BOILERS

INTRODUCTION

- **Fossil fuels form the sources of heat energy**
- **Combustion of fossil fuels produces heat (thermal) energy**
- **Heat energy thus derived is used to heat water, evaporate it and generate steam**
- **Steam is produced in a closed vessel called BOILER**

USES OF STEAM:

(A) Power Generation

Steam is used in *thermal power plants* to run *steam turbines* and hence generate power

(B) Process Heating

Steam as *process steam* is used in textile industries, paper mills, chemical industries, sugar factories, pharmaceutical industries and breweries for bleaching, sizing and processing

STEAM BOILERS

Definition of a Boiler

Boiler is defined as a closed metallic vessel in which the water is heated beyond the boiling state by the application of heat liberated by the combustion of fuels to convert it into steam.

Function of a Boiler

The function of a boiler is to supply the steam at the required constant pressure with its quality either dry, or as nearly as dry, or superheated.

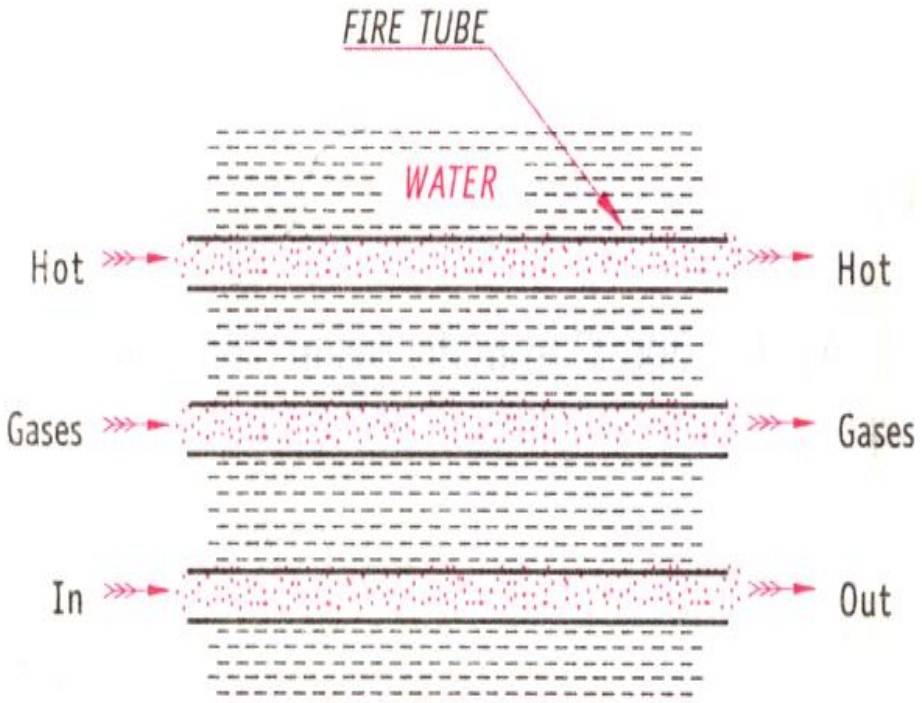
CLASSIFICATION OF BOILER

1. **According to the axis of the shell:**
   a. Horizontal boiler
   b. Vertical boiler
   c. Inclined boiler
2. **According to the application**
   a. Stationary boiler
   b. Mobile boiler
3. **According to the location of the furnace**
   a. Internally fired boiler
   b. Externally fired boiler

4. **According to the type of fuel used**
   a. Solid fueled boiler
   b. Liquid fueled boiler
   c. Gaseous fueled boiler
5. **According to the method of circulation of water**
   a. Natural circulation boiler
   b. Forced circulation boiler
6. **According to the flow of water and flue gases**
   a. Fire tube boilers
   b. Water tube boilers

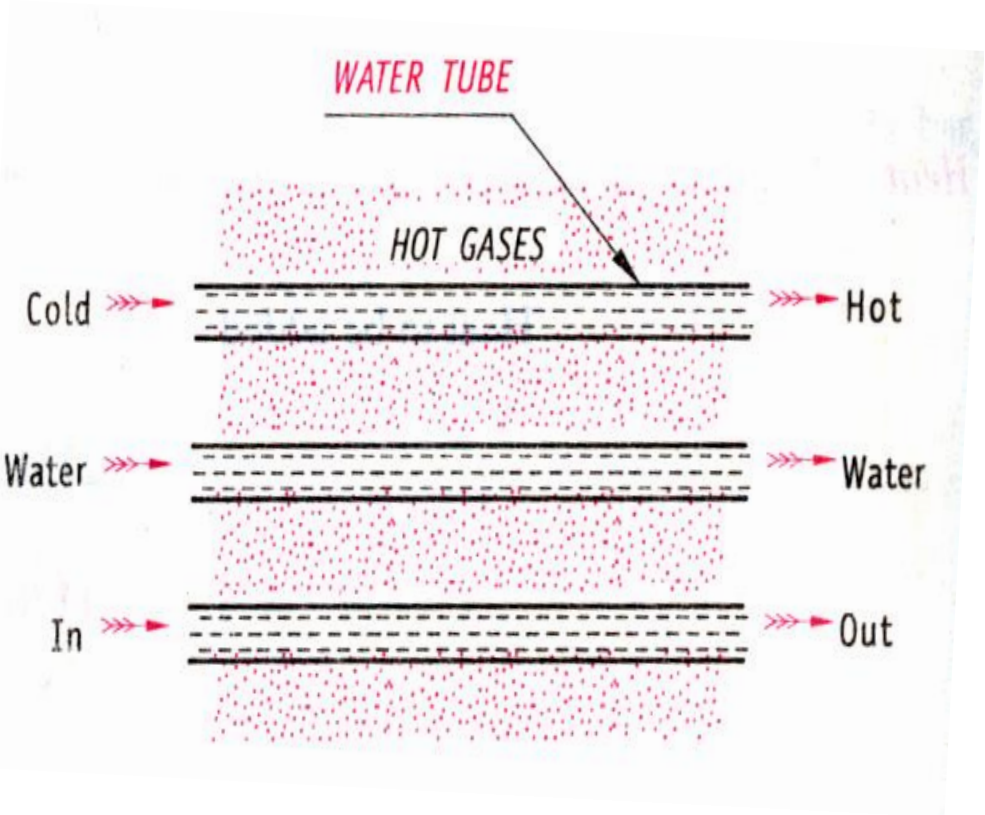
Fire Tube Boiler

- In the fire tube boilers, the hot flue gases produced by the combustion of fuels are led through a tube or a nest of tubes around which the water circulates.
- The examples are Cochran boiler, Cornish boiler, & Lancashire boiler.

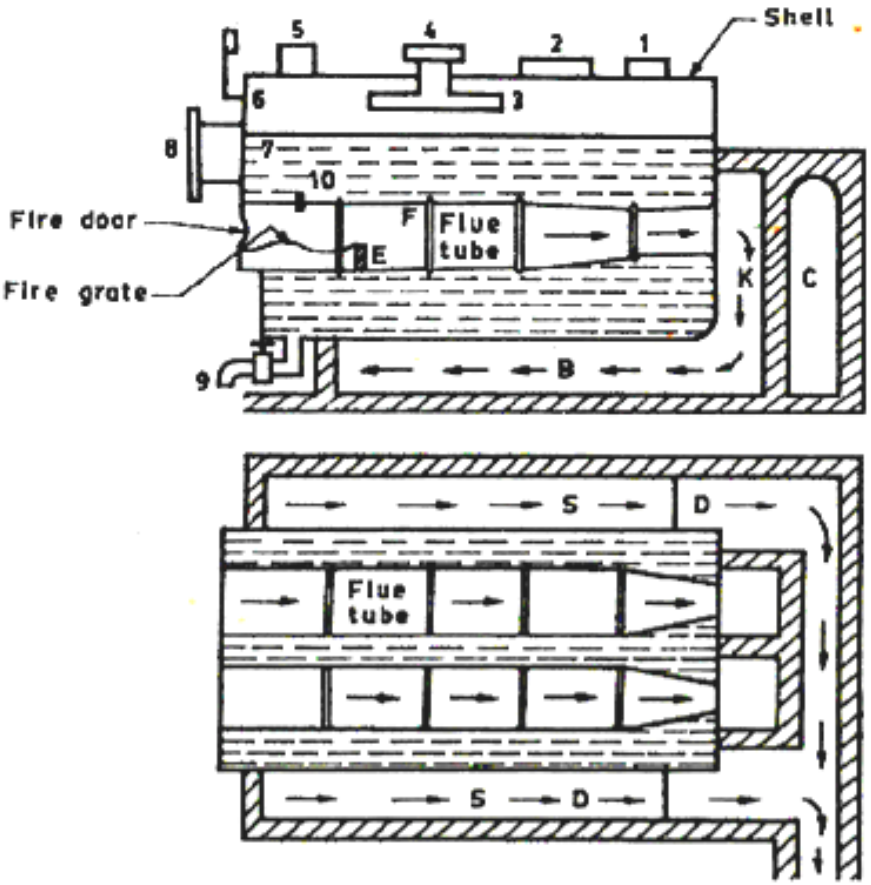


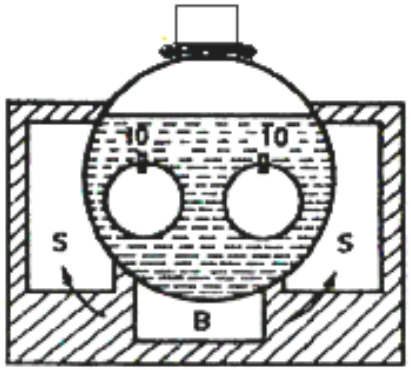
Water Tube Boiler

- In the water tube boilers, the water circulates inside the tubes while the hot gases produced by the combustion of the fuels pass around them externally
- The examples are **Babcock and Wilcox boiler** & Stirling boiler



LANCASHIRE BOILER



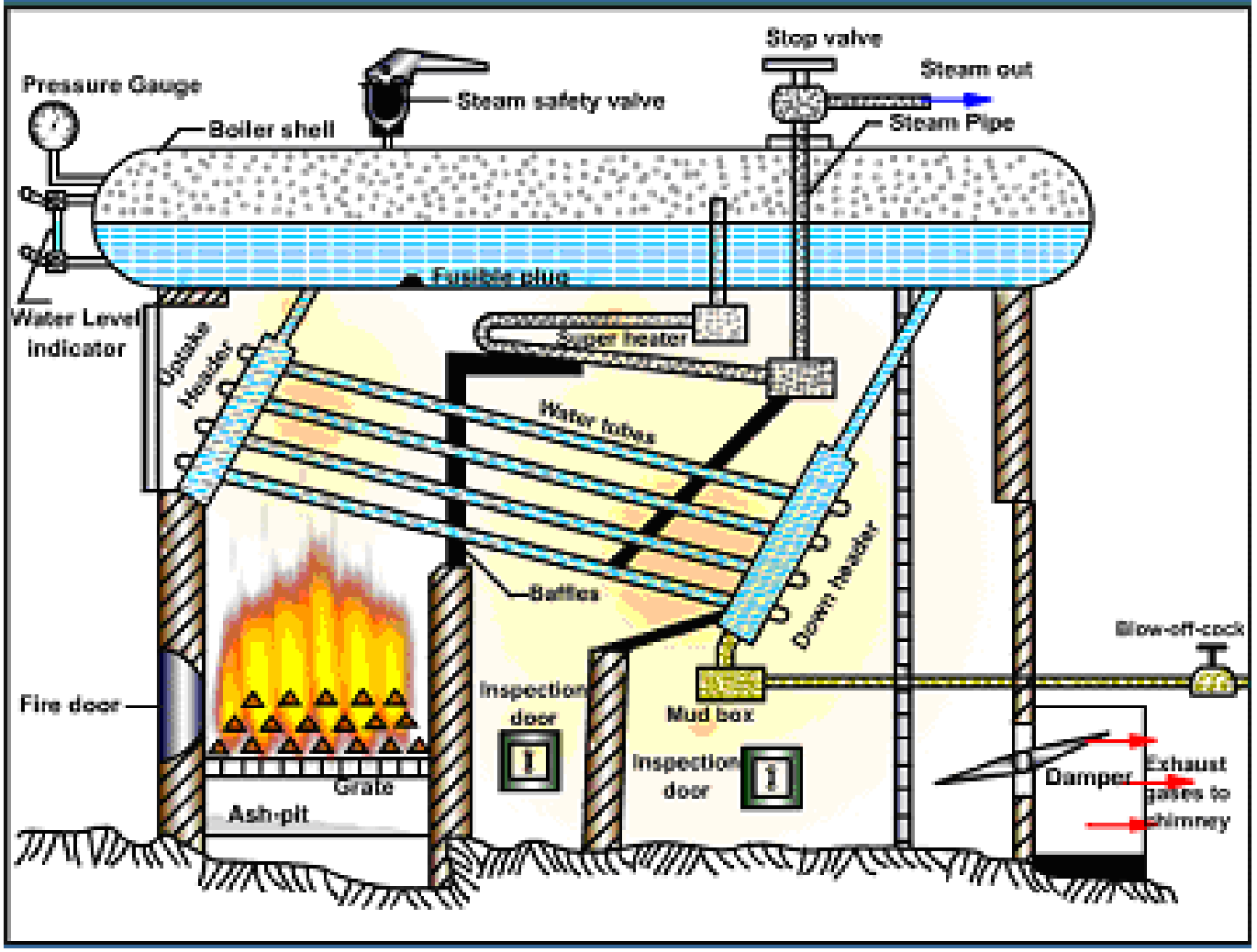


1. Safety valve
2. Man hole
3. Steam pipe
4. Steam stop valve
5. Safety valve
6. Pressure gauge
7. Feed check valve
8. Water gauge
9. Blowoff valve
10. Fusible plug

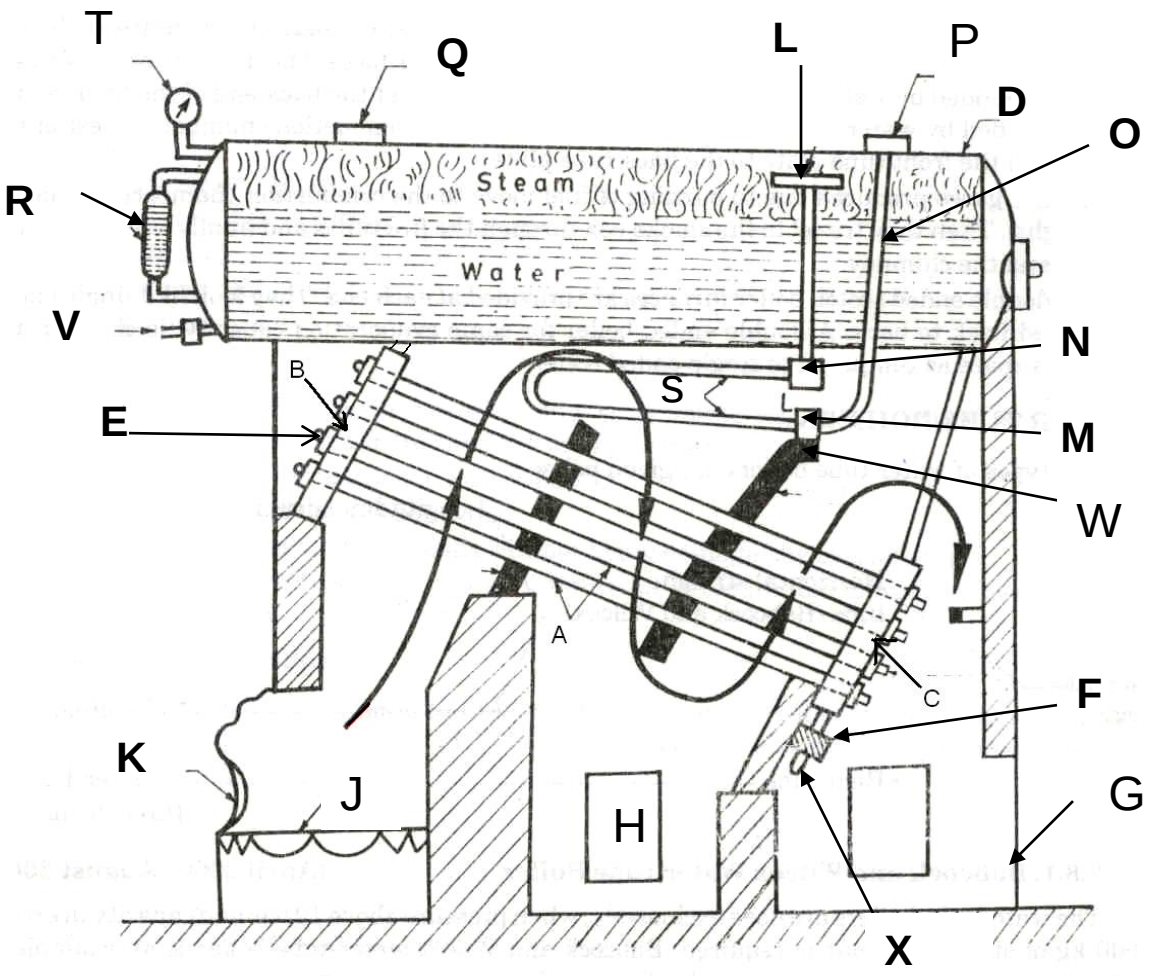
B: Bottom central channel D: Dampers S: side channels

C: Chimney E: Fire grate F :Flue tube K: Main channel

Babcock and Wilcox Boiler



Babcock and Wilcox boiler



A: Water tubes
B: Uptake header
C: Downtake header
D: Water drum
E: Steel Caps
F: Mud Box
G: Dampers
H: Doors
J: Chain grate stoker
K: Furnace door
L: 'T' tube
M: Lower junction box
N: Upper junction box.
O: Stop valve connection

P: Stop valve, **Q:** Safety valve, **R:** Water-level indicator, **S:** Superheater,

T: Pressure gauge, **V:** Feed check valve, **W:** Baffles, **X:** Blowoff valve

Advantages of Water Tube Boilers over Fire Tube Boilers

1. *Steam can be raised more quickly*
2. *Steam at higher pressures can be produced*
3. *Higher rate of evaporation*
4. *Sediment deposition is less*
5. *Suitable for any type of fuel and method of firing*
6. *More effective heat transfer*
7. *Failure of water tubes will not affect the working of boiler*
8. *Occupies less Space, Easy maintenance & Easy transportation*

Disadvantages of Water Tube Boilers over Fire Tube Boilers

1. Not suitable for ordinary water
2. Not suitable for mobile application
3. High initial cost and hence not economical

Differences / Comparison

Particulars	Fire tube	Water tube
Flow of water & hot gases	Hot gases inside the tubes and water outside the tubes	Water inside the tubes and hot gases outside the tubes
Mode of firing	Internally fired	Externally fired
Operating pressure	Low (Max. up to 16 bar)	High (Max. up to 75 bar)
Rate of steam production	Low	High

Differences / Comparison (Contd.)

Particulars	Fire tube	Water tube
Applications	Suitable for chemical industries & not for power generation	Ideally suitable for power generation plants.
Risk of bursting	Safe, due to low pressure	Not safe, due to high pressure
Treatment of water	Not essential	Essential
Shell diameter	Large for given capacity	Small for given capacity

Boiler Mountings and Accessories

BOILER MOUNTINGS are required for:

- complete ***controlling*** of the steam generation,
- ***measurement*** of some of the important steam properties, and
- to provide ***safety*** to the boiler.

1	Water level indicators
2	Pressure gauge
3	Safety valves
4	Steam stop valve
5	Blow-off valve
6	Feed check valve
7	Fusible plug
8	Manhole

Function of the Boiler Mountings

Water Level Indicator: The function of the water level indicator is to indicate the level of the water in the boiler drum.

Pressure Gauge: The function of the pressure gauge is to indicate the pressure of steam in the boiler.

Safety Valves: A *safety valve suddenly* blows off the excess of steam from the boiler and shuts off automatically.

Steam Stop Valve: A steam stop valve or Junction valve is used to regulate the flow of steam from the boiler.

Feed Check Valve: When the level of water in the boiler falls, it is brought back to the specified level by supplying the additional water through the *feed check valve.*

Blow off Valve: The function of the blow off valve is to remove periodically the sediments & also used to empty the water in the boiler when required.

Fusible Plug: Fusible plug is a safety device used to extinguish the fire in the furnace of the boiler when the water level falls below the normal level.

Manhole: Its an opening in the boiler shell through which a man can go in for periodic inspection and cleaning.

BOILER ACCESSORIES are required

- to improve the efficiency of steam power plant, and
- to enable for the proper working of the boiler.

1	*Economiser*
2	*Air preheater*
3	*Superhater*
4	*Feed pump*
5	*Steam separator*
6	*Steam trap*

Function of the Boiler Accessories

Economizer: It is a device, in which the waste heat of the flue gases is utilized for preheating the feed water.

Air preheater: It is a device, in which the waste heat of the flue gases is utilized for preheating the air supplied for the combustion of the fuel in the furnace.

Superheater: Superheaters are used in boilers to increase the temperature of the steam above the saturation temperature

Steam trap: Steam trap is a device used to ***drain off the condensed water*** accumulating in the steam pipe lines while at the same time the high pressure steam does not escape out of it.

- It is connected to a small by-pass pipe which branches off from the main steam pipe line.

Steam Separator: A steam separator ***separates the water particles*** from the steam flowing in the pipe lines.

- It is installed very close to the steam engine or turbine on the main supply line.

Feed Pump: A feed pump is a boiler accessory to force the feed water at higher pressure into the boilers.