SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES, CHITTOOR

(AUTONOMOUS)

Approved by AICTE, New Delhi, Affiliated to JNTUA, Ananthapuramu.

LECTURE NOTES

Subject Name : Power Plant Engineering &23MEC472A
Year/Branch : IV Year VII Sem / Mech
Regulation : R23
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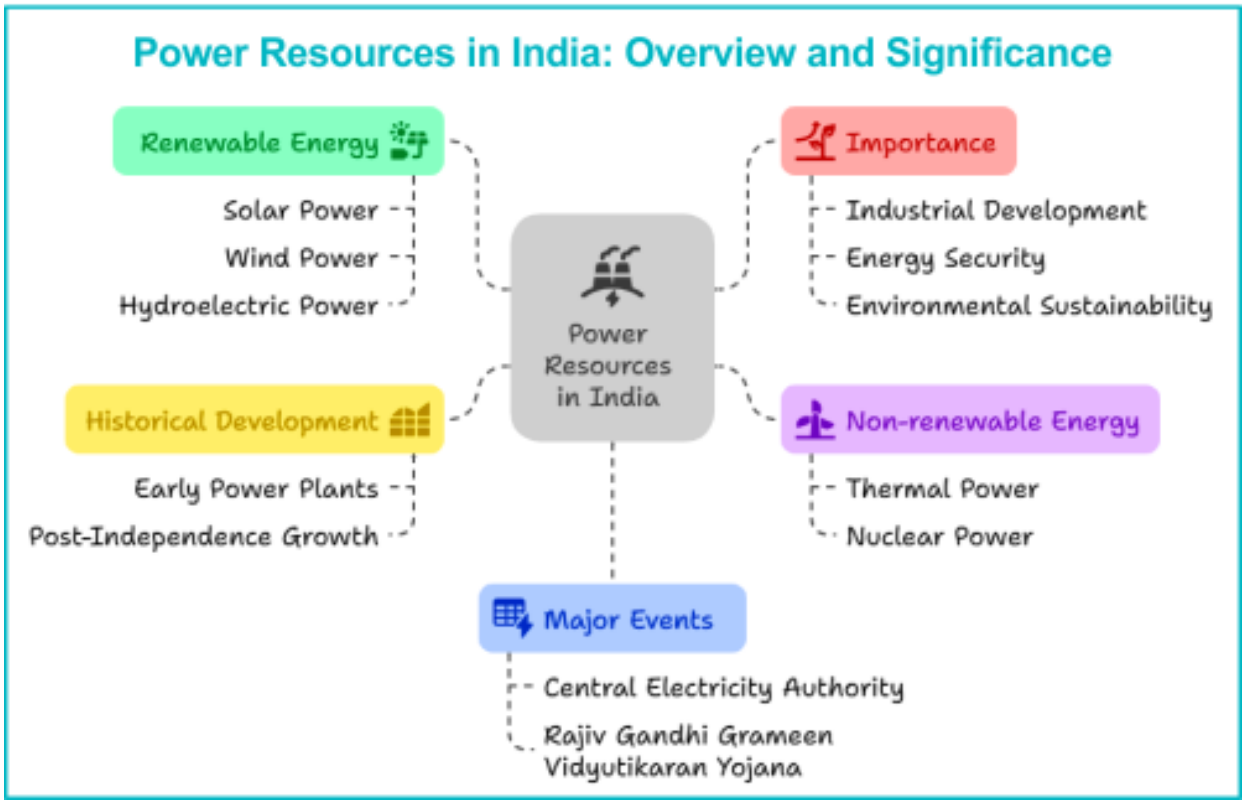
UNIT- I

INTRODUCTION TO THE SOURCES OF ENERGY

Resources and Development of Power in India:



India is a vast country with a wide variety of power resources, including both renewable and non-renewable sources. Non-renewable sources include fossil fuels and coal. India imports most of its crude oil, while coal is abundantly available domestically and is widely used for electricity generation, which leads to significant pollution.

To combat pollution the Indian government is prioritizing renewable energy sources. These include hydroelectric power, solar energy and wind energy. Additionally, atomic power is a highly efficient energy resource in India, generating substantial electricity over long periods using natural atomic resources.

Renewable Energy Resources

Renewable energy resources are sustainable sources of power that can be replenished naturally. Examples include biomass, wind, hydro-power, geothermal and solar energy. Unlike fossil fuels and other non-renewable sources, renewable energy can be used repeatedly without being depleted, making it an important part of efforts to reduce environmental impact and promote sustainable development.

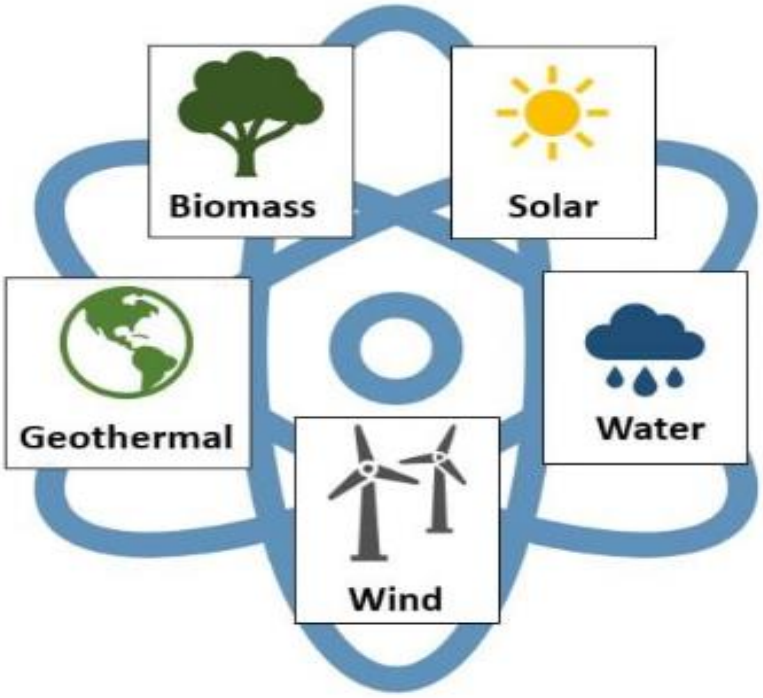


Fig: Renewable energy resources

Non-renewable Energy Resources

Non-renewable energy resources are those derived from finite sources that cannot be replenished in a short period. They include fossil fuels such as coal, crude oil, and natural gas, which formed millions of years ago from organic matter. Uranium, used for nuclear energy, is also considered non-renewable. These resources are finite and their extraction and use contribute to environmental concerns like pollution and climate change.

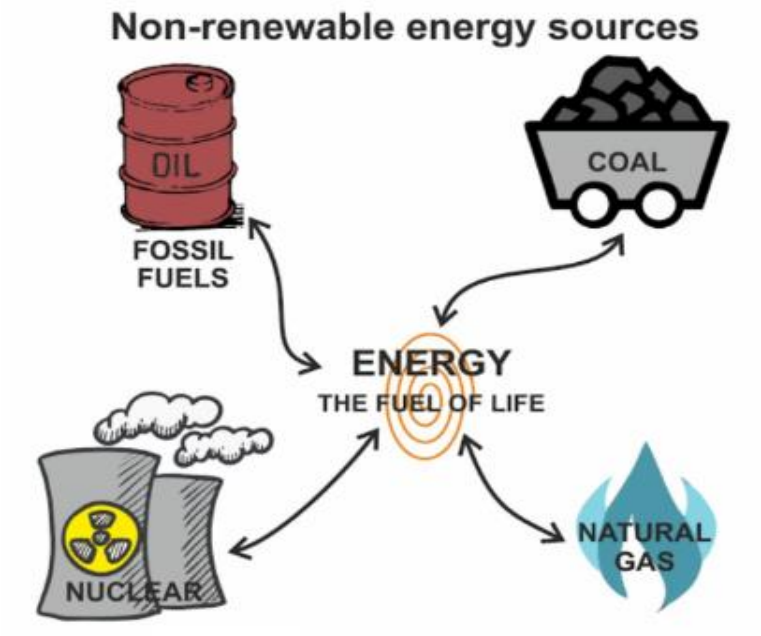


Fig: Non-renewable energy resources

Sources of Energy

The various sources of energy are :

1. Fuels
   - Solids—Coal, coke anthracite etc.
   - Liquids—Petroleum and its derivatives
   - Gases—Natural gas, blast furnace gas etc.

   } Conventional

2. Energy stored in water
3. Nuclear energy
4. Wind power
5. Solar energy
6. Tidal power
7. Geothermal energy
8. Thermoelectric power.

} Non-conventional

1.3.1. Fuels

Fuels may be chemical or nuclear. Here we shall consider chemical fuels only.

***A chemical fuel** is a substance which releases heat energy on combustion.* The principal combustible elements of each fuel are *carbon* and *hydrogen*. Though *sulphur* is a combustible element too but its presence in the fuel is considered to be *undesirable.*

Classification of fuels :

Fuels can be *classified* according to whether :

1. They *occur in nature* called *primary fuels* or are *prepared* called *secondary fuels.*
2. They are *in solid, liquid* or *gaseous state.*

Type of fuel	*Natural (Primary)*	*Prepared (Secondary)*
Solid	Wood	Coke
	Peat	Charcoal
	Lignite coal	Briquettes.
Liquid	Petroleum	Gasoline
		Kerosene
		Fuel oil
		Alcohol
		Benzol
		Shale oil.
Gaseous	Natural gas	Petroleum gas
		Producer gas
		Coal gas
		Coke-oven gas
		Blast furnace gas
		Carburetted gas
		Sewer gas.

Power Plant Economics:

Power plant economics deals with the **cost of generating electrical energy** while ensuring reliable and efficient operation. Environmental considerations focus on **minimizing pollution and protecting natural resources** during power generation.

Electricity generation requires huge investments in:

- Land
- Buildings
- Machinery
- Fuel
- Transmission systems
- Environmental protection equipment

The objective of power plant economics is:

To generate electricity at the minimum possible cost while maintaining high reliability and environmental safety.

Objectives of Power Plant Economics:

The major objectives are:

- Produce electricity economically.
- Ensure continuous power supply.
- Minimize operating costs.
- Improve plant efficiency.
- Reduce fuel consumption.
- Increase plant life.
- Minimize environmental pollution.
- Maximize profit.

Power plant economics is the study of **generating electrical energy at the lowest possible cost while maintaining reliability, efficiency, safety, and environmental protection.**

The major objectives are:

- Minimum cost of generation
- Maximum plant efficiency
- Reliable power supply
- Reduced fuel consumption
- Reduced environmental pollution
- Increased profit

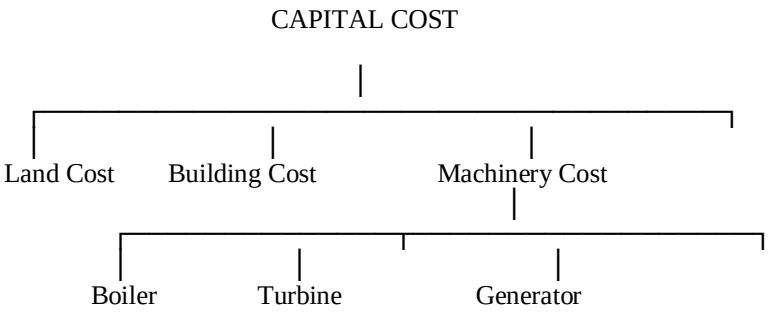
Capital Cost

Capital cost is the **initial investment required for constructing a power plant.**

It includes:

- Cost of land
- Civil construction
- Boiler
- Turbine
- Generator
- Transformer
- Cooling tower
- Chimney
- Switchyard
- Pollution control equipment
- Transmission facilities

Diagram of Capital Investment



Advantages

- Better efficiency
- Long plant life
- Lower maintenance

Disadvantages

- High initial investment
- Long payback period

Investment of Fixed Charges

Fixed charges are expenses that **do not depend on electricity generation.**

Fixed Charges Include

- Interest on investment
- Depreciation
- Taxes
- Insurance
- Salaries
- Administrative expenses

Operating Costs

Operating cost depends upon the amount of electricity generated.

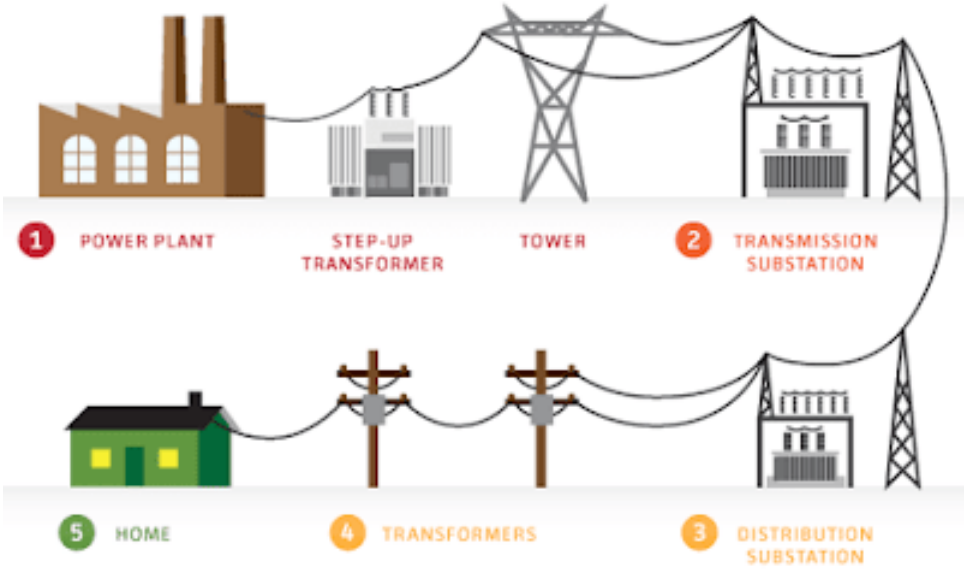
Operating Cost Includes

- Fuel cost
- Water
- Lubricating oil
- Chemicals
- Maintenance
- Repairs
- Labour
- Ash handling

General Arrangement of Power Distribution

Electricity generated in the power plant is transmitted to consumers through transmission and distribution systems.

Neat Diagram



POWER STATION
|
Step-up Transformer
|
220/400 kV Transmission
|
Grid Substation
|
Step-down Transformer
|
33 kV Distribution
|
Distribution Transformer
|
415/230 V Supply
|
Consumers

Load Curve

A load curve is a graph showing **variation of electrical load with time.**

Diagram

Load (MW)

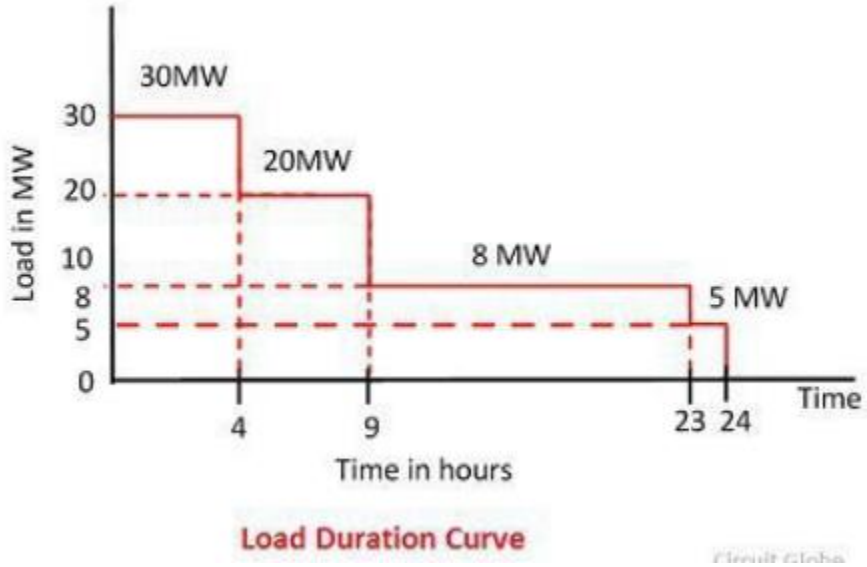
Importance

- Determines plant capacity
- Fuel scheduling
- Maintenance planning
- Economic operation

Load Duration Curve

Load duration curve is obtained by arranging the load values in descending order.

Diagram



Load Duration Curve

Advantages

- Shows duration of various loads
- Helps select plant capacity
- Useful in economic planning

Connected Load

The sum of all electrical equipment connected to the supply.
Example
Fan =100 W
Light =200 W
Motor =1500 W
Connected Load
=1800 W

Maximum Demand

Maximum load occurring during any period.
Example
Connected Load =100 kW
Maximum Demand =75 kW

Demand Factor

$$Demand\ Factor = \frac{Maximum\ Demand}{Connected\ Load}$$

Example

Maximum Demand =80 kW

Connected Load =100 kW

Demand Factor

=80/100

=0.8

Average Load

$$Average\ Load = \frac{Energy\ Generated}{Time}$$

Load Factor

$$Load\ Factor = \frac{Average\ Load}{Maximum\ Demand}$$

Example

Average Load =60 MW

Maximum Demand =100 MW

Load Factor

=0.6

Diversity Factor

$$Diversity\ Factor = \frac{Sum\ of\ Individual\ Maximum\ Demands}{Maximum\ Demand\ of\ Complete\ System}$$

Always greater than 1.

Example

Individual Maximum Demand

100 MW

80 MW

70 MW

Total

250 MW

System Maximum Demand

200 MW

Diversity Factor

250/200

=1.25

Tariff

Tariff is the **price charged for supplying electrical energy.**

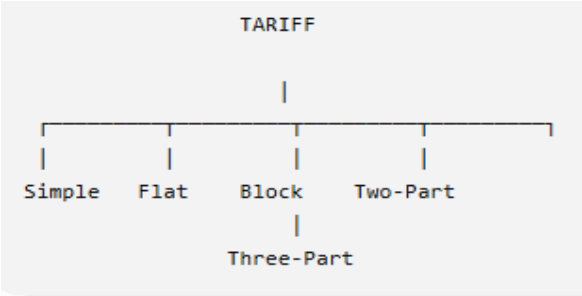
Objectives

- Recover investment
- Encourage efficient power use
- Provide profit

Types

- Simple Tariff
- Flat Rate Tariff
- Block Rate Tariff
- Two-Part Tariff
- Three-Part Tariff

Tariff Diagram



Related Numerical Problems

Problem 1

Connected Load =120 kW

Maximum Demand =90 kW

Find Demand Factor.

Solution

Demand Factor

=90/120

=0.75

Problem 2

Average Load =75 MW

Maximum Demand =100 MW

Load Factor

=75/100

=0.75

Problem 3

Annual Cost

₹5 Crore

Units Generated

2 Crore Units

Cost per Unit

=₹5/2

=₹2.50 per unit

Environmental Considerations

Power plants produce pollutants affecting

- Air
- Water
- Soil
- Human health

Major impacts include

- Global warming
- Acid rain
- Climate change
- Respiratory diseases

Effluents from Power Plants

Air Effluents

- CO_2
- SO_2
- NO_x
- Fly ash
- Carbon monoxide

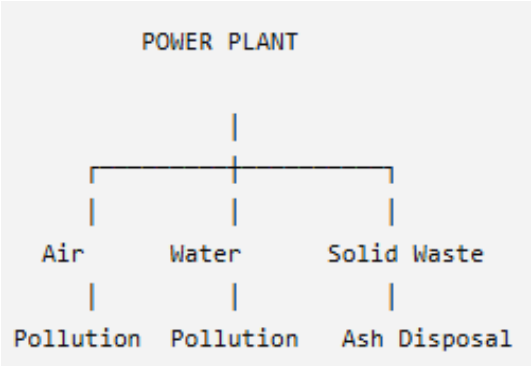
Liquid Effluents

- Hot cooling water
- Oil
- Chemicals
- Heavy metals

Solid Effluents

- Fly ash
- Bottom ash
- Sludge

Environmental Impact Diagram



Pollutants and Pollution Standards

Pollutant	Effect
CO_2	Global warming
SO_2	Acid rain
NO_x	Smog
Fly Ash	Lung diseases
CO	Poisonous gas
Mercury	Water contamination

Indian Pollution Standards (Typical)

- SO_2 emissions controlled using FGD systems.
- NO_x emissions controlled using low-NOx burners or SCR.
- Particulate matter controlled using ESPs and bag filters.
- Wastewater must be treated before discharge.
- Continuous Emission Monitoring Systems (CEMS) are installed for compliance.

Methods of Pollution Control

Electrostatic Precipitator (ESP)

Dirty Gas
↓
| Charging Electrodes |
↓
Dust Collected

↓

Clean Gas

↓

Efficiency

99%

Bag Filter
Removes fine dust.

Cyclone Separator
Uses centrifugal force.

Wet Scrubber
Removes SO_2.

Catalytic Converter
Reduces NO_x.

Cooling Tower
Reduces thermal pollution.

Hot Water

↓

Cooling Tower

↓

Cold Water

↓

Power Plant

Inspection and Safety Regulations

Power plants must comply with safety regulations to protect personnel, equipment, and the environment.

Routine Inspections

- Boiler inspection
- Turbine inspection
- Pressure vessel testing
- Electrical equipment testing
- Chimney inspection
- Cooling tower inspection
- Pollution control equipment inspection

Safety Equipment

- Safety helmet
- Gloves
- Safety shoes
- Goggles
- Ear protection
- Fire extinguisher
- Gas detector
- First-aid kit

Safety Rules

- Follow lockout/tagout (LOTO) procedures before maintenance.
- Inspect pressure relief valves regularly.
- Ensure proper grounding of electrical systems.
- Maintain fire detection and suppression systems.
- Use personal protective equipment (PPE) at all times.
- Conduct emergency drills and evacuation training.
- Monitor confined spaces before entry.
- Ensure compliance with statutory inspections and environmental regulations.

Important University Examination Questions (10 Marks)

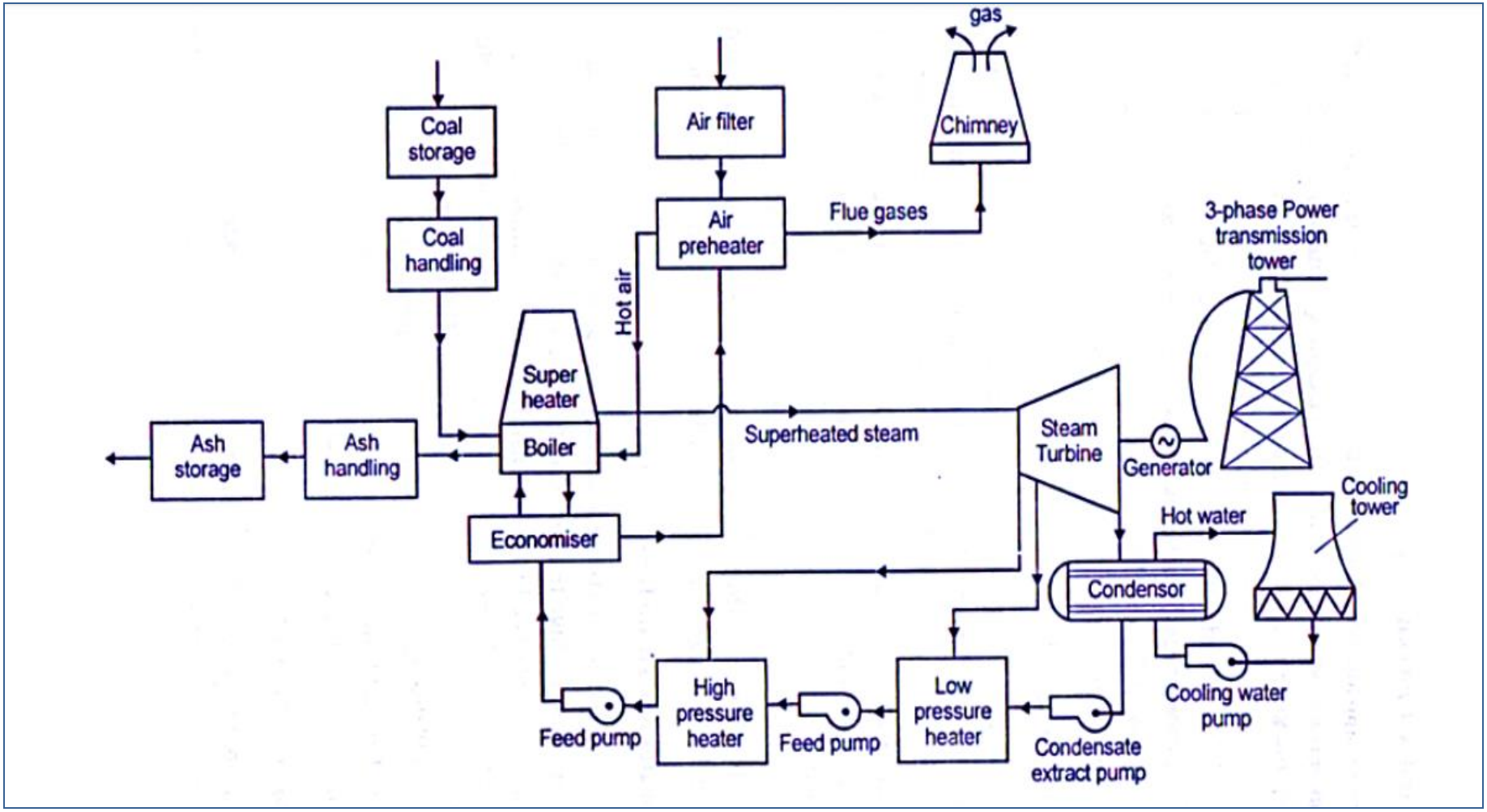
1	**Explain the capital cost, fixed charges, and operating costs of a power plant**
2	**Draw and explain the general arrangement of a power distribution system**
3	**Explain the load curve and load duration curve with neat sketches**
4	**Define connected load, maximum demand, average load, load factor, demand factor, and diversity factor with examples.**
5	**Explain different types of electricity tariffs with suitable examples**
6	**Discuss the environmental impacts of power plants and explain the methods of pollution control.**
7	**Discuss the role of pollution control equipment such as ESPs, bag filters, scrubbers, and cooling towers in thermal power plants.**
8	**Explain the major pollutants released from thermal power plants and their effects on the environment.**
9	**Describe the inspection procedures and safety regulations followed in power plants**
10	**Solve numerical problems based on demand factor, load factor, diversity factor, and cost of electrical energy.**

INTRODUCTION ABOUT POWER PLANT ENGINEERING

STEAM POWER PLANT

- A thermal power station is a power plant in which the prime mover is steam driven.
- Water is heated ,Steam will produce then it strikes to steam turbine blades which produces Electricity , the process is known as Rankin's Cycle
- Some prefer to use the term energy center because such facilities convert forms of heat energy into electricity.
- A large proportion of CO2 is produced by the worlds fossil fired thermal power plants; efforts to reduce these outputs are various and widespread

LAYOUT OF STEAM POWER PLANT



The four main circuits one would come across in any thermal power plant layout are.

1. Coal and Ash Circuit
2. Air and Gas Circuit
3. Feed Water and Steam Circuit
4. Cooling Water Circuit

1. Coal and Ash circuit in a thermal power plant layout mainly takes care of feeding the boiler with coal from the storage for combustion. The combustion in the Coal and Ash circuit is controlled by regulating the speed and the quality of coal entering the grate and the damper openings.

2. Air from the atmosphere is directed into the furnace through the air preheated by the action of a forced draught fan or induced draught fan. The exhaust gases from the combustion heat the air, which goes through a heat exchanger and is finally let off into the environment.

3. The steam produced in the boiler is supplied to the turbines to generate power. The steam that is expelled by the prime mover in the thermal power plant layout is then condensed in a condenser for re-use in the boiler. To make up for the lost steam and water while passing through the various components of the thermal power plant layout, feed water is supplied through external sources.

4. The quantity of cooling water required to cool the steam in a thermal power plant layout is significantly high and hence it is supplied from a natural water source like a lake or a river. it is passed through the condenser where the steam is condensed. Cooling water circuit can also be a closed system where the cooled water is sent through cooling towers for re-use in the power plant.

Advantages

1. Generation of power is continuous.
2. Initial cost low compared to hydel plant.
3. Less space required.
4. This can be located near the load centre so that the transmission losses are reduced.
5. It can respond to rapidly changing loads.

Disadvantages

1. Long time required for installation.
2. Transportation and handling of fuels major difficulty.
3. Efficiency of plant is less.
4. Power generation cost is high compared to hydel power plant.
5. Maintenance cost is high.

HYDEL POWER PLANTS

Hydroelectric power plants convert the hydraulic potential energy from water into electrical energy. Such plants are suitable were water with suitable head are available.

Coal Handling Systems

- Coal handling systems for coal fired boilers. Coal handling at utilities requires specialized technology and equipment from unloading to crushing and dust control to fire protection.
- Coal from the coal wagons is unloaded by Tipplers in the coal handling plant. This coal is transported up to the coal storage bunkers through conveyor belts.
- Coal is then transported to the Crush house by conveyor belts where it is crushed to small pieces and light dust is separated. The crushed coal is then transported to the bowl mill by coal feeders.
- In the bowl mill, coal is grounded to a powder form. The mill consists of a round metallic table on which coal particles fall. The crushed coal is then taken to the Boiler through coal pipes with the help of hot and cold air mixture.

ASH HANDLING EQUIPMENT

Ash Handling means are required for the disposal of ash. The handling equipment should perform the following functions:

(1) Capital investment, operating and maintenance charges of the equipment should be low.

(2) It should be able to handle large quantities of ash.

(3) Clinkers, soot, dust etc. create troubles, the equipment should be able to handle them smoothly.

(4) The equipment used should remove the ash from the furnace, load it to the conveying system to deliver the ash to a dumping site or storage and finally it should have means to dispose of the stored ash.

(5) The equipment should be corrosion and wear resistant.

Commonly used ash handling system

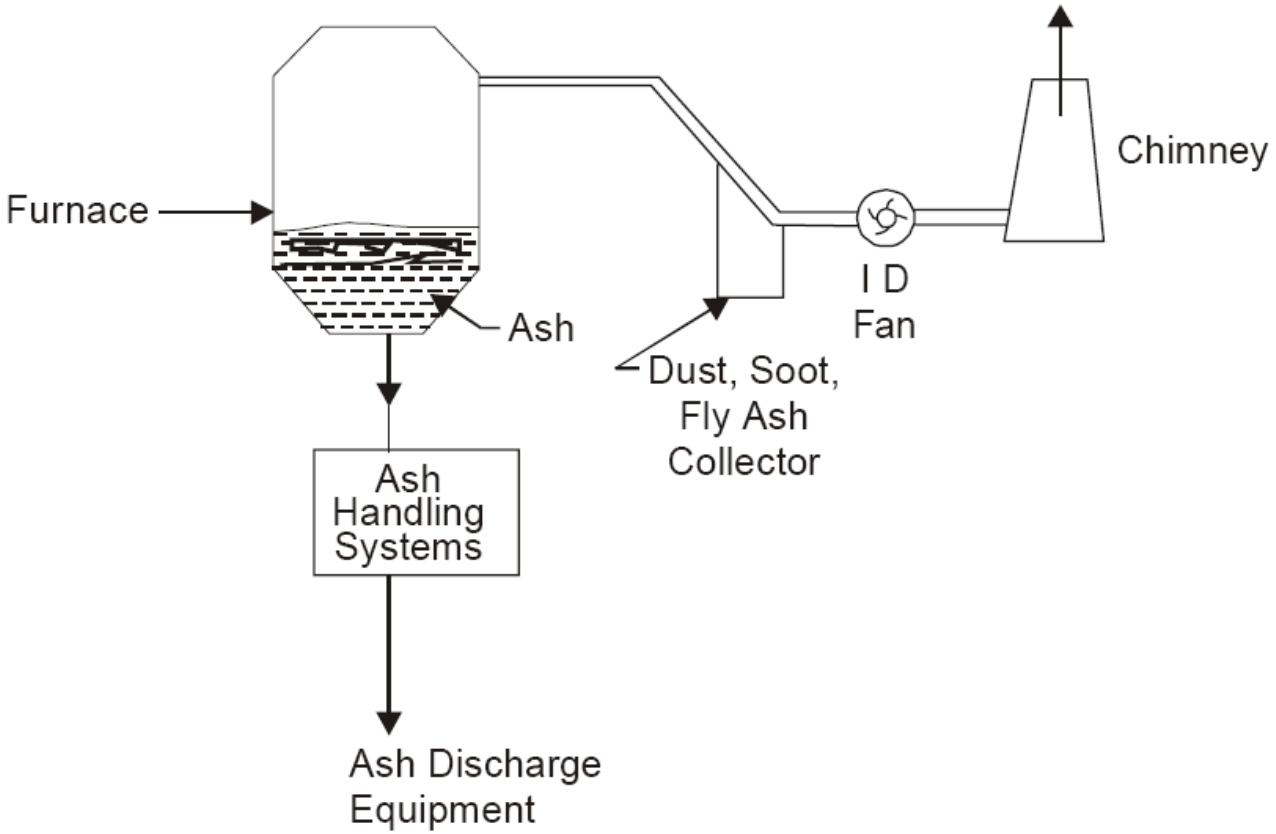


Fig. 4.33. Ash Handling and Dust Collections System.

Hydraulic system

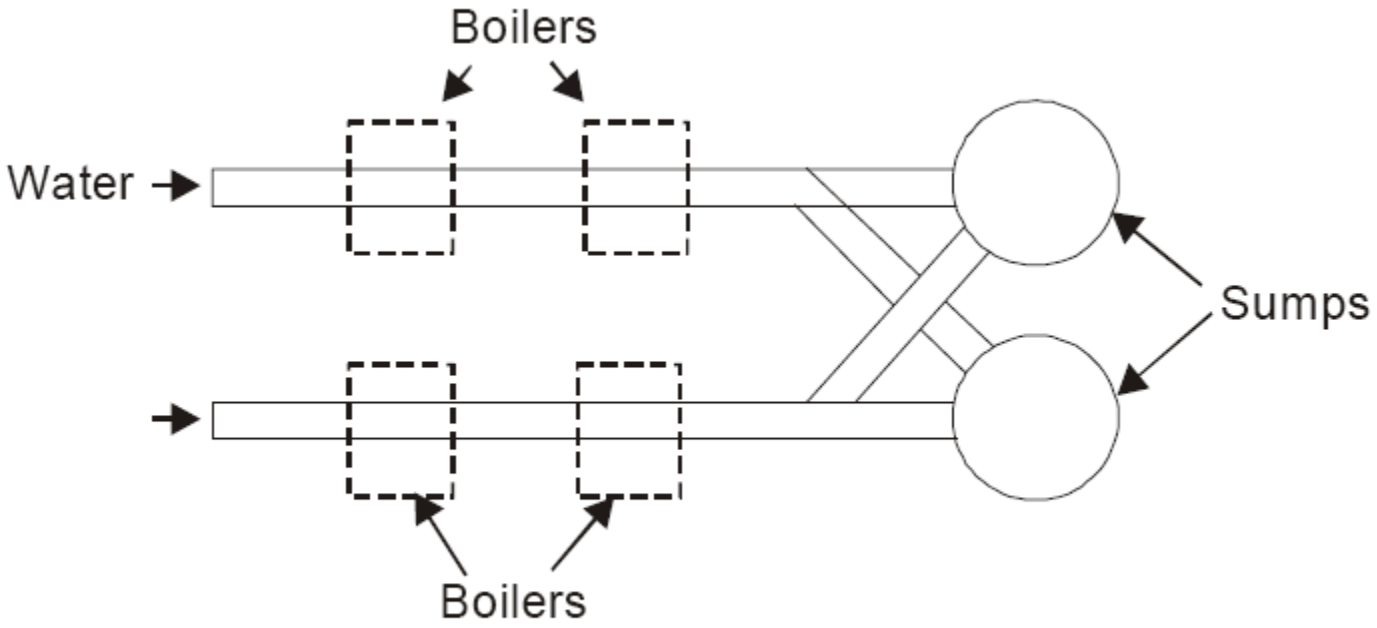


Fig. 4.34. Hydraulic System.

Water Jetting

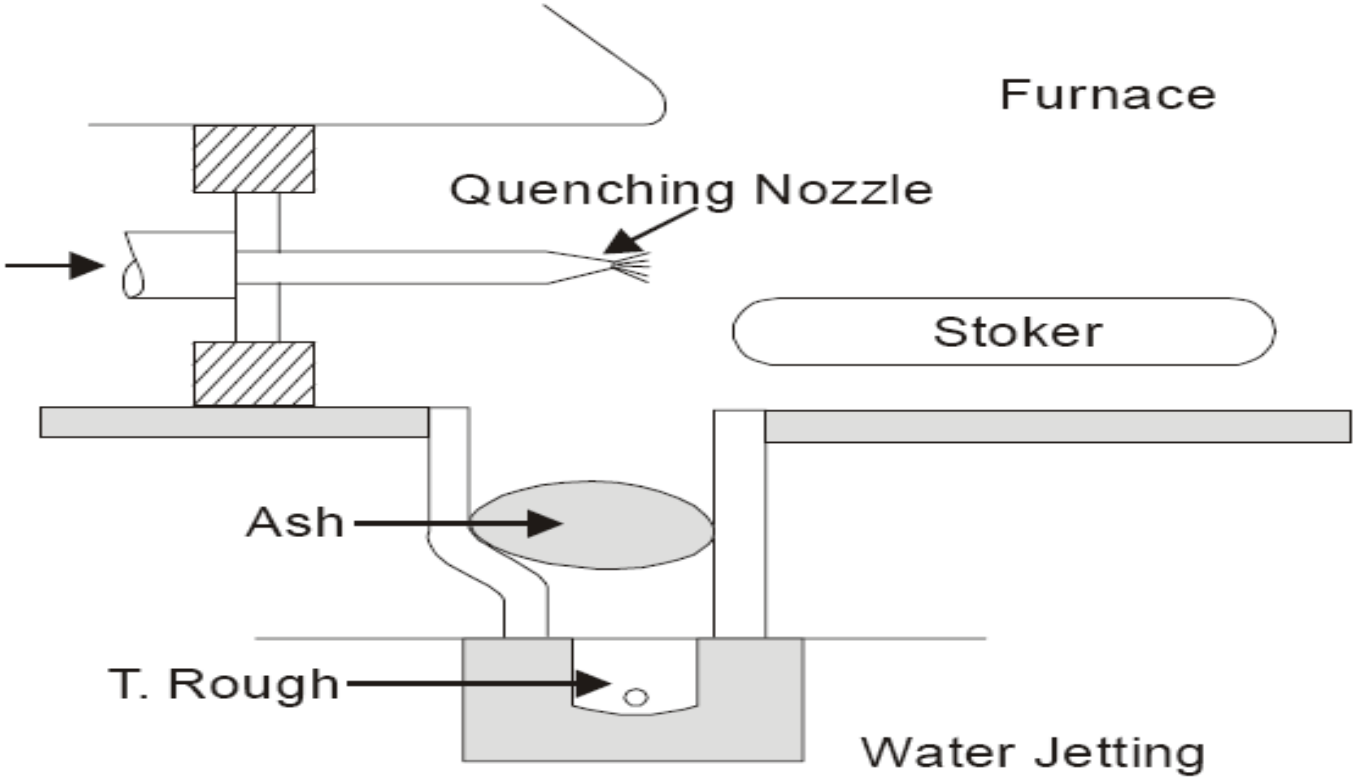


Fig. 4.35. Water Jetting of Ash.

Ash Sluice Ways and Ash Sump System

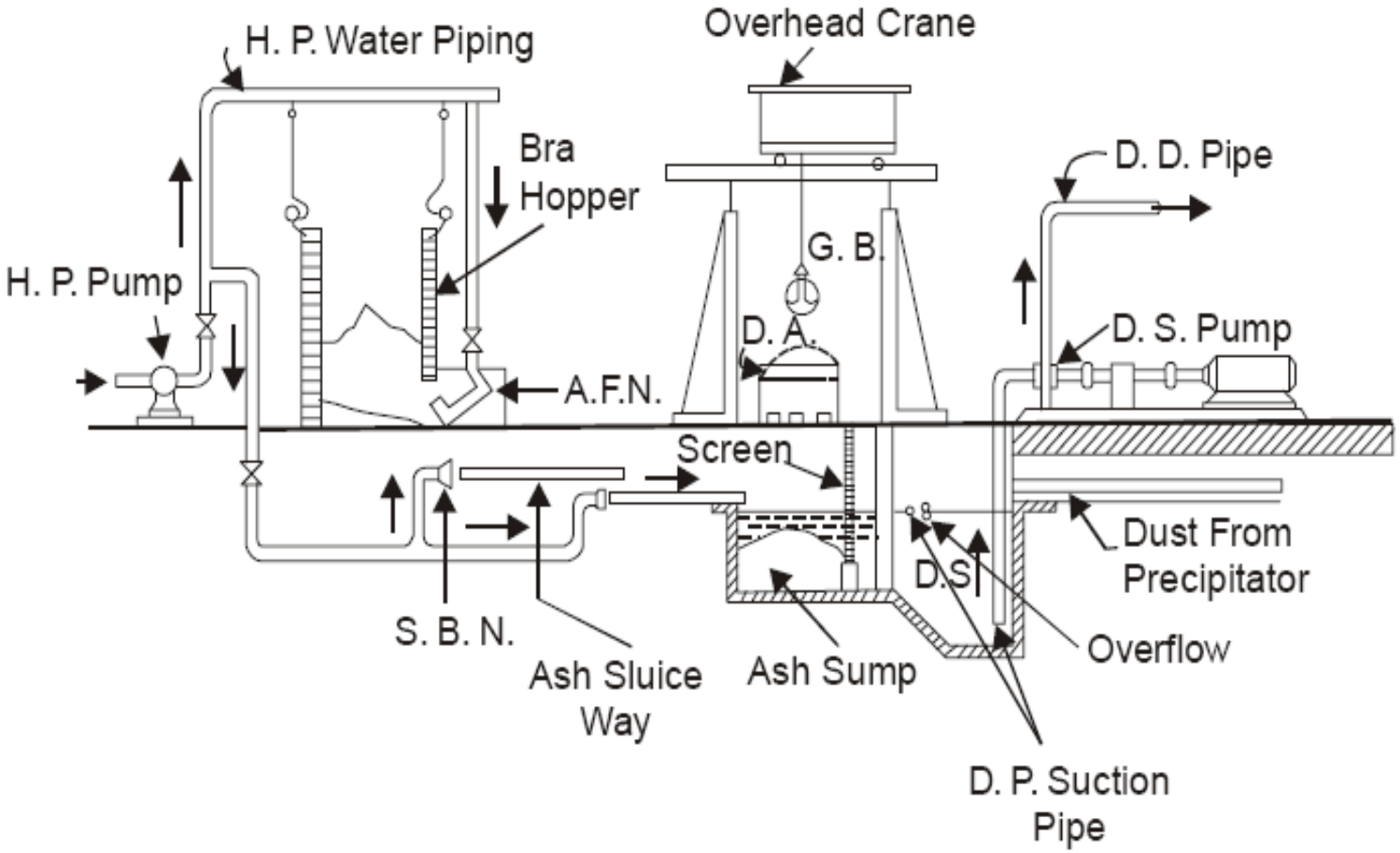


Fig. 4.36. Ash Sump System.

Pneumatic system & Mechanical ash handling system

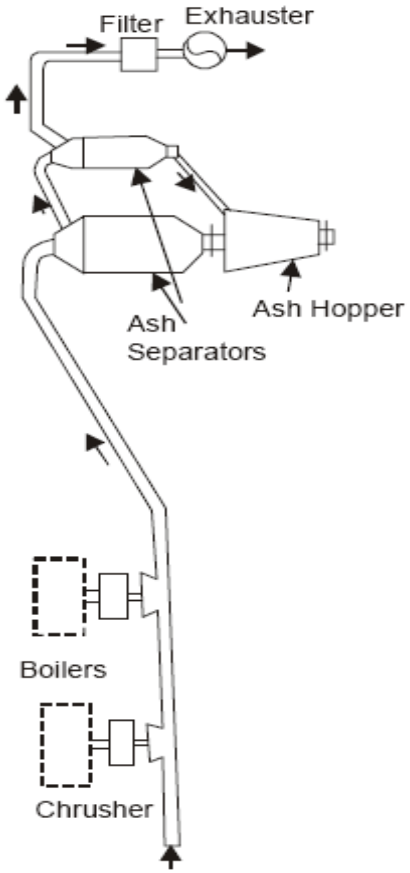


Fig. 4.37. Pneumatic System.

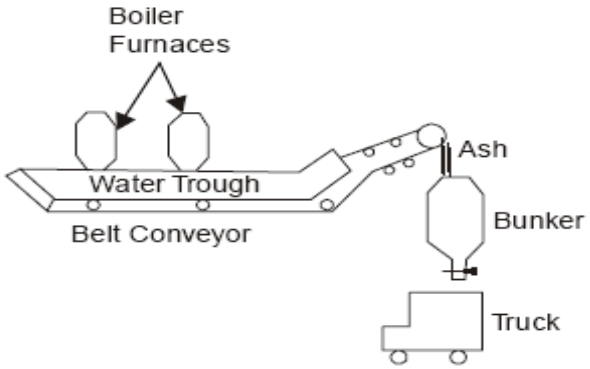


Fig. 4.38. Mechanical Ash Handling.

METHOD OF FUEL FIRING

- The solid fuels are fired into the furnace by the following methods :

1. Hand firing.
2. Mechanical firing.

HAND FIRING

- This method of fuel firing is discontinuous process, and there is a limit to the size of furnace which can be efficiently fired by this method

Hand Fired Grates.

- A hand fired grate is used to support the fuel bed and admit air for combustion.
- While burning coal the total area of air openings varies from 30 to 50% of the total grate area.
- The width of air openings varies from 3 to 12 mm.
- The construction of the grate should be such that it is kept uniformly cool by incoming air. Hand fired grates are made up of cast iron.

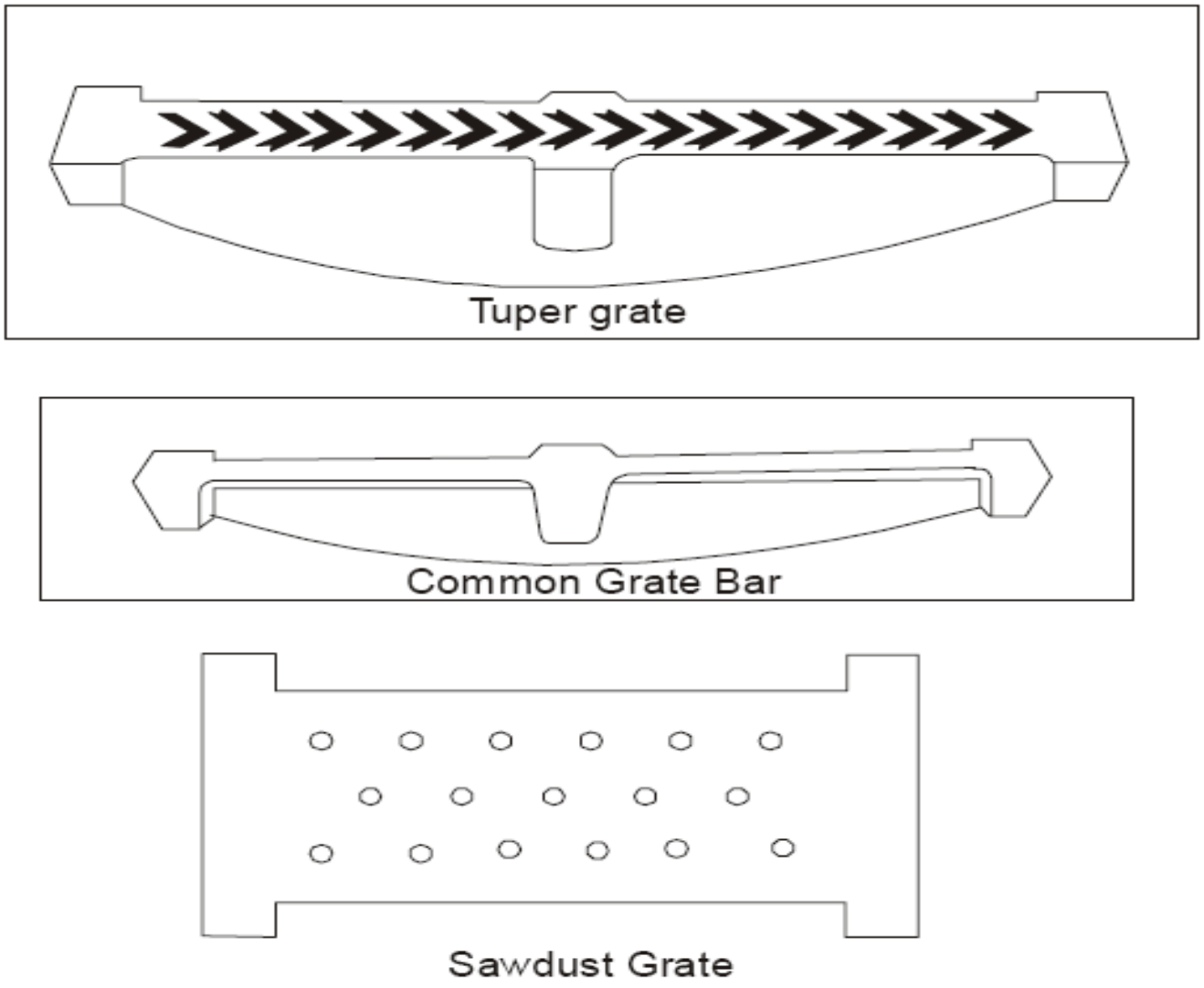


Fig. 4.10. Various Types of Hand Fired Grates.

MECHANICAL FIRING (STOKERS)

- Mechanical stokers are commonly used to feed solid fuels into the furnace in medium and large size power plants.

The various advantages of stoker firing are as follows :

(i) Large quantities of fuel can be fed into the furnace. Thus greater combustion capacity is achieved.

(ii) Poorer grades of fuel can be burnt easily.

(iii) Stoker save labour of handling ash and are self-cleaning.

(iv) By using stokers better furnace conditions can be maintained by feeding coal at a uniform rate.

(v) Stokers save coal and increase the efficiency of coal firing. The main disadvantages of stokers are their more costs of operation and repairing resulting from high furnace temperatures.

- **Principles of Stokers**

1. Overfeed Principle

- According to this principle the primary air enters the grate from the bottom.
- The air then passes through a layer of incandescent coke where oxygen reacts with coke to form-C02 and water vapours accompanying the air react with incandescent coke to form CO2, CO and free H2.
- Then additional air known as secondary air is supplied to burn the combustible gases.

2. Underfeed Principle

- In underfeed principle air entering through the holes in the grate comes in contact with the raw coal (green coal).
- Then it passes through the incandescent coke where reactions similar to overfeed system take place.
- Underfeed principle is suitable for burning the semi-bituminous and bituminous coals.

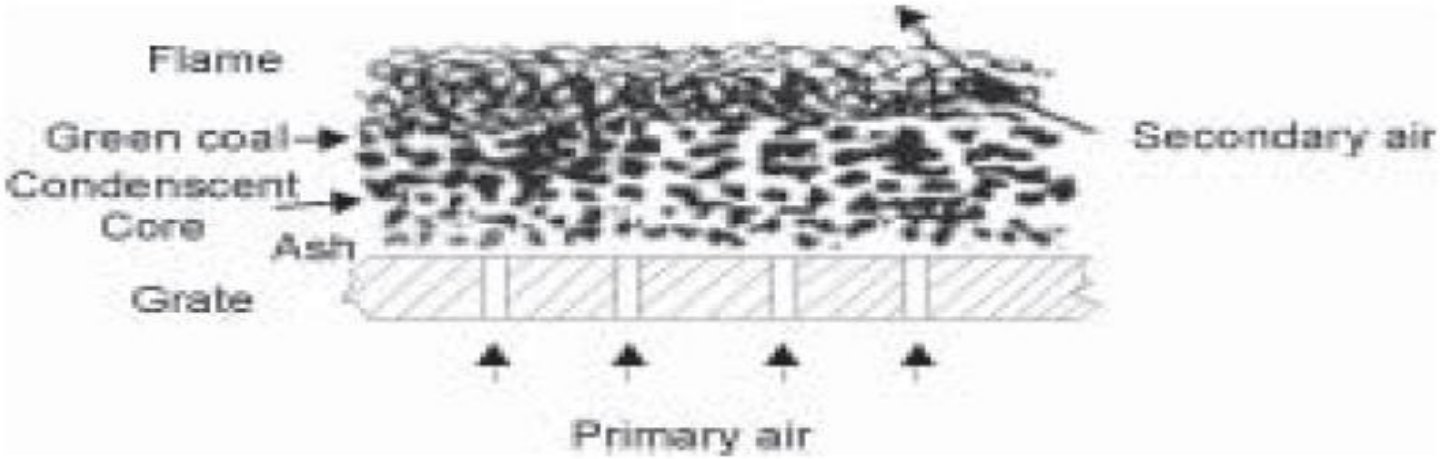


Fig. 4.13. Stokers

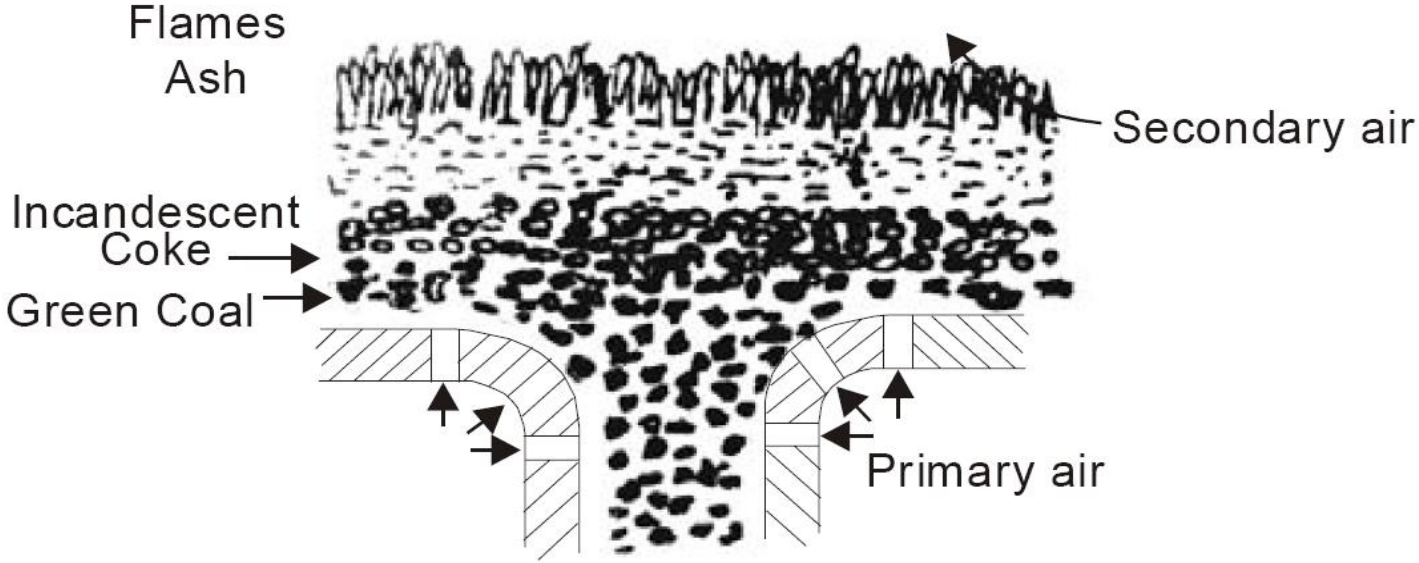


Fig. 4.14. Underfeed Principle.

Types of Stokers:

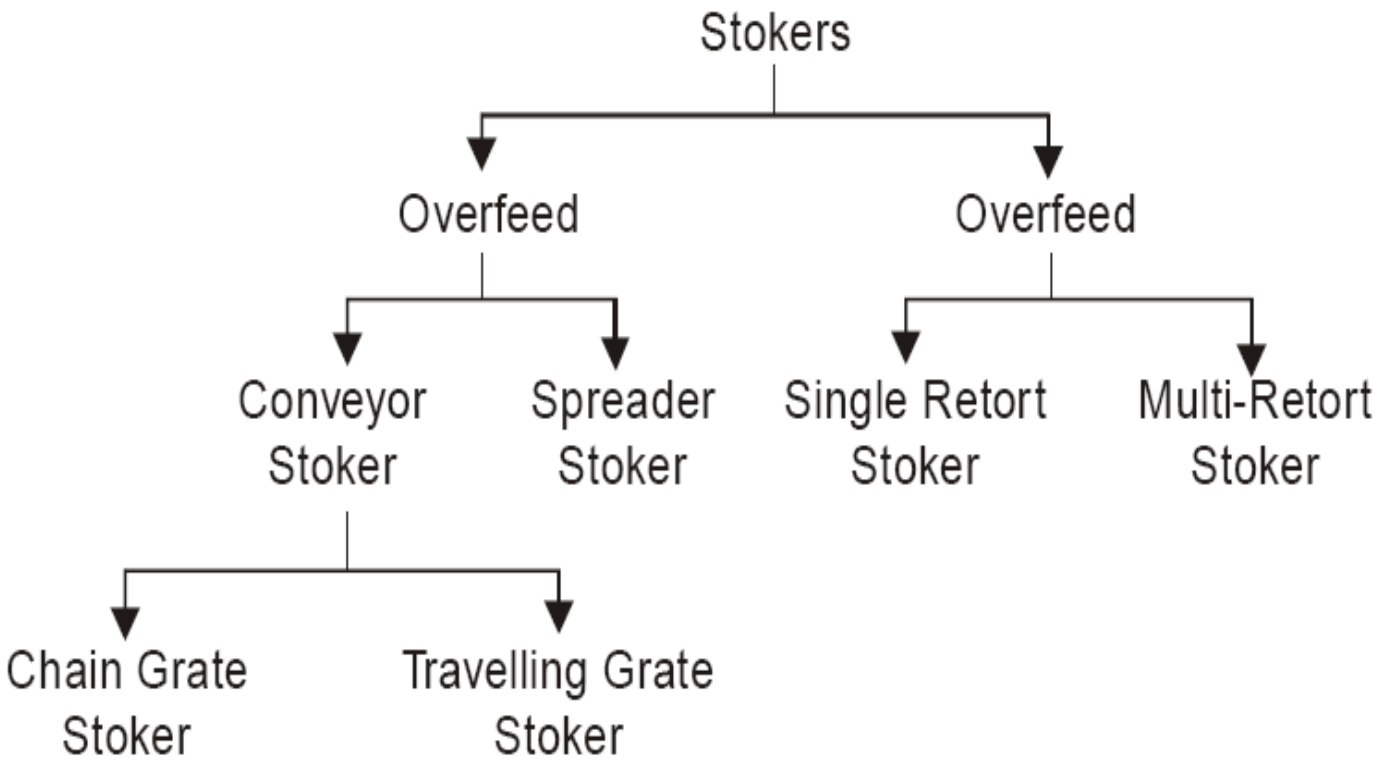
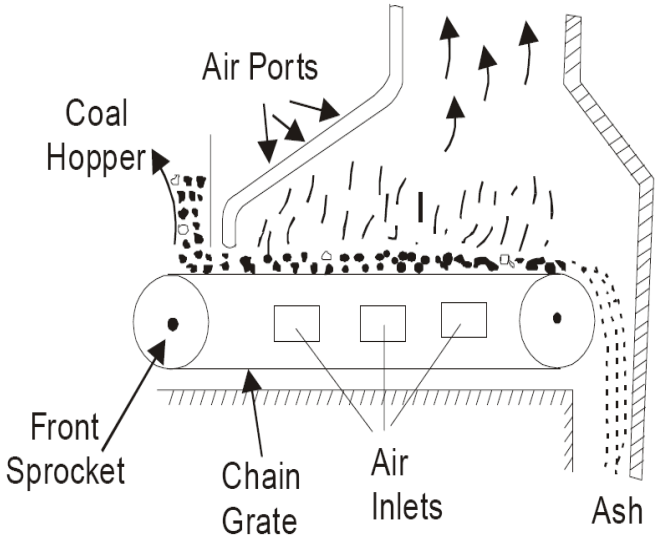


Fig. 4.15. Various Tyles of Stokers.

- Charging of fuel into the furnace is mechanized by means of stokers of various types. They are installed above the fire doors underneath the bunkers which supply the fuel. The bunkers receive the fuel from a conveyor.
- (*i) **Chain Grate Stoker.***



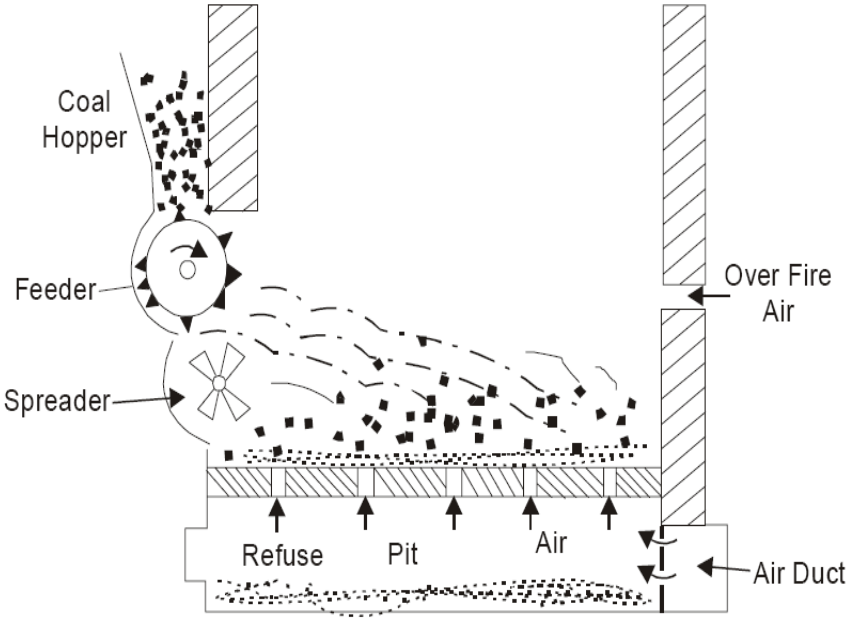


Fig. 4.17. Spreader Stoker.

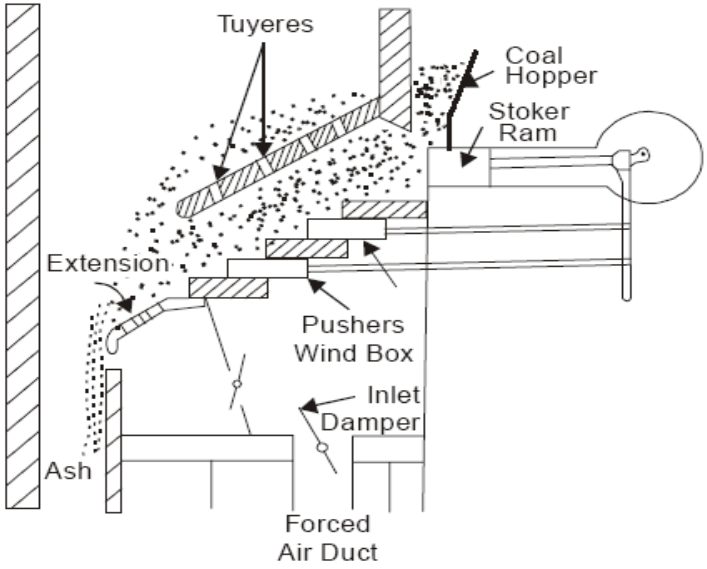


Fig. 4.18. Multi-retort Stoker.

PULVERISED COAL FIRING

Pulverized coal firing is done by two system :

(i) Unit System or Direct System.

(ii) Bin or Central System.

(i) Unit System or Direct System:

Advantages

(*i) The system is simple and cheaper than the central system.*

(*ii) There is direct control of combustion from the pulverising mill.*

(*iii) Coal transportation system is simple.*

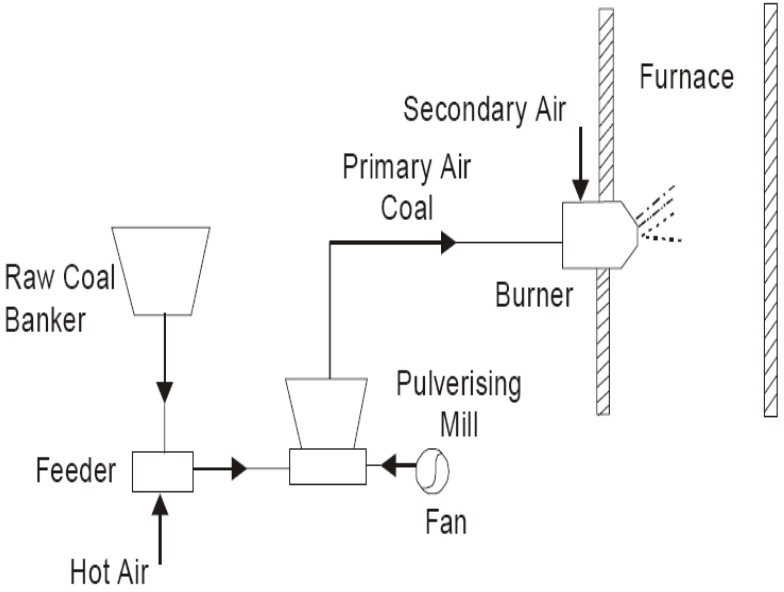


Fig. 4.25. Unit or Direct System.

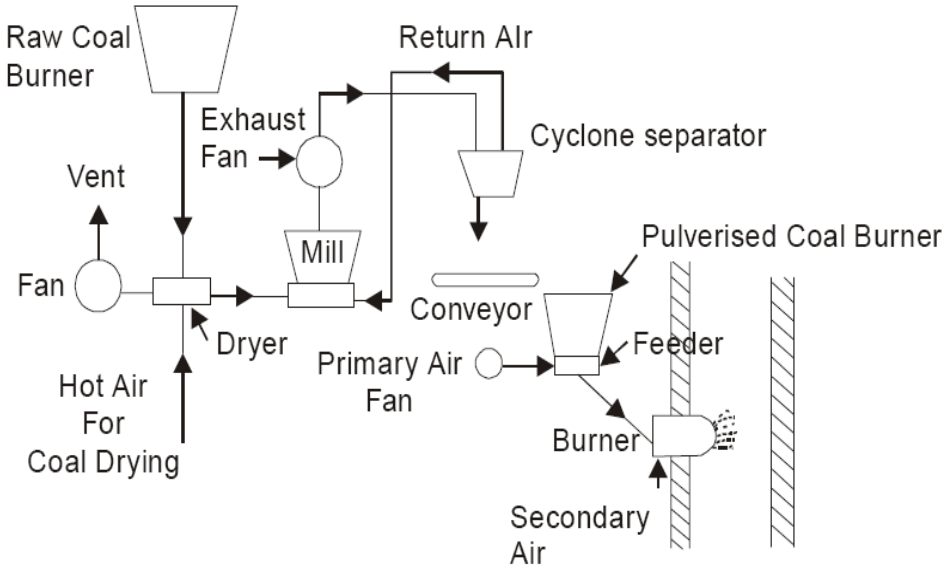


Fig. 4.26. Bin or Central System.

PULVERISED COAL BURNERS

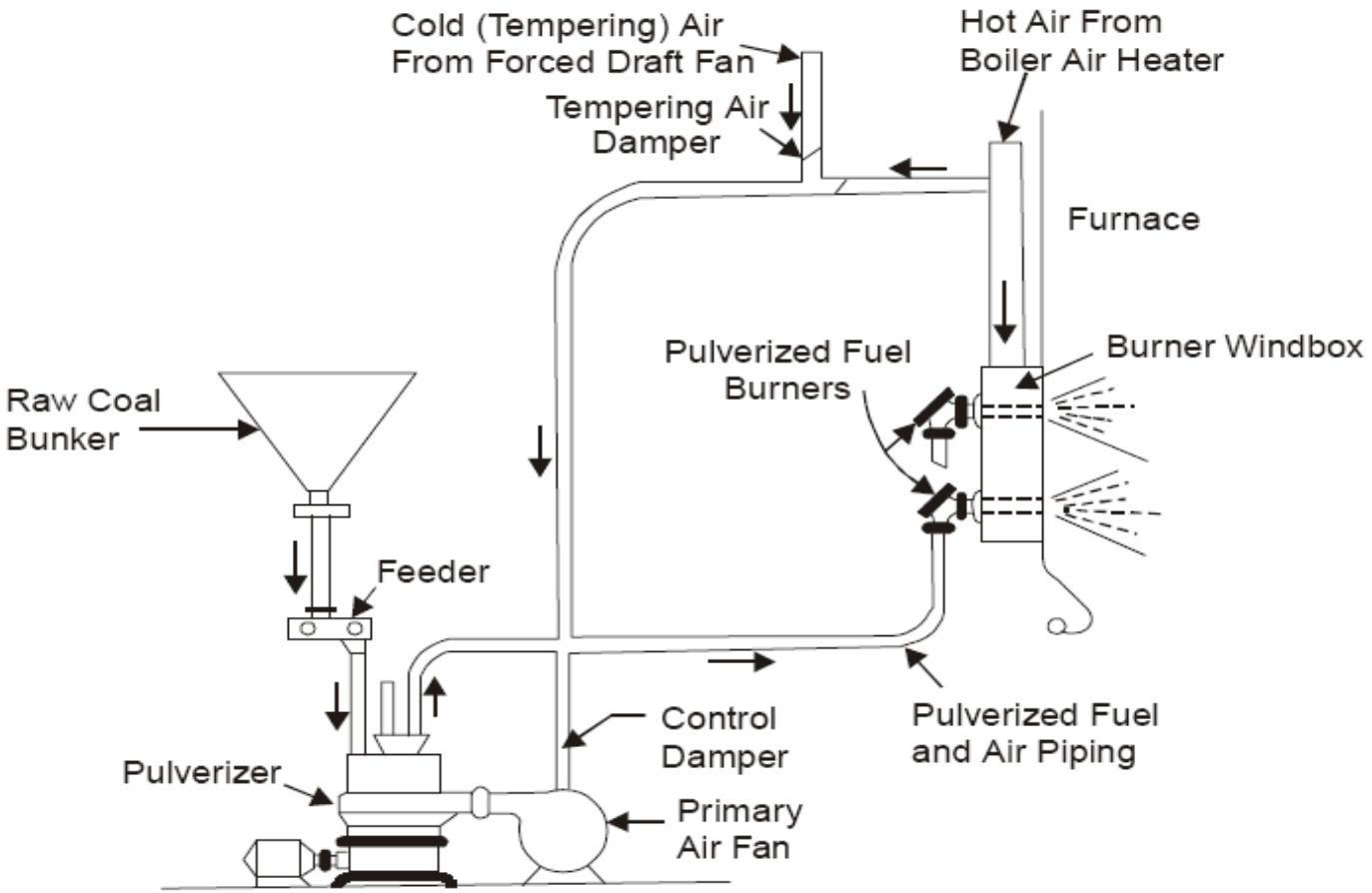
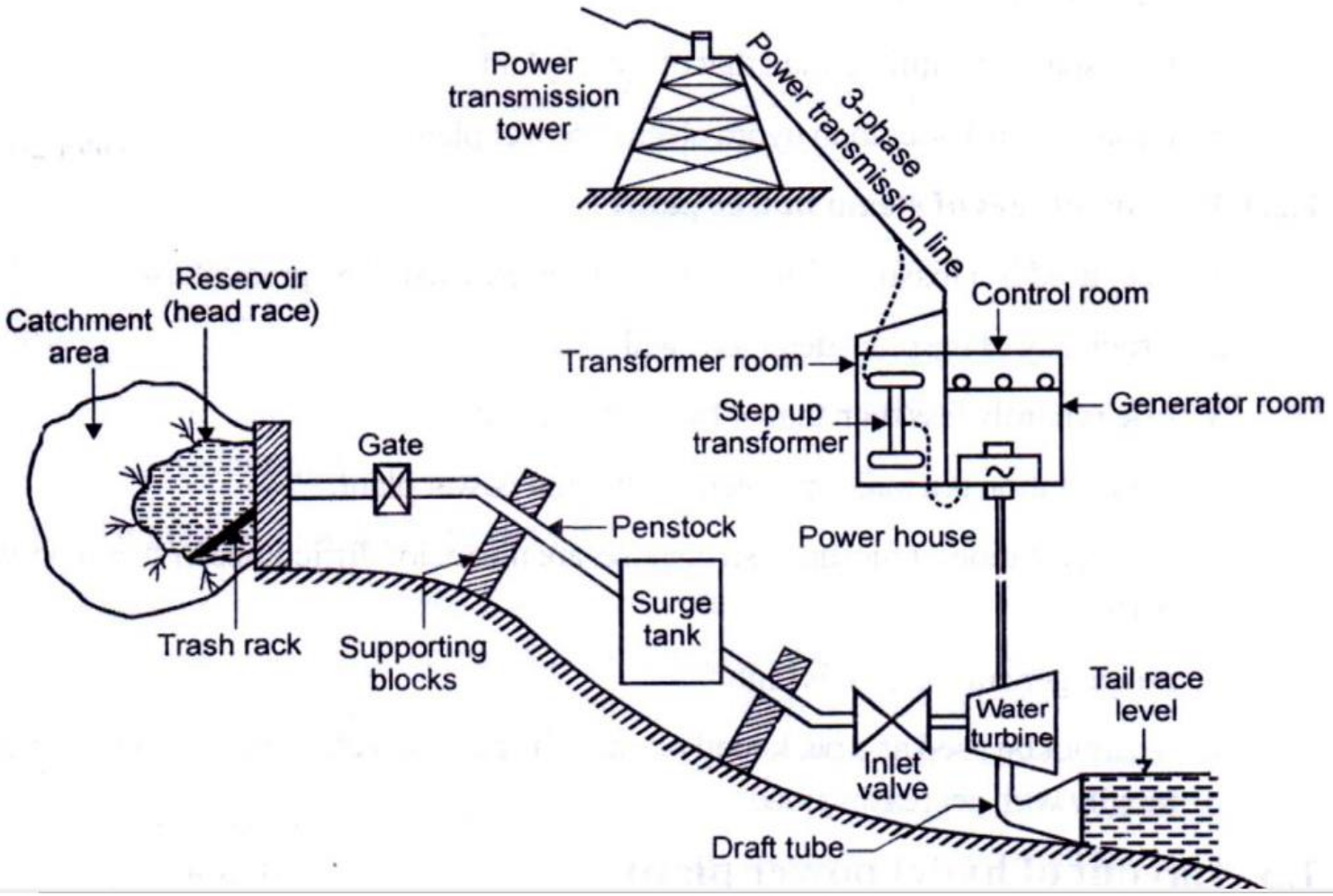


Fig. 4.28. A Pulverised Coal Burner System.

LAYOUT OF HYDEL POWER PLANT



(1) Dam : Dams are structures built over rivers to stop the water flow and form a reservoir. This water is diverted to turbines in power stations. There are different types of dams such as arch dams, gravity dams and buttress dams. The height of water in the dam is called head race.

(2) Spillway: A spillway as the name suggests could be called as a way for spilling of water from dams. Spillways could be controlled type or uncontrolled type. The uncontrolled types start releasing water upon water rising above a particular level. But in case of the controlled type, regulation of flow is possible.

(3) Penstock and Tunnels: Penstocks are pipes which carry water from the reservoir to the turbines inside power station. A tunnel serves the same purpose as a penstock. It is used when an obstruction is present between the dam and power station such as a mountain.

(4) Surge Tank : Surge tanks are tanks connected to the water conductor system. It serves the purpose of reducing water hammering in pipes which can cause damage to pipes. when the water requirements increase, it supplies the collected water thereby regulating water flow and pressure inside the penstock.

(5) Power Station: Power station contains a turbine coupled to a generator. The water brought to the power station rotates the vanes of the turbine producing torque and rotation of turbine shaft. This rotational torque is transferred to the generator and is converted into electricity.

The used water is released through the tail race. The difference between head race and tail race is called gross head and by subtracting the frictional losses we get the net head available to the turbine for generation of electricity.

Advantages

1. Water the working fluid is natural and available plenty.
2. Life of the plant is very long.
3. Running cost and maintenance are very low.
4. Highly reliable.
5. No fuel transport problem.
6. No ash disposal problem.

Disadvantages

1.Initial cost of plant is very high.

2.Power generation depends on quantity of water available which depends on rainfall.

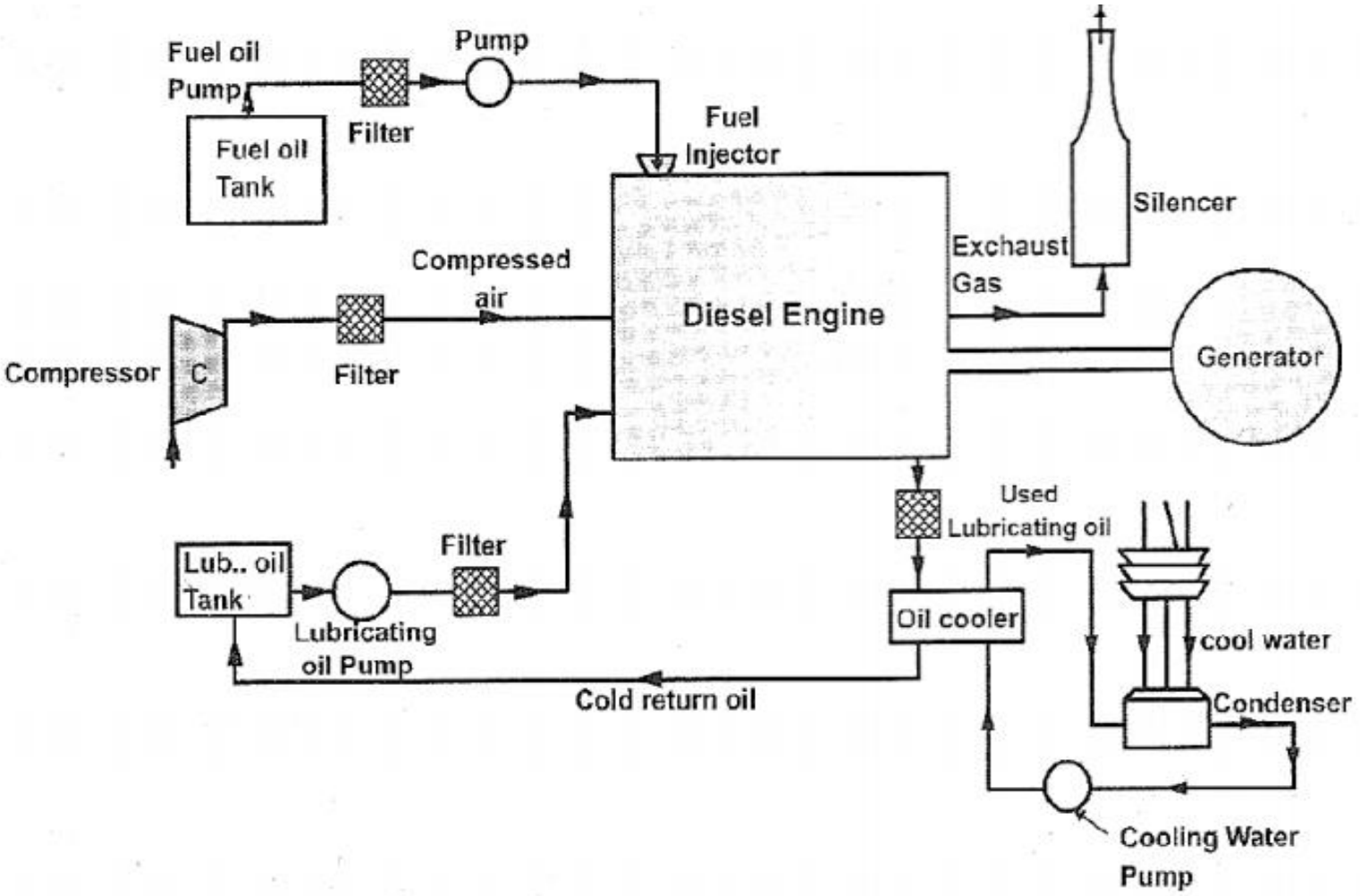
3.Transmission losses are very high.

4.More time is required for erection.

Introduction about Diesel power plant

- Diesel power plants produce power in the range of 2 to 50MW, are used as central stations for supply authorities and work.
- They are used as standby sets for continuity of supply such as hospitals, telephone exchanges, radio stations, cinema theatres and industries.
- They are suitable for mobile power generation and widely used in railways and ships.
- Used as Peak Load Plants, Mobile Plants, Stand By Units, Emergency Plants, Starting Stations, Central Stations, Industries where power requirement is small 500kW.

LAYOUT OF DIESEL POWER PLANT



Advantages

1. Diesel power plants can be quickly installed and commissioned.
2. Quick starting.
3. Requires minimum labour.
4. Plant is smaller, operate at high efficiency and simple compared to steam power plant.
5. It can be located near to load centres.

Disadvantages

1. Capacity of plant is low.
2. Fuel, repair and maintenance cost are high.
3. Life of plant is low compared to steam power plant.
4. Lubrication costs are very high.
5. Not guaranteed for operation under continuous overloads.
6. Noise is a serious problem in diesel power plant.
7. Diesel power plant cannot be constructed for large scale.

UNIT II

DIESEL CYCLE POWER PLANTS

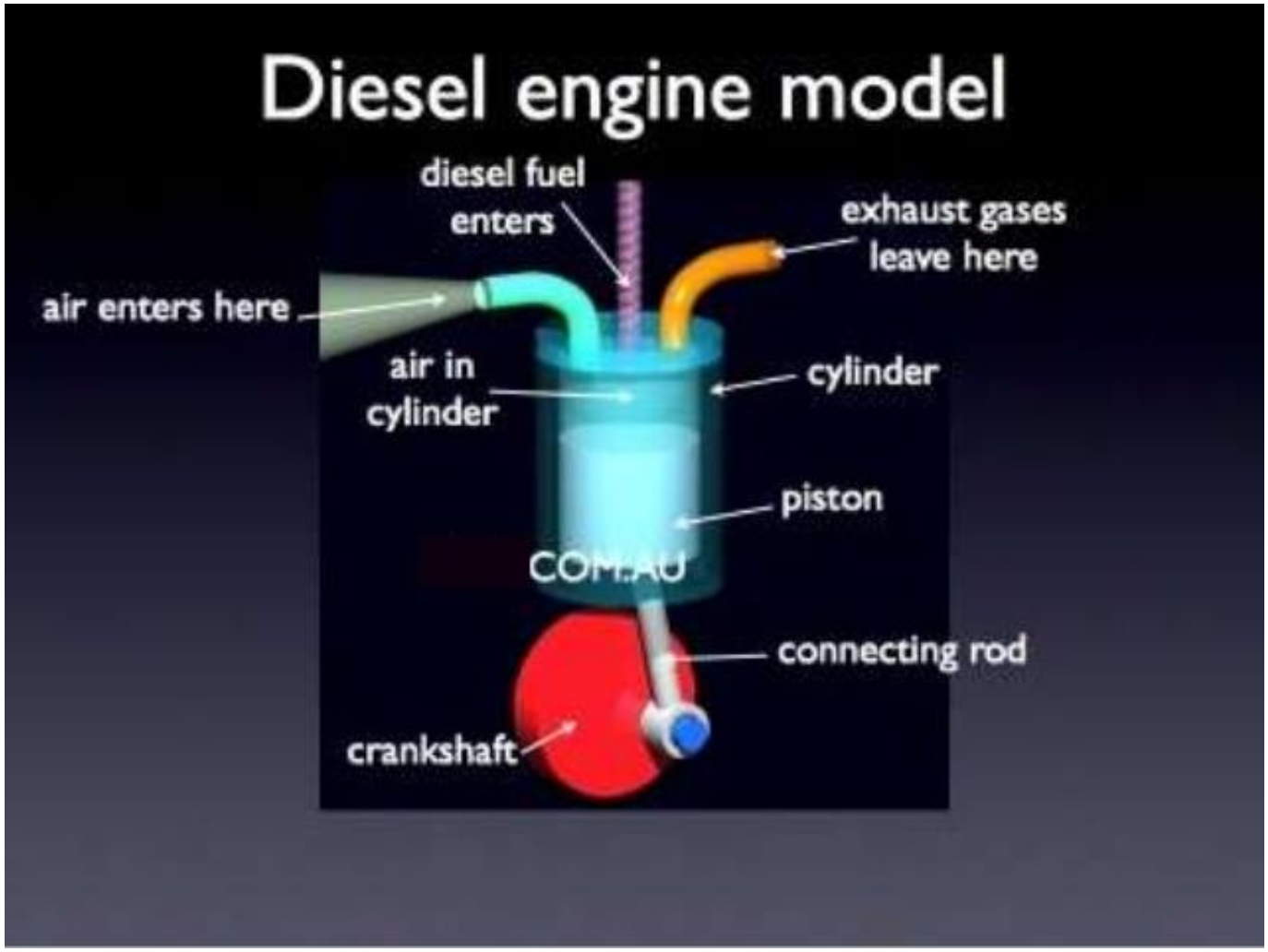
Power plant engineering
Diesel power plant

➢ INTRODUCTION:

- A generating station in which **diesel engine** is used as the prime mover for the generation of electrical energy is known as **diesel power station**
- Diesel power plants produce power in the range of 2 to 50 MW.
- They are used as standby sets for continuity of supply such as hospitals, telephone exchanges, radio stations, cinema theatres and industries.
- They are suitable for mobile power generation and widely used in railways , submarine & ships.

Applications of diesel power plant

- They are used as central station for small or medium power supplies.
- They can be used as stand-by plants to hydro-electric power plants and steam power plants for emergency services.
- They can be used as peak load plants in combinations with thermal or hydro-plants.
- They are quite suitable for mobile power generation and are widely used in transportation systems such as automobiles, railways, air planes and ships.
- Now-a-days power cut has become a regular feature for industries. The only solution to tide over this difficulty is to install diesel generating sets.


Diesel engine model
diesel fuel enters
exhaust gases leave here
air enters here
air in cylinder
cylinder
piston
COM.AU
connecting rod
crankshaft

DIESEL ENGINE power plant

FIELD OF USE

The diesel electric power-plants are chiefly used in the fields mentioned below.

1. **Peak load plant: The** diesel plants are used in combination with thermal or hydro-plants as peak load plants. This plant is particularly preferable as peak load plant as it can be **started quickly** and it has no standby losses as in the case of thermal plants where boilers always must be kept hot.
2. **Mobile plants**: Mobile diesel plants mounted on skids or trailers can be used for temporary or emergency purposes such as for supplying power to large civil engineering works for supplementing electricity supply systems that are temporarily short of power.
3. **Stand-by Units**: This can be used as a standby unit to **supply part load** when required. For example, this can be used with hydro-plant as stand-by unit. If the water available is not sufficient due to reduced rainfall, a diesel station supply power in parallel with hydro-station. The use is made temporarily till the water is available to take the full load.

4. **Emergency plant:** The plants used for emergency purposes are at to standby units, normally idle but are used where power interruption would mean financial loss or danger in key industrial processes, tunnel lighting and operating rooms of hospitals. They are also used for telecommunication and water supply under emergency conditions.
5. **Nursery station:** When the diesel plant is used to supply the power to a small town in the absence of main grid and which can be moved to another area which needs power on a small scale when the main grid is available is known as "Nursery Station". The main grid cannot extend to every corner of the country till there is enough load. Many times the extension of grid is not possible due to the constructional difficulties as in Assam. Diesel unit of small capacity can be installed to supply the load to a small town during the process of development and it can be removed to another required place till the main grid for tapping the power is available.
6. **Starting stations:** The diesel units are used to run the auxiliaries for starting the large steam plants.
7. **Central stations:** This can be used as central station where the capacity required is small **(5 to 10 MW**). The limit is generally decided by the cost of the plant and local conditions regarding the availability of fuel and water, space requirements and non-availability of the grid. Small supply units for commercial purposes and public utilities *e.g.,, cinema hall, hospital and* municipalities are commonly used in practice.

Diesel power plants in INDIA

- As on July 31, 2013, and as per the Central Electricity Authority the total installed capacity of Diesel based power plants in India is 1,199.75 MW. Normally the diesel based power plants are either operated from remote locations or operated to cater peak load demands. Here is some list of presently operating plants.

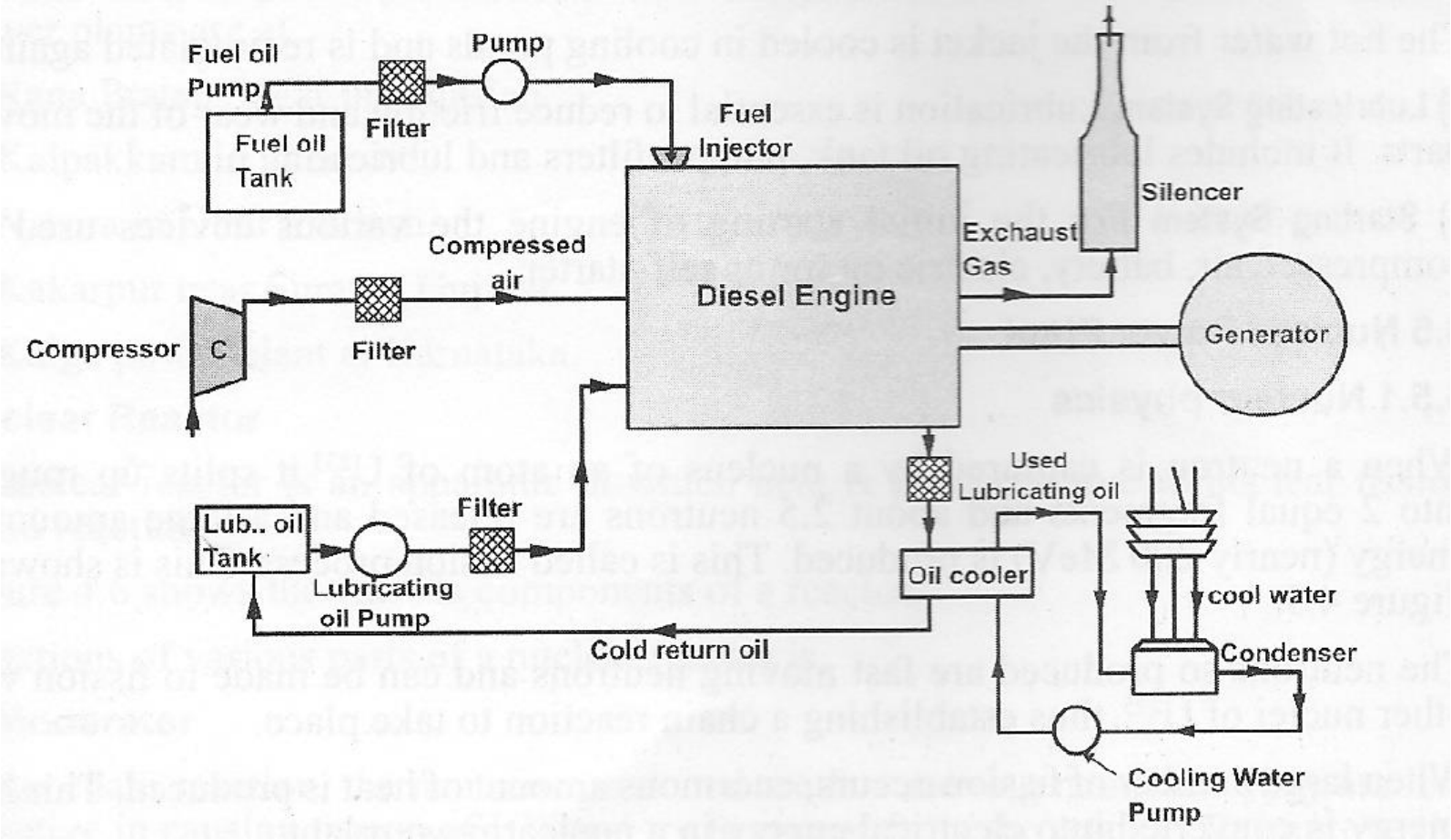
- SOURCE: Wikipedia.

List of diesel power plants in INDIA

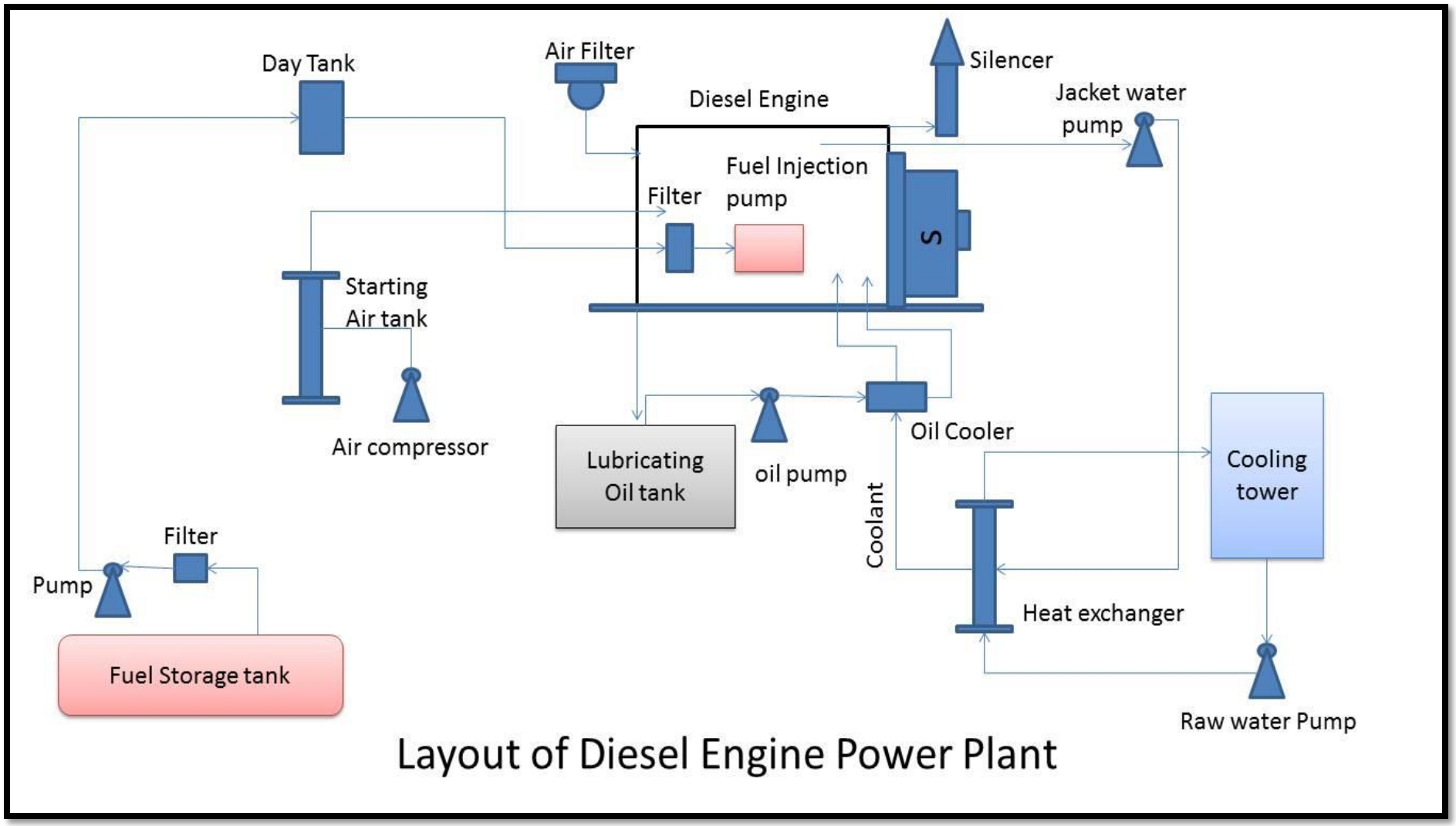
Power station	Operator	Location	District	State	Sector	Region	Units	Capacity (MW)	Plant Coordinates
GMR Vasavi Diesel Power Plant	TNEB	Basin Bridge	Chennai	Tamil Nadu	State	Southern	4 x 50	200	
Kozhikode Diesel Power Station	KSEB	Kozhikode	Kozhikode	Kerala	State	Southern	8 x 16.00	128	
Yelahanka Diesel Power Station	KPCL	Yelahanka	Bangalore	Karnataka	State	Southern	6 x 21.32	127.92	
Brahmapuram Diesel Power Station	KSEB	Brahmapuram		Kerala	State	Southern	5 x 21.32	106.6	
Southern						***4***	***23***	***562.52***	
Suryachakra Diesel Power Station	SPCL	A & N		Andaman & Nicobar	Private	Islands		20	
Islands						***1***		***20***	
Bemina Diesel Power Station	J&K Govt	Bemina	Srinagar	Jammu & Kashmir	State	Northern	1 x 5	5	
Leh Diesel Power Station	J&K Govt	Leh	Leh	Jammu & Kashmir	State	Northern	1 x 2.18	2.18	
Ambala Diesel Power Station	Haryana Govt	Ambala	Ambala	Haryana	State	Northern	1 x 2.18	2.18	
Upper Sindh Diesel Power Station	J&K Govt			Jammu & Kashmir	State	Northern	1 x 1.7	1.70	
Keylong Diesel Power Station	HP Govt	Keylong	Lahaul and Spiti	Himachal Pradesh	State	Northern	1 x 0.13	0.13	
Kamah Diesel Power Station	J&K Govt			Jammu & Kashmir	State	Northern	1 x 0.06	0.06	
Northern						***6***	***6***	***11.25***	
Gangtok Diesel Power Station	Sikkim Govt	Gangtok	East Sikkim	Sikkim	State	Eastern		4	
Ranipool Diesel Power Station	Sikkim Govt	Ranipool	East Sikkim	Sikkim	State	Eastern		1	
Eastern						***2***		***5***	
Total						***13***		***598.77***	

Layout of Diesel Power Plant

GENERAL LAYOUT



Simple layout



Essential elements of Diesel Power Plant

- Engine System
- Starting System
- Lubrication System
- Fuel System
- Air filter and Supercharge
- Cooling System
- Exhaust System
- Governing System

Engine system

- **ENGINE:** This is the **main component** of the plant which develops required power. The engine is generally directly coupled to the **generator**
- Generally classified as two stroke engine and four stroke engines

Industrial GenSet

Engine and Air intake system

- Engine-
- This is the main component of the plant which develops the required power. The electrical generator is usually direct coupled to the engine.
- Air intake system-
- The air intake system conveys fresh air through pipes or ducts to (i) air intake manifold of 4 stroke engine (ii) The scavenging pump inlet of a two stroke engine (iii) The supercharger inlet of a supercharged engine.

Air filter and supercharger

- Air filter is used to remove the dust from the air which is taken by the engine.
- The supercharger is used to increase the pressure of the air supplied.

Air intake system

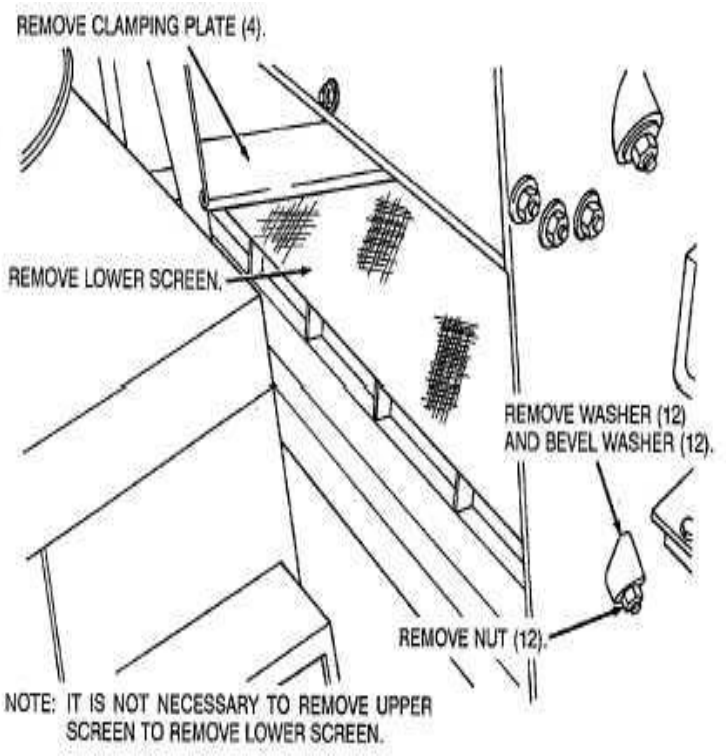
- Air is first drawn through a filter to catch dirt or particles that may cause excessive wear in cylinders. Filters may be of following types:
- Dry type (paper, cloth, felt, glass wool etc)
- Wet type (oil impingement type, oil bath type where oil helps to catch particles)
- Following precautions should be taken while designing air intake systems

Following precautions should be taken while designing air intake systems

- Air intake should be located outside the engine room.
- Air intake should not be located in confined places to avoid undesirable acoustic vibrations.
- Pressure drop in the air intake line should minimum to avoid engine starvationbe
- Air filters should be accessible for periodic cleaning.
- In some cases a muffler may be introduced to prevent engine noise from reaching outside air.

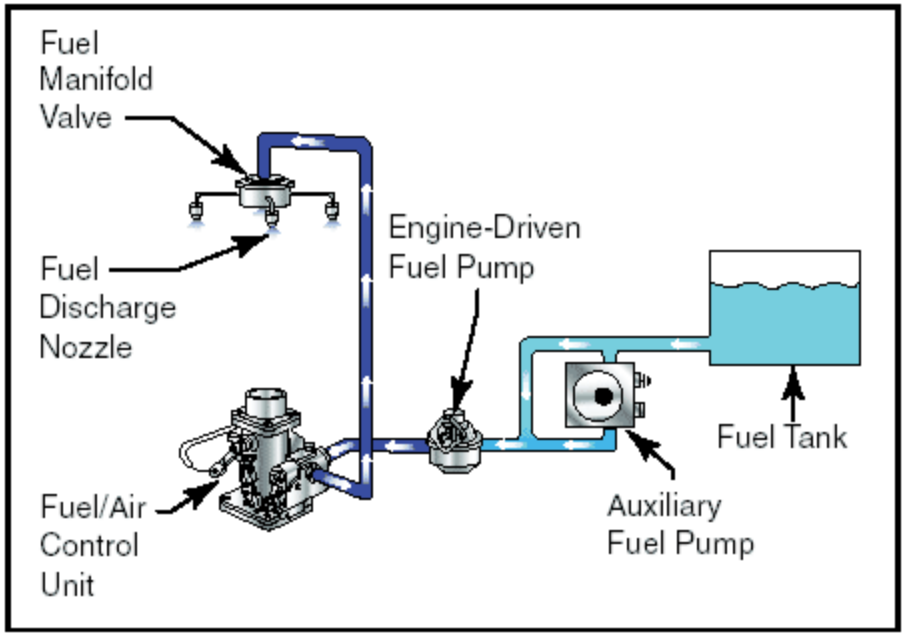
Air intake system

- The air required for the combustion of fuel inside the diesel engine cylinder is drawn through the air filter. The purpose of the filter is to remove dust from the incoming air.
- dry filter- may be made of felt , wood or cloth.
- wet filter- oil bath is used.



Fuel supply system

- Fuel from the storage tank is pumped through a filter into a smaller tank called all day tank . this tank supplies the daily requirements of the diesel engine.



Starting system

- The function of this system is to start the engine from cold by supplying compressed air at about 17 bar supplied from an air tank is admitted to a few cylinders making them work like reciprocating air motors to run the engine shaft. Fuel is admitted to the remaining cylinders and ignited in the normal way causing the engine to start.

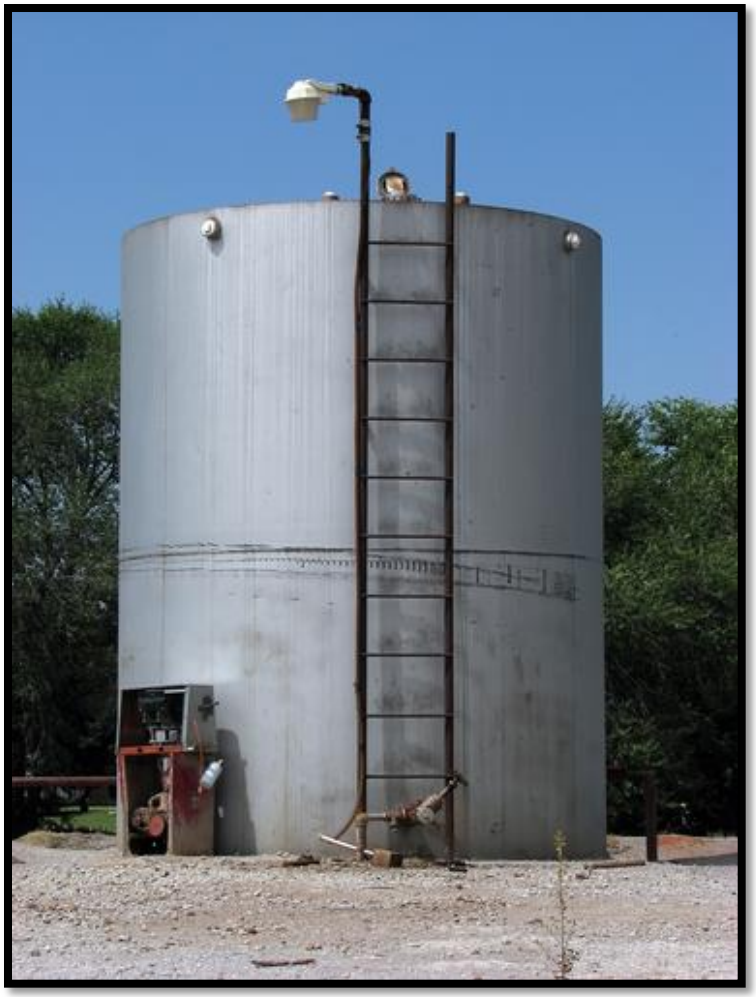
Lubrication system

- It includes the oil pumps, oil tanks, filters, coolers and connecting pipes.
- The purpose of the lubrication system is to reduce the wear of the engine moving parts
- Part of the cylinder such as piston , shafts , valves must be lubricated. The lubricant is cooled before recirculation.
- Lubrication also helps to cool the engine

The following are the important functions of a lubrication system

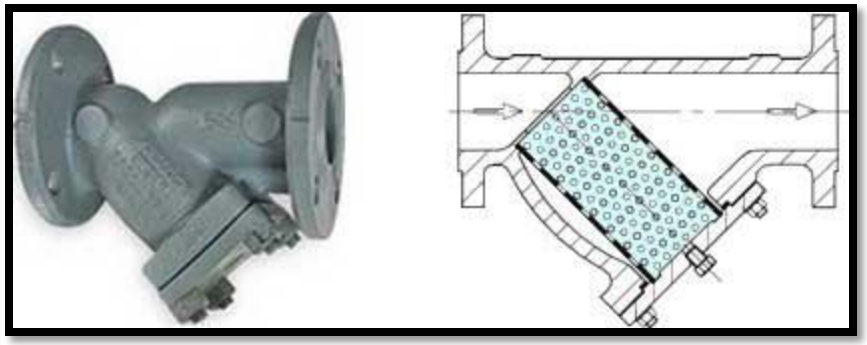
- LUBRICATION: To keep parts sliding freely past each other, reducing friction and wear.
- COOLING: To keep surfaces cool by taking away part of the heat caused by friction.
- CLEANING: To keep the bearings and piston rings clean.
- SEALING: To form a good seal B/W the piston rings and cylinder walls.
- REDUCING NOISE: to reduce the noise of the engine by absorbing vibration.

oil tank



Fuel system

- It includes the storage tank, fuel pump, fuel transfer pump, strainers and heater.
- Pump draws diesel from storage tank to day tank through the filter
- The day tank is usually placed high so that diesel flows to engine under gravity.
- Diesel is filtered before being injected into the engine by the fuel injection pump.



The fuel injection system performs the following functions

- Filter the fuel
- Meter the correct quantity of the fuel to be injected
- Time the injection process
- Regulate the fuel supply
- Secure fine atomization of fuel oil
- Distribute the atomized fuel properly in the combustion chamber

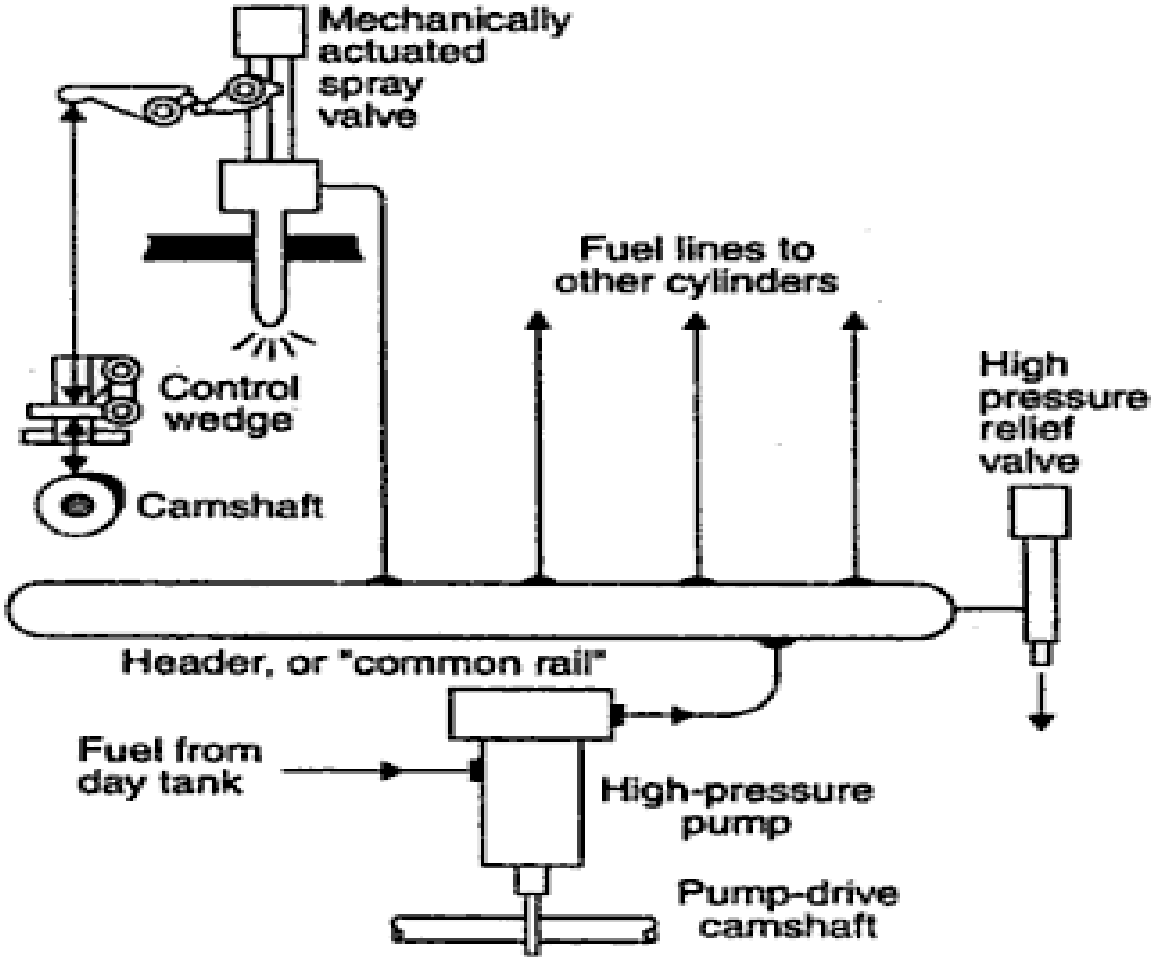
➢ Oil is atomized either by **blast** or **pressure jet**.

In **pressure jet atomization** oil is forced to flow through spray nozzles at pressure above **100 bar**. It is known as **solid injection**

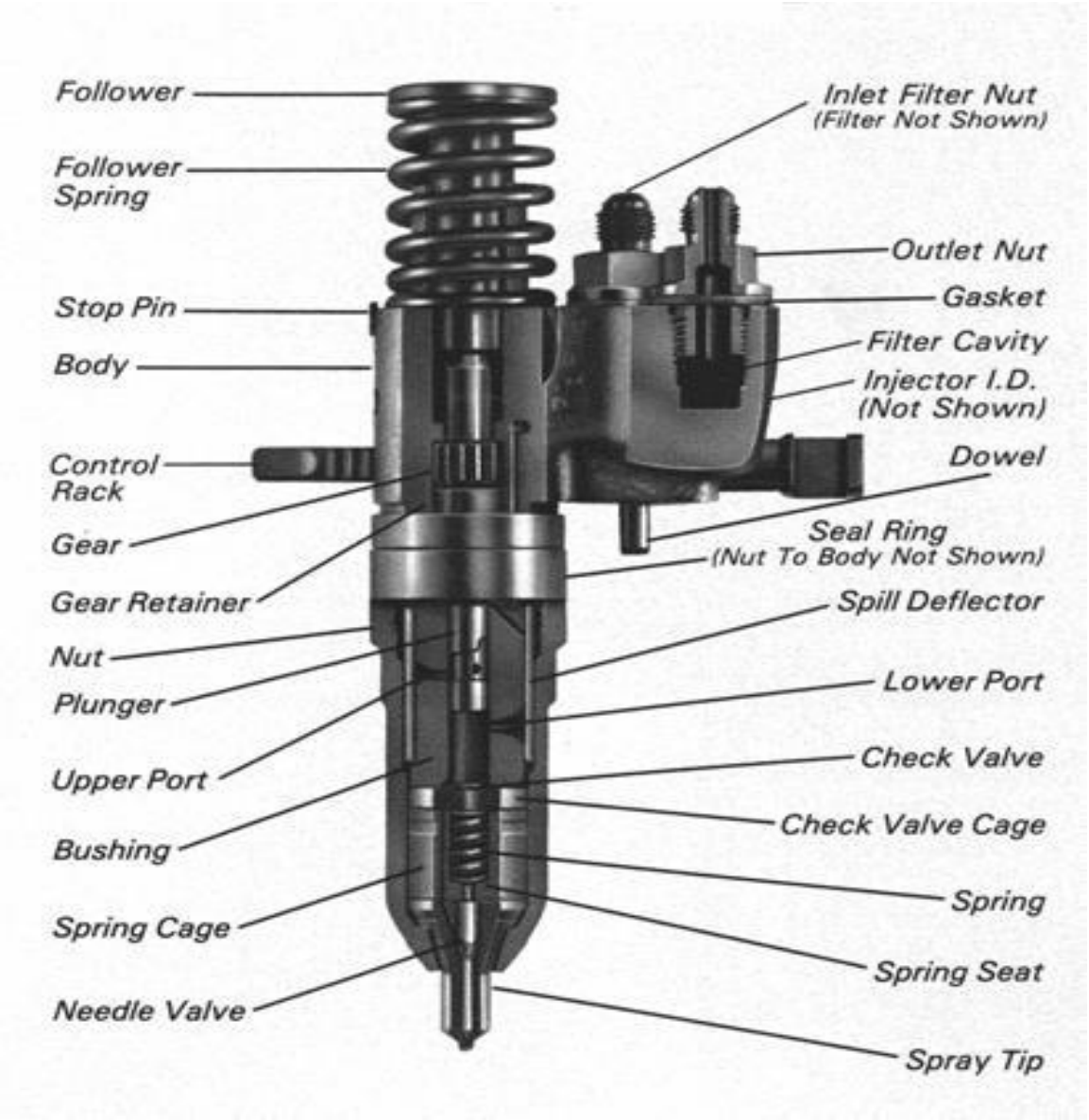
Classification of solid injection systems

- **Common rail injection system:** The system is named after the shared high-pressure (100 to 200 bars)reservoir (common rail) that supplies all the cylinders with fuel. With conventional diesel injection systems, the fuel pressure has to be generated individually for each injection. With the common rail system, however, pressure generation and injection are separate, meaning that the fuel is constantly available at the required pressure for injection.
- **Individual pump injection system:**
- **Distributor system:**

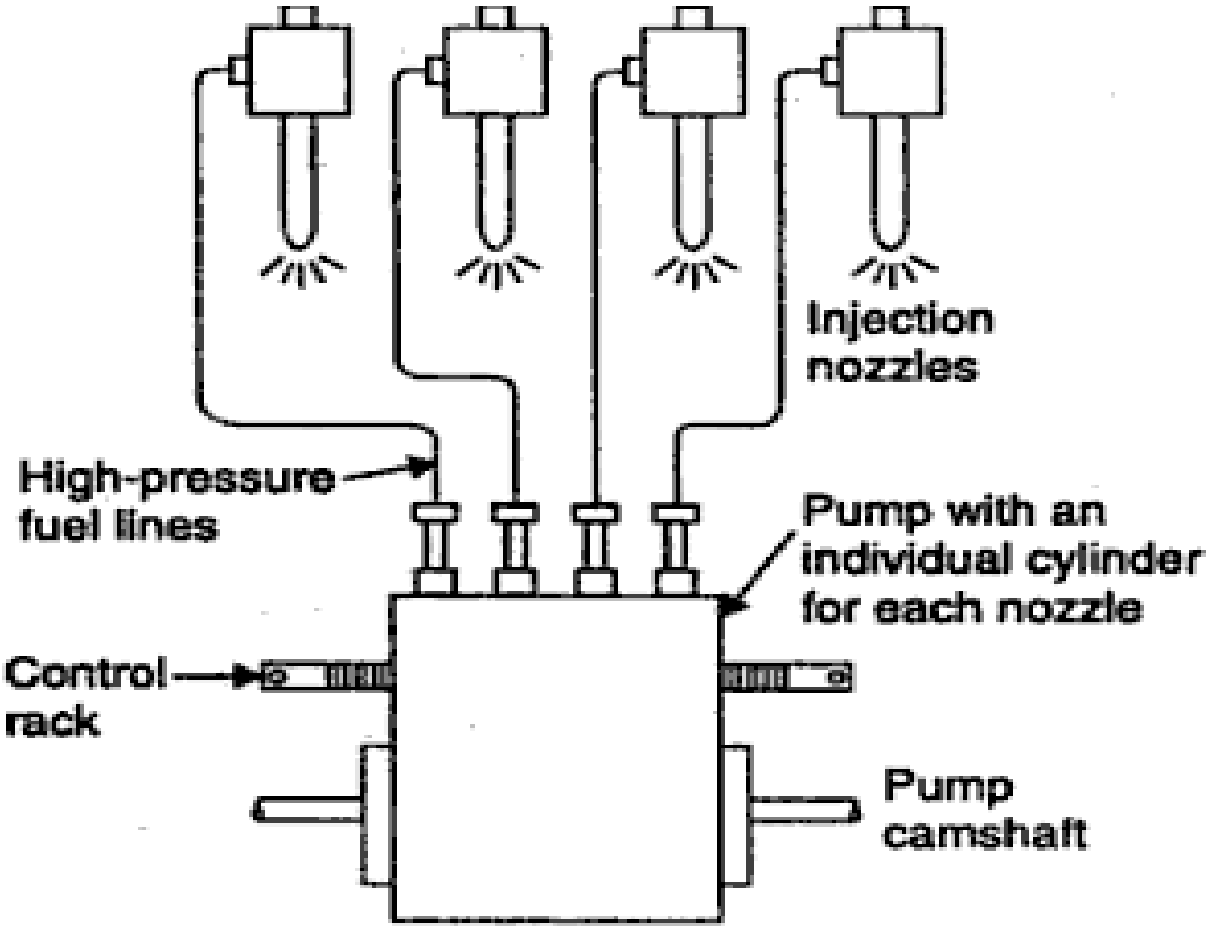
CRDI


Mechanically actuated spray valve
Fuel lines to other cylinders
High pressure relief valve
Control wedge
Camshaft
Header, or "common rail"
Fuel from day tank
High-pressure pump
Pump-drive camshaft

Fuel Injector

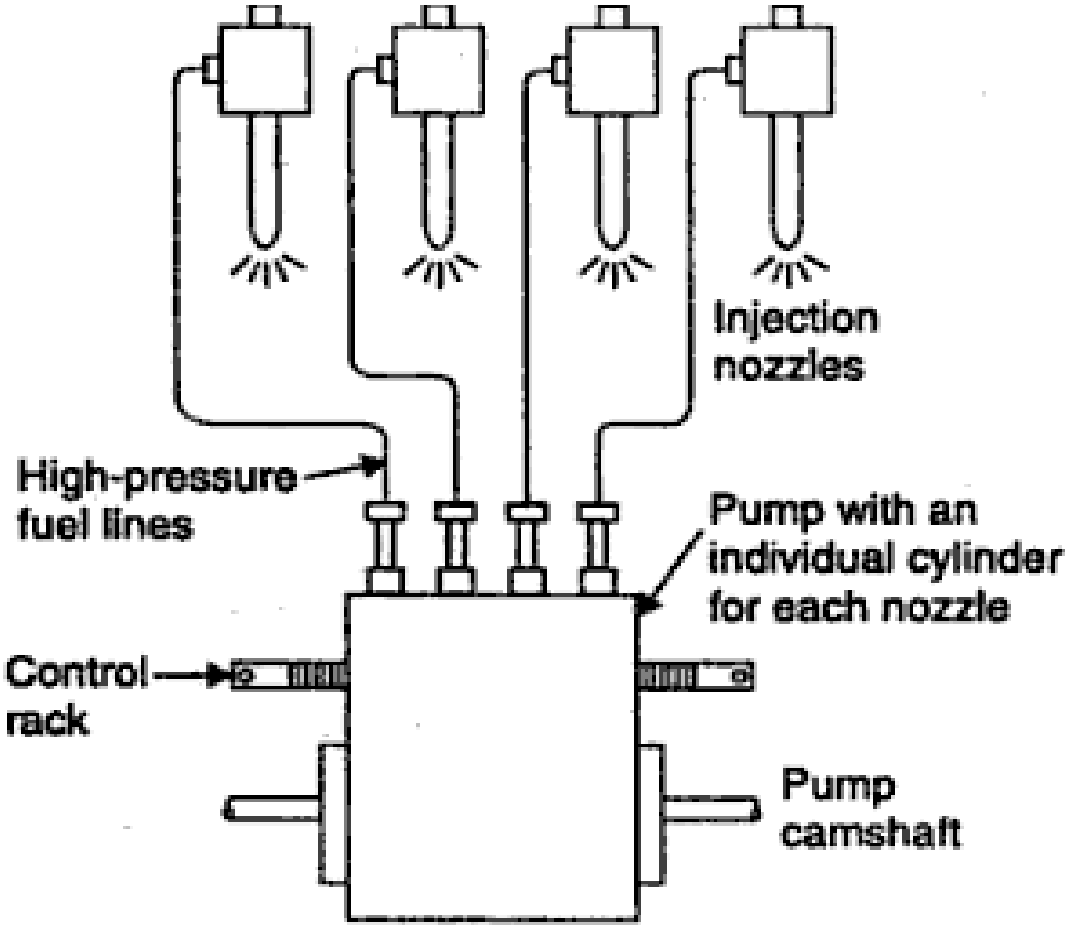


Individual pump Injection System

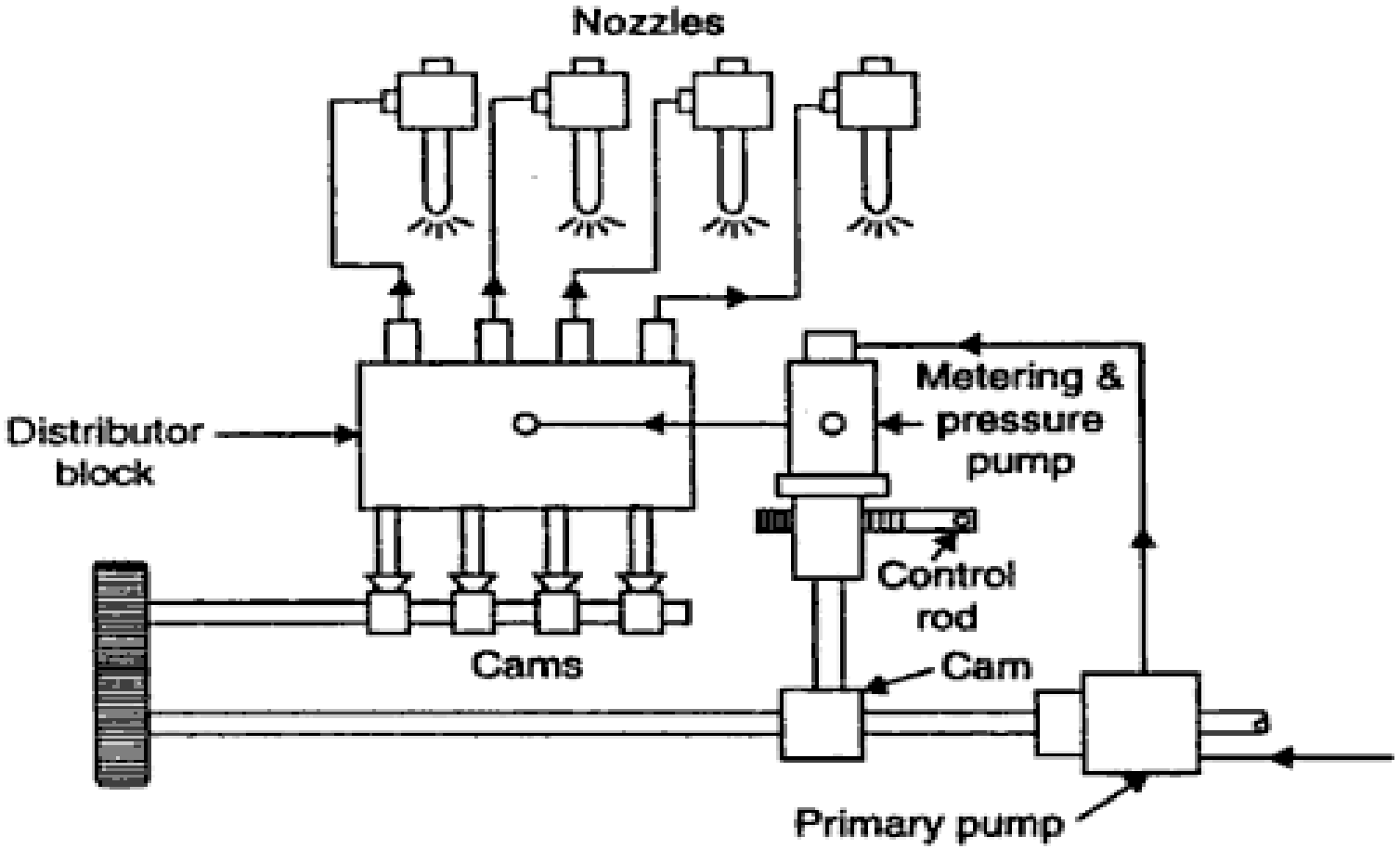


Individual pump Injection System

- The schematic is shown in fig.
- An individual pump or pump cylinder connects directly to each fuel nozzle.
- Metering and injection timing controlled by individual pumps.
- Nozzle contains a delivery valve actuated by the fuel pressure.

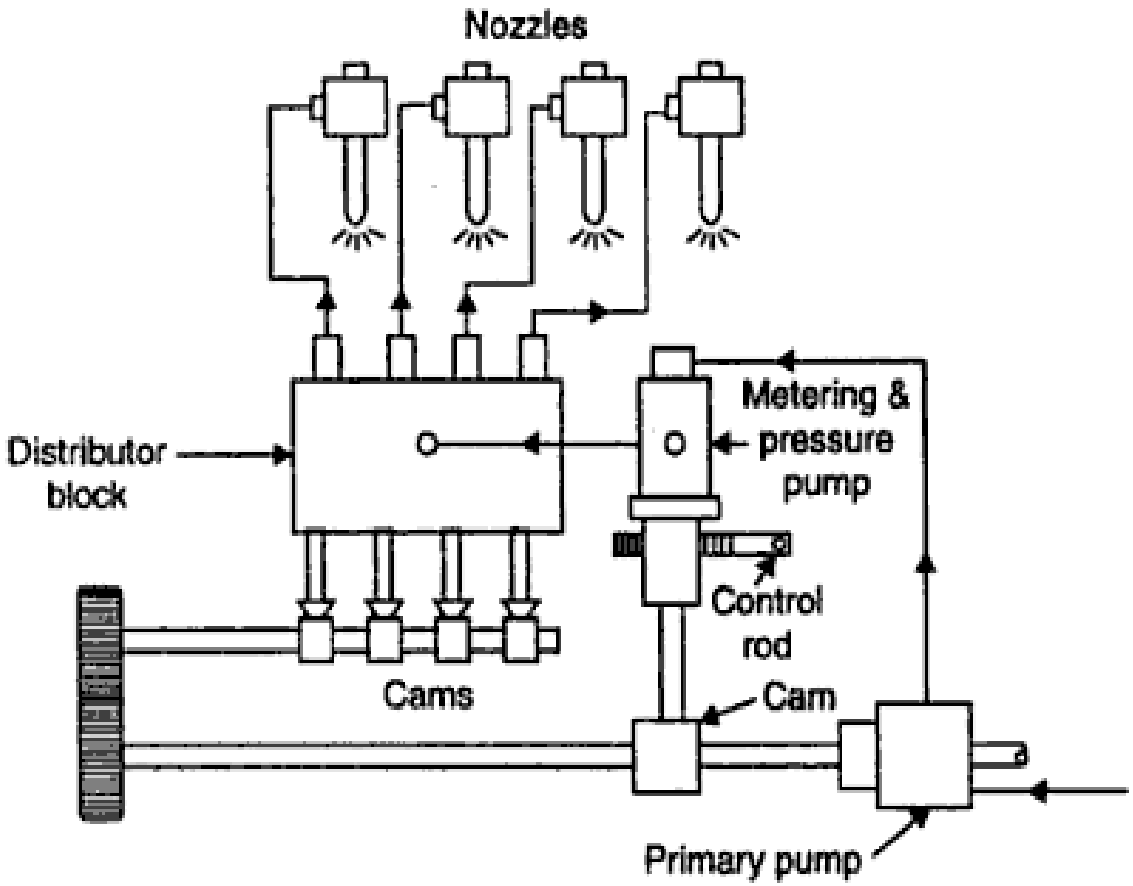


Distributor System



Distributor System

- The schematic is shown here.
- The fuel is metered at a central point.
- A pump meters, pressurizes and times the fuel injection.
- Fuel is distributed to cylinders in correct firing order by cam operated poppet valves which admit fuel to nozzles.



Cooling system

- The cooling system consists of a water source, pump and cooling towers. The pump circulates water through cylinder and head jacket. The water takes away heat form the engine and it becomes hot. The hot water is cooled by cooling towers and re circulated for cooling.

Cooling system

- The temperature of the hot gases inside the cylinder may be as high as 2750 c . If there is no external cooling, the cylinder walls and piston will tend to assume the average temp. of the gases.
- Cooling is necessary because:
- To avoid deterioration or burning of lubricating oil.
- The strength of the materials used for various engine parts decreases with increase in temperature. Local thermal stress can develop due to uneven expansion of various parts.
- Increase in pre-ignition and knocking
- Due to high cylinder head temp. the volumetric efficiency and hence power O/P of the engine are reduced.

cooling system

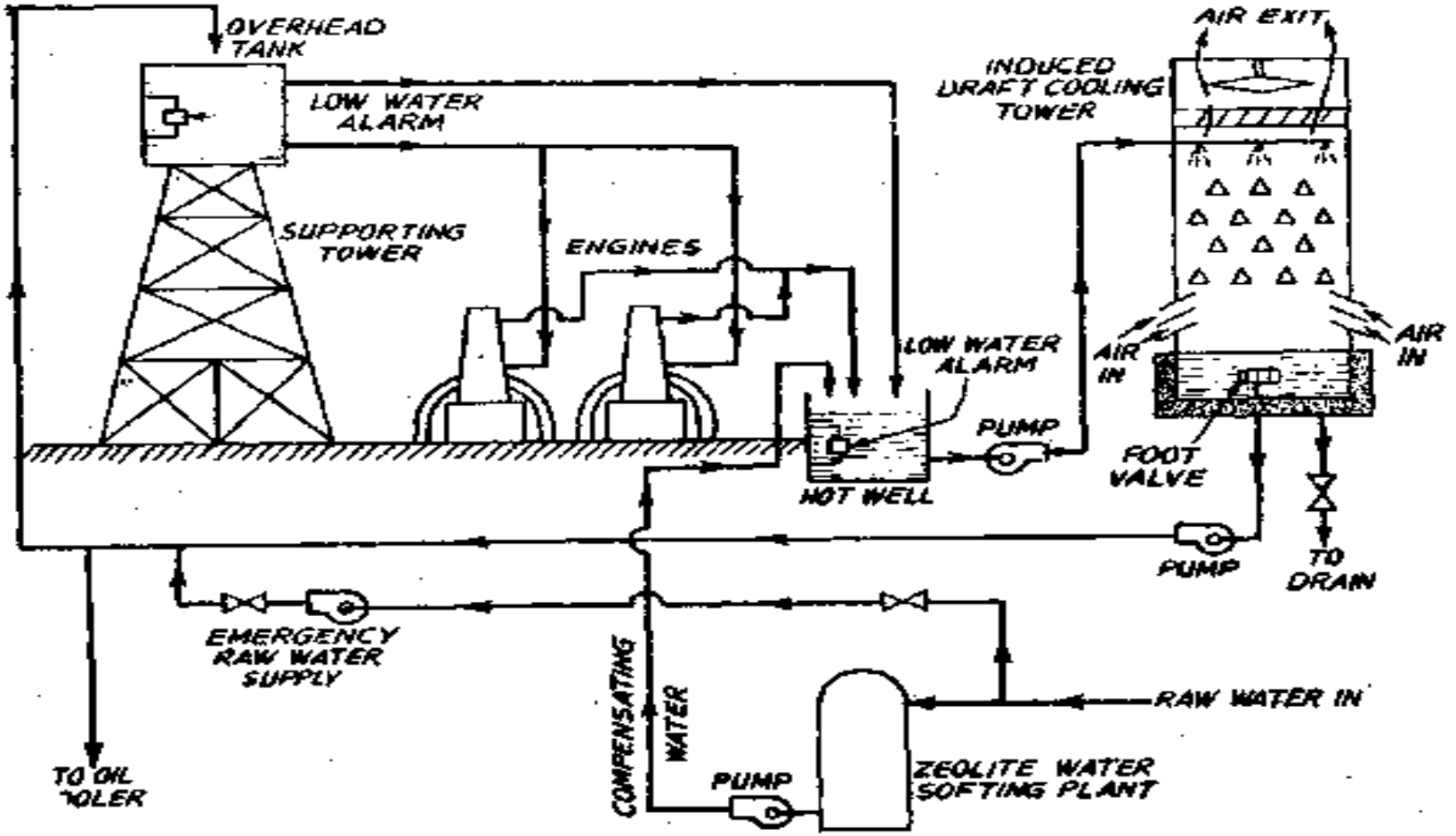


Fig. 23.3. Cooling water system using water softing plant and cooling-tower.

Elements of cooling system

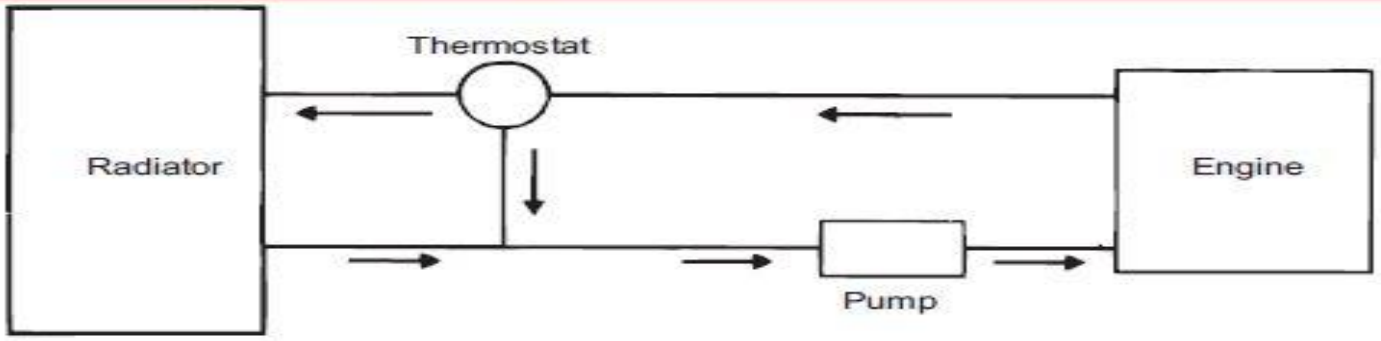


Figure 5.4 : Water Cooling System using Thermostat Valve

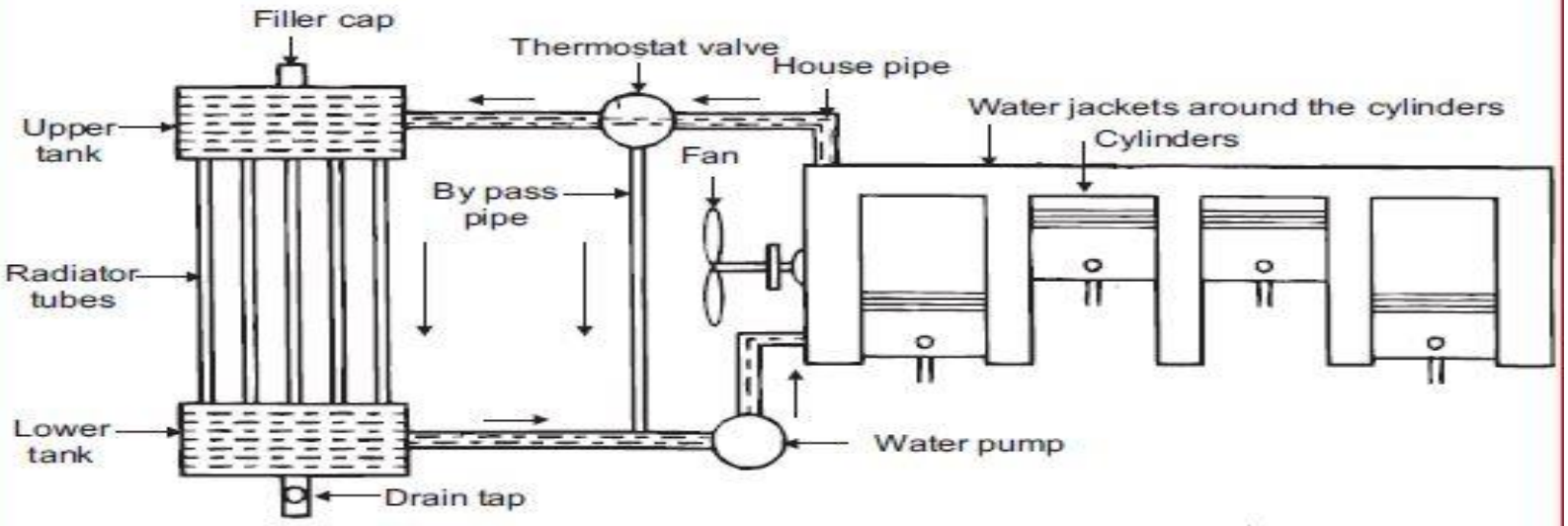
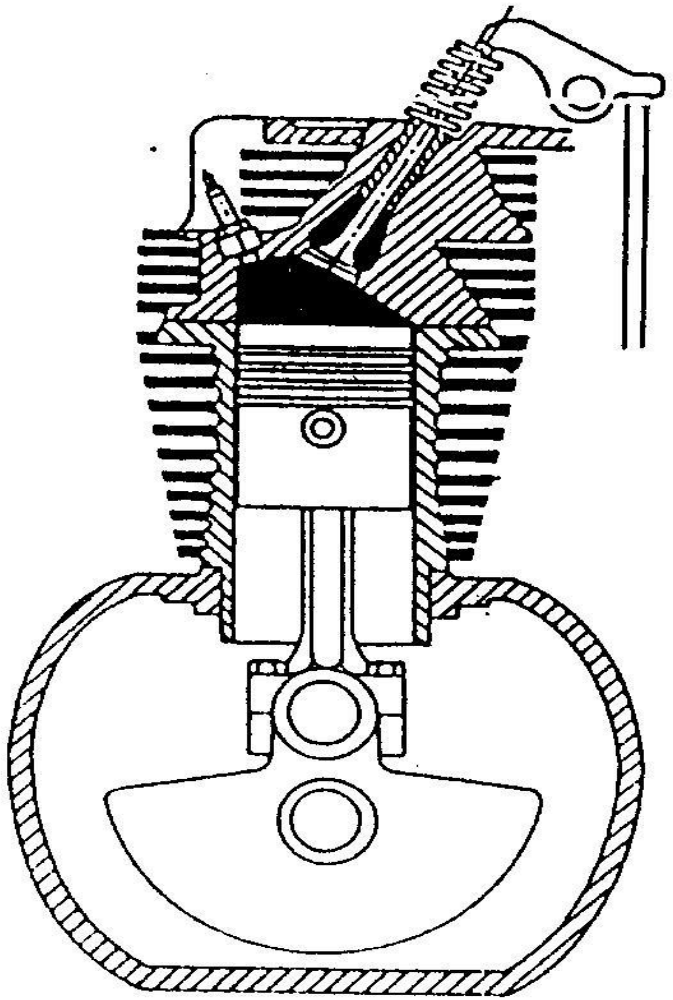


Figure 5.5 : Water Cooling System of a 4-cylinder Engine

There are two methods of cooling I.C. engi

- 1.Air cooling.
- 2. Liquid cooling



Air cooling :

- In this method, heat is carried away by the air flowing over and around the cylinder.
- Fins are added on the cylinder which provide additional mass of material for conduction as well as additional area for convection and radiative modes of heat transfer

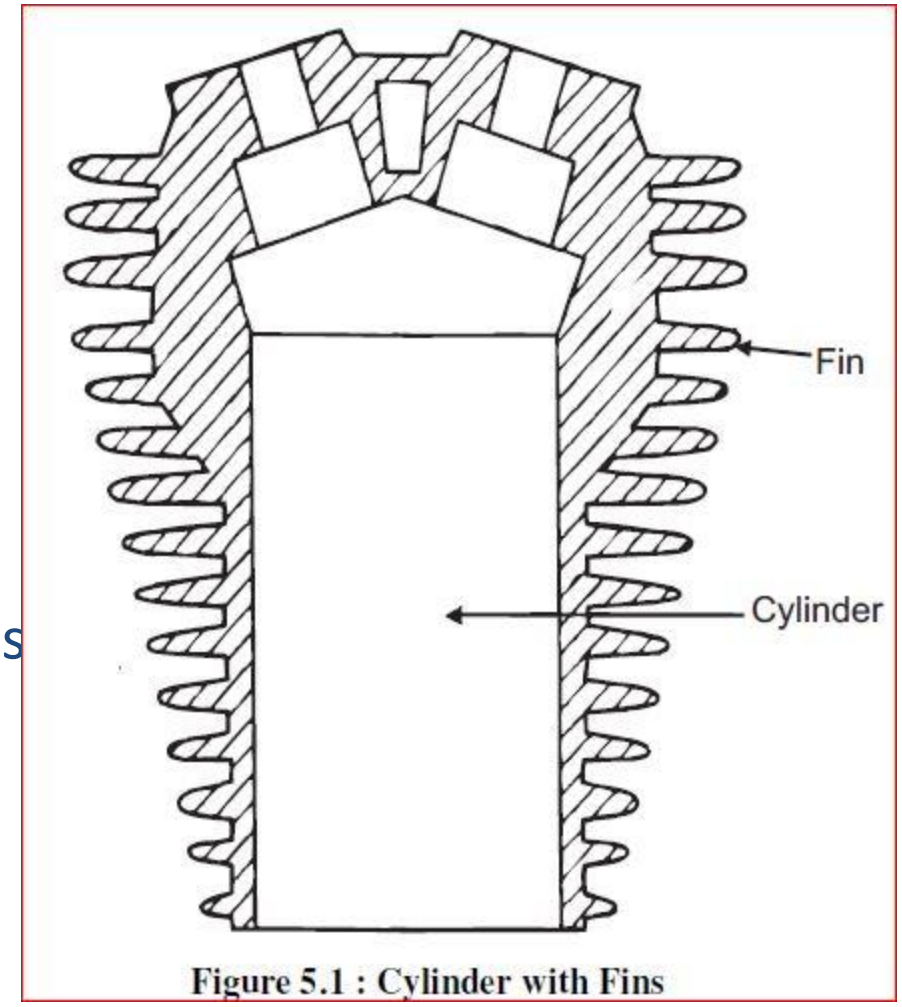
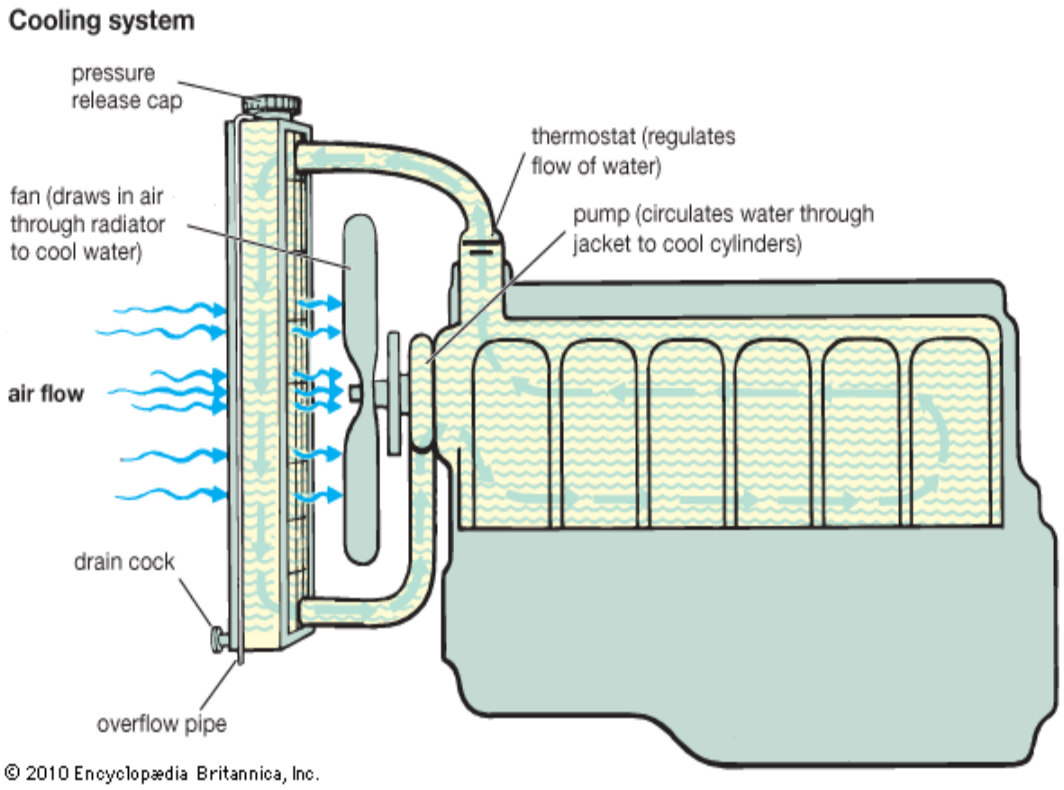


Figure 5.1 : Cylinder with Fins

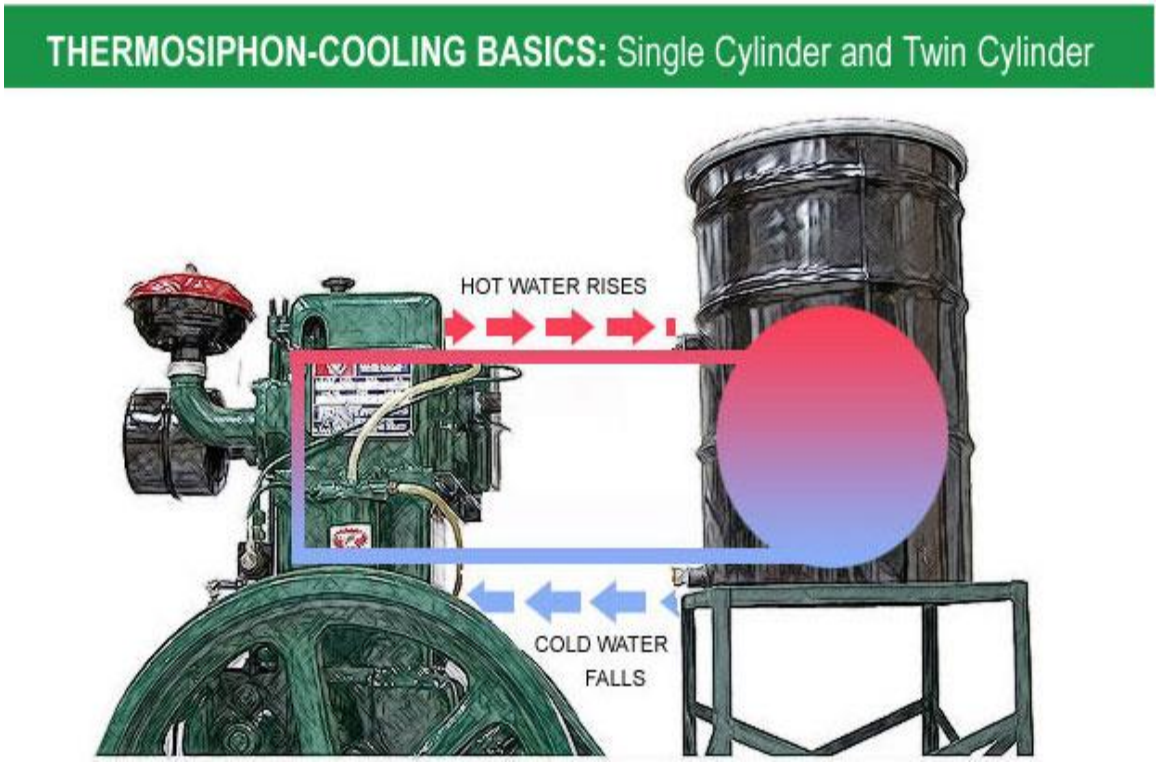
Liquid cooling

- In this method, the cylinder walls and head are provided with jackets through which the cooling liquid can circulate.
- The heat is transferred from the cylinder walls to the liquid by convection and conduction.
- The liquid gets heated during its passage through the cooling jackets and is itself cooled by means of an air cooled radiator system.

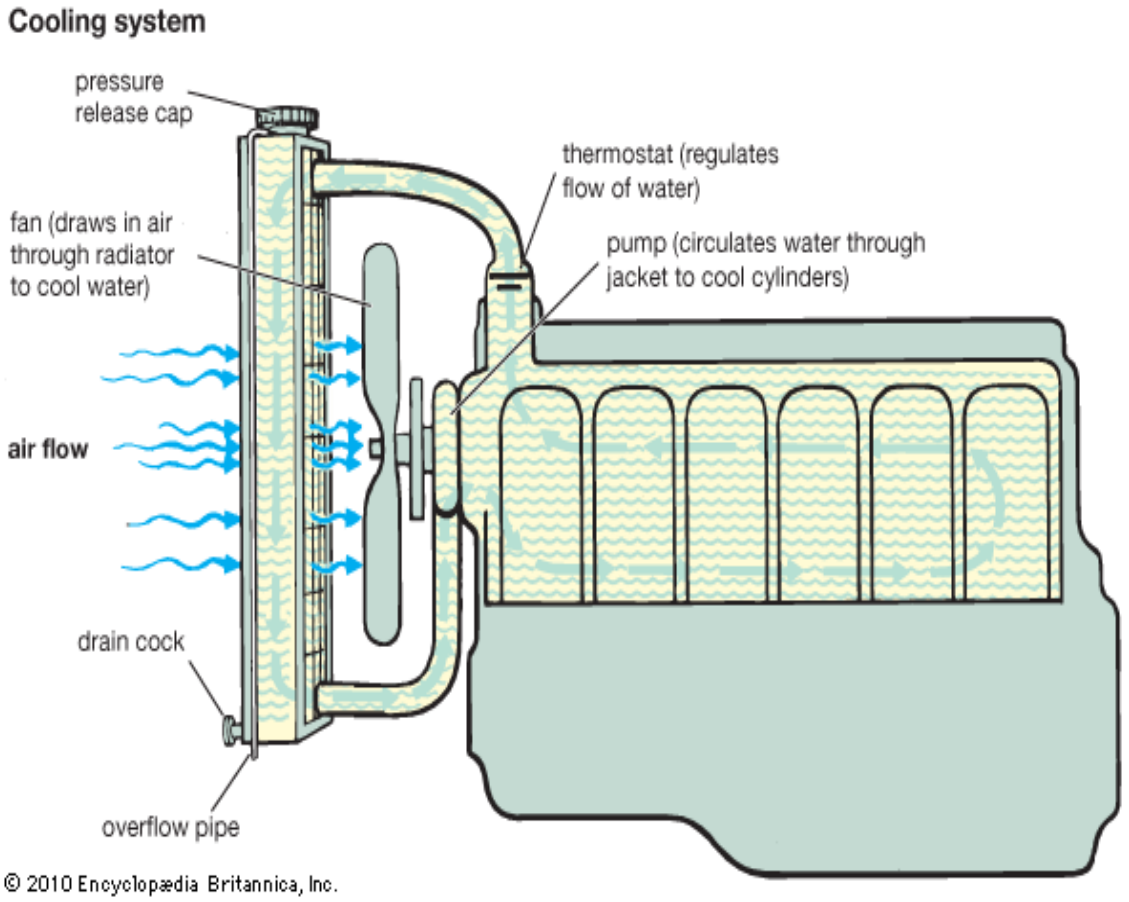


Types of Water Cooling System

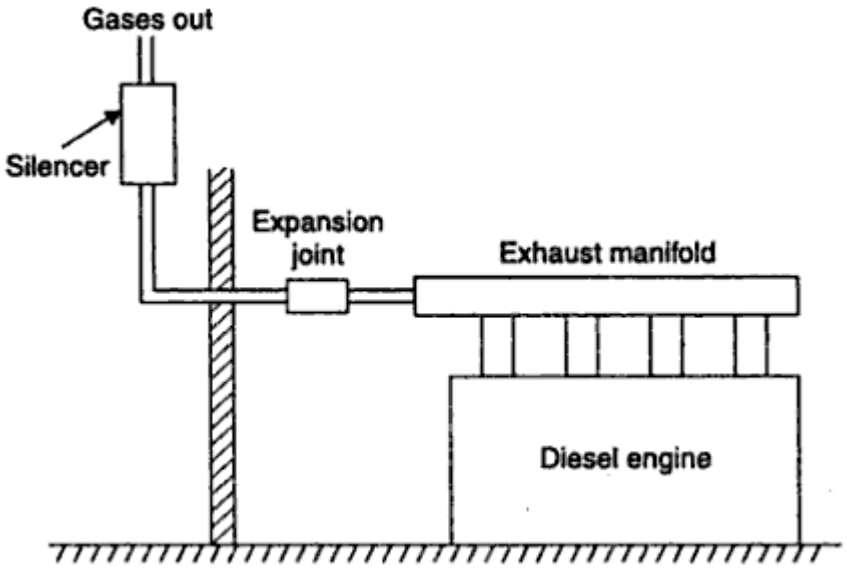
- **Thermo Siphon System**
- In this system the circulation of water is due to difference in temperature
- (i.e. difference in densities) of water. So in this system pump is not required
- but water is circulated because of density difference only.



- ***Pump Circulation System***
- In this system circulation of water is obtained by a pump. This pump is
- driven by means of engine output shaft through V-belts.

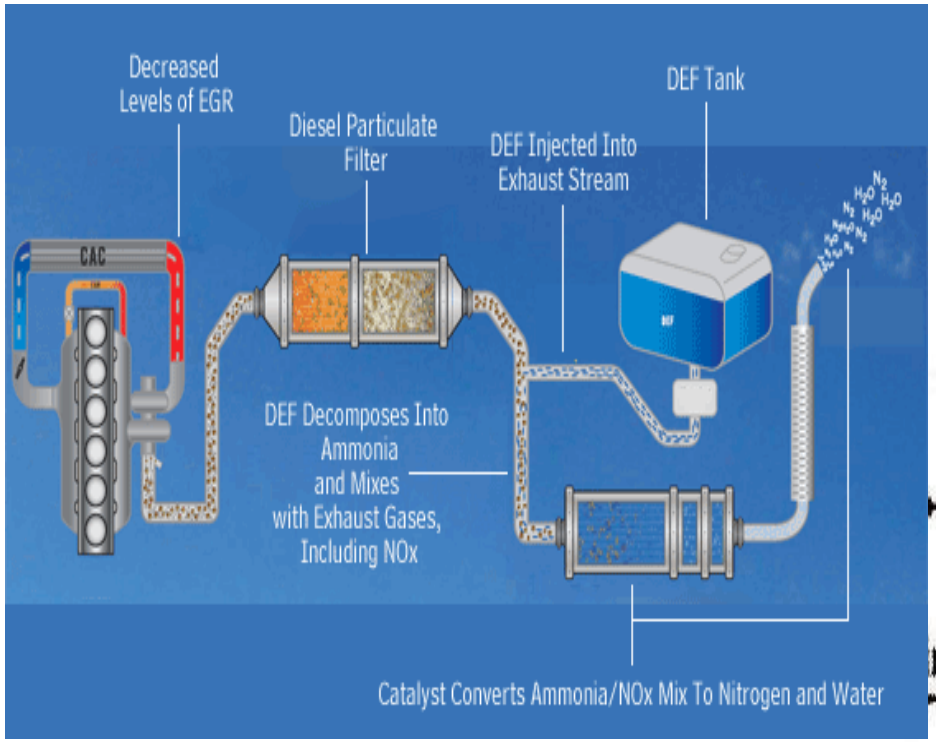


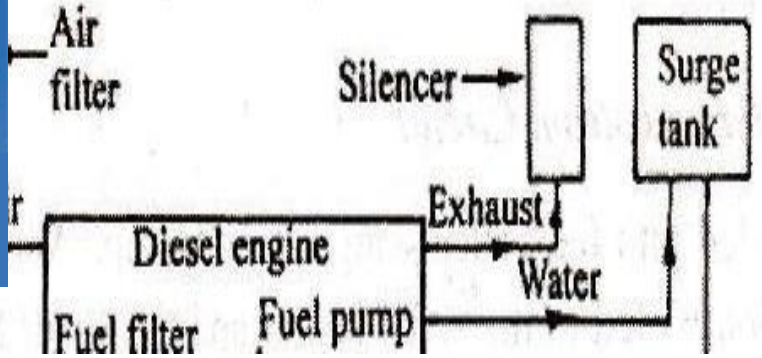
Exhaust system



Exhaust system

- The exhaust gases coming out of the engine is very noisy. In order to reduce the noise a silencer is used.





Exhaust system

- This includes the silencers and connecting ducts.
- The exhaust gases coming out of the engine is very noisy.
- silencer (muffler) is provide to reduce the noise.

Exhaust system

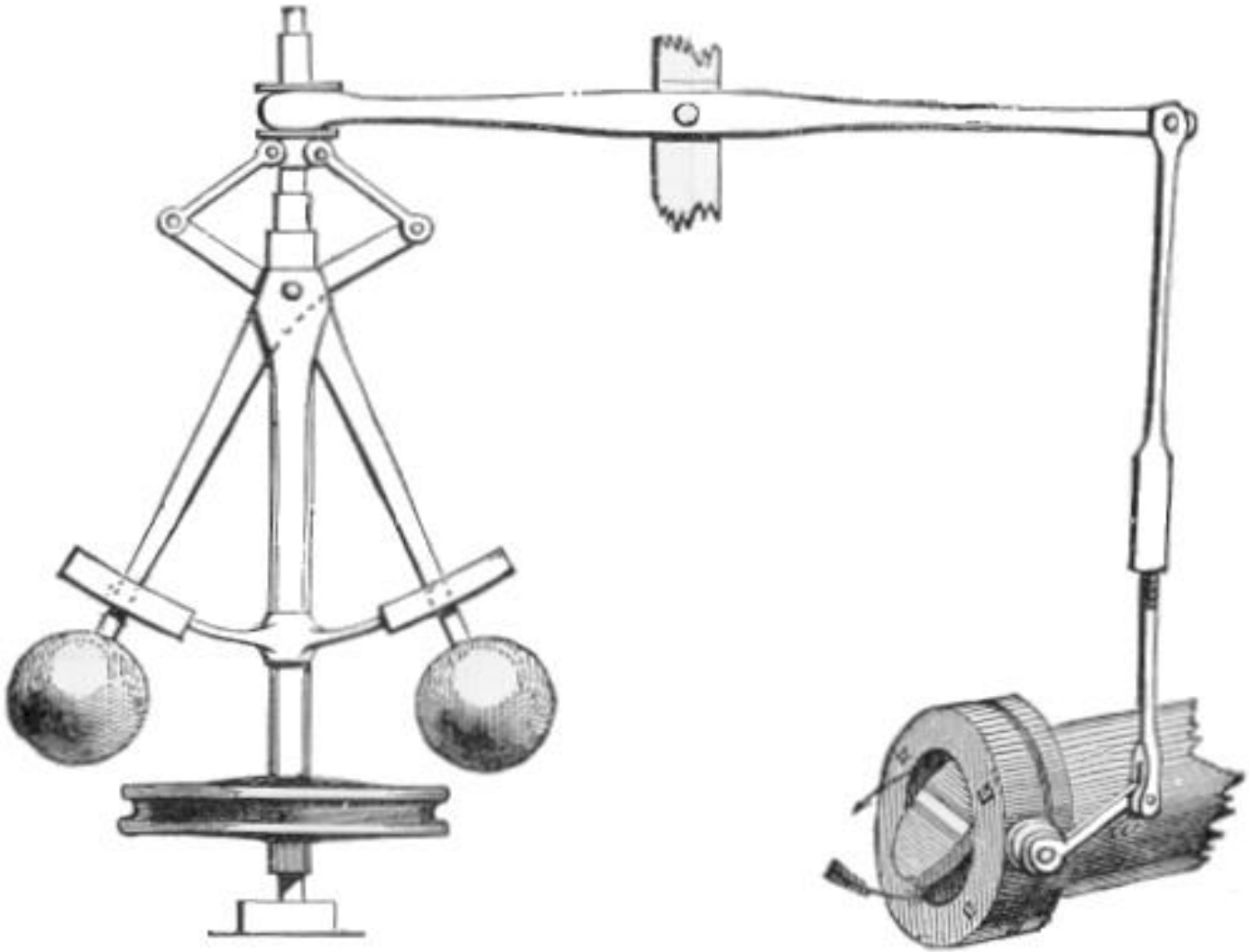
- Exhaust pipe leading out of the building should be short in length with minimum number of bends to provide as low a pressure loss as possible.
- Flexible tubings may be added in exhaust pipe to take care of misalignments and expansion/contraction and also to isolate the system from engine vibrations.

Exhaust system

- Each engine should have its independent exhaust system.
- Where possible, exhaust heat recovery should be made to improve plant thermal efficiency. E.g., air heating, low pressure steam generation in diesel-steam power plant etc

Governing system

- The function of the governing system is to maintain the speed of the engine
- This is done generally by varying fuel supply to the engine according to load.
- It is achieved with use of governors.



ADVANTAGES AND DISADVANTAGES OF DIESEL POWER PLANT

ADVANTAGES->

- Simple design & layout of plant
- Occupies less space & is compact
- Can be started quickly and picks up load in a short time
- Requires less water for cooling
- Thermal efficiency better that of Steam Power Plant of same size
- No ash handling problem
- Less operating and supervising work is required

DISADVANTAGES->

- High running charges due to costly price of Diesel
- Generates small amount of power
- Cost of lubrication very high
- Maintenance charges are generally high
- Noise problem
- Capacity is restricted. Cannot be of very big size

Hydro-Electric Power Plant

Definition of Hydro-Electric Power Plant

- A generating station which utilizes the potential energy of water at a high level for the generation of electrical energy is known as a hydro-electric power station.
- **Principal of Hydro-Electric Power Plant.**

PE↔KE↔ME↔EE

(Potential Energy↔ Kinetic Energy ↔Mechanical Energy ↔Electrical Energy)

- **Selection of Site for Hydro-Electric Power Plant:**

1. **Quantity of Water Required:**

   As we know that, the hydro-electric power plant totally runs on water, so that ample quantity of water is continuously available throughout the year.

2. **Hilly Area Required:**

   For storage of ample quantity of water, both side of dam hilly area or strong mountains required for storage of water.

3. Civil Work:

It should have strong foundation or the cost of foundation should be as low as possible.

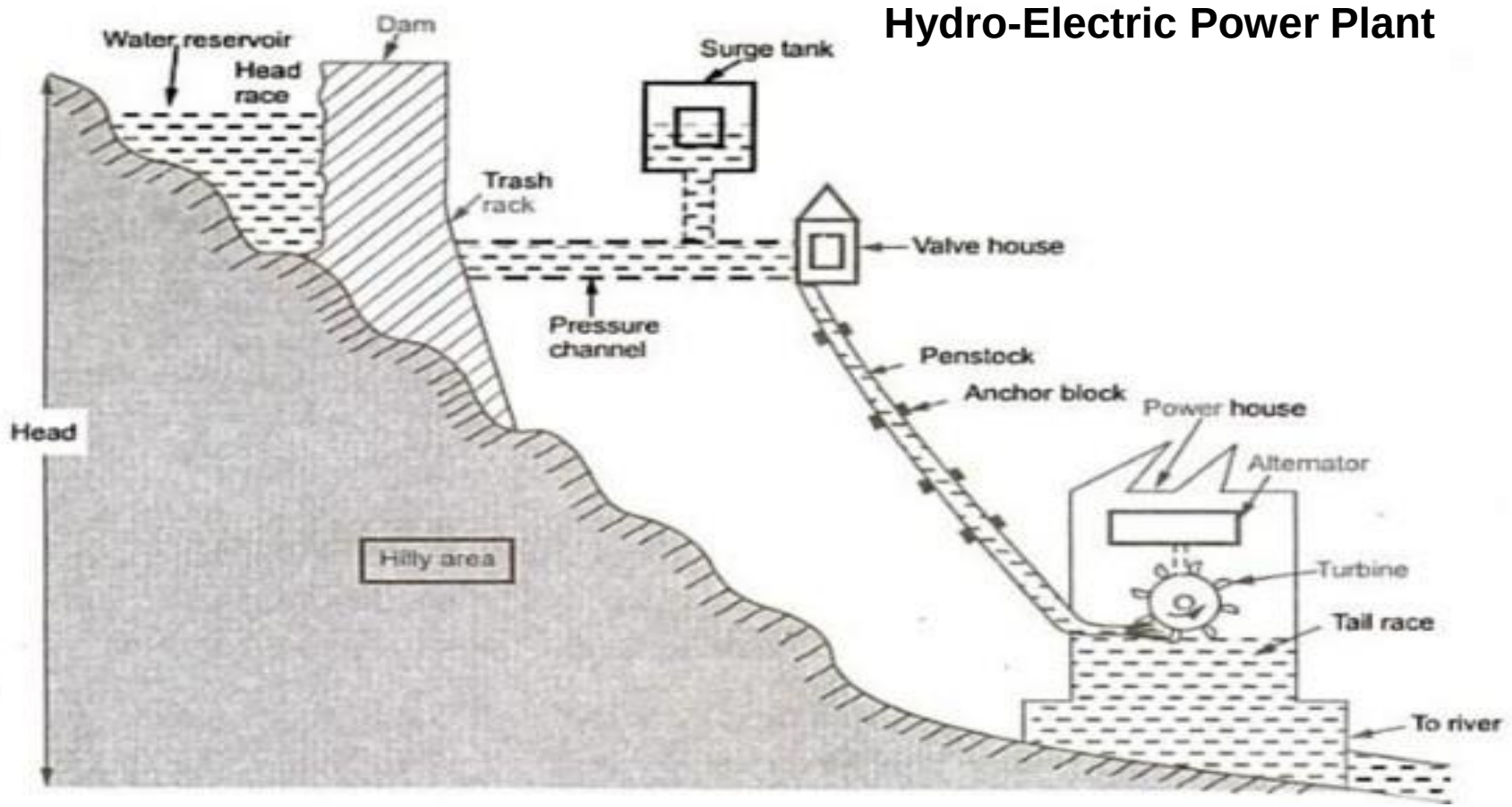
4. Large Catchment Area:

Large catchment area required, so that the water in it should never fall below the minimum level.

5. Transportation Facility:

For Workers & Civil Material required better transportation facility.

Schematic arrangement of Hydro-Electric Power Plant:



Function of Different Components used in Hydro-Electric Power Plant:

1. **Catchment Area:**

   In hydro-electric power plant collect the rain water through surrounding hilly area, the surrounding all water collect & stored area to those place is known as catchment area.

2. **Reservoir:**

   The function of reservoir is to store the water near dam; this water is useful to drive the water turbines. The reservoir is useful to provide a head of stored water.

3. **Track Rash:**

   It is used in hydro-electric power plant to filter the water before it flows towards turbine. The unwanted impurities (e.g. fish, plastics etc.) present in the stored water are avoided to flow towards turbine.

4. Head-Race Level:

The water surface in the reservoir up to the dam is known as head-race level.

5. Dam:

The dam is used in hydro-electric power plant to store the water. Whenever the dam stored the water, it provides suitable head to this stored water. This stored water is useful throughout the year to run the hydro-electric power plant. Dam is made up of cement, concrete & sand materials. If higher rainfall occurs then door of dams are opened to flow of water.