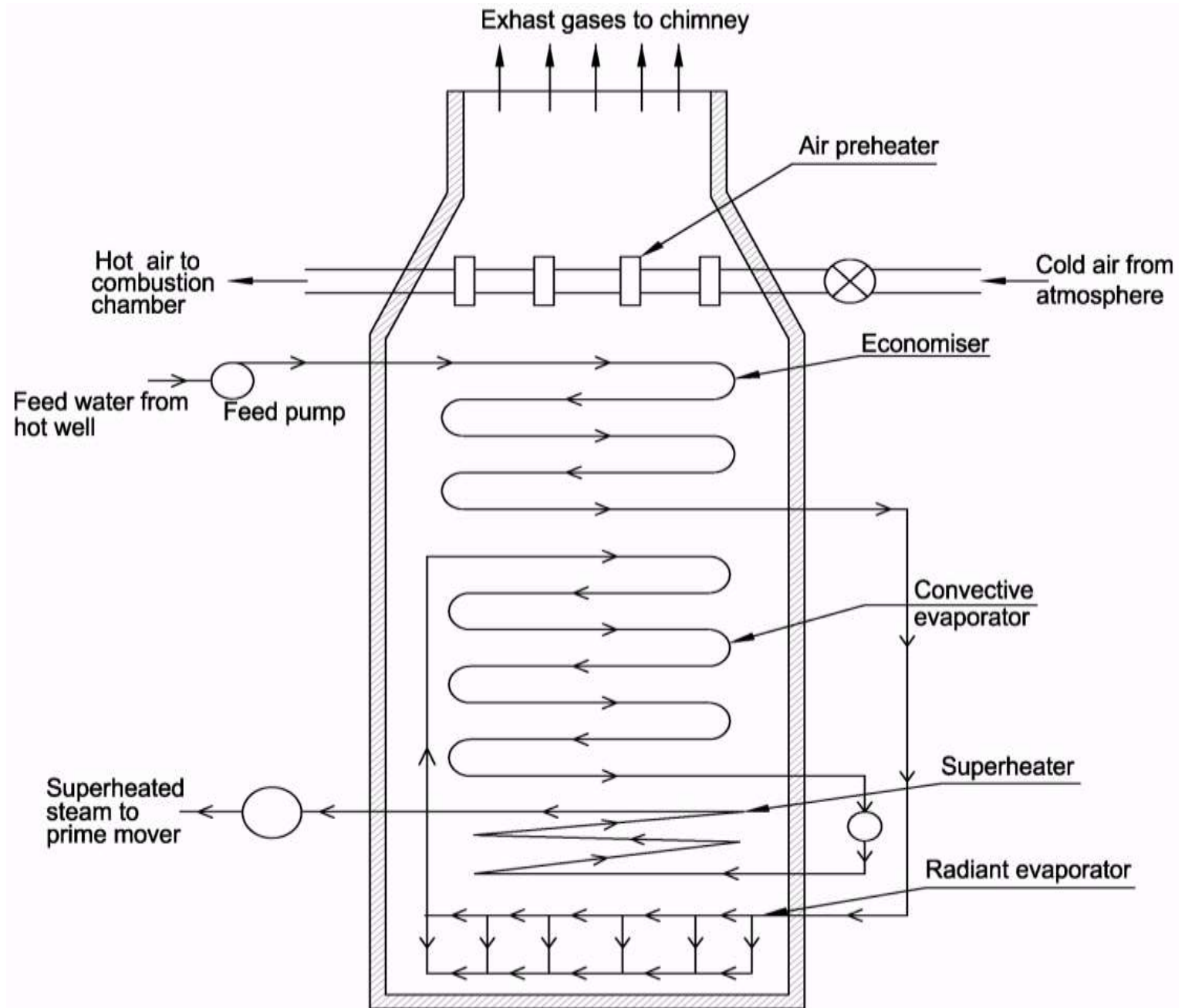
*Locomotive boiler*

# HIGH PRESSURE BOILERS.

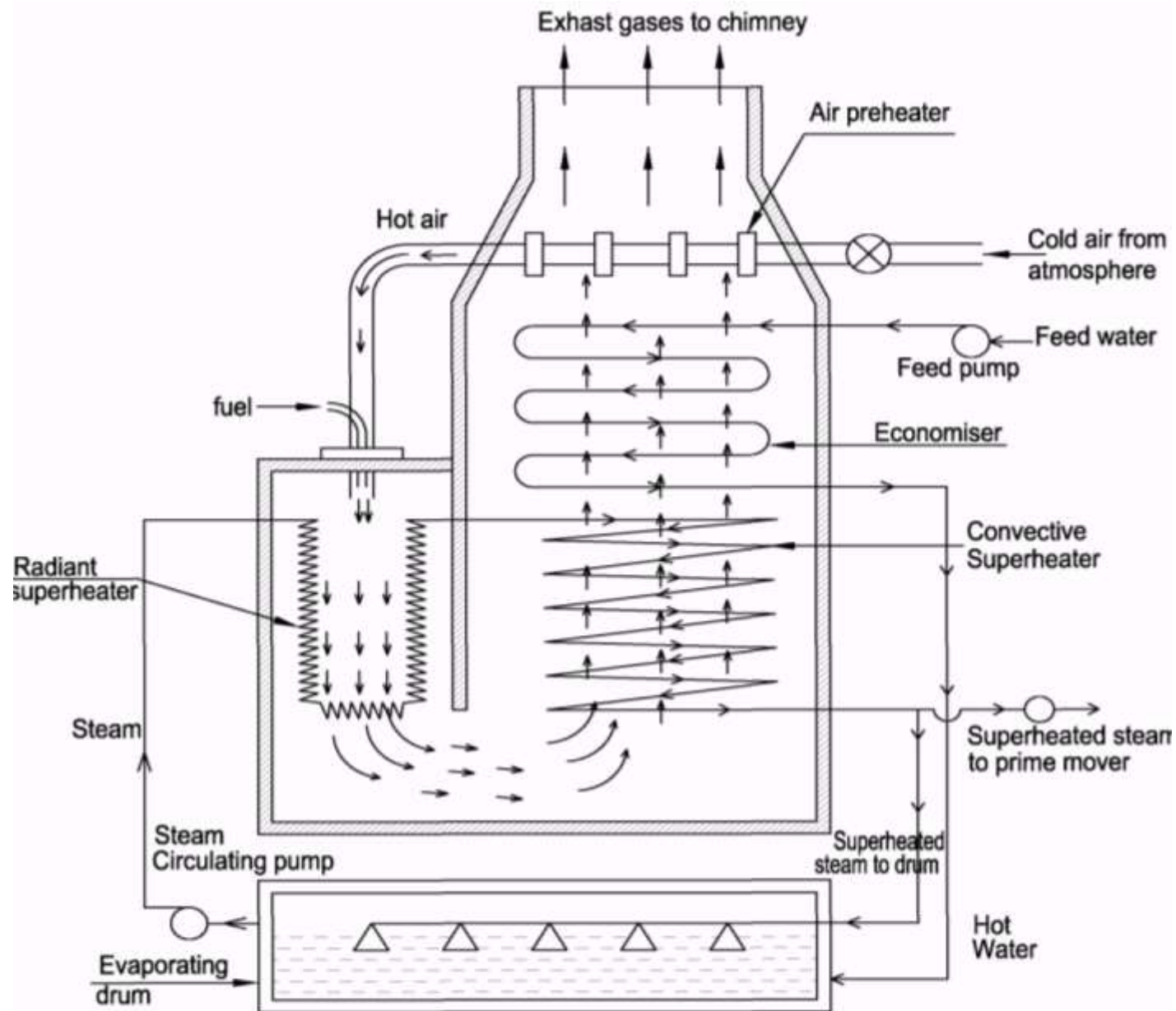
- **Advantages of High Pressure (More than 30 bar) Boiler.**
  - Small Diameter tubes are used, which increases heat transfer rate.
  - Less Fuel Consumption.
  - Due to High Pressure and Temperature, Plant Efficiency increases.
  - Due to Forced Circulation of Water.
    - Evaporation of water in the Boiler is faster.
    - Less Size of Drum is required.
    - Scale Formation tendency is eliminated.
    - Compact, so Less Floor Space Required.



***La-Mont boiler***

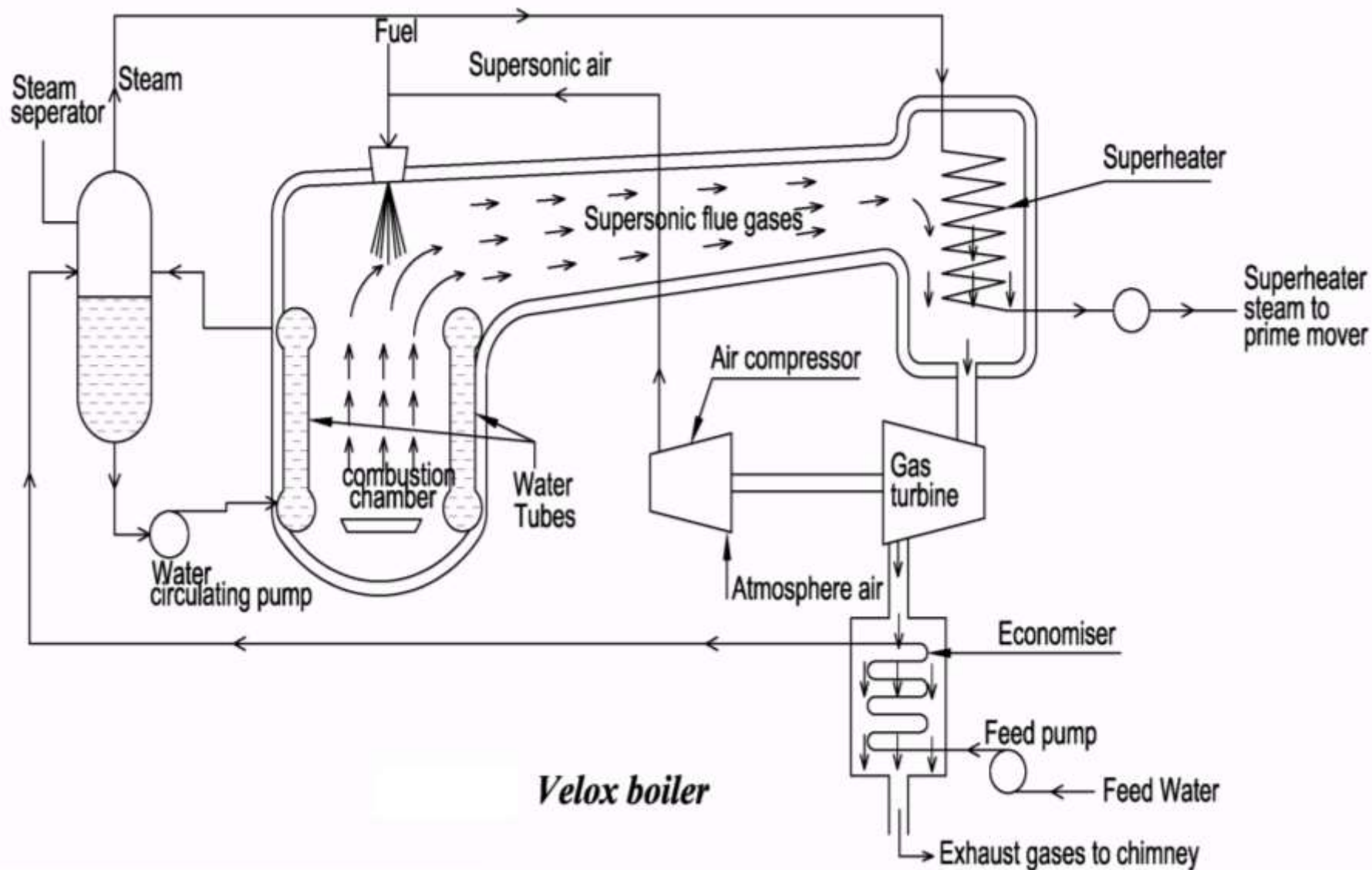


***Benson boiler***



***Lo-effler boiler***







# BOILER MOUNTINGS AND ACCESSORIES

- **Boiler Mountings** are the fittings/devices used as
  - Indicating Devices.
  - Controlling Devices.
  - Safety Devices.

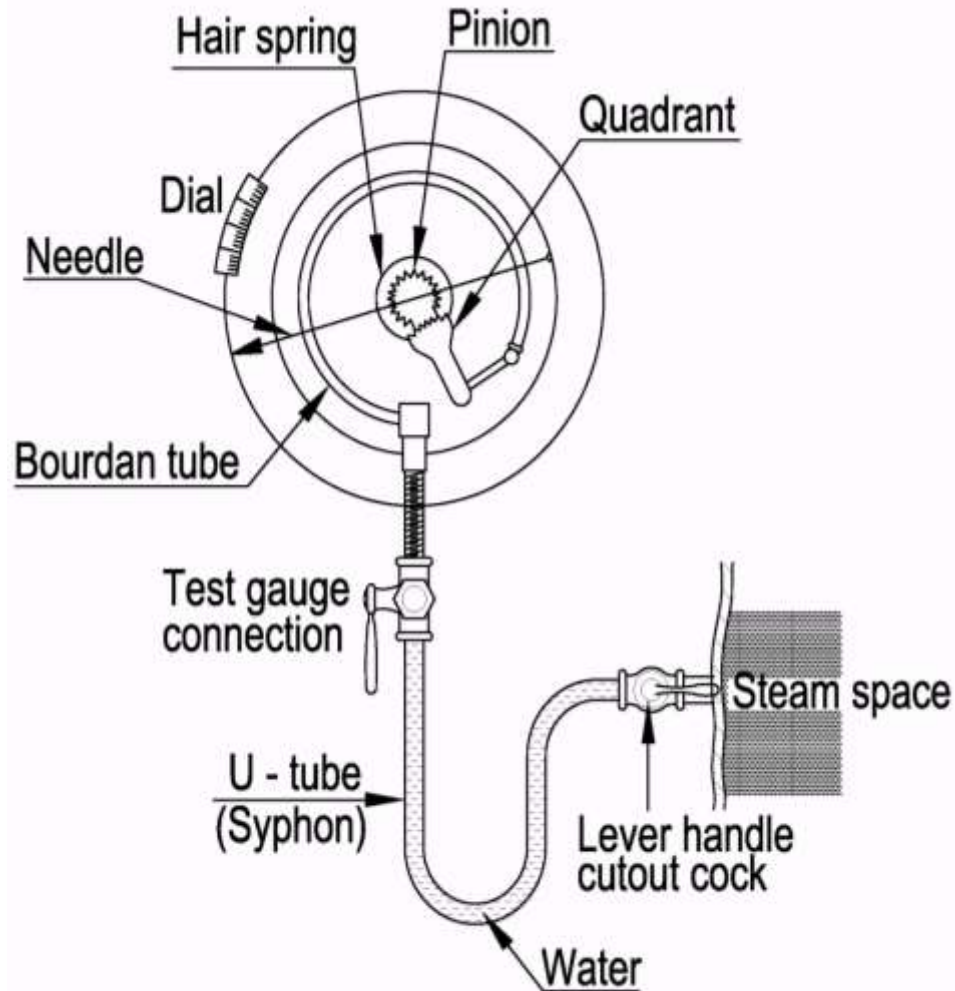
In order to ensure safety in Boiler Operation.

- They are compulsory as per Boiler Regulation.
- They does not increase the efficiency of Boiler.

# BOILER MOUNTINGS AND ACCESSORIES

- **Boiler Accessories** are the extra fittings/devices used for
  - Proper Operation of Boiler.
  - Increasing Efficiency of Boiler.
- They are not compulsory as per Boiler Regulation.
- They increases the efficiency of Boiler.

# BOILER MOUNTINGS



***Bourdon tube pressure gauge***

Function:-

Indication of the pressure of the stream inside the boiler.

Construction:-

Bourden gauge with its interior mechanism is shown in to the figure.

The bent bourden tube of oval cross section is close at one end and connect at the other end to the boilers pressure.

Close end of the tube is attach by the links and pins to a tooth quadrant.

This quadrant meshes with the small pinion on the central spindle.

Construction:-

Bourden gauge with its interior mechanism is shown in to the figure.

The bent bourden tube of oval cross section is close at one end and connect at the other end to the boilers pressure.

Close end of the tube is attach by the links and pins to a tooth quadrant.

This quadrant meshes with the small pinion on the central spindle.

Working:-

When pressure is apply to the interior of the oval tube, it tends to be assume a circular cross section.

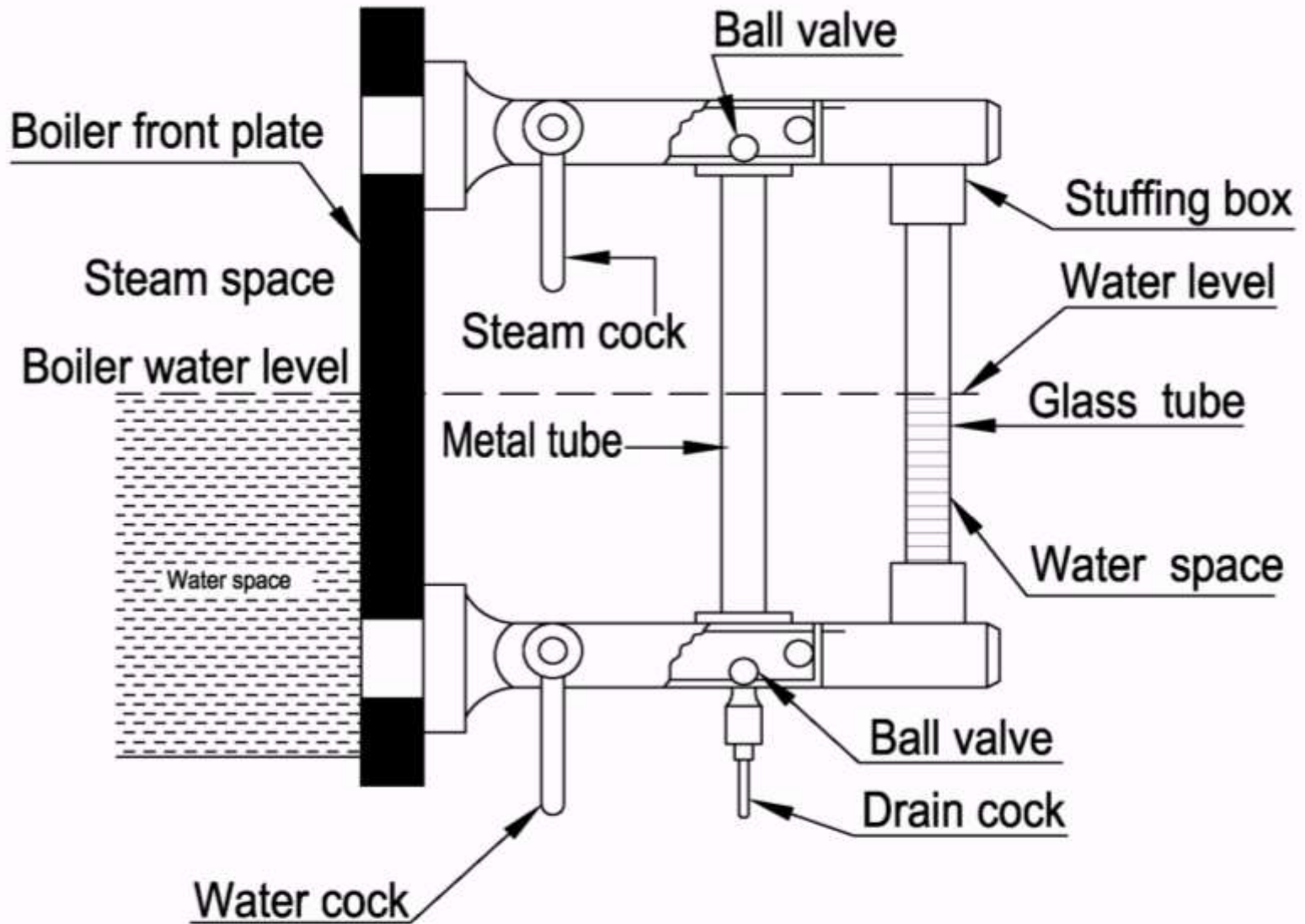
But before the tube can do so, means change its shape from circular, it must be straighten out.

The tendency to move from straighten circular position moves the free end due to the pressure , turning the spindle by the links and gearing.

This will causes the needle to move and register the pressure on to the graduated dial.

A tube or some other type of the material like a siphon is use to prevent stream from entering pressure gauge.

# BOILER MOUNTINGS



*Water level Indicator*



Function:-

Indication of water level inside the boiler to the observer.

Two water level indicators are fit in front of the boiler.

The water level indicators show the level of the water in the boiler drum and warns the operator if by chance the water level goes below a fix mark, so that corrective action may be taken in time to avoid any accident.

## Construction:-

Water level indicator use in low pressure boiler is shown in to the figure.

Consists of three cocks and glass tube.

The steam cock connects or disconnects the glass tube with the steam space in the boiler.

The water cock connects or disconnects the glass tube from water in the boiler.

The water in the glass tube is drain out at the intervals opening the drain cock.

This ensures that steam and water cocks are to be clear in the operation.

The glass tube is in general protect with the shield.

Working:-

To observe the water level in to the boiler, the steam and the water cocks are open and drain cock is kept to be close.

The steam enters the glass tube through upper tube and water enters through lower glass tube.

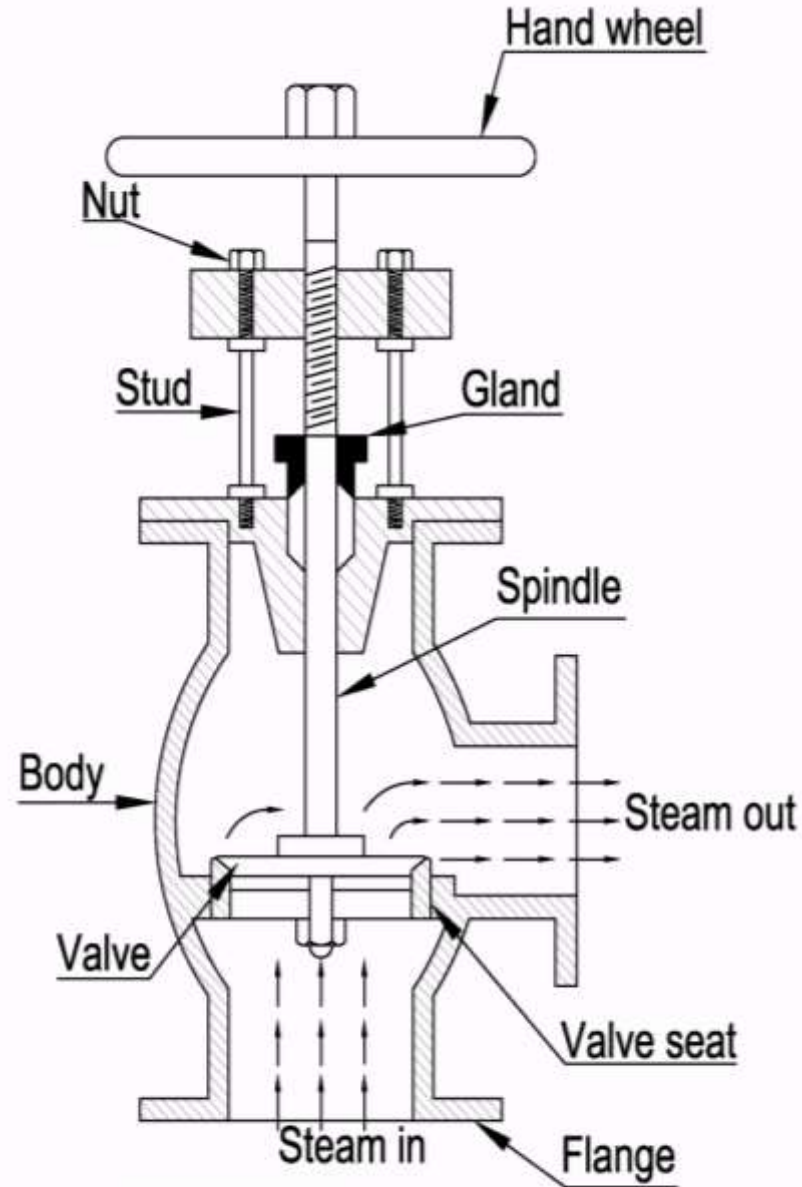
The level of the water in the glass tube will be the same as the level of the water in to the boiler.

The rectangular passage at the ends of the glass tube contain two balls.

In case the glass tube is broken, the balls are carry along the passage to the ends of the glass tube and then close the reduced passage.

Thus flow of the water or the stream out of the boiler is prevented.

# BOILER MOUNTINGS



*Steam stop valve*

Function:-

Use to control the passage of the stream from the boiler to the steam pipe or from one steam pipe to the other.

When it is place directly over the boiler, it is called junction valve otherwise it is called the stop valve.

Construction:-

Largest valve on the steam boiler and usually fit to the highest part of the boiler shell.

Commonly use steam stop valve is shown in the figure.

The main body is made up of cast steel.

The valve, valve seat, and the nut through which the valve spindle works are made up of brass for the smooth working.

The spindle is pass through a gland to prevention the leakage of the steam.

Working:-

The spindle is rotate by means of the hand wheel. The rotation of the spindle causes the valve to be move up and down.

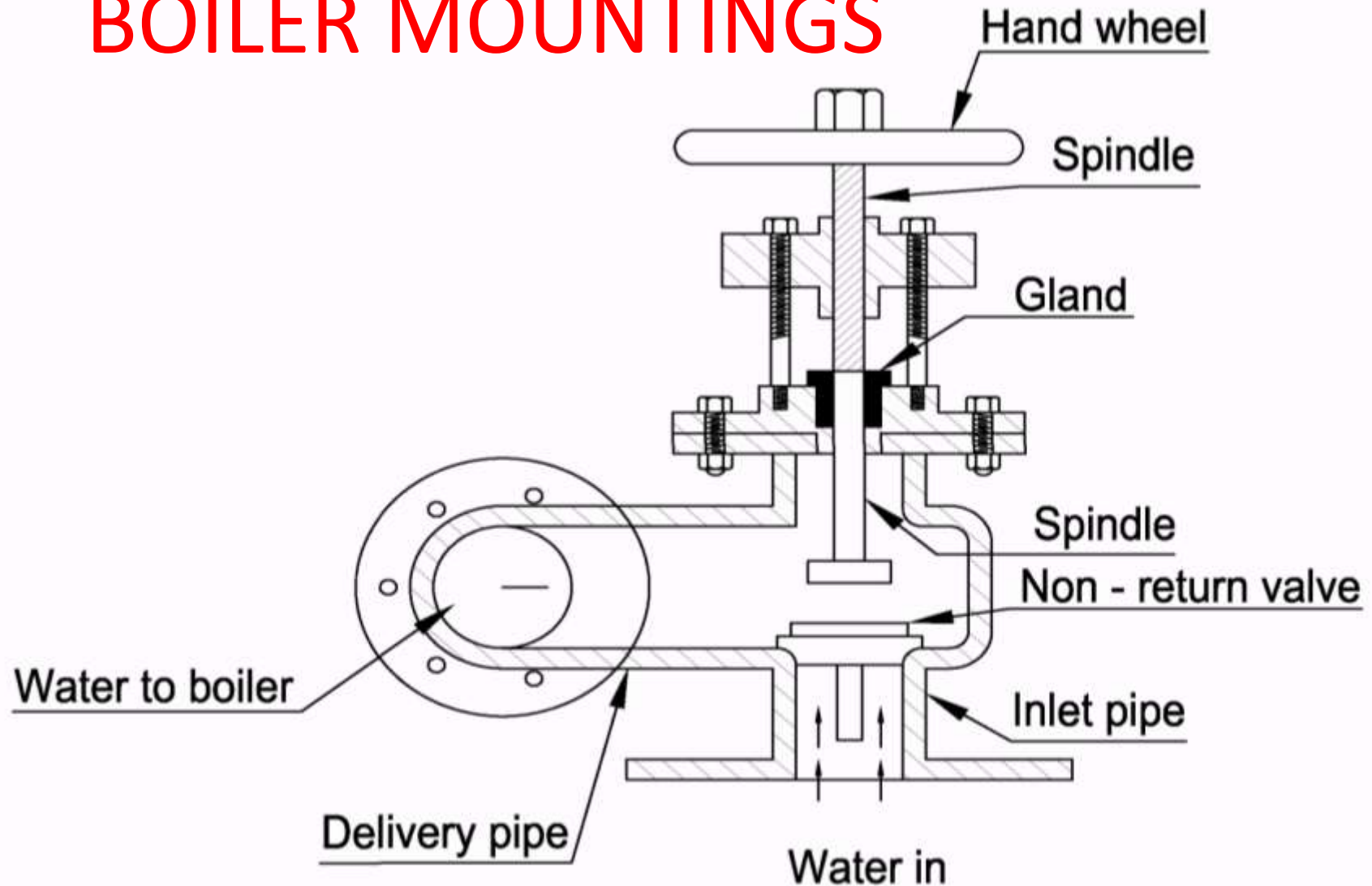
When the valve sits over the valve seat the passage of the stream is completely close.

The passage may be partially or fully open for the flow of the stream by moving the valve up rotating the hand wheel.

The flow of the stream is control by means of the regulator which is place inside boiler shell and operate by the handle from driver's cabin.



# BOILER MOUNTINGS



***Feed check valve***

Function:-

Feed check valve controls the water from pump to the boiler.

Does not allow the back flow from the boiler to the pump when the pump pressure is less than boiler pressure or the pump has been stop.

## Construction:-

Feed check valve is fit on the delivery pipe from feed pump, as near to boiler as possible.

The main parts of the valve are : non return valve water inlet pipe, water outlet pipe, spindle, gland and the hand wheel.

Working:-

Pump pressure acts from below the non return valve and boiler pressure acts from above it.

Under the normal working conditions, the pump delivery pressure is higher than the boiler pressure. So the valve is lift from it seat and allows the water to flow to the boiler.

The lift of the valve is control by moving the spindle up and down with the help of the hand wheel.

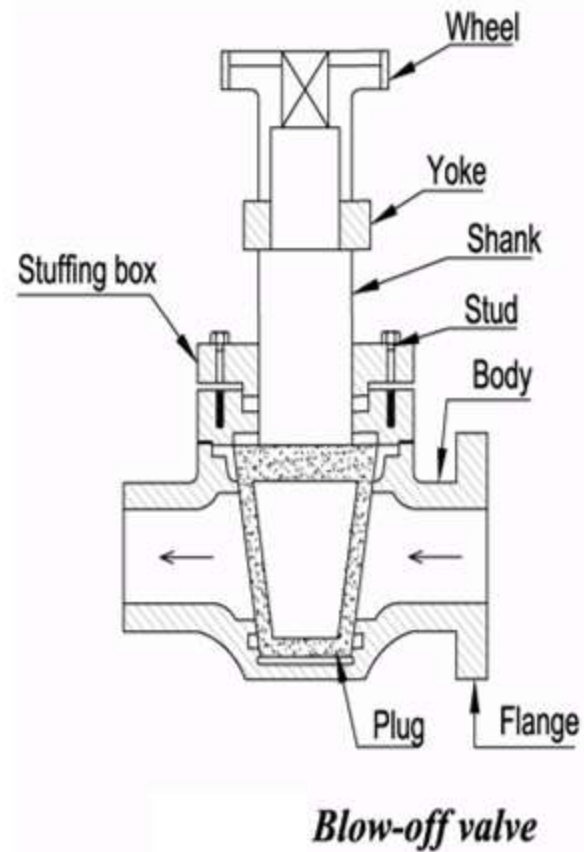
Thus the flow of the water can be control.

If the boiler pressure is higher than pump pressure or the pump is stop, the upward force on non-return valve is higher.

So it sits on its seat and closes the passage.

Thus water from boiler is not allow to flow backward towards the pump.

# BOILER MOUNTINGS



Function:-

(1).The water fed to the boiler always contain some portion of the sediments and dissolved salts.

The water is evaporate but these sediments and dissolved salts get accumulate near the bottom of the boiler.

The blow off cock is use to periodically discharging a portion of water from the bottom of the boiler which has high density of sediments and salts.

Function:-

(2). It is necessary to empty the boiler periodically for cleaning and the inspection.

The boiler is emptied opening the blow off cock.

The blow off cock is fit in the lower portion of the boiler.



Construction:-

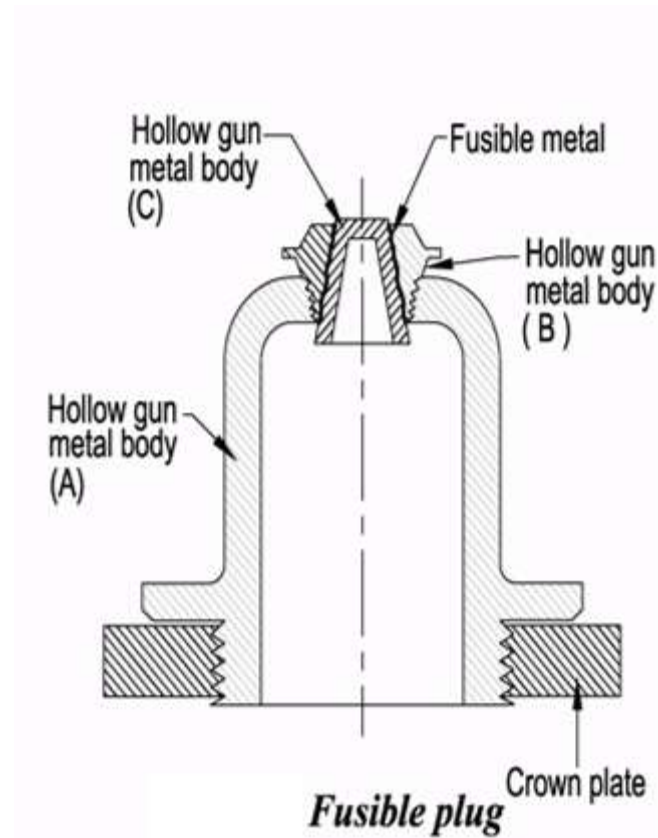
Common type of the blow off cock is shown in the figure.

Conical plug is fit accurate into a similar casing.  
The plug has a rectangular opening.

Working:-

The plug slot is perpendicular to the flow passage. When the plug slot is brought in line with the flow passage of the body by rotating the plug, the water from the boiler comes out with the great force. If the sediments are to be removed, the blow off cock is operated when the boiler is on. This forces the sediments quickly out of the boiler.

# BOILER MOUNTINGS



Function:-

To put off the fire in the furnace of the boiler when water level in the boiler falls below the unsafe level. If this kind of fusible plug type work is not done, then the tubes and the shells may get to be overheated and resulting due to that an explosion. The fusible plug is generally fit over the crown of the furnace or over the combustion chamber.

Construction:-

Common type of the fusible plug is shown in to the figure.

“A” is a hollow gun metal body screw in to the crown of the boiler.

“B” is a hollow gun metal body screw in to the plug A.

“C” is a hollow gun metal body which lock with Plug B by pouring a low melting point metal in to the grooves provide for the same.

Working:-

Under normal water level conditions in the boiler, upper surface of the fusible plug is cover by the water while the other end of the plug is expose to the fire or hot gases.

The lower melting metal does not melt till the upper surface of the plug is submerge in to the water.

When the level of the water in the boiler falls lower means not to cover the plug, its temperature rising. The fusible metal between “B” and “C” which quickly melts and plug “C” drops out.

Working:-

This thing will allow the stream to rush in to the furnace and extinguish the fire.

This thing prevents further over heating.

## Safety Valves:-

Use to maintain safe pressure inside the boiler.

When the pressure of the stream inside the boiler increases beyond the safe value, the valve opens and blows off the excess stream.

All the boilers should have at least two safety valves and they are mount directly over the boiler.

Dead weight safety valve

Lever loaded safety valve

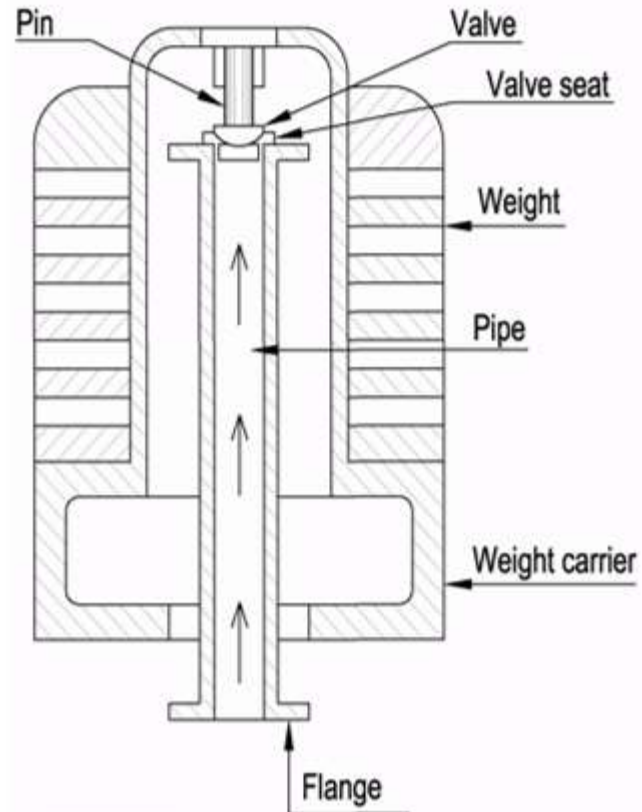
Spring loaded safety valve

High stream low water safety valve

are the different types of the safety valves.



# BOILER MOUNTINGS



*Dead weight safety valve*

Construction:-

Valve has a flange at the end of a long pipe.

This flange is fix at the top of the boiler.

Valve sits on to the valve seat at the top of the pipe.

Weight carrier carry dead weights.

These weights act upon the valve through pin in to the downward direction.

Working:-

When the pressure in the boiler exceeds the normal limit, the upward force on the valve exceed the downward force on it due to the weights.

So the valve is lift from its seat and excess stream escape through the pipe to the outside.

Advantages and disadvantages:-

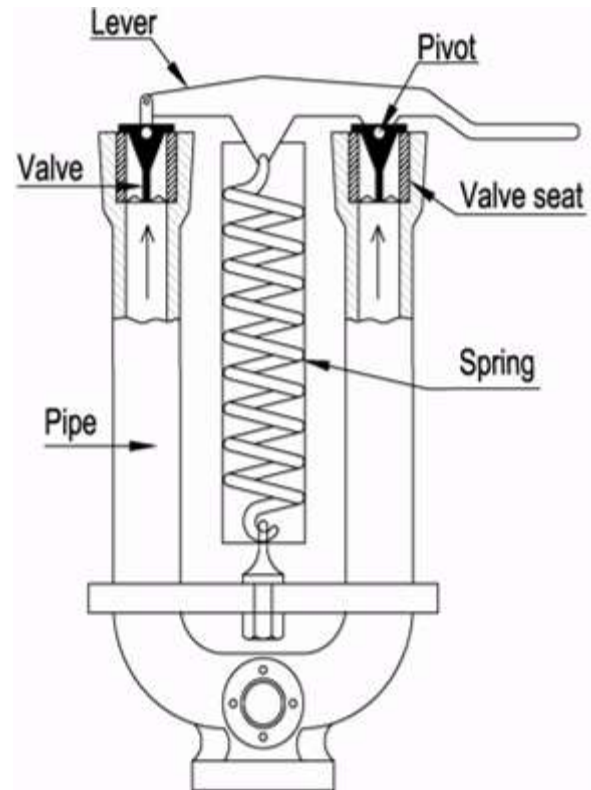
Construction of the valve is simple and gives satisfactory operation for the lower pressure and stationary boilers.

This type of valve is not suitable for moving boilers as the force of the weights should always work vertically downward.

Valve is also not suitable for the high pressure boilers as weight becomes too larger.

Due to the use of the lever safety valve this disadvantage can be reducing.

# BOILER MOUNTINGS



*Ramsbottom safety valave*

Ramsbottom Safety Valve or Spring loaded safety valve:-

Construction:-

Valve consists of a cast iron body having two branch pipes.

Two valves sit on the corresponding valve seats at the end of the pipes.

The lever is placed over the valves by means of the two pivots.

The lever is held tight at its position by means of the compression spring.

One end of this spring is connected with the lever while the other end of the spring is connected with that of valve.

Working:-

Under normal working condition, the spring pulls the lever down.

This apply the downward force on the valves which is greater than the upward force apply by the stream.

When stream pressure exceed from the normal value upward force become larger than the downward force on the valve due to the spring.

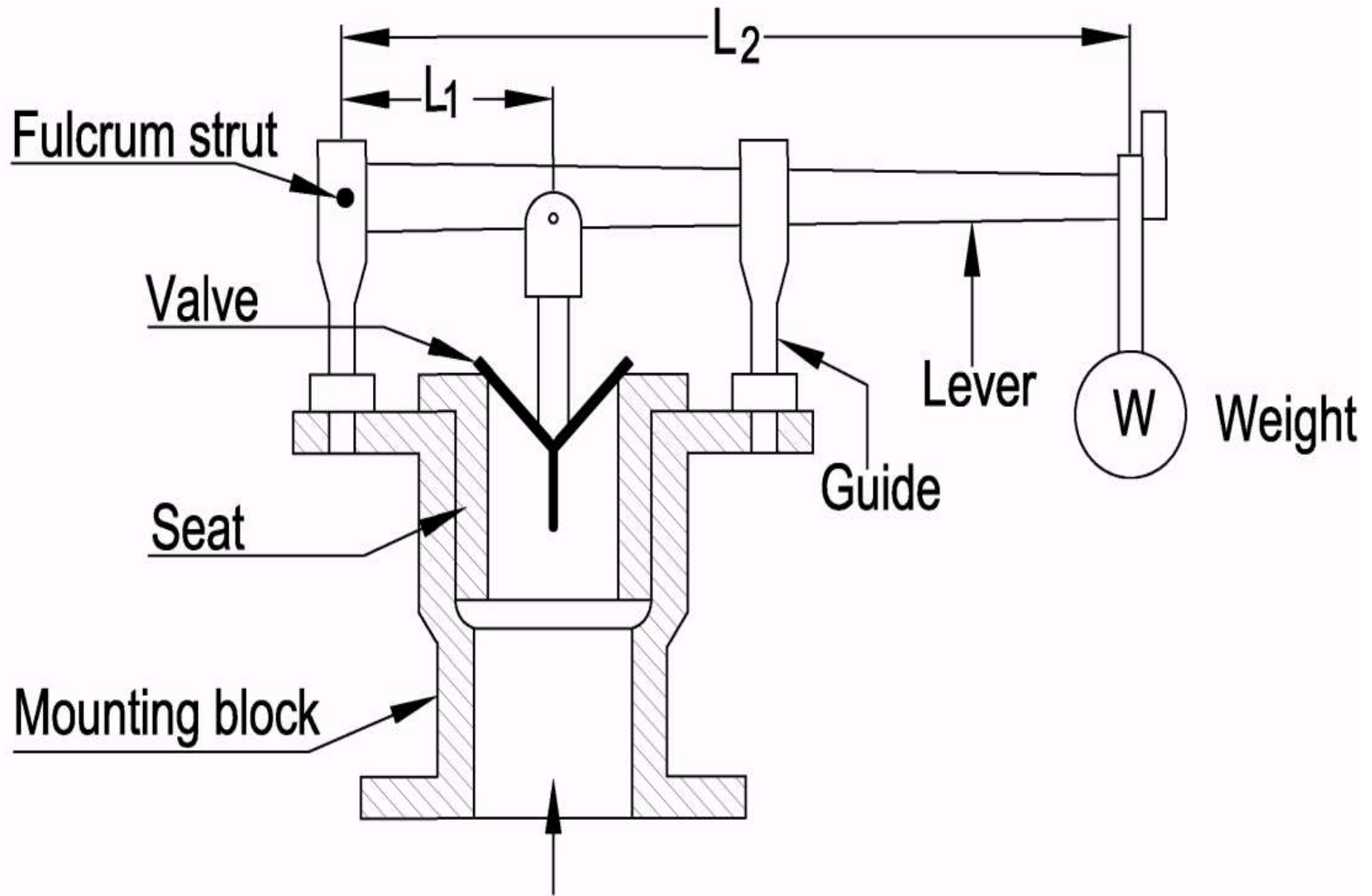
Thus the valves are lift from their seats, opening for the stream to release out.

The valve closes due to the spring force when the pressure in the boiler become normal.

Advantages and the Application of the boiler:-  
Spring loaded safety valve operation is not affected by the jerks and the vibration, so that it can be used on the portable boilers such as locomotive boilers and the marine boilers.



# BOILER MOUNTINGS



*Lever safety valve*

Construction:-

Valve is place over a valve seat which is fix over a mounting block.

Mounting block is fit over the boiler shell with the help of studs.

One end of the lever is hinge to a rod of the mounting block at the fulcrum.

The weight hangs at the other end.

A short strut of the lever is place over the valve.

Guide limits the maximum angular movement of the lever.

Working:-

When the pressure of the stream exceed the safe limit, the upward force on to the valve become greater than the downward force on it apply through the strut.

Valve is lift from its seat and the stream is allow to escape till pressure falls back to the safe value.

If we apply moment balance at the fulcrum than

$$F \times L_1 = W \times L_2$$

Where

$F$  = Downward force on valve through strut

$W$  = Weight suspend at the end of the lever

Working:-

As the  $L_2$  is much larger than  $L_1$ ,

As the  $F$  is much larger than  $W$ .

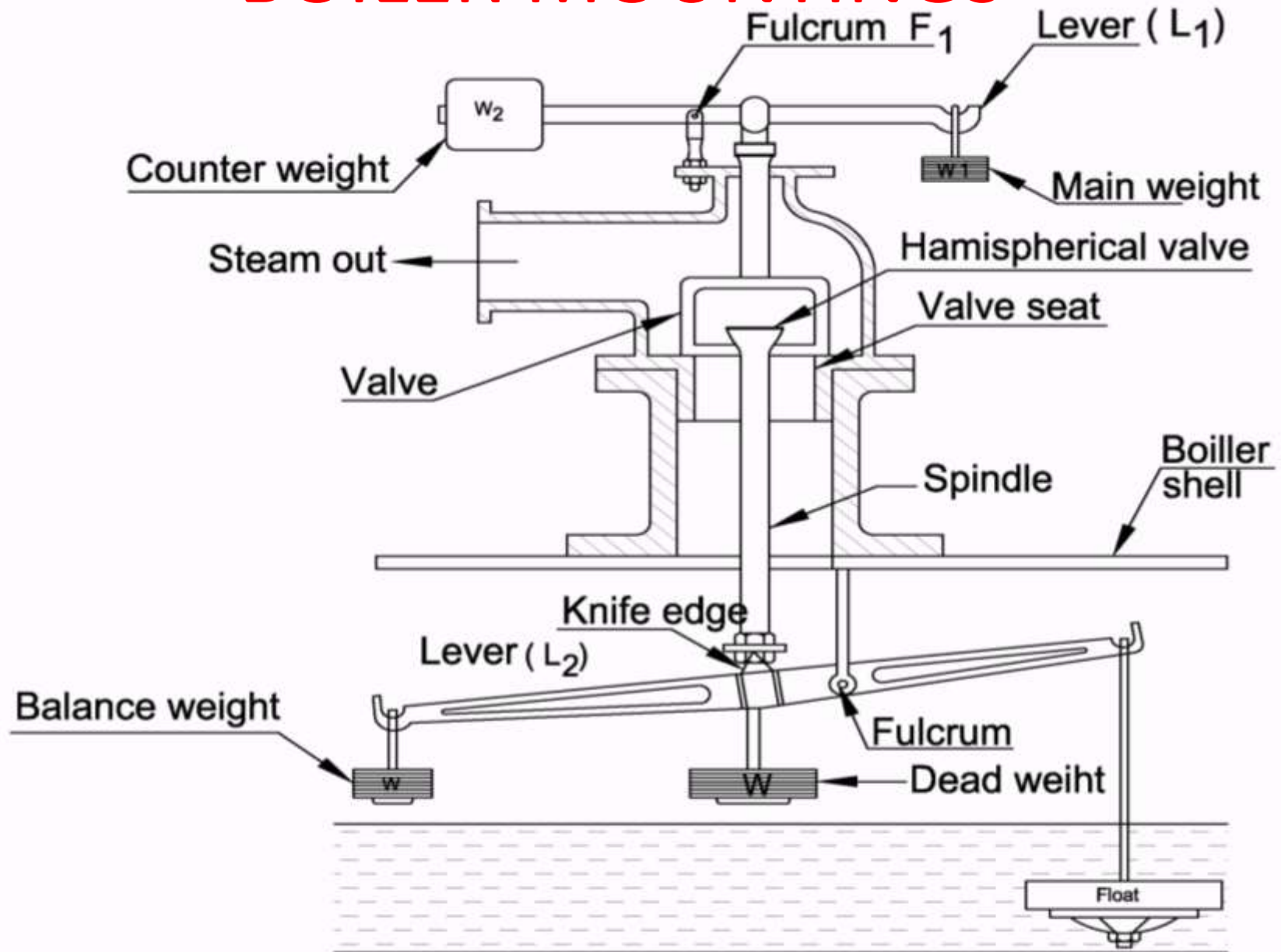
Thus using the leverage principal a larger force on the valve can be produce.

## Applications and Limitations:-

This type of valve can be use at a pressure higher than that of dead weight safety valve.

But this valve also can be use only for the stationary boilers.

# BOILER MOUNTINGS



*High steam and low water safety valve*

Function:-

Allow the steam to escape out of the boiler when stream pressure exceed normal value or water level in the boiler fall below the normal level.

## Construction and Working:-

There are two valves use in this equipment, V and U.

Valve V high stream valve is actuated by the high stream pressure rests on the valve seat.

Valve U is load by weight  $W_2$  through a long rod.

And it is rest on to the valve V.

When stream pressure exceed the normal limit, the valve V alongwith valve U rise up against the downward force apply by the strut of the lever.

The excess stream is release to the atmosphere.



Inside the boiler, a lever L is hinge at the point F. One end of the lever carry a weight W1 on one side and float E on the other side.

The lever is balance when the weight of E is under water.

But When the water level falls in such a way that the float is out of water, the lever gets to be unbalanced, moving the weight E in the downward direction.

Due to this kind of thing the knife edge K which can pushes the collar C upward.

Collar C is mount on to the rod connect the weight W2 and valve U.

So when the collar moves upward side, valve U is also lift.

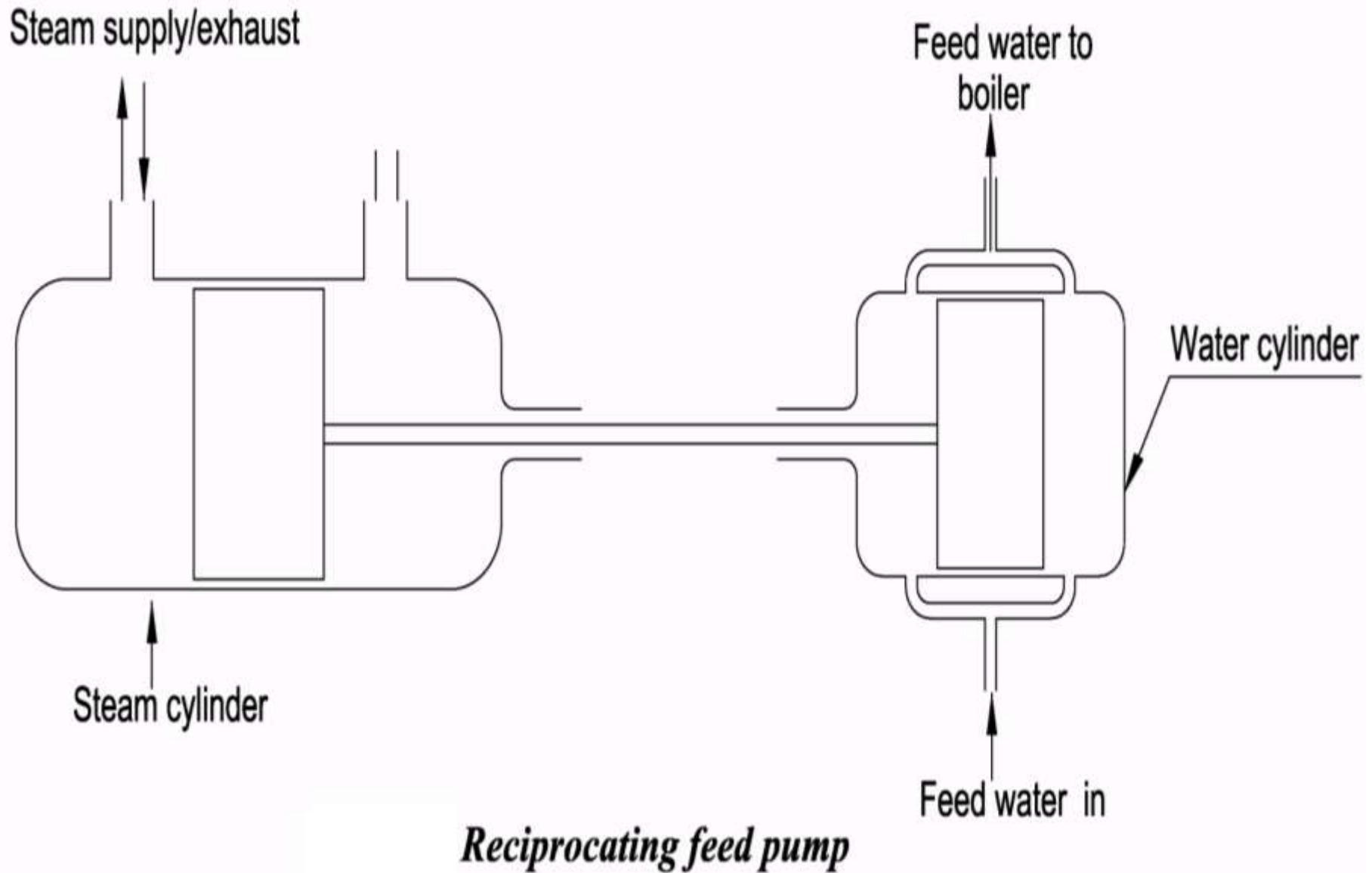
This will causes the stream inside the boiler to escape through a narrow passage causing a loud noise.

This alerts the operator to start the feed water pump to increase the level of the water in to the boiler.

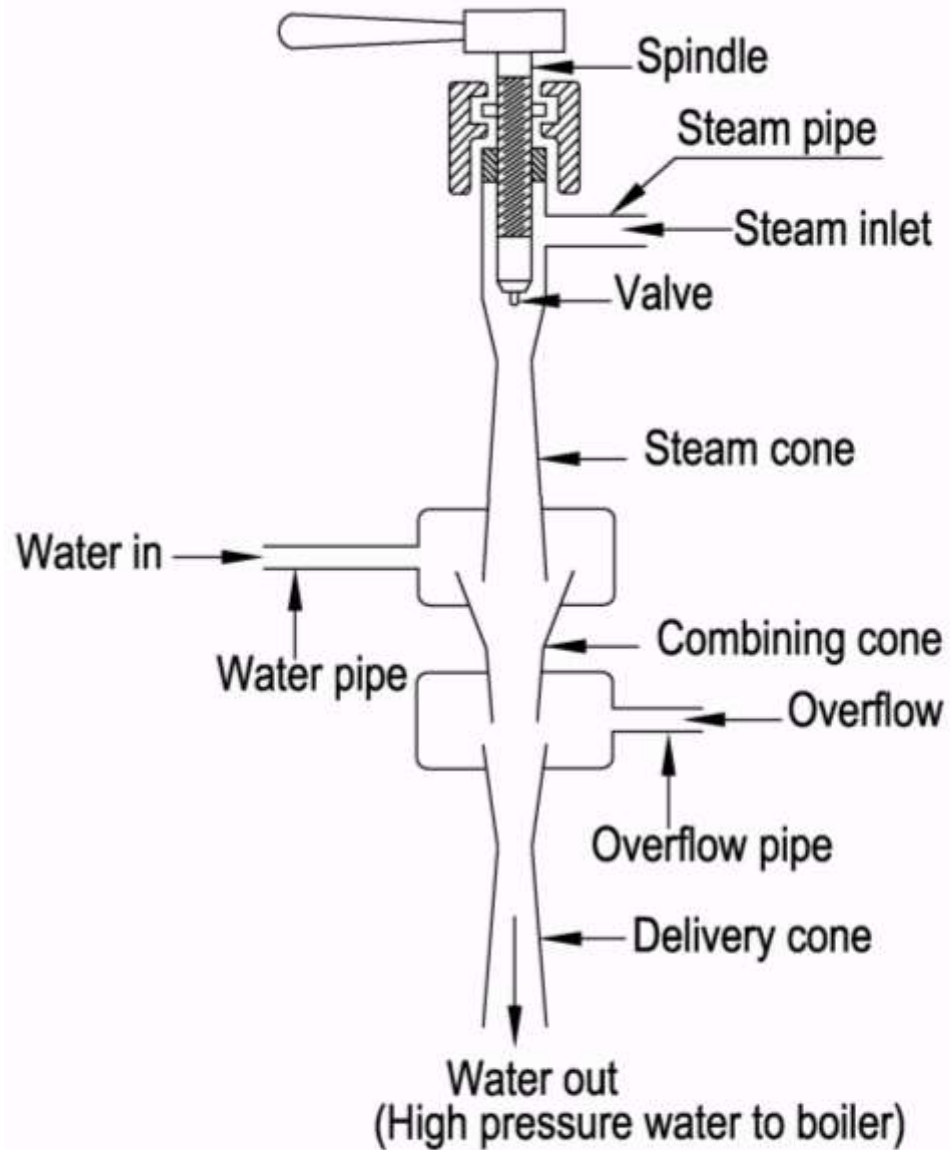
Application:-

Valve is generally use in the Cornish boiler or the Lancashire boiler.

# BOILER ACCESSORIES



# BOILER ACCESSORIES



***Injector***

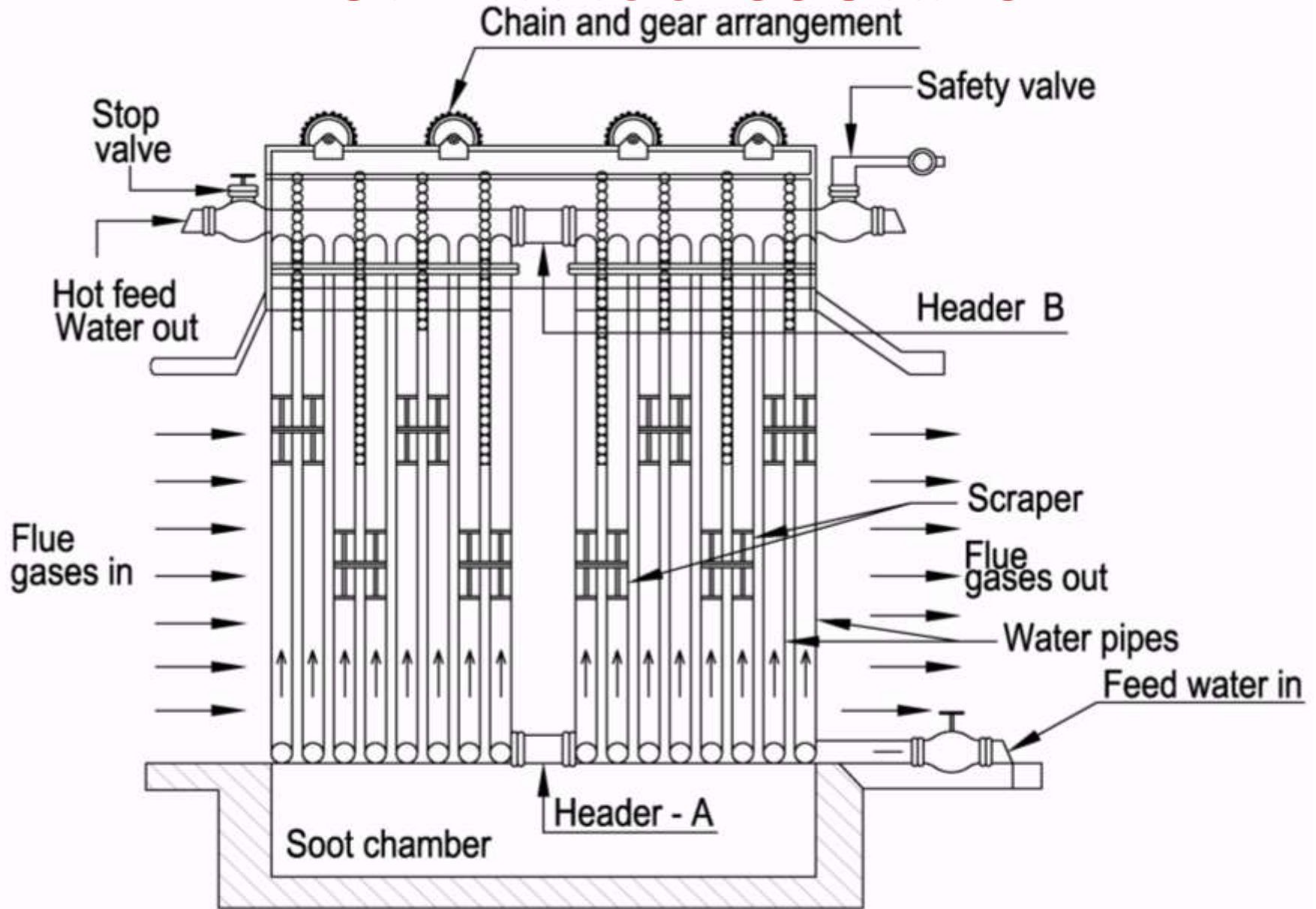
Injector is a very simple type of device use to supply water inside a boiler.

The water is force into the boiler by the pressure of the stream.

The stream is taken from the boiler.

The injector is use in the small stationary boilers and locomotive boilers.

# BOILER ACCESSORIES



*Economiser*

Economizer consists of large number of vertical cast iron or steel pipes P, which are connect with the two horizontal pipes, A and B, one at the top and the other at the bottom.

The feed water is pump into the economizr through the bottom pipe B.

From the bottom pipe, the water comes into the top pipe A through the vertical pipes and finally goes to the boiler.

The exhaust gas flow is shown by the horizontal arrows.

Indirect heat transfer occur from these gases to the feedwater.



The rear end of the vertical pipes, a blow off valve which is not shown in to the figure is fit through which any mud particles or the sediments deposit in the bottom boxes may be discharge.

Soot of the flue gases deposits on the outer surface of the vertical pipes and this will reducing the efficiency of the economizer.

System of scrapers S is therefore adopt to clean the outer surface of the vertical pipes.

Each of the vertical pipe is fit with a scrapper which moves up and down automatically and continuously by mean of chain and gear arrangement.

Safety valve SV is also provide at the end of the pipe A for the safety of the pipes.

## Advantages and Disadvantages:-

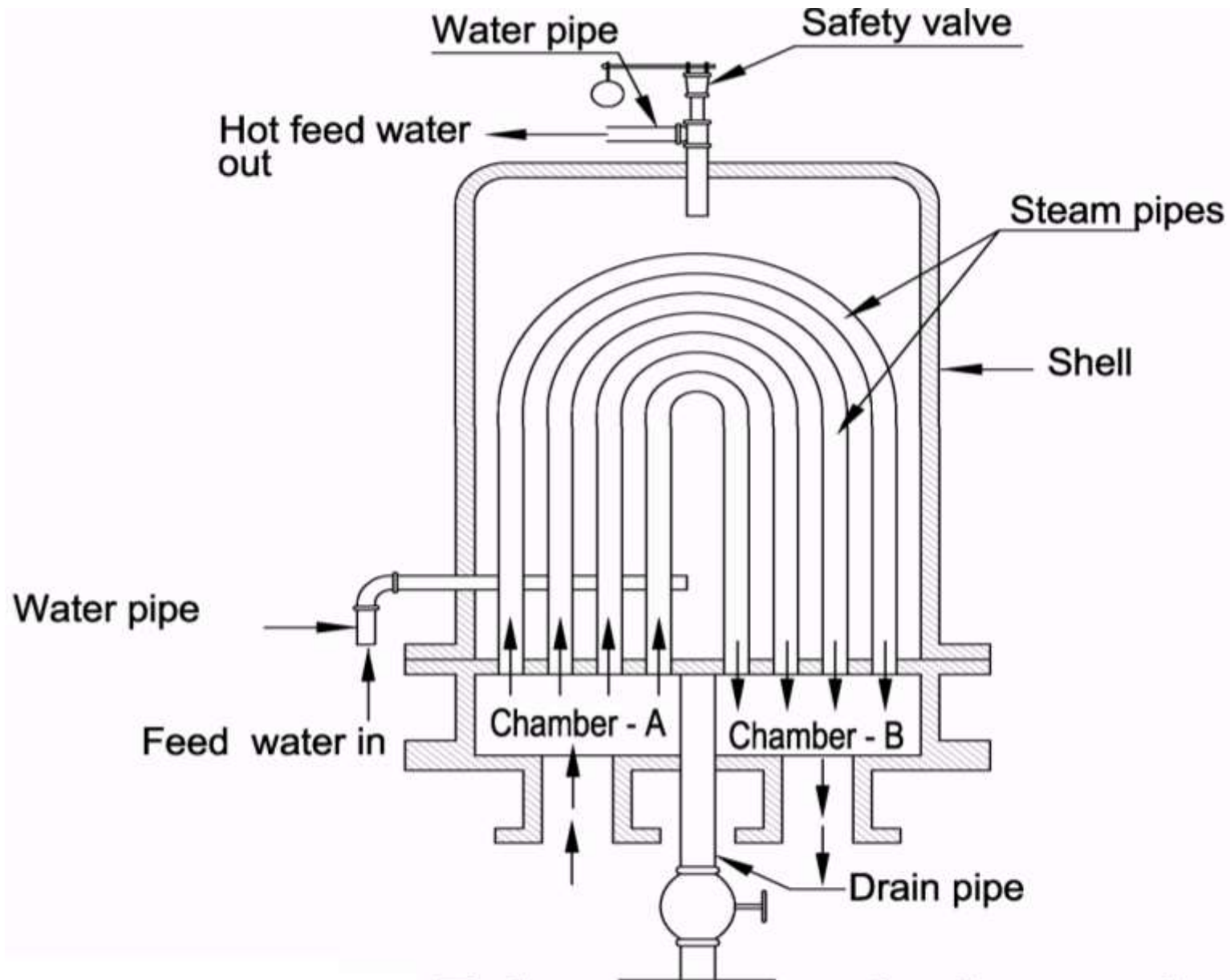
Economizer offer considerable resistance to the flue gas and therefore some form of mechanical draught induced draught fan must be install when they are use.

They take up the space, add to the initial cost of installation and involve extra maintenance cost for cleaning and repair.

On the other hand they may be effect quite a larger saving in to the fuel consumption.

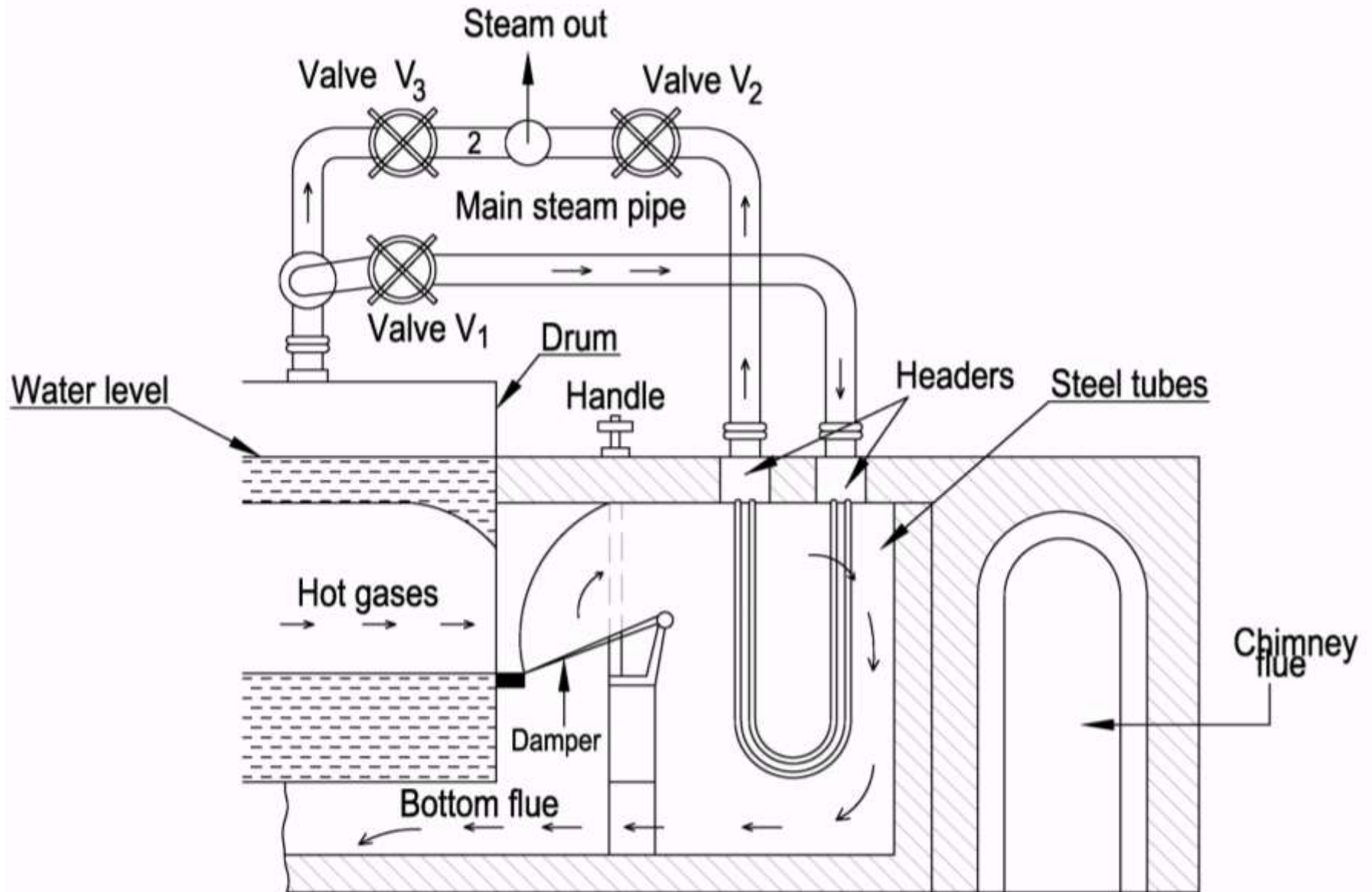
Higher fedwater temperature tend to reduce boiler stresses evaporative capacity of the boiler.

# BOILER ACCESSORIES



***Exhaust steam feed water heater***

# BOILER ACCESSORIES



*Superheater*

Stream leaves the water surface and pass into the stream space in boiler drum.

Stream form above the surface of the water is always wet, it will carry some minute droplets of the water. If the wet stream is all that is require, the stream is pipe directly from the stream space to the stream main.

But if the superheated stream is required, then the wet stream is remove from the stream space and pipe in to the super heater.

This consists of the long tube or the series of the tubes which are suspend across the path of the hot gases from the furnace.

As the wet stream progresses through the tube or tubes, it is gradually dried out and eventually superheated.

Following are the advantages of the superheated stream.

- (1) Superheated stream is at high temperature. So it will increase the overall efficiency of the steam plant.
- (2) It reduces steam consumption for the same power produced.
- (3) It reduces condensation losses in the pipes and the engine cylinder of steam engine.

Superheater is commonly use in to the Lancashire boiler as shown in to the figure.

Superheater consists of two headers and a set of superheater tubes made up of high quality steel in form of the U- tubes.

Superheater is locate in the path of the furnace gases where the temperature of the gase is not less than  $550^{\circ}\text{C}$ .

Superheater is locate just before the entry of the hot gase to the bottom flue.

Amount of hot gase pass over the superheater tubes should be in the proportion to the stream pass through tubes and degree of the superheat required.



To avoid overheating some amount of hot gases may be diverted with the help of the the damper.

Superheater may be by pass by bringing the damper in to the vertical position and thus pass flue gases direct to the bottom flue.

The damper may be partially close to control the degree of the superheat irrespective of the stream flow rate.

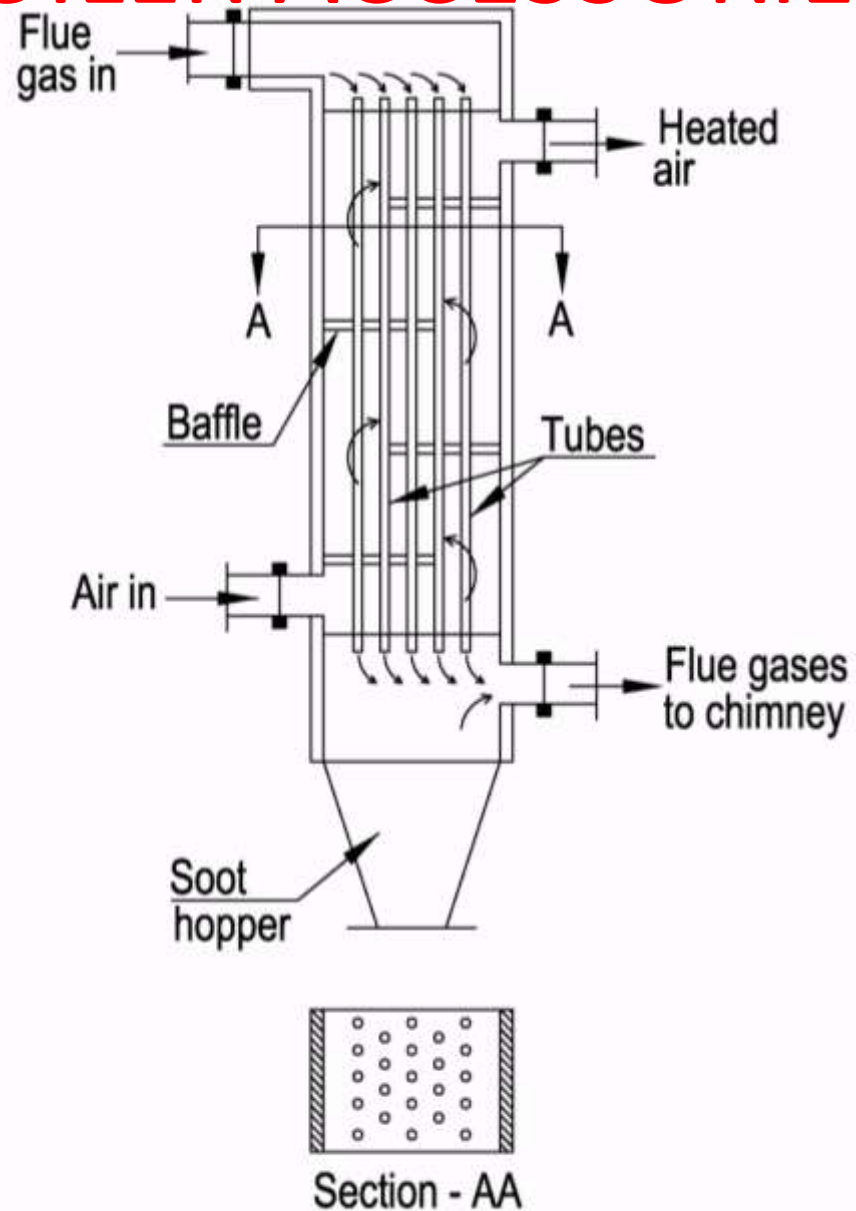
Valves A, B, C are provided at the top side of the arrangement.

The valve A and B control the passage of the stream enters and coming out of the superheater respectively.

When valve A and B are open and valve C is close, wet stream pass through superheater and enter the stream main.

When valve A and B are close and valve C is open, wet stream directly enter the stream main.

# BOILER ACCESSORIES



*Air preheater*

Air for the combustion purpose may be preheated before it enters to the boiler furnace by passing it through banks of the tubes place in flue leading from boiler to the chimney.

It thus use some heat of leaving flue gases that would otherwise pass to waste.

# Advantages and Disadvantages:-

## Advantages

- (1) Due to high combustion air temperature , combustion improves and fuel is use effectively.
- (2) Low grade , high ash coal can be utilize.
- (3) Stream generation capacity of the boiler increases.

## Disadvantages

- (1) If there is clogging in to the air preheater, entire stream generation may be critically hampered.
- (2) Low temperature flue gases cause corrosion on the heat exchanger tubes.
- (3) Maintenance and power costs are involves in there operation.

Recuperative air heaters and Regenerative air heaters are the main two types of air preheater.

Here we will discuss the Recuperative air preheater.

They are mostly tubular heat exchanger in which heat is continuously transfer from flue gases to the air.

Air is pass through shell side and flue gases through tube side.

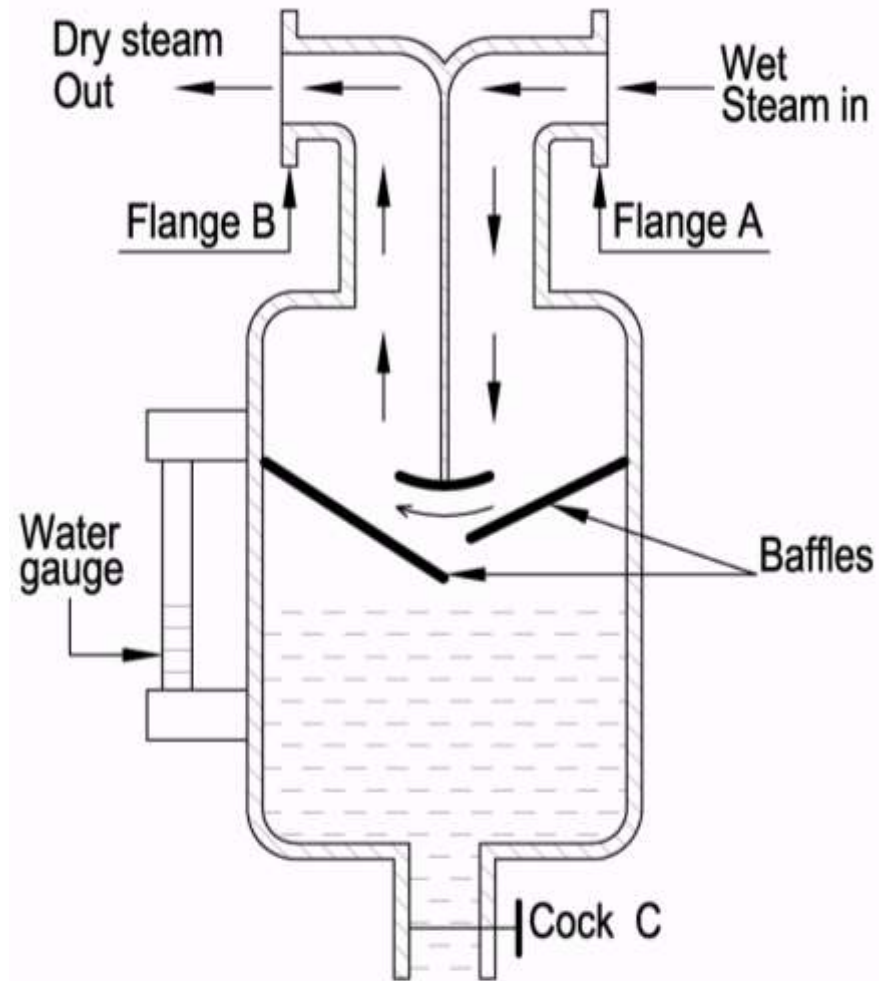
The tubes are welded at both the ends to the tube plates.

The increases the total path length of the air and thus increase heat transfer.

A force draft fan push the air through air preheater.

Soot hopper provide at the bottom is use to remove soot after cleaning operation of the tubes.

# BOILER ACCESSORIES



*Steam separator*



Function:-

Stream separator is an apparatus for separating out the moisture that may be carried in to the suspension by stream flowing in to the pipe lines.

It prevents this moisture from reaching and probably damage engines, turbines or any other machinery that may be driven by the stream.

Stream separator is locate near the engine to remove water particles from the stream as completely as possible.

Construction and Working:-

Stream enters at A and moves down.

It strikes the baffle at the bottom and suddenly change its direction of the motion.

The dry stream gets deflected but the heavy water particals stay on to the baffles because of its weight and inertia.

It falls to the bottom of the stream separator from baffles.

The dry stream moves up and is taken out from pipe B.

The water collect at the bottom of the separator is discharge through a cock C from time to time.

Gauge glass G exhibits the level of the water in the

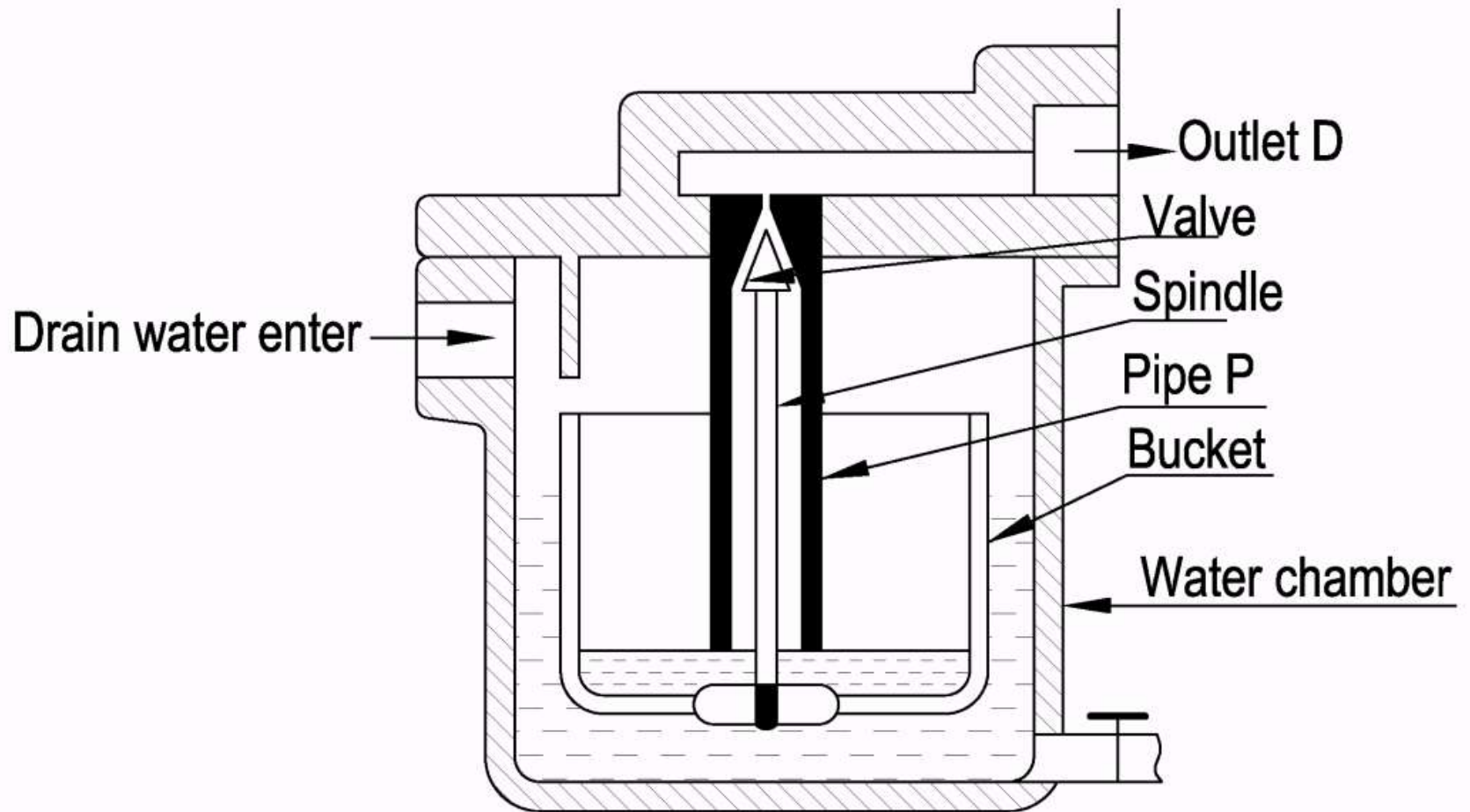
It falls to the bottom of the stream separator from baffles.

The dry stream moves up and is taken out from pipe B.

The water collect at the bottom of the separator is discharge through a cock C from time to time.

Gauge glass G exhibits the level of the water in the separator.

# BOILER ACCESSORIES



*Steam trap*

Function:-

Stream trap automatically drain away the condense stream from stream pipes, stream jackets and stream separators without allowing any stream to escape.

There are the various types of stream traps of which bucket type is describe here.

## Construction and Working:-

Stream trap consists of a bucket which is fit with a spindle S at its center.

The upper end of the spindle act as a valve.

Pipe P is fit inside the chamber which has an outlet at its top.

As in the normal condition, the bucket B floats over the water and the outlet is close by the valve.

When water level increase in the chamber, it enters the bucket to fill it.

This cause the bucket to come down, open the valve.

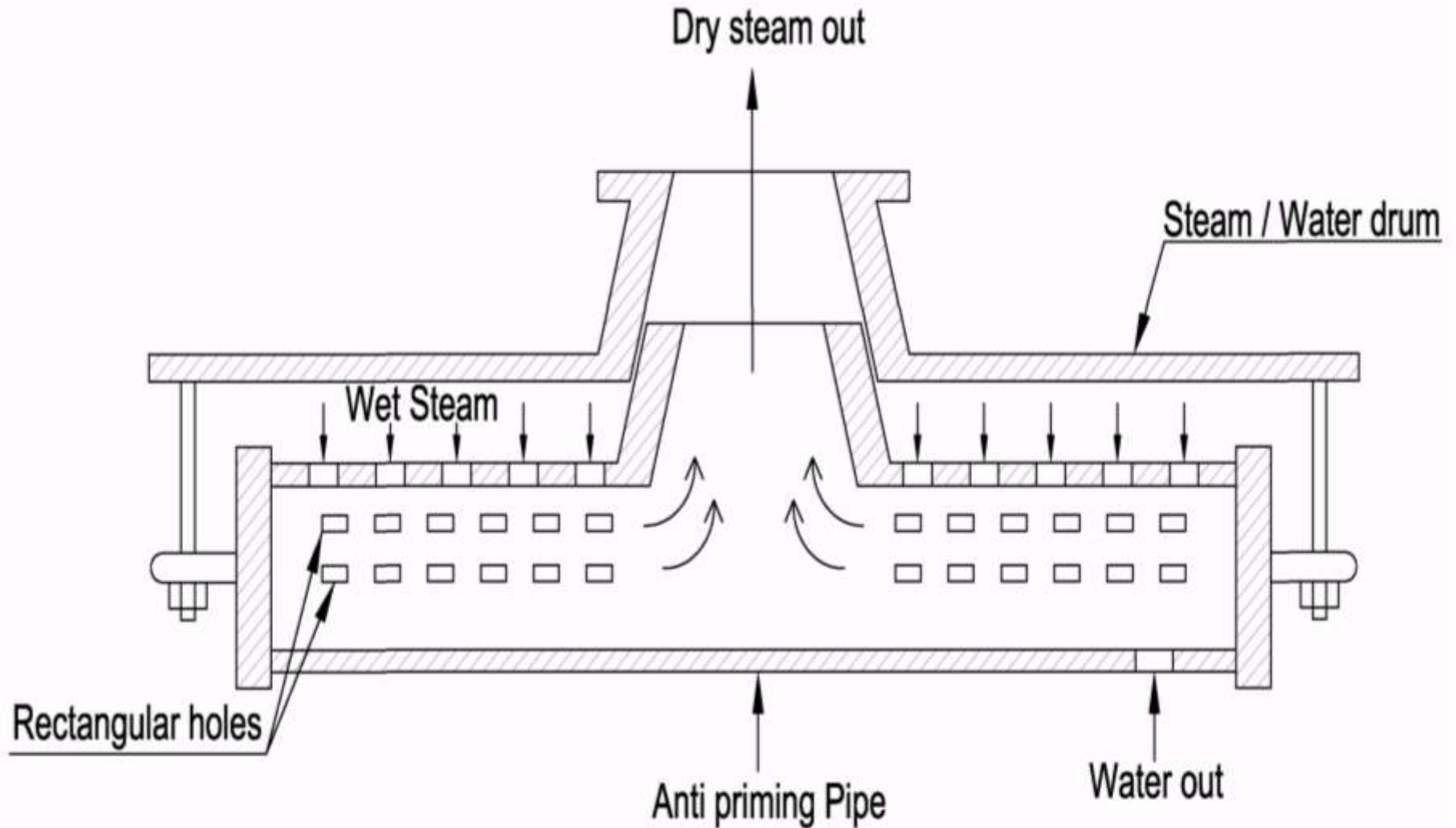
Due to pressure of the stream the water is discharging through the outlet till the bucket is nearly empty.

When water level increase in the chamber, it enters the bucket to fill it.

This cause the bucket to come down, open the valve. Due to pressure of the stream the water is discharging through the outlet till the bucket is nearly empty.

Then the valve comes down and closes the outlet.

# BOILER ACCESSORIES



*Anti - priming pipe*

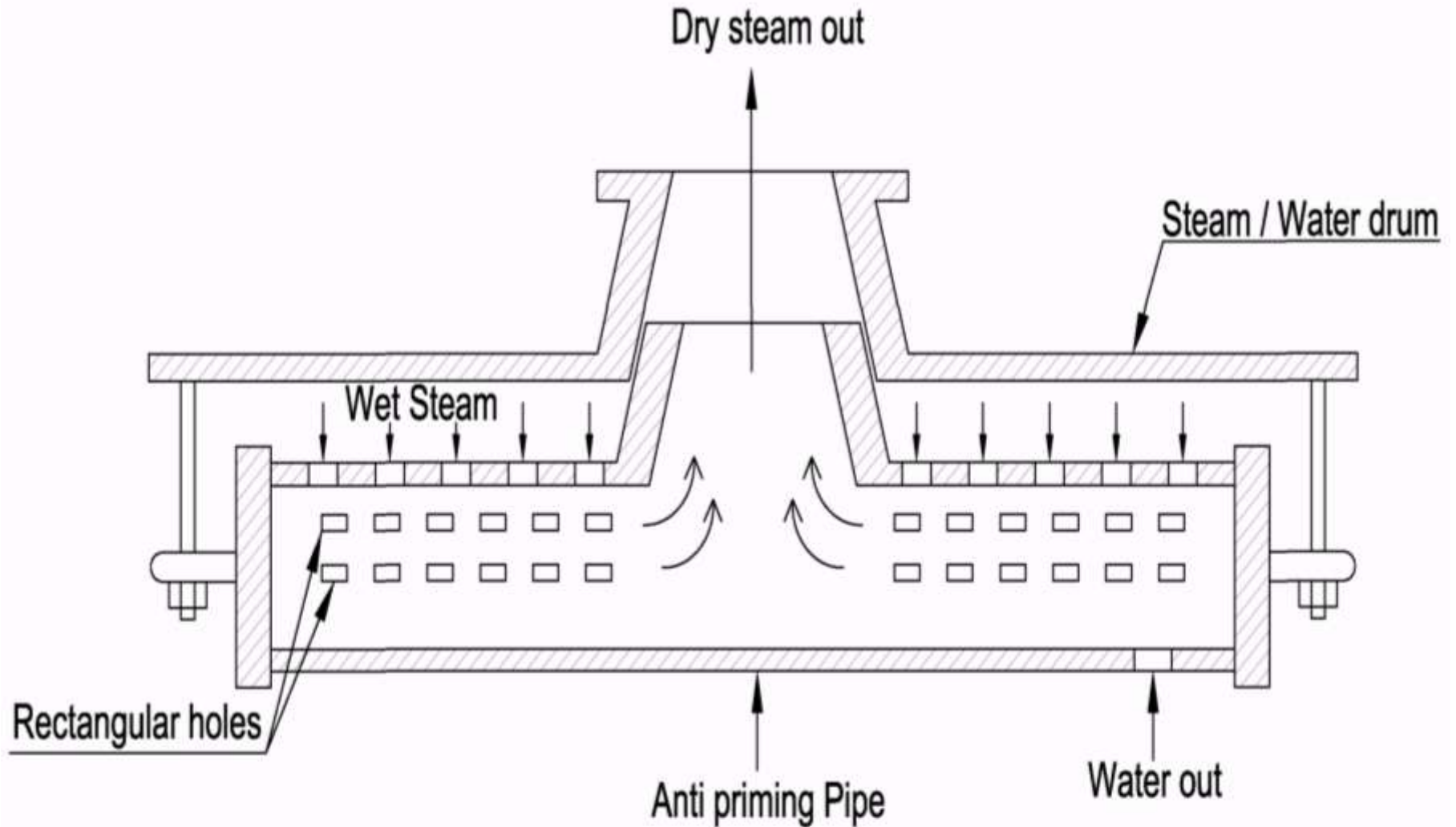


When water level increase in the chamber, it enters the bucket to fill it.

This cause the bucket to come down, open the valve. Due to pressure of the stream the water is discharging through the outlet till the bucket is nearly empty.

Then the valve comes down and closes the outlet.

# BOILER ACCESSORIES



*Anti - priming pipe*

Stream always contain some amount of water particles when it is in contact with the surface of the water.

Water particles have higher specific gravity. So as the stream moves up, water particles tend to fall back.

Again if a deflection is provided in the path of the stream.

Water particles with more weight and higher inertia, cannot follow the stream path and fall back.

This principle is used in the steam collecting pipe or antipriming pipe.

It is the horizontal perforated pipe placed on to the top of the steam space of the boiler.

The wet stream enters into the pipe through rectangular holes in the downward direction as shown in to the figure.

Now the stream again has to change direction and move up.

But water particles fall back and settle at the bottom of the pipe.

Water can be drain out from a hole provide at the bottom of the pipe.

