JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER

Year & Sem. – I Year & I SEM

Subject –Basic Mechanical Engineering (1FY3-07)

Unit– 3

Coordinators– Nitin Chhabra, Dilip kumar Prajapati
(Assistant Professor)

VISION AND MISSION OF INSTITUTE

VISION OF INSTITUTE

To became a renowned centre of outcome based learning and work towards academic professional ,cultur al and social enrichment of the lives of individuals and communities .

MISSION OF INSTITUTE

Focus on evaluation of learning ,outcomes and motivate students to research aptitude by project based learning.

•Identify based on informed perception of Indian ,regional and global needs ,the area of focus and prov ide platform to gain knowledge and solutions.

•

•Offer opportunities for interaction between academic and industry .

•Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted lea ders may emerge.

VISION AND MISSION OF DEPARTMENT

Vision

The Mechanical Engineering Department strives to be recognized globally for excellent technical kno wledge and to produce quality human resource, who can manage the advance technologies and contrib ute to society through entrepreneurship and leadership.

Mission

1) To impart highest quality technical knowledge to the learners to make them globally competitive mechanical engineers.

2) To provide the learners ethical guidelines along with excellent academic environment for a long pro ductive career.

3)To promote industry-institute linkage.

Course Outcomes of BME

- To describe the importance of mechanical engineering in any industry and to apply the various concepts in thermal based industry.
- To understand the various machines and power transmission related to it and also the effect of parameters on a job.
- To relate the industrial issues with the environment and to consider key concepts in in engineering materials.
- To come across new practices and researches going in mechanical engineering line CAD, CAM etc.

Contents of UNIT-3

- Introduction to Refrigeration
- Terminology of Refrigeration.
- Vapor Compression Refrigeration System.
- Vapor Absorption Refrigeration System.
- Air Conditioning.

Refrigeration

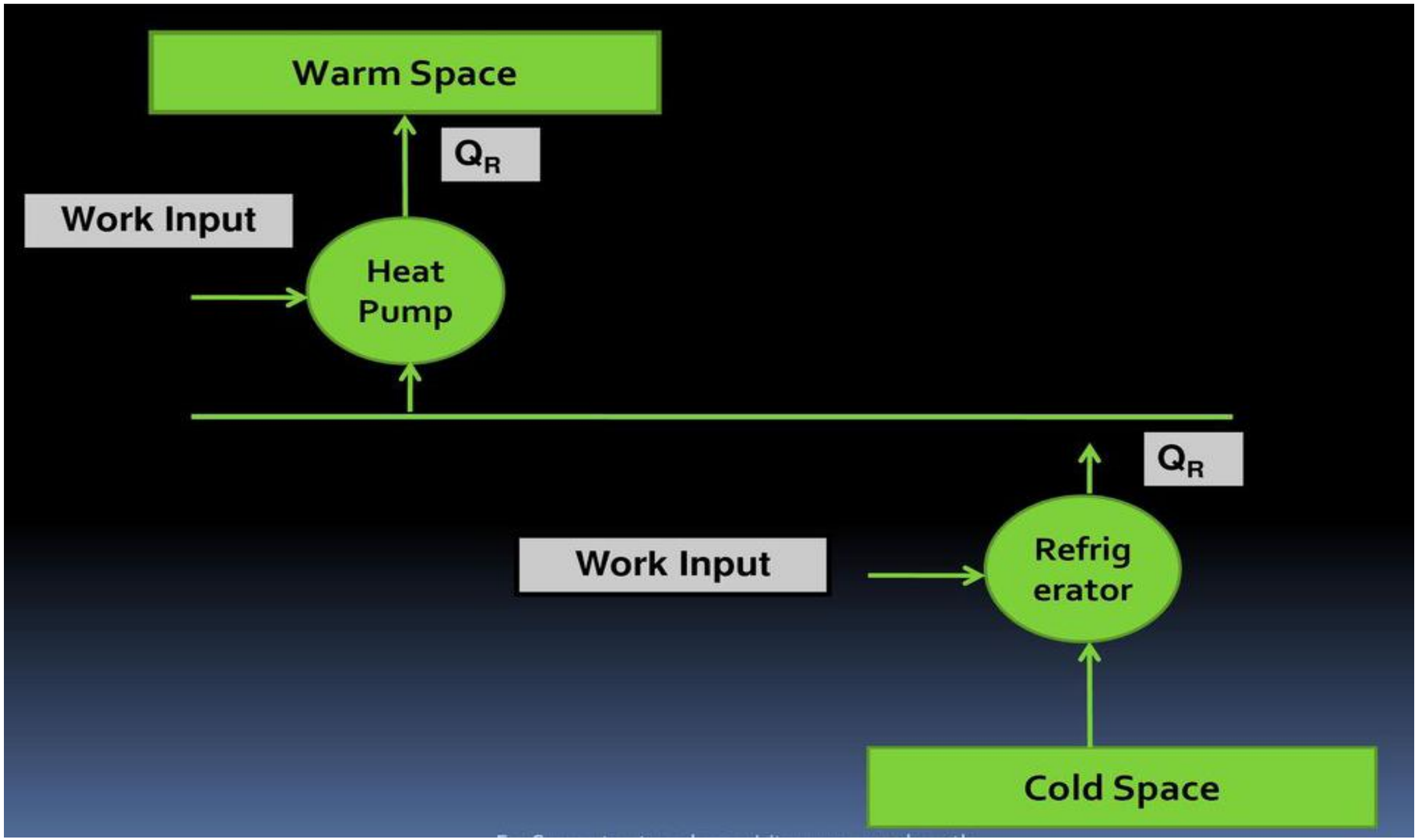
It is defined as the process of providing and maintaining a temperature well below that of surrounding atmosphere.

In other words refrigeration is the process of cooling substance.

Refrigerators and heat pumps

- If the main purpose of the machine is to cool some object, the machine is named as refrigerator.
- If the main purpose of machine is to heat a medium warmer than the surroundings, the machine is termed as heat pump.

Refrigerator and Heat pump



Terminologies of Refrigeration

Capacity of a Refrigeration Unit :

- Capacity of a refrigerating machines are expressed by their cooling capacity.
- The standard unit used for expressing the capacity of refrigerating machine is ton of refrigeration.
- One ton of refrigeration is defined as, "the quantity of heat abstracted (refrigerating effect) to freeze one ton of water into one ton of ice in a duration of 24 hours at 0^{o} c".

Heat extracted from at 0^{o} c = latent heat of ice

Latent heat of ice = 336 kJ/kg

i.e., 336 kJ of heat should be extracted from one kg of water at 0^{o} C to convert it into ice.

Terminologies of Refrigeration

One ton of refrigeration $= 336 \times 1000$ kJ/24 hrs.

$$= \frac{336 \times 1000 \text{ kJ/min}}{24 \times 60}$$

One ton of refrigeration $= 233.333$ kJ/min

$= 3.8889$ kJ/sec

Co efficient of Performance: It is defined as the ratio of heat extracted in a given time (refrigerating effect) to the work input.

$$\text{Co efficient of performance} = \frac{\text{Heat extracted in evaporator}}{\text{Work Input}}$$

$$\text{Co efficient of performance} = \frac{\text{Refrigerating Effect}}{\text{Work Input}}$$

$$\text{Co efficient of performance} = \frac{N}{W}$$

The COP is always greater than 1 and known as theoretical coefficient of performance.

Refrigerants

Refrigerant: **Any substance that absorbs heat through expansion and vaporisation process and loses heat due to condensation is a refrigeration process is called refrigerant.**

Some examples of refrigerants are,

- *Air*
- *Ammonia (NH_3)*
- *Carbon dioxide (CO_2)*
- *Sulphur dioxide (SO_2)*
- *Freon – 12*
- *Methyl Chloride*
- *Methylene chloride.*

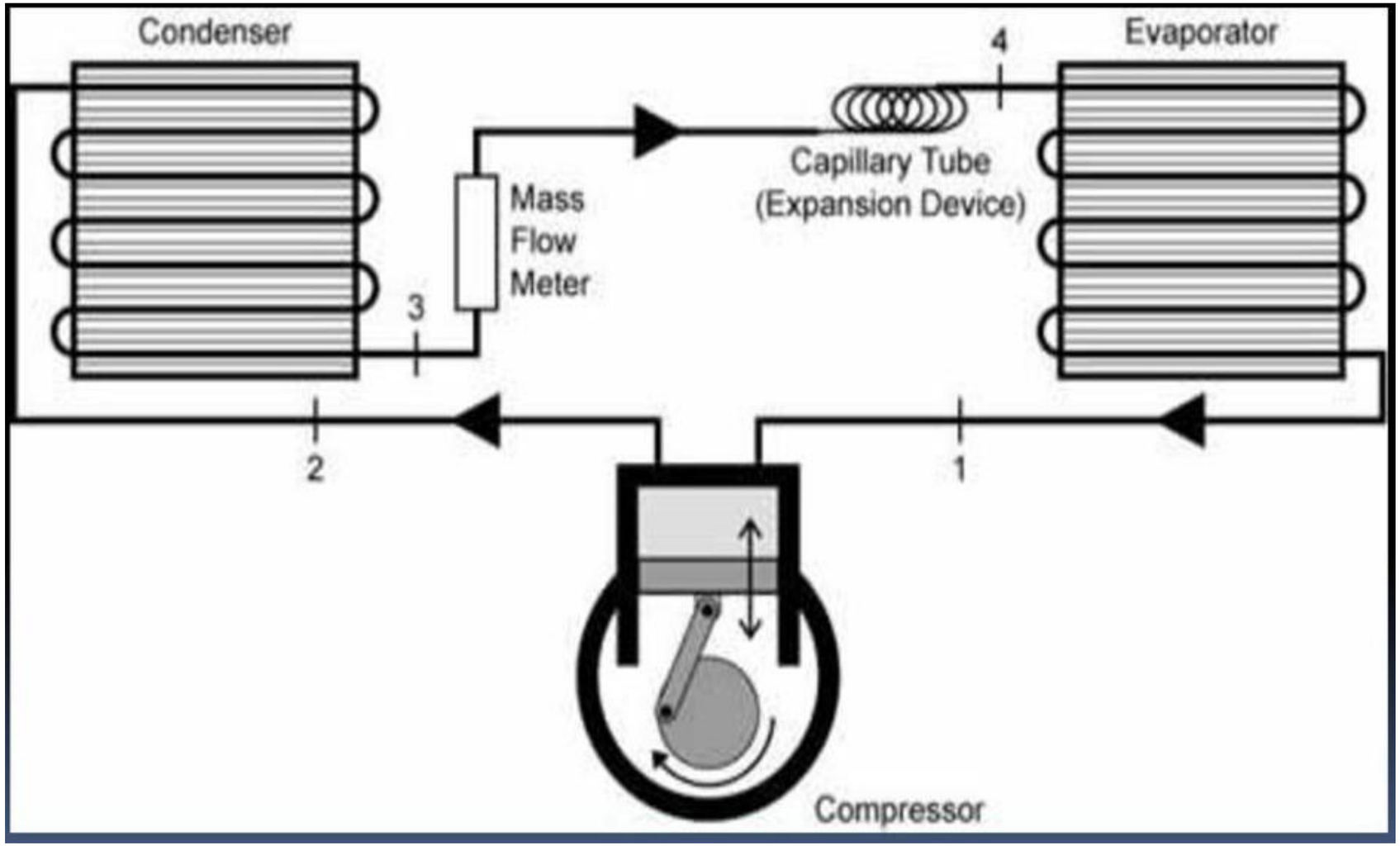
Applications of Refrigeration

- In chemical industries, for separating and liquefying the gases.
- In manufacturing and storing ice.
- For the preservation of perishable food items in cold storages.
- For cooling water.
- For controlling humidity of air manufacture and heat treatment of steels.
- For chilling the oil to remove wax in oil refineries.
- For the preservation of tablets and medicines in pharmaceutical industries.
- For the preservation of blood tissues etc.,
- For comfort air conditioning the hospitals, theatres, etc.,

Properties of Refrigeration

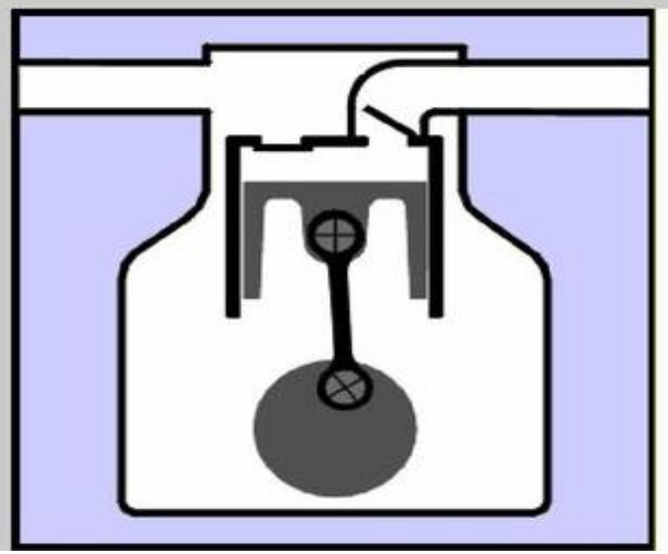
- A good refrigerant should have high latent heat of vapourisation.
- It should have low boiling and low freezing point.
- It should be non toxic and should non corrosiveness
- It should be non flammable and non explosive.
- It should have high thermal conductivity
- It should be easy to handle
- It should have low specific volume of vapour.
- It should have high co efficient of performance

Vapour Compression Refrigeration System



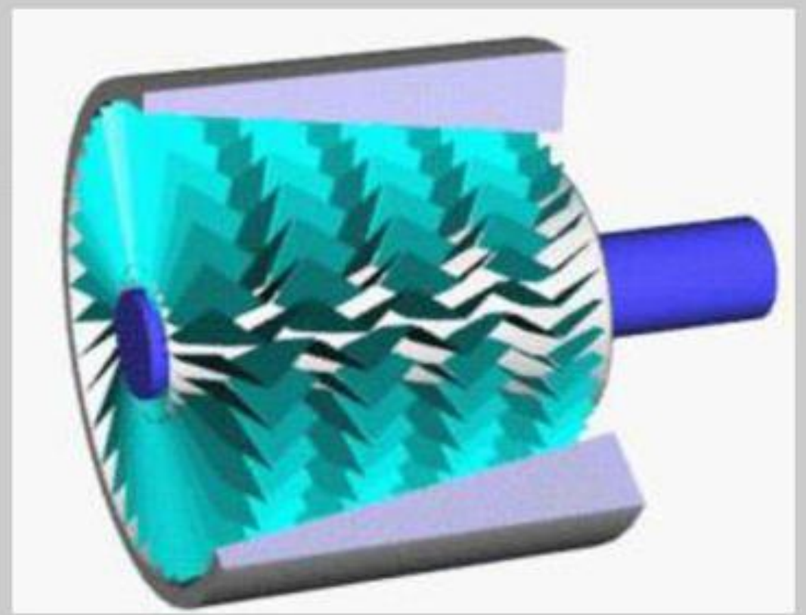
Vapour Compression Refrigeration System - Construction

- This system consists of a compressor, condenser, a receiver tank, an expansion valve and an evaporator.
- **Compressor :** Reciprocating compressors generally used. For very big plants centrifugal compressors directly coupled with high speed rotating engines (gas turbine) are used.



Vapour Compression Refrigeration System - Construction

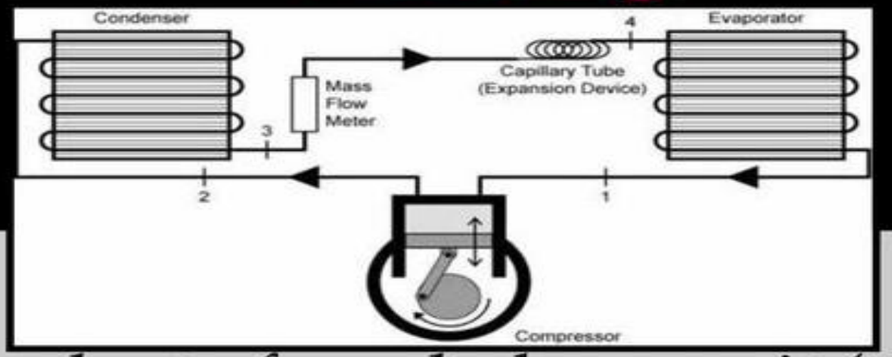
Compressor: For very big plants Centrifugal compressors directly coupled with high speed rotating engines (gas turbine) are used



Vapour Compression Refrigeration System - Construction

- **Condenser :** It is a coil of tubes made of copper.
- **Receiver tank:** It is the reservoir of liquid refrigerant.
- **Expansion Valve:** This is a throttle valve. High pressure refrigerant is made to flow at a controlled rate through this valve.
- **Evaporator :** It is the actual cooler and kept in the space to be cooled. The evaporator is a coil of tubes made of copper

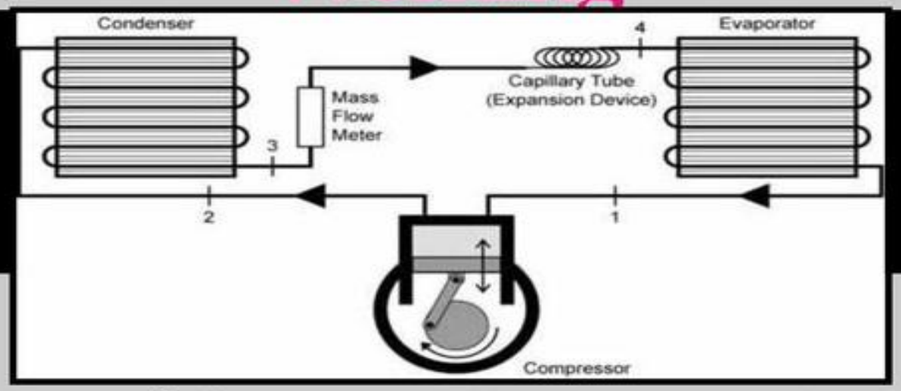
Vapour Compression Refrigeration System - Working



Working :

6. The heat equivalent of work done on it (w) on the compressor.
7. This heat is carried by condenser medium which may be air or water.
8. The high pressure liquid refrigerant then enters the expansion valve.
9. This valve allows the high pressure liquid refrigerant to flow at a controlled rate into the evaporator.
10. While passing though this valve the liquid partially evaporates.

Vapour Compression Refrigeration System - Working



Working :

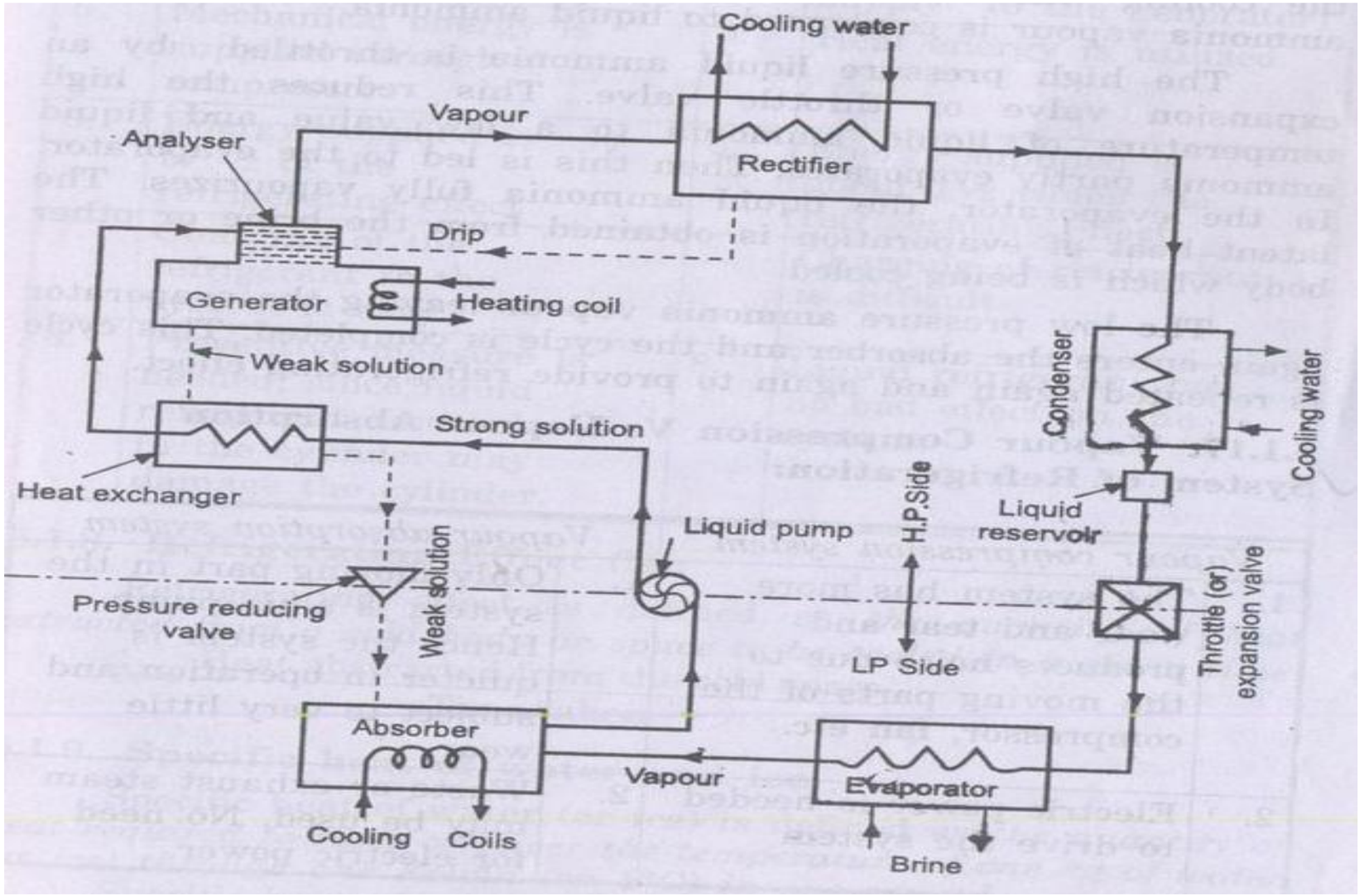
11. Most of the refrigerant is vapourised only in the evaporator, at a low pressure.
12. In the evaporator the liquid refrigerant absorbs its latent heat of vapourisation from the material which is to be cooled.
13. Thus the refrigerating effect (N) is obtained.
14. Then the low pressure refrigerant enters the compressor and the cycle is repeated.

Vapour Absorption Refrigeration system

In this system compression process of vapour compression cycle is eliminated. Instead of that the following three processes are carried out.

1. *Absorbing ammonia vapour into water.*
2. *Pumping this solution to a high pressure cycle*
3. *Producing ammonia vapours from ammonia solution by heating.*

Vapour Absorption Refrigeration system



Vapour Absorption Refrigeration system – Working

Working:

1. Dry ammonia vapor at low pressure passes in to the absorber from the evaporator.
2. In the absorber the dry ammonia vapor is dissolved in cold water and strong solution of ammonia is formed.
3. Heat evolved during the absorption of ammonia is removed by circulating cold water through the coils kept in the absorber.
4. The highly concentrated ammonia (known as Aqua Ammonia) is then pumped by a pump to generator through a heat exchanger.

Vapour Absorption Refrigeration system – Working

Working:

5. In the heat exchanger the strong ammonia solution is heated by the hot weak solution returning from the generator to the absorber.
6. In the generator the warm solution is further heated by steam coils, gas or electricity and the ammonia vapour is driven out of solution.
7. The boiling point of ammonia is less than that of water.
8. Hence the vapours leaving the generator are mainly of ammonia.

Vapour Absorption Refrigeration system – Working

Working:

9. The weak ammonia solution is left in the generator is called weak aqua.
10. This weak solution is returned to the absorber through the heat exchanger.
11. Ammonia vapours leaving the generator may contain some water vapour.
12. If this water vapour is allowed to the condenser and expansion valve, it may freeze resulting in chocked flow.
13. Analyser and rectifiers are incorporated in the system before condenser.

Vapour Absorption Refrigeration system – Working

Working:

14. The ammonia vapour from the generator passes through a series of trays in the analyser and ammonia is separated from water vapour.
15. The separated water vapour returned to generator.
16. Then the ammonia vapour passes through a rectifier.
17. The rectifier resembles a condenser and water vapour still present in ammonia vapour condenses and the condensate is returned to analyser.
18. The virtually pure ammonia vapour then passes through the condenser.

Vapour Absorption Refrigeration system – Working

Working:

19. The latent heat of ammonia vapour is rejected to the cooling water circulated through the condenser and the ammonia vapour is condensed to liquid ammonia.
20. The high pressure liquid ammonia is throttled by an expansion valve or throttle valve.
21. This reduces the high temperature of the liquid ammonia to a low value and liquid ammonia partly evaporates.
22. Then this is led to the evaporator.
23. In the evaporator the liquid fully vaporizes.

Vapour Absorption Refrigeration system – Working

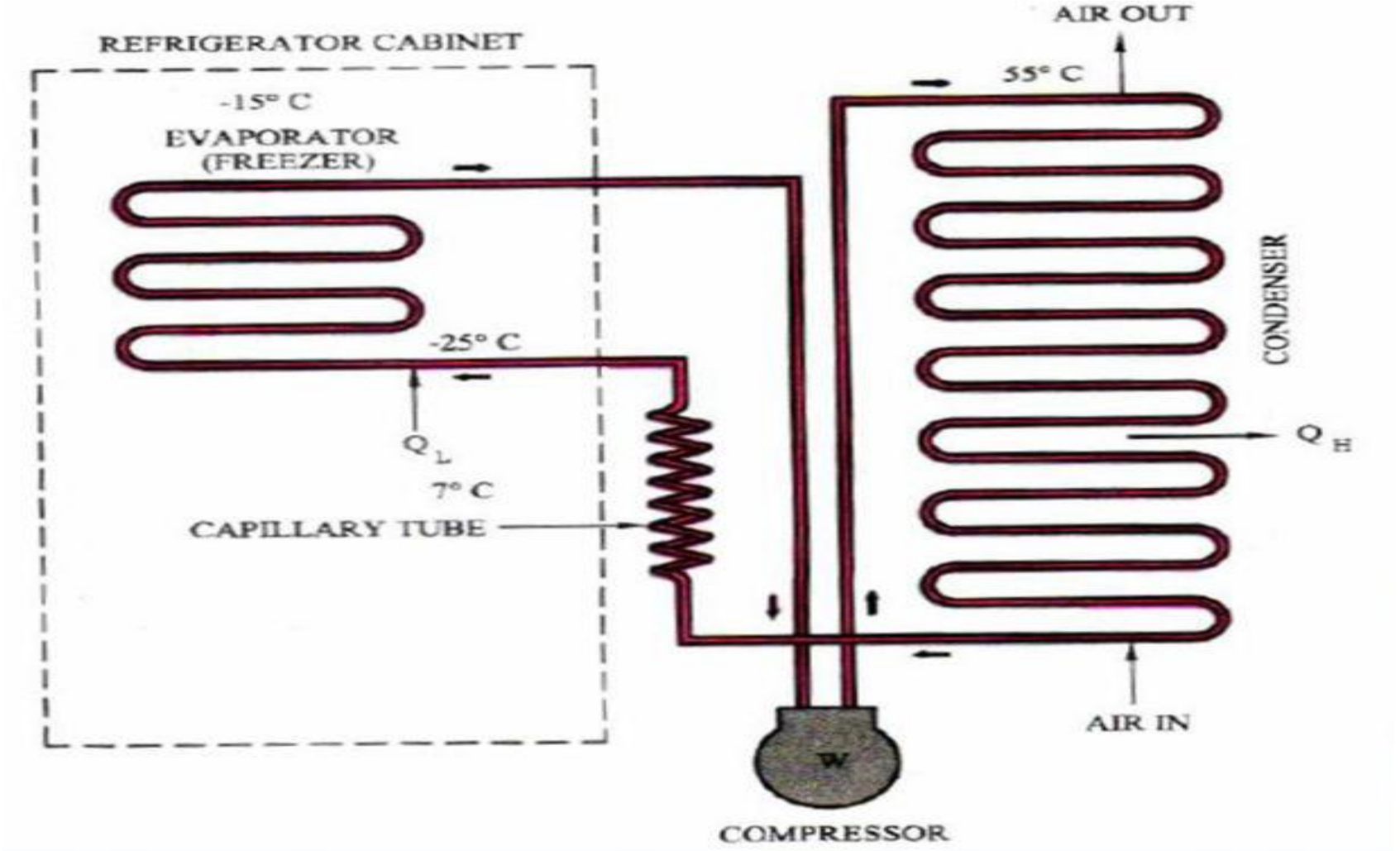
Working:

24. The latent heat of evaporation is obtained from the brine or other body which is being cooled.
25. The low pressure ammonia vapour leaving the evaporator again enters the absorber and the cycle is completed.
26. This cycle is repeated again to provide the refrigerating effect.

Comparison between Vapour compression & Vapour Absorption refrigeration systems

S.No.	Vapour Compression System	Vapour Absorption System
1	This system has more wear and tear and produces more noise due to the moving parts of the compressor.	Only moving part in this system is an aqua pump. Hence the quieter in operation and less wear and tear
2.	Electric power is needed to drive the system	Waste of exhaust steam may be used. No need of electric power
3.	COP is more	COP is less
4.	At partial loads performance is poor.	At partial loads performance is not affected.
5.	Mechanical energy is supplied through compressor	Heat energy is utilised
6.	Energy supplied is ¼ to ½ of the refrigerating effect (less)	Energy supplied is about one and half times the refrigerating effect (more)

LAYOUT OF DOMESTIC REFRIGERATOR



DOMESTIC REFRIGERATOR

- House hold refrigerators use vapor compression cycle
- Less energy: (90 W to 600 W)
  - Due to small and high efficiency motors and compressors,
  - better insulation materials,
  - large coil surface area,
  - better door seals
- Designed to maintain:
  - Freezer section -18 °C
  - Refrigeration section at 3 °C

DOMESTIC REFRIGERATOR

- Energy consumption can be minimized for practicing good measures
  - Open the refrigeration doors fewest times possible
  - Cool the hot foods to room temperature
  - Clean the condenser coil behind the refrigerator
  - Check the door gaskets for air leaks
  - Avoid unnecessary low temperature settings
  - Avoid excessive ice build up
  - Use the power saver switch
  - Do not block the air flow passages to and from the condenser coil.

AIR CONDITIONING

Air Conditioning is the process of conditioning the air according to the human comfort, irrespective of external conditions.

AIR CONDITIONING

Applications of Air Conditioning

- Used in offices, hotels, buses, cars.,etc
- Used in industries having tool room machines.
- Used in textile industries to control moisture.
- Used in printing press.
- Used in Food industries, Chemical plants.

CLASSIFICATION OF AIR CONDITIONING

Air conditioning systems are classified as

1) According to the purpose
   a) Comfort Air conditioning.
   b) Industrial Air conditioning.
2) According to Season of the year
   a) Summer Air conditioning.
   b) Winter Air conditioning.
   c) Year round Air conditioning.

AIR CONDITIONING

Types of Air conditioners

a) Room Air conditioners
b) Winter Air conditioners
c) Central Air conditioners

Functions of Air conditioners

a) Cleaning air.
b) Controlling the temp of air.
c) Controlling the moisture content.
d) Circulating the air.

Window Type Air Conditioner

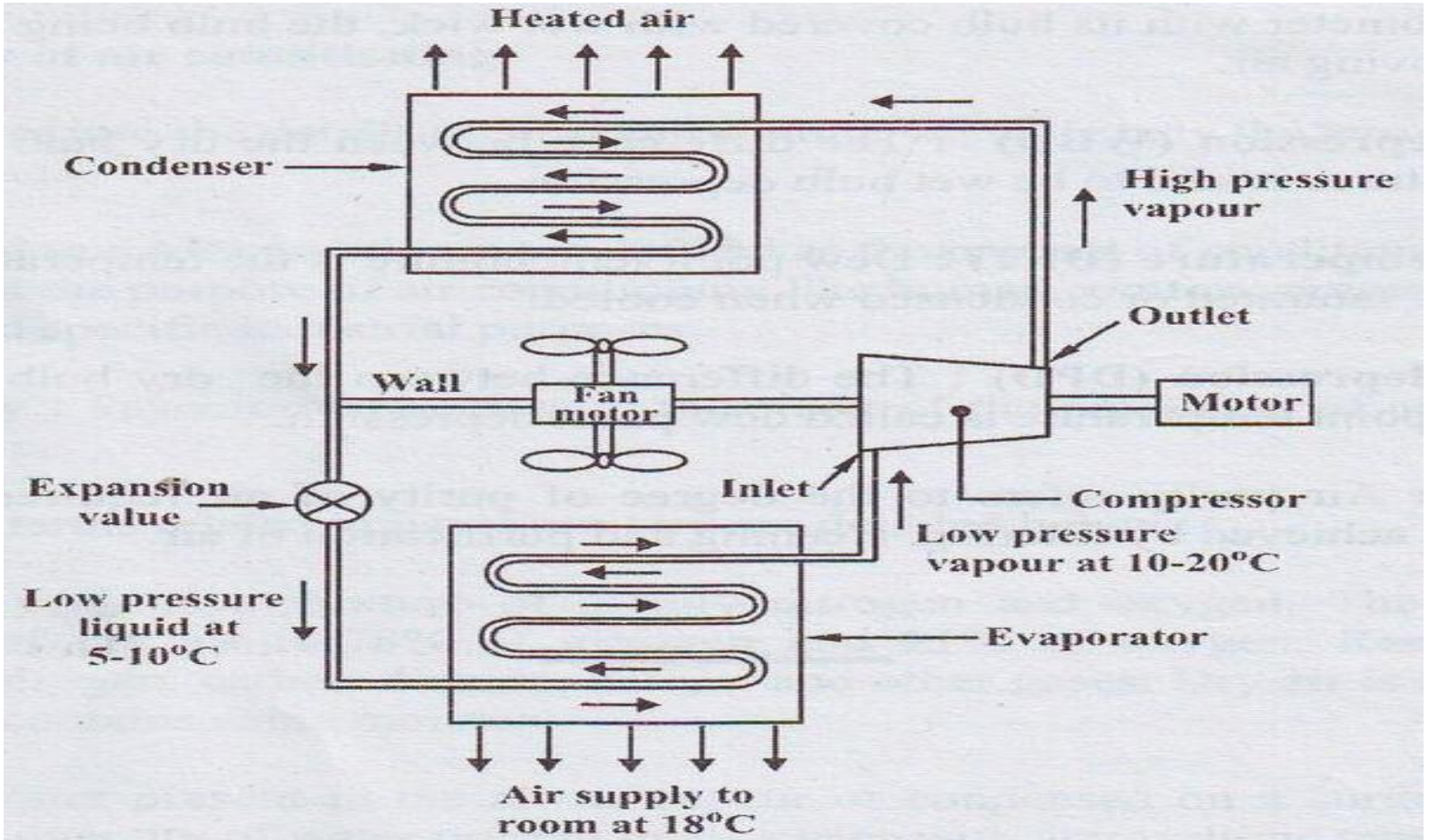
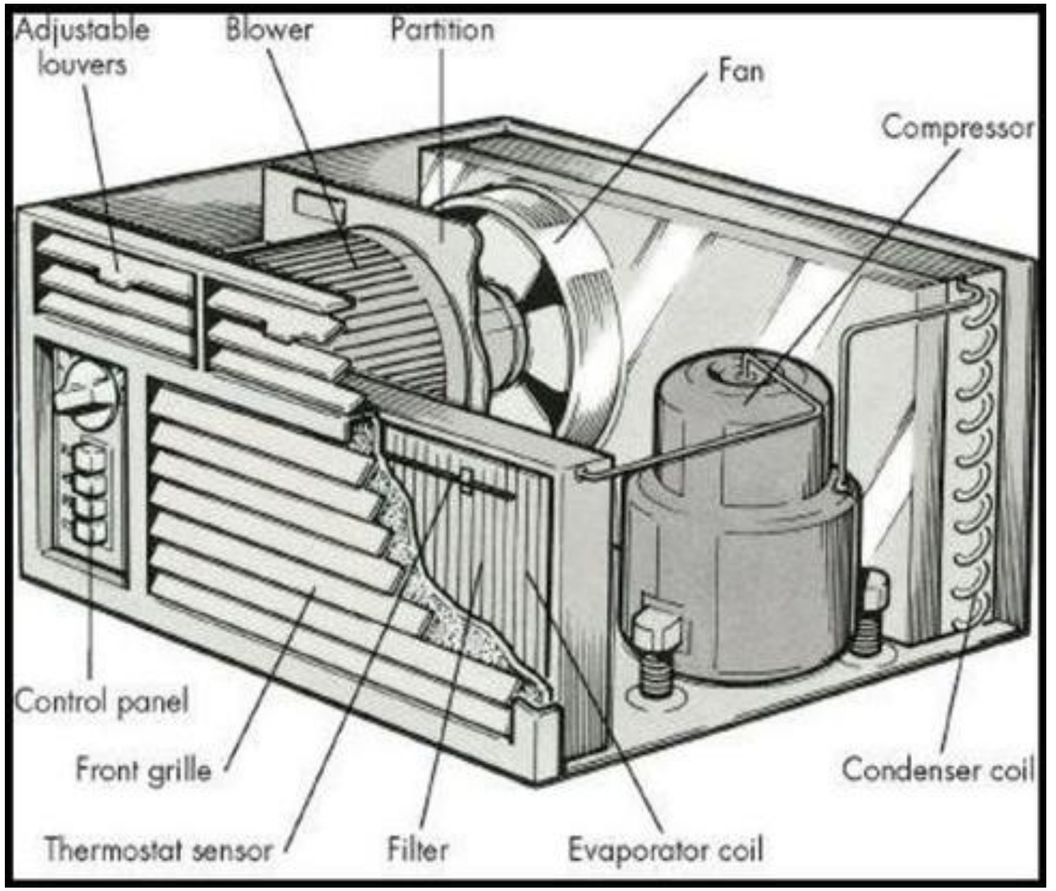
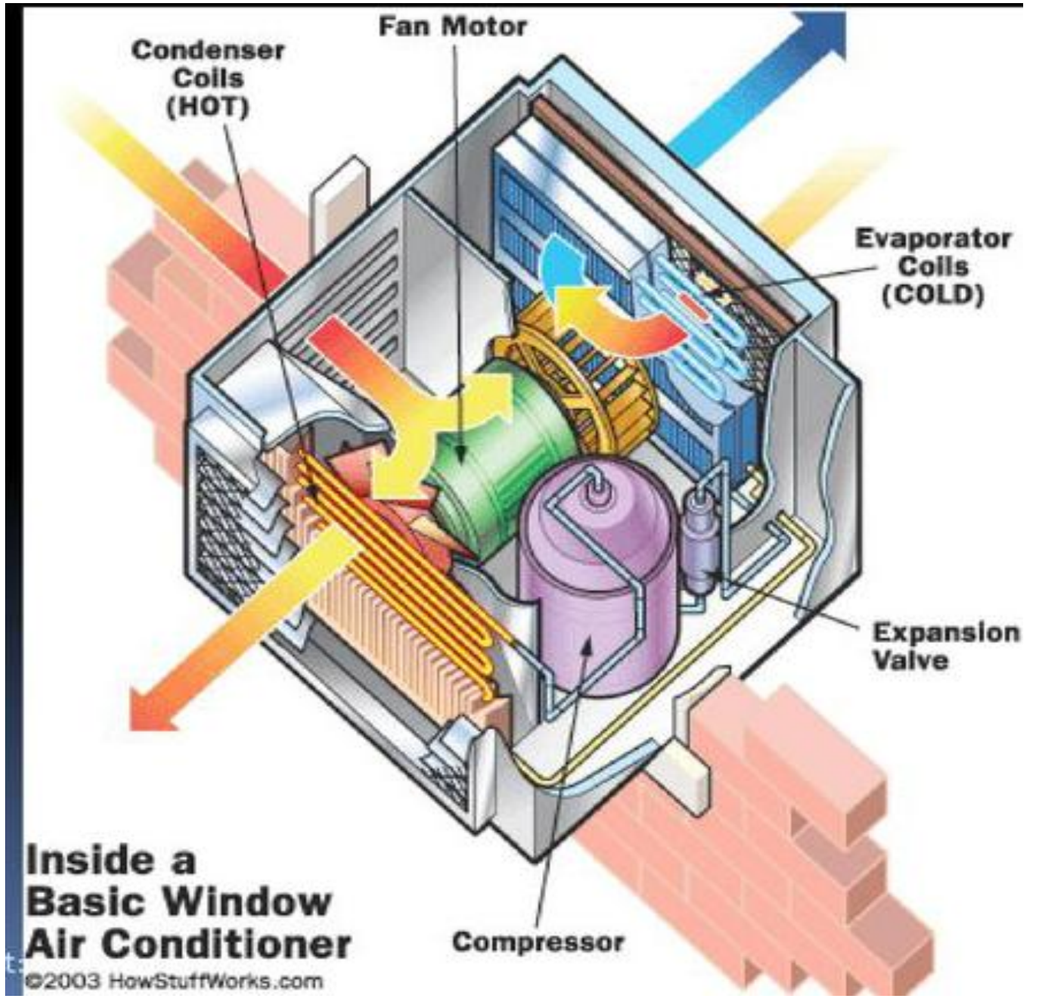


Fig.1 Window room air conditioner

Window Type Air Conditioner





Window Type Air Conditioner - Working

- The low pressure vapour refigerant from the evaporator is sucked by compressor through the open inlet valve.
- The compressor compresses the vapour refrigerant.
- The high pressure and high temperature vapour refrigerant then flows to the condenser through the open outlet valve.
- In the condenser, the outside atmospheric temperature in summer being around 42° C, air is circulated by fan.
- After condensation, the high pressure liquid refrigerant formed passes through an expansion valve which reduces its pressure

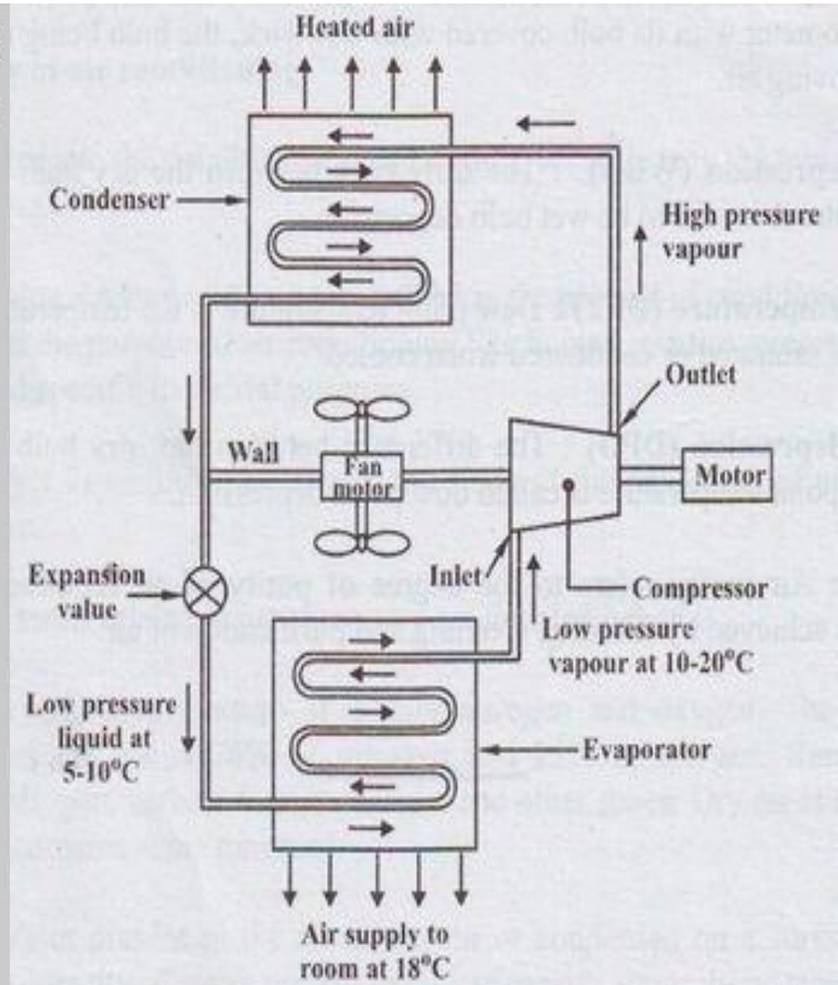


Fig.1 Window room air conditioner

Window Type Air Conditioner - Working

- The low pressure refrigerant then enters the evaporator and evaporates, thus absorbing latent heat of vapourisation from the room air.
- The equipment which is used for evaporating the refrigerant is called evaporator.
- After evaporation, the refrigerant becomes vapour.
- The low pressure vapour is again passed to the compressor. Thus the cycle is repeated.
- A partition separates high temperature side of condenser, compressor and low temperature side of evaporator

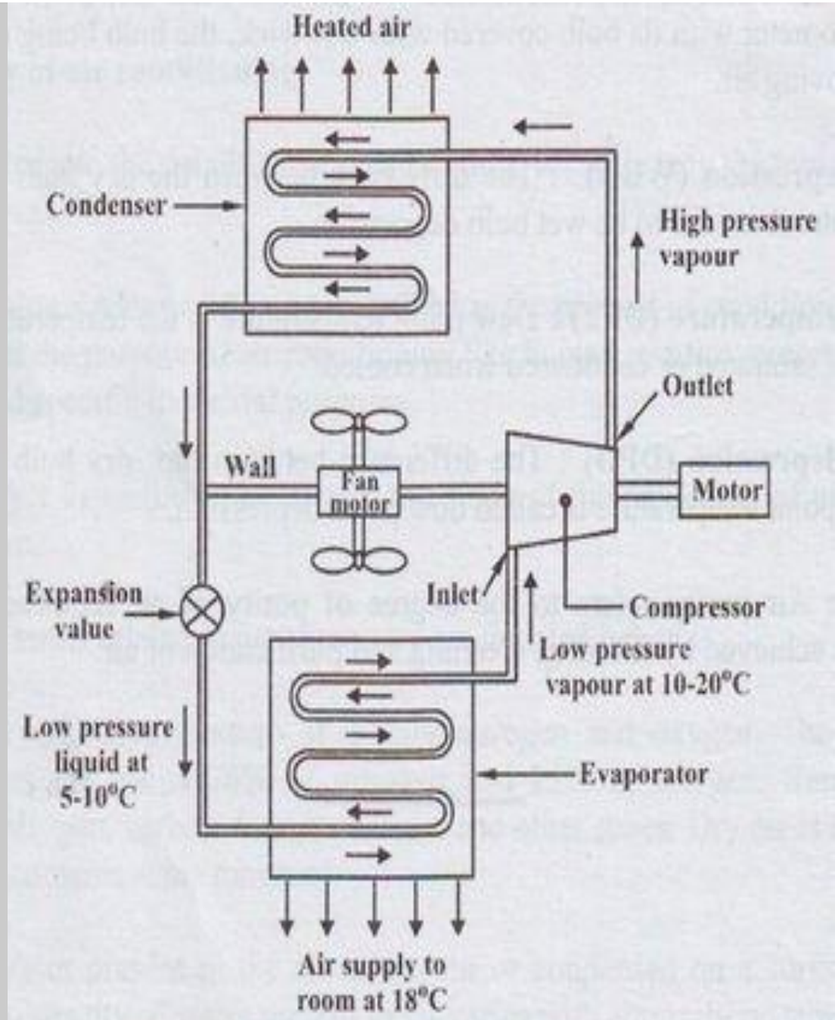


Fig.1 Window room air conditioner

Window Type Air Conditioner - Working

- The quantity of air circulated can be controlled by the dampers.
- The moisture in the air passing over the evaporator coil is dehumidified and drip into the trays.
- The unit automatically stops when the required temperature is reached in the room. This is accomplished by the thermostat and control panel.
- Generally, the refrigerant monochloro difluro methane ($CHCLF_2$) is used in air conditioner. It is called Freon 22.

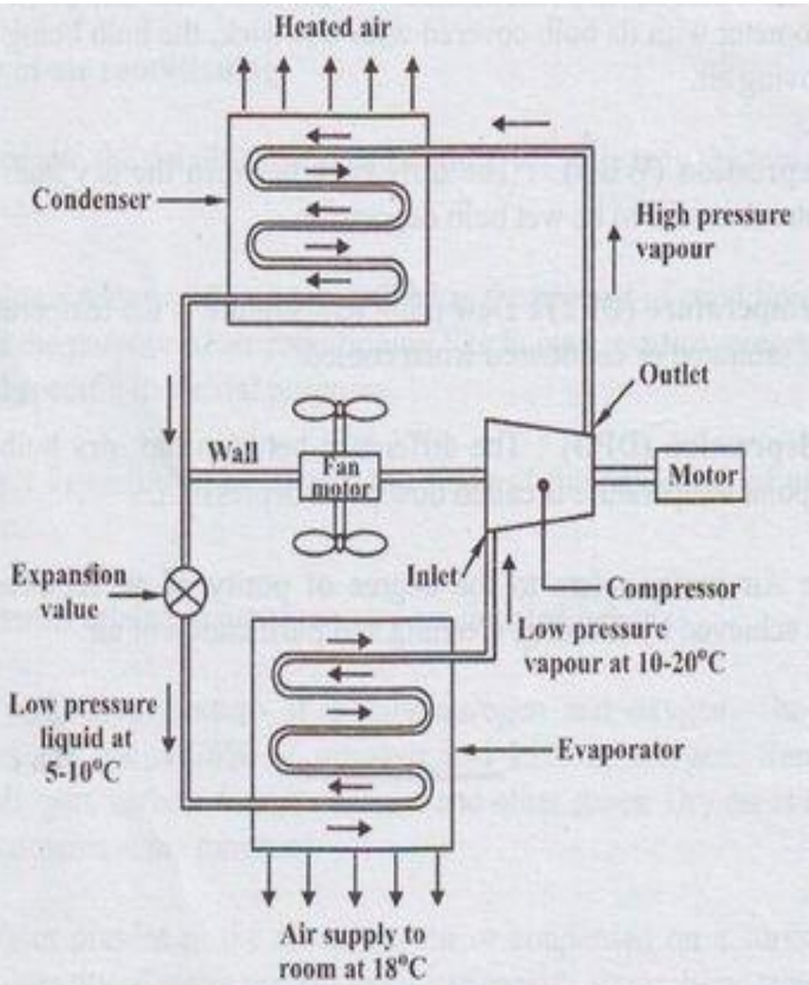


Fig.1 Window room air conditioner

Merits and Demerits of Window type air conditioner

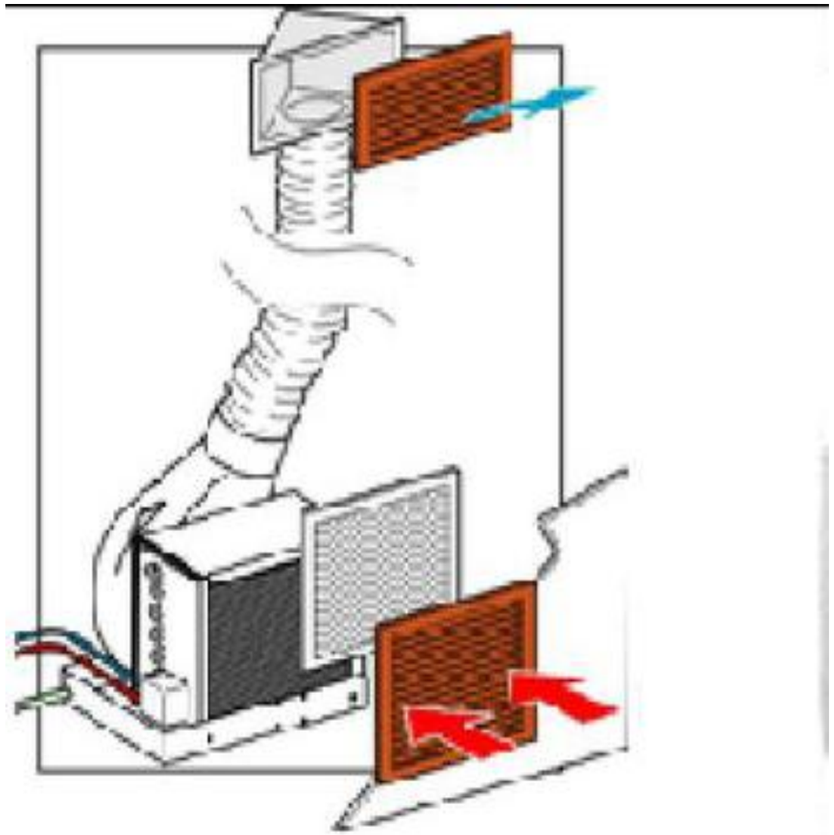
Merits :

- A separate temperature control is provided in each room.
- Ducts are not required for distribution.
- Cost is less.
- Skilled technician is required for installation.

Demerits:

- It makes noise.
- Large hole is made in the external wall or a large opening to be created in the window panel. This leads to insecurity to inmates.
- Air quantity cannot be varied.

Split Type Air Conditioner - Construction



Split Type Air Conditioner - Layout

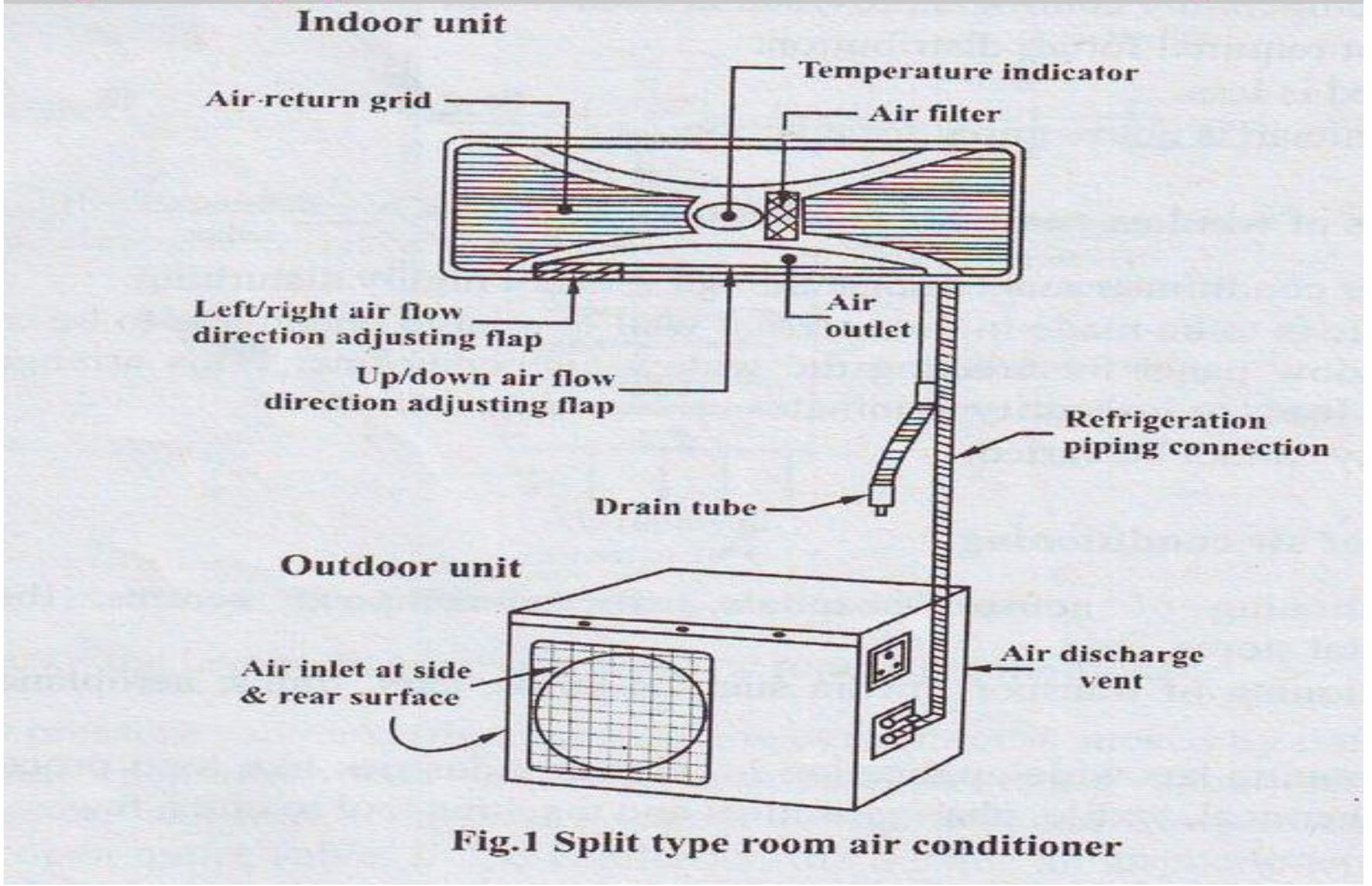
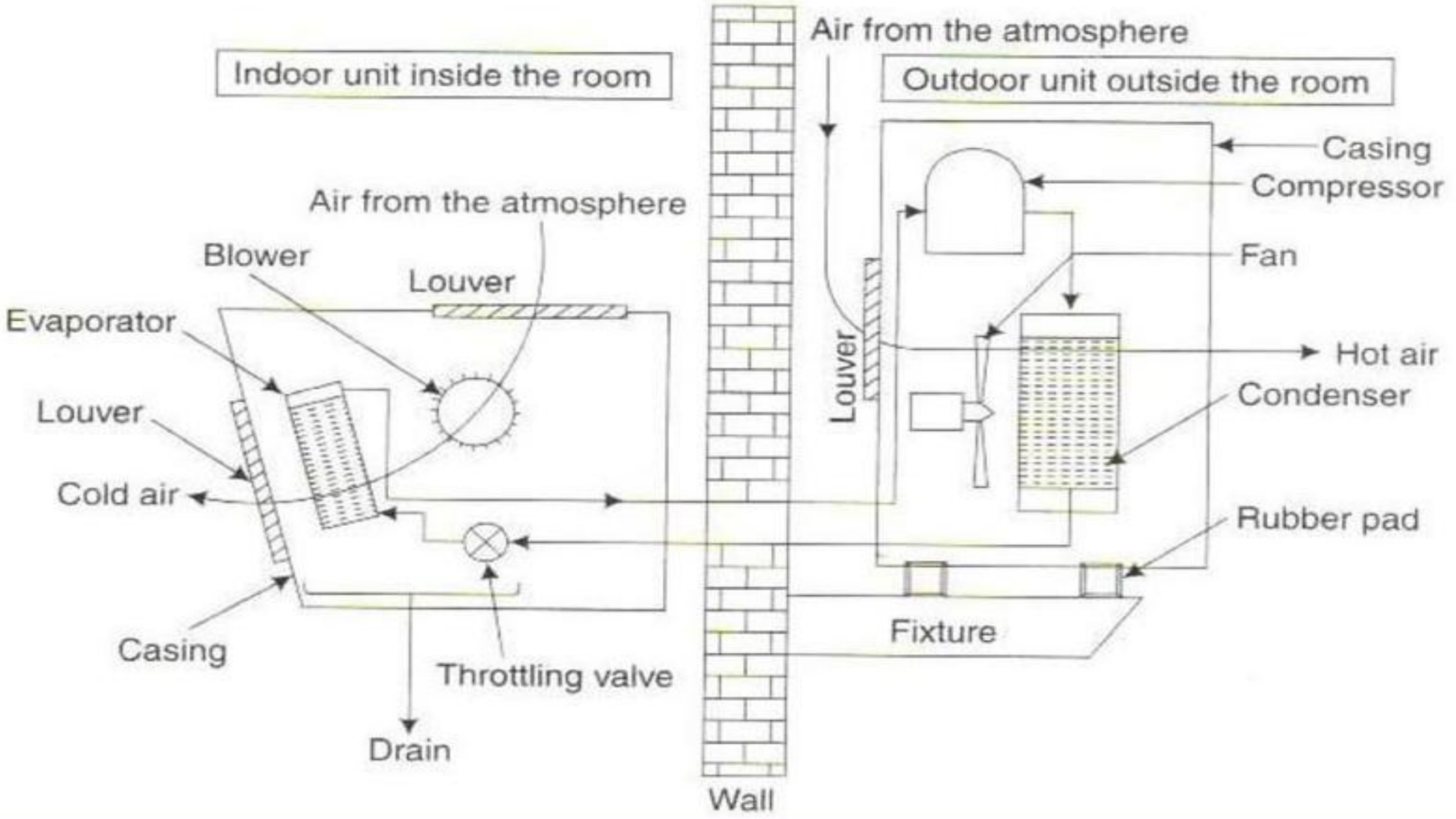


Fig.1 Split type room air conditioner

Split Type Air Conditioner - Layout



Split Type Air Conditioner - Layout

- In split air type air conditioner noise making components like compressor and condenser are mounted outside or away from room.
- Split type air conditioning system has two main components.

  (i) Outdoor Unit (ii) Indoor unit.

- The outdoor unit consists of compressor and condenser.
- The indoor unit consists of power cables, refrigerant tube and an evaporator mounted inside the room.

Split Type Air Conditioner - Working

- Compressor is used to compress the refrigerant.
- The refrigerant moves between the evaporator and condenser through the circuit of tubing and fins in the coils.
- The evaporator and condenser are usually made of coil of copper tubes and surrounded by aluminium fins.
- The liquid refrigerant coming from the condenser evaporates in the indoor evaporator coil.
- During this process the heat is removed from the indoor unit air and thus, the room is cooled.
- Air return grid takes in the indoor air.
- Water is dehumidified out of air is drained through the drain pipe.

Split Type Air Conditioner - Working

- The hot refrigerant vapour is passed to the compressor and then to the condenser where it becomes liquid.
- Thus the cycle is repeated.
- A thermostat is used to keep the room at a constant, comfortable temperature avoiding the frequent turning on off.

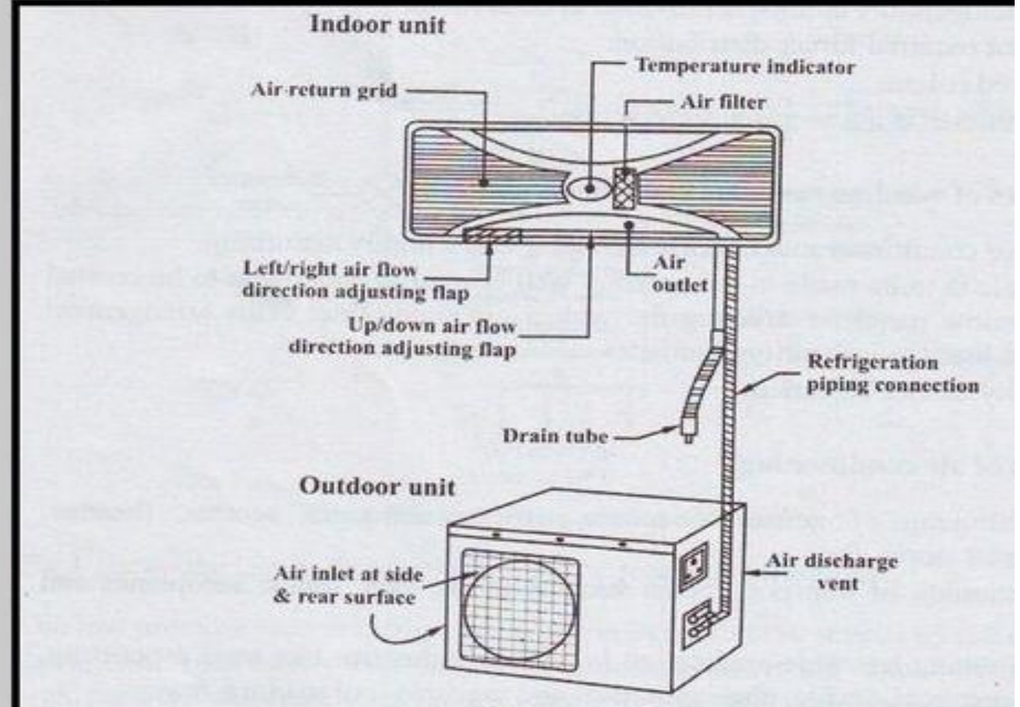


Fig.1 Split type room air conditioner

Fig.1 shows the layout diagram of a split type room air conditioner.

Merits and Demerits of Split type air conditioner

Merits :

- It is compact
- It is energy and money saving.
- Duct is not used.
- Easier to install.
- It is noiseless, because rotary air compressor used is, kept outside.
- It is more efficient and powerful.
- It has the flexibility for zoning.

Merits and Demerits of Split type air conditioner

DeMerits :

- Initial cost is higher than window air conditioner
- Skilled technician is required for installation.
- Each zone or room requires thermostat to control the air cooling.

Applications of air conditioning

- Used in houses, hospitals, offices, computer centres, theatres, departmental stores etc.,
- Air-conditioning of transport media such as buses, cars trains, aeroplanes and ships.
- Wide application in food processing, printing, chemical, pharmaceutical and machine tool, etc.,

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Thank you!

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