

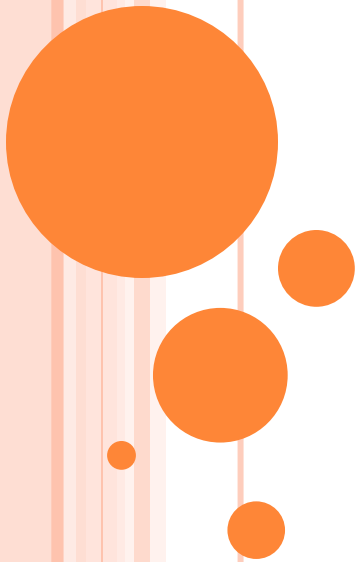


BOILERS

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STEAM BOILERS, MOUNTINGS & ACCESSORIES

The equipment used for producing and transferring steam is called *Steam generator/ Boiler*.



APPLICATIONS OF STEAM

- For power generation in steam engines
- In textile industries for bleaching, sugar mills, chemical industries etc.
- Other industry applications like:
 - Heating/Sterilisation
 - Propulsion/Drive
 - Cleaning
 - Humidification




PRIMARY REQUIREMENTS OF A BOILER

A boiler must be able to deliver the steam safely in the desired conditions with regard to its pressure, temperature, quality and required rate.

- (i) Safety. The boiler should be safe under operating conditions.
- (ii) Accessibility. The various parts of the boiler should be accessible for repair and maintenance.
- (iii) Capacity. Should be capable of supplying steam according to the requirements.



- (iv) Efficiency: Should be able to absorb a maximum amount of heat produced due to burning of fuel in the furnace.
 - (v) simple in construction .
 - (vi) Its initial cost and maintenance cost should be low.
 - (vii) The boiler should have no joints exposed to flames.
 - (viii) Should be capable of quick starting and loading.
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Classification of Boilers:

Boilers may be classified according to the following-

1. *Relative position of Hot gases and Water*

a) Fire tube boiler:

The hot gases produced by the combustion of the fuel are lead through the tubes that are surrounded by water.

Examples are:

Lancashire boiler,

Cohran boiler

Cornish boiler

Locomotive boiler.

b) Water tube Boiler:

The water passes through the tubes and the hot gases produced by combustion of fuel, flow outside.

Examples are:

Babcock and Wilcox Boiler (straight but inclined tubes which connect the headers).

Stirling Boiler

They are more suitable than the fire tube boilers for the generation of steam at very high pressure.

2. *Method of firing*

a) Internally fired Boilers:

The furnace is provided *inside* the boiler shell and is completely surrounded by water cooled surfaces. This method of firing is used in:

- Lancashire Boilers
- Locomotive Boilers and
- Scotch Boilers

STEAM BOILERS, MOUNTINGS & ACCESSORIES

b) Externally fired Boilers:

The furnace is provided *outside/ under* the boiler. It has an advantage that its furnace is simple to construct and can easily be enlarged, as and when required. This method of firing is used in Babcock and Wilcox Boiler.

3) Pressure of Steam:

High pressure Boilers:

Boilers producing steam *80 bar* and above are called High pressure boilers. E.g.

- * **Babcock and Wilcox Boiler**
- * **Lamont Boilers**
- * **Velox Boilers and**
- * **Benson Boilers etc.**

ii) Low pressure Boilers:

Boilers producing steam Lower than *80 bar* are called Low pressure boilers. E.g.

- **Cochran Boilers**
- **Cornish Boiler**
- **Lancashire Boiler**
- **Locomotive Boiler**

4. Method of circulation of water:

a) Natural circulation method

Circulation set up by convection current or by gravity.

b) Forced circulation method

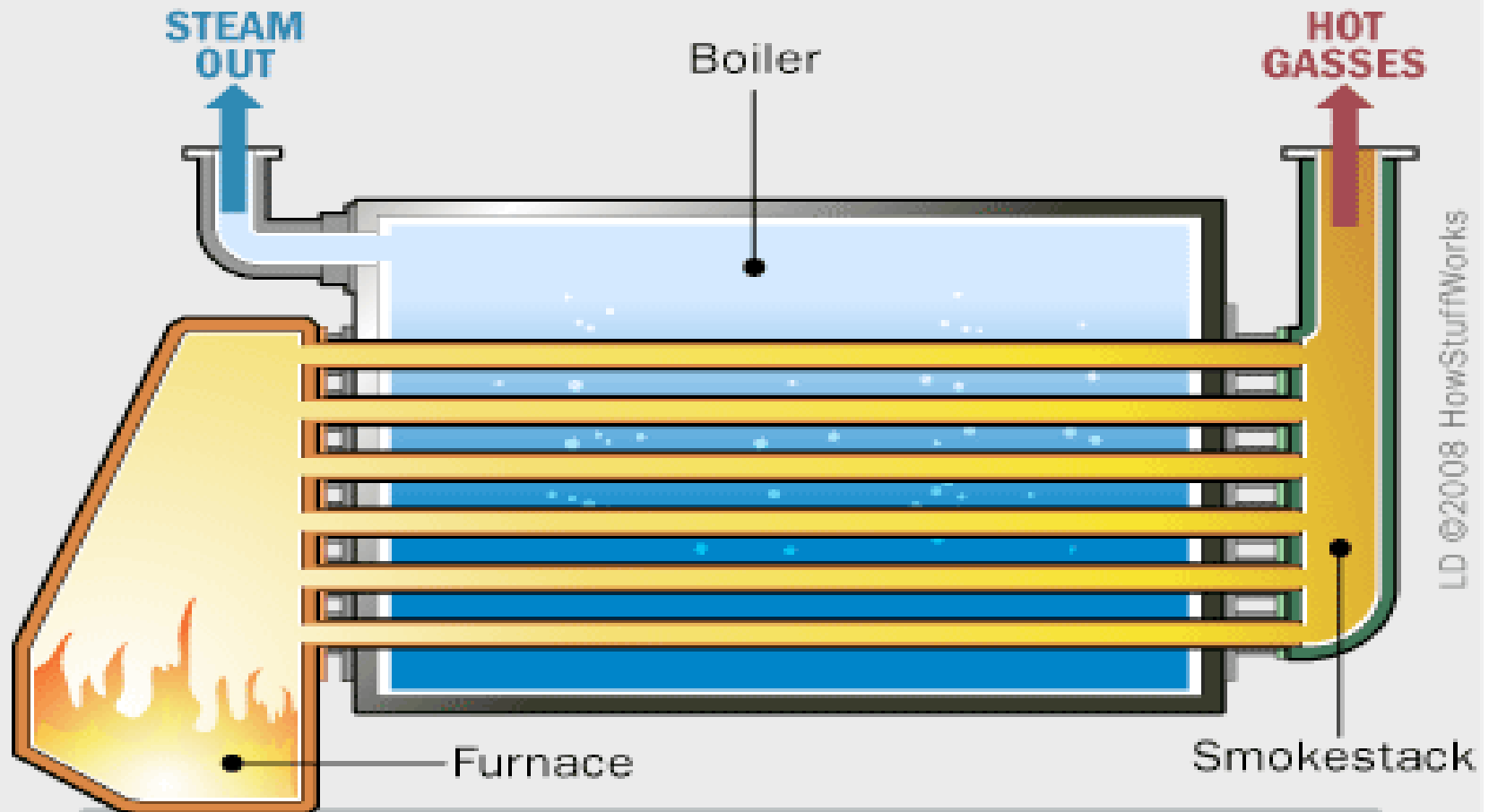
Circulation set up for high pressure steam through pumps.

FIRE TUBE BOILERS

- In fire tube boiler, hot gases pass through the tubes and boiler feed water in the shell side is converted into steam.
- Generally used for relatively small steam capacities and low to medium steam pressures.
- As a guideline, fire tube boilers are competitive for steam rates up to 12,000 kg/hour and pressures limited to 16 bar.
- Fire tube boilers are available for operation with oil, gas or solid fuels.
- For economic reasons, most fire tube boilers are nowadays of “packaged” construction (i.e. manufacturers shop erected) for all fuels.



How Steam Engines Work Fire-tube Boiler



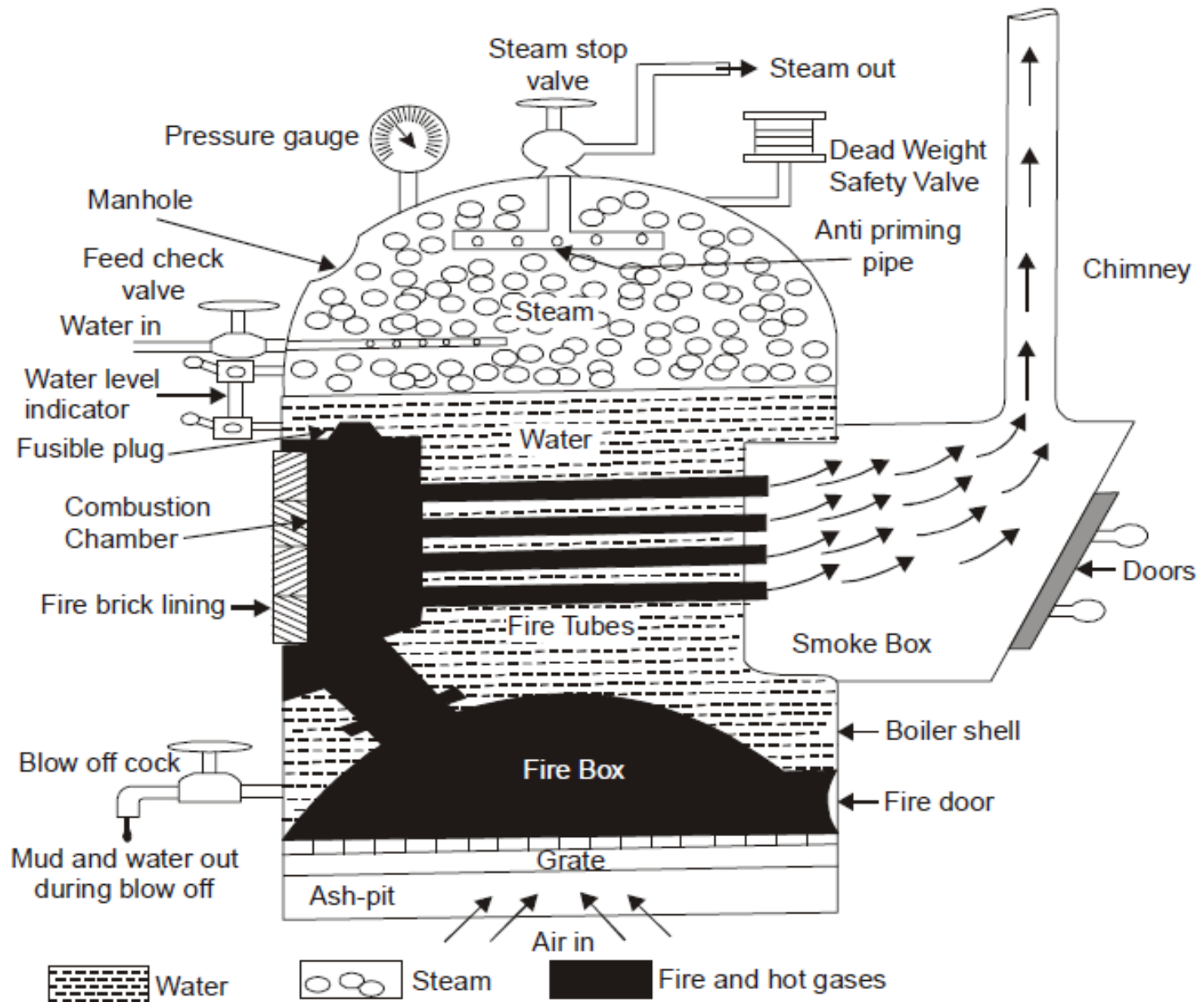
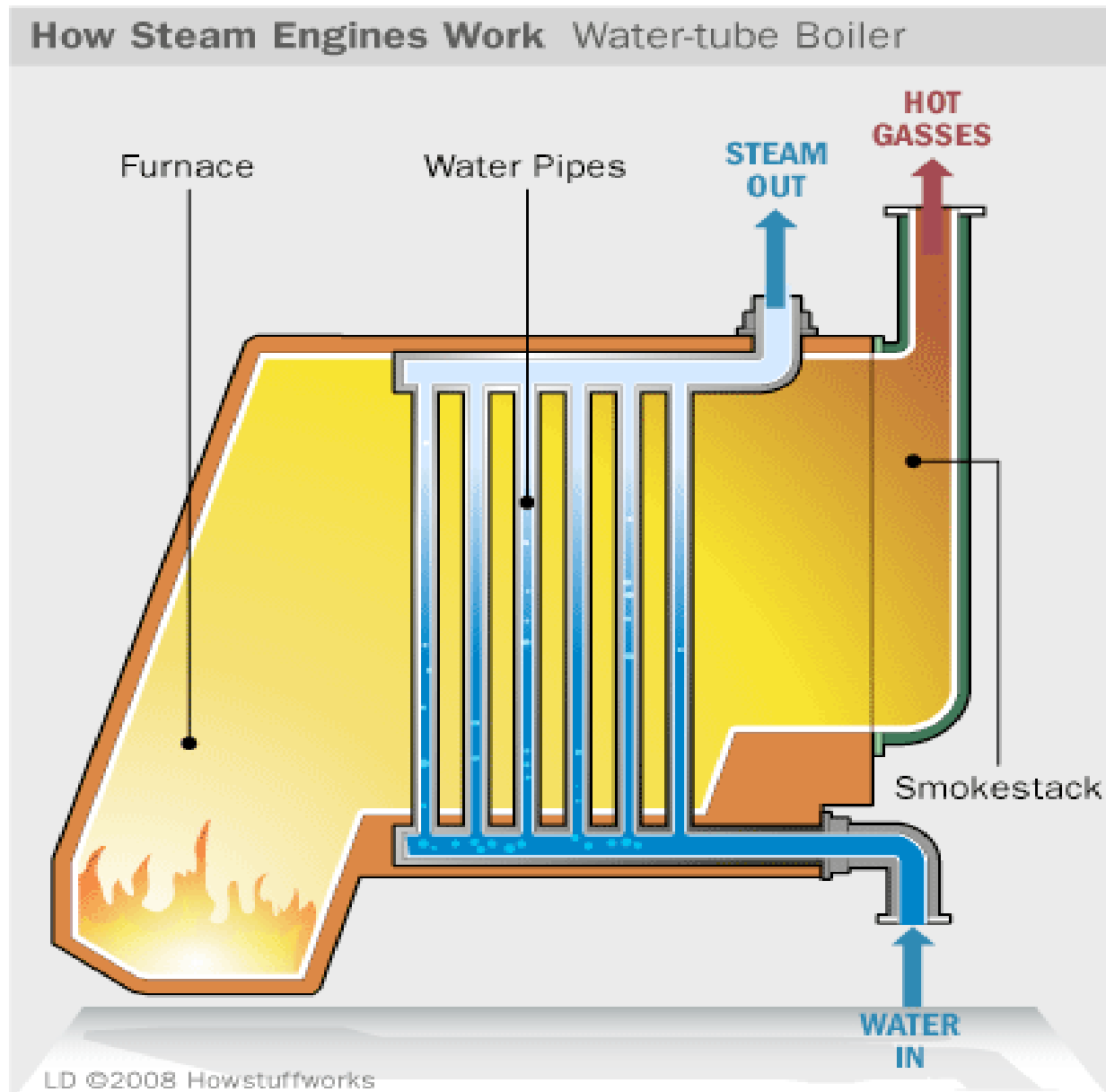
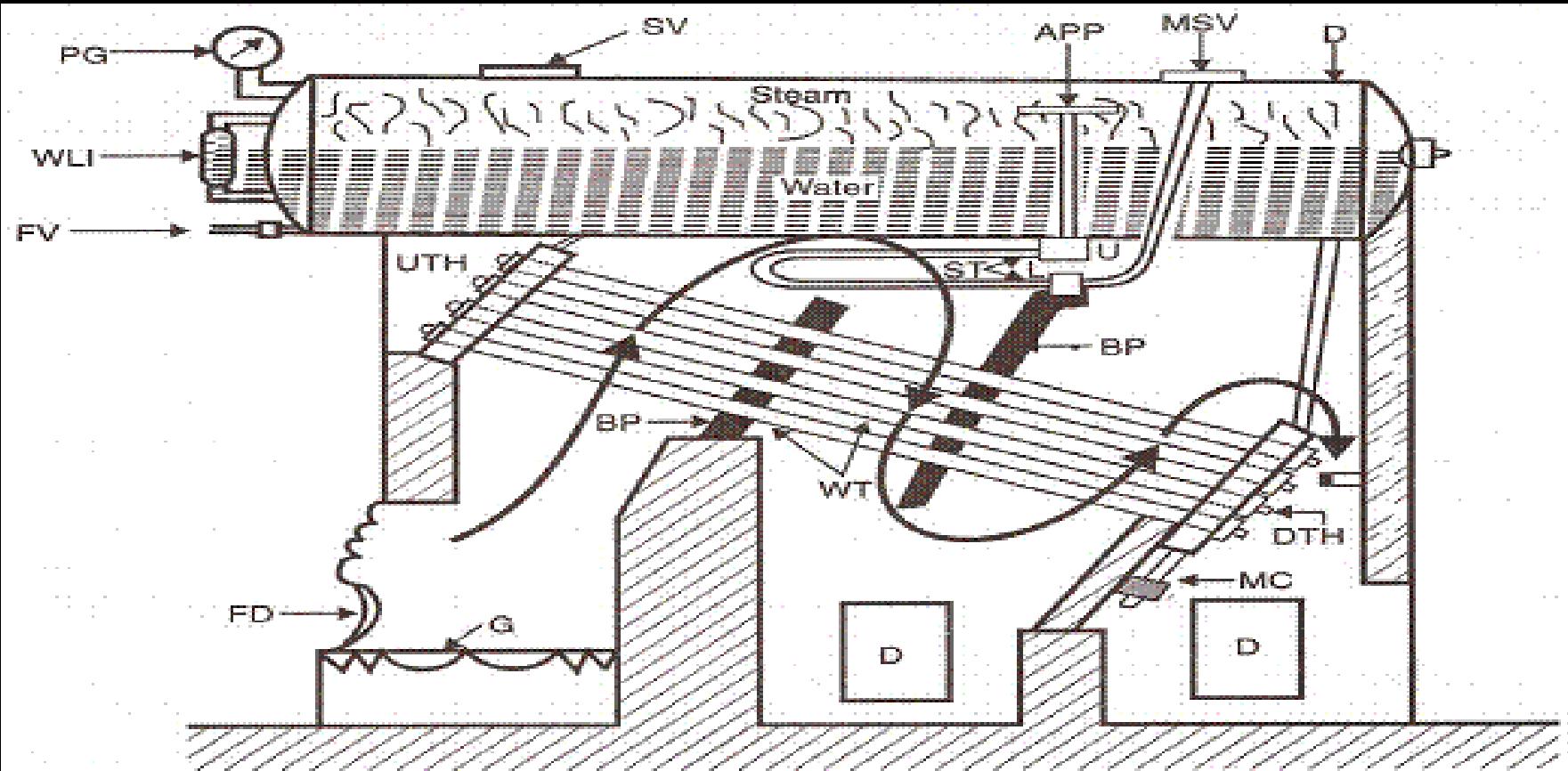


Fig. 5.1. Cochran Boiler.

WATER TUBE BOILER



BABCOCK AND WILCOX BOILER



D = Drum
DTH = Down take header
WT = Water tubes
BP = Baffle plates
D = Doors
G = Grate
FD = Fire door
MC = Mud collector
WLI = Water level indicator

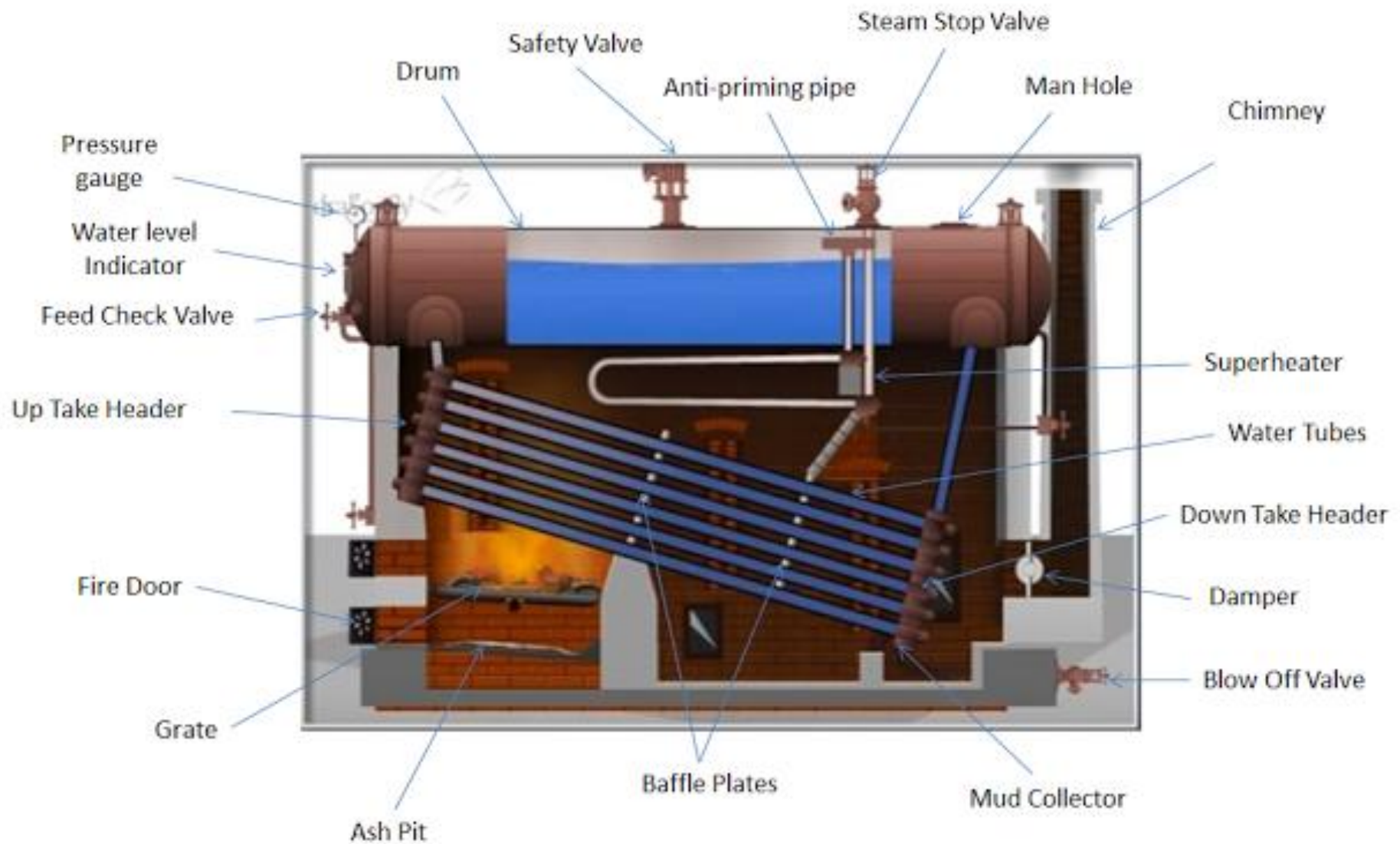
PG = Pressure gauge
ST = Superheater tubes
SV = Safety valve
MSV = Main stop valve
APP = Antipriming pipe
L = Lower junction box
U = Upper junction box
FV = Feed valve

WATER TUBE BOILERS

Working principle of Babcock – Wilcox Boiler

- The longitudinally placed drum as mentioned in the construction of longitudinal drum boiler, is fed by colder water at its rear feed water inlet.
- As colder water heavier, it falls down through down-comer fitted at the rear part of the drum. From down-comer the water enters in to horizontal water tube where it becomes hot and lighter. As the water becomes lighter, it passes up through these inclined horizontal tubes and ultimately comes back to the boiler drum through riser.
- During travelling of water through inclined water tubes, it absorbs heat of the hot gases, surrounds the water tube, consequently steam bubbles are created in these tubes. These steam bubbles then come to the steam drum through riser and naturally separated from water and occupies the space above the water surface in the longitudinal drum of **Babcock – Wilcox Boiler**.
- The working is based on **thermosyphon principle**.





MERITS OF WATER TUBE BOILERS OVER FIRE TUBE BOILERS

- 1. Generation of steam is much quicker due to small ratio of water content to steam content. This also helps in reaching the steaming temperature in short time.
- 2. Its evaporative capacity is considerably larger and the steam pressure range is also high-200 bar.
- 3. Heating surfaces are more effective as the hot gases travel at right angles to the direction of water flow.



- 4. The combustion efficiency is higher because complete combustion of fuel is possible as the combustion space is much larger.
- 5. The thermal stresses in the boiler parts are less as different parts of the boiler remain at uniform temperature due to quick circulation of water.
- 6. The boiler can be easily transported and erected as its different parts can be separated.



- 7. Damage due to the bursting of water tube is less serious. Therefore, water tube boilers are sometimes called safety boilers.
- 8. All parts of the water tube boilers are easily accessible for cleaning, inspecting and repairing.
- 9. The water tube boiler's furnace area can be easily altered to meet the fuel requirements.



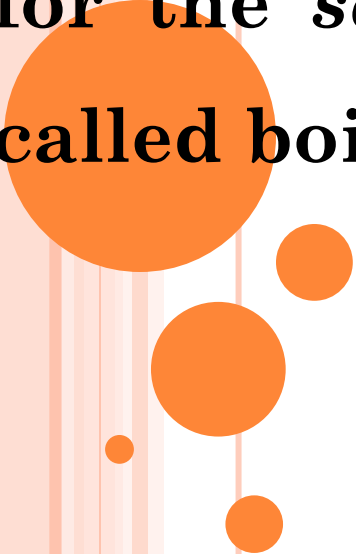
DEMERITS :

- 1. It is less suitable for impure and sedimentary water, as a small deposit of scale may cause the overheating and bursting of tube. Therefore, use of pure feed water is essential.
- 2. They require careful attention. The maintenance costs are higher.
- 3. Failure in feed water supply even for short period is liable to make the boiler over-heated.




Boiler Mountings:

The necessary devices installed or mounted for the *safety* of boiler and its *control* are called boiler mountings.




Boiler Accessories

The devices which are installed in the boiler for their *efficient operation* and *smooth working* are called Boiler Accessories.



Boiler Mountings for safety:

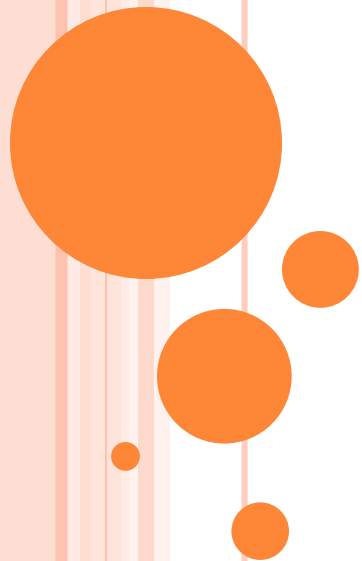
1. **Two water level indicators – 2**
 2. **Two safety valves.**
 3. **Fusible plug.**
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Boiler Mountings for control

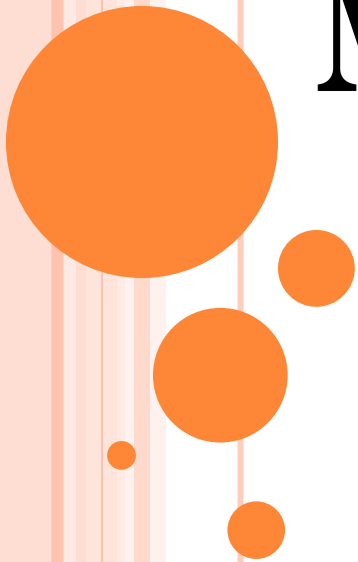
1. **Pressure gauge**
2. **Safety valve**
3. **Steam stop valve**
4. **Feed check valve**
5. **Blow-off cock**
6. **Man hole and mud hole**

Boiler Accessories for efficient operation:

- 1. Air preheater**
- 2. Economizer**
- 3. Super heater**



BOILER MOUNTINGS



- **Pressure Gauge**

- fitted in front of a boiler such that operator can conveniently read it
- Indicates the pressure of steam in a boiler

- **Steam Stop Valve**

- Placed on the highest part of the steam space of a boiler.
- Connected to a steam pipe which supplies the steam to outside
- Function is to stop or allow the steam flow from the boiler to the steam pipe.



- **Feed Check Valve**

- Fitted to the boiler slightly below the working level of the water in the boiler
- Prevents the back flow of water from the boiler when the feed water pump is either not working or in case of its failure.
- Checks the level of water in boiler and opens/closes as required and water is supplied from feed pump

- **Blow off Cock**

- Fitted at the lowest part of the boiler
- Removes sediments collected at the bottom of boiler periodically. Also to empty the boiler for cleaning/inspection purpose



- **Fusible Plug**

- Safety device, fitted in the crown plate of the furnace
- Function –to extinguish the fire in the furnace of a boiler when water level in boiler falls to an unsafe extent,
- prevents explosion which may takes place due to overheating of furnace plate

- **Man hole**

- Provided on the boiler at a convenient position so that a man can enter through it inside the boiler
- For cleaning/inspection purpose
- Opening is closed by steam tight cover



STEAM TRAP

Steam trap is used to collect and automatically drain away the water resulted from partial condensation of steam without steam to escape with this condensate through a valve. The valve after draining the condensate is closed. It prevents the leakage of steam from the trap.

BOILER ACCESSORIES

The devices used to improve the performance and operation of the boilers are called boiler accessories.

Main accessories used are:

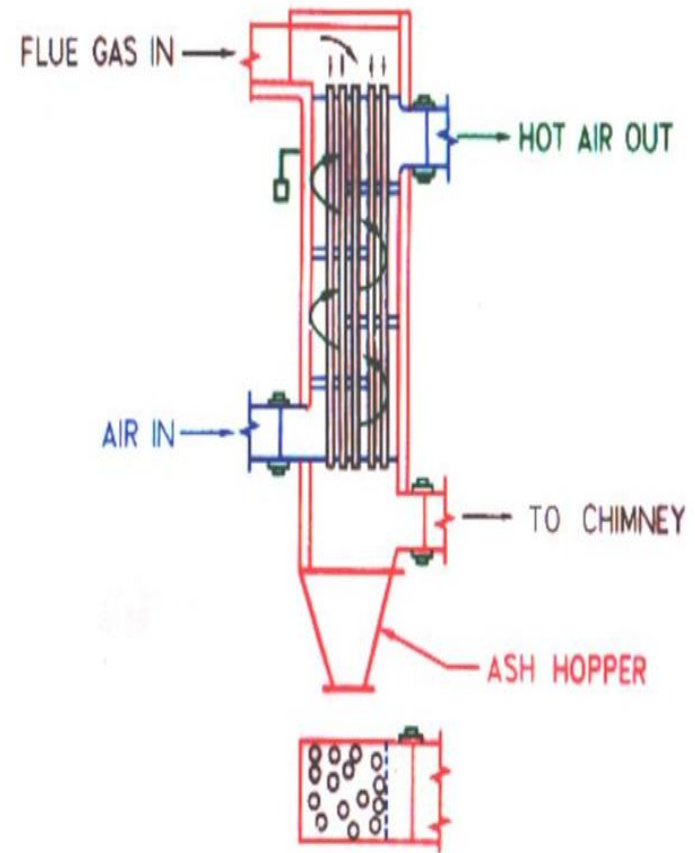
1. Air preheater
 2. Economiser
 3. Superheater
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AIR PREHEATER

Function:

The function of the air pre-heater is to increase the temperature of air before it enters the furnace.

It is generally placed after the economiser.



ECONOMISER

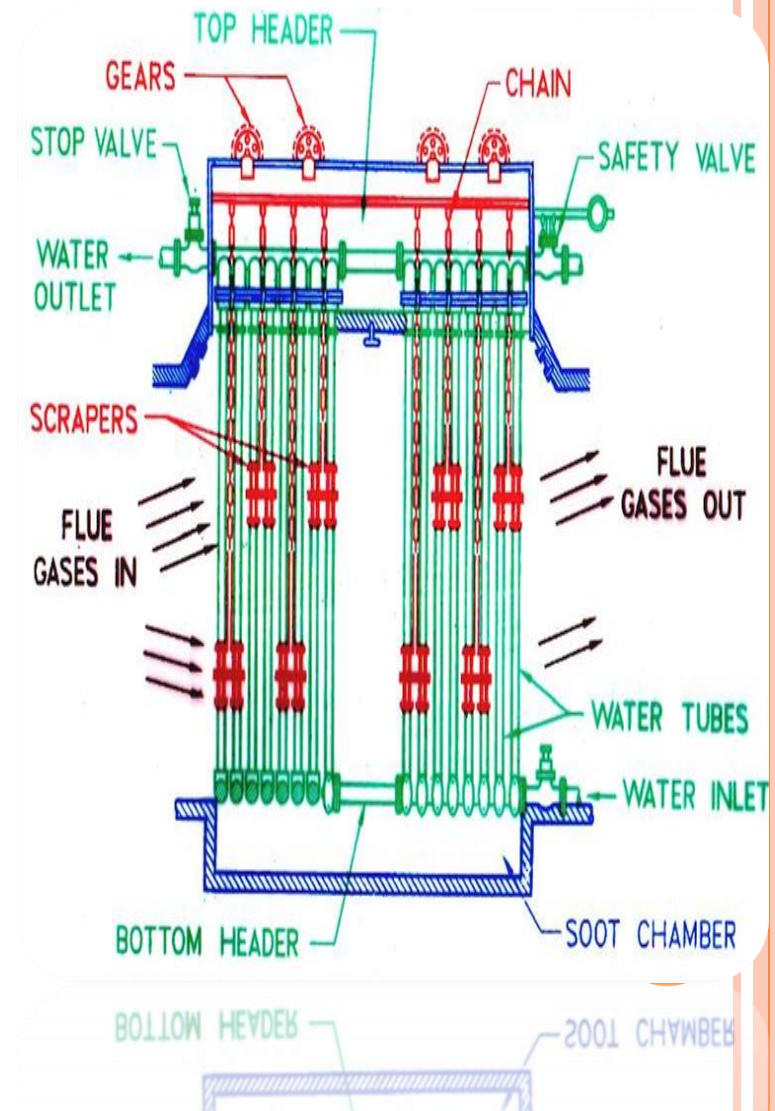
Function:

An economiser is a device in which the waste heat of the flue gases is utilised for heating the feed water.

Economiser are of two types :

Independent type, and

Integral type



- **Superheater** : Placed in the path of hot flue gases from the furnace. The heat recovered from the flue gases is used in superheating the steam before entering into the turbine (i.e., prime mover). Its main purpose is to increase the temperature of saturated steam without raising its pressure.

