ARCHITECTURAL SCIENCE
(HVAC)

VENTILATION

The process of supplying air to any space within a building without noticeable odor and without objectionable levels of contaminants, such as dusts and harmful gases, and of removing stale, polluted air from the space. Outside air is generally used as an acceptable source of ventilation air.

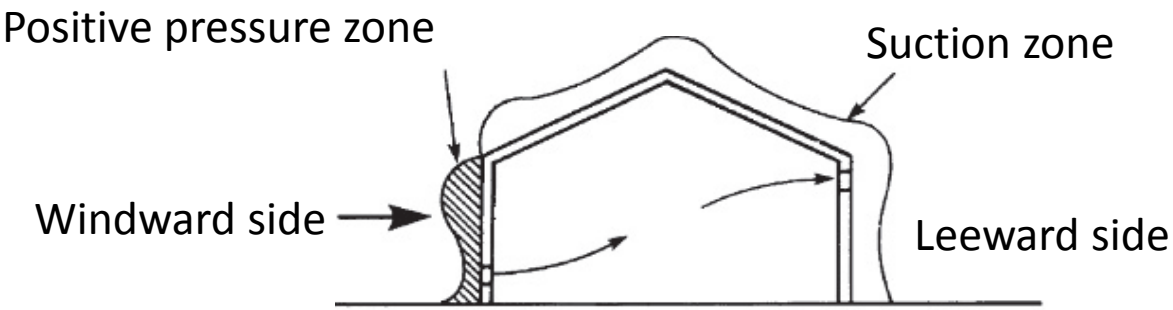
• Purpose of Ventilation

- Provide fresh air for respiration.
- Preserve the correct level of oxygen in the air.
- Control carbon dioxide content to no more than 0.1%.
  Concentrations above 2% are unacceptable as carbon dioxide is poisonous to humans and can be fatal.
- Control moisture relative humidity of 30% to 70% is acceptable.
- Remove excess heat from machinery, people, lighting, etc.
- Dispose of odours, smoke, dust and other atmospheric contaminants.
- Relieve stagnation and provide a sense of freshness.

- **Natural/Passive Ventilation** - is the ventilation of a building without the use of a fan or other mechanical system. It is an economic means of providing air changes in a building. It uses components integral with construction such as air bricks and louvers, or open able windows. Natural ventilation in buildings is caused by the temperature difference between the air in the building and the outside air and by openings in the outside walls or by a combination of both. The sources for natural ventilation are wind effect/pressure and stack effect/pressure.

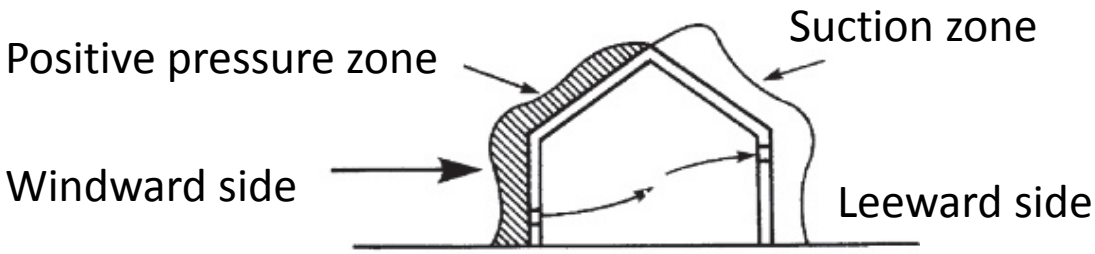
4 Basic Components of Natural Ventilation System

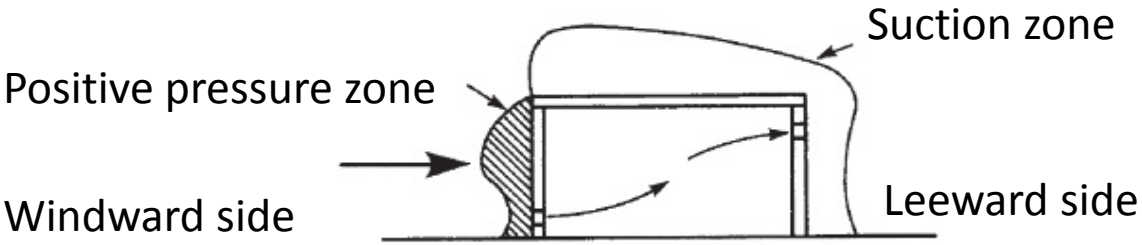
1. An air source of acceptable temperature, moisture content, and cleanliness
2. A force to move the air through the inhabited space of the building
3. A means of controlling the volume, velocity, and direction of the airflow
4. A means of recycling or disposing of contaminated air



Wind diagram for roofs with pitches up to 30 deg.

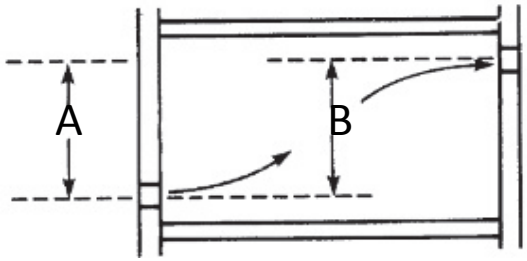
Wind diagram for roofs with pitches above 30 deg.



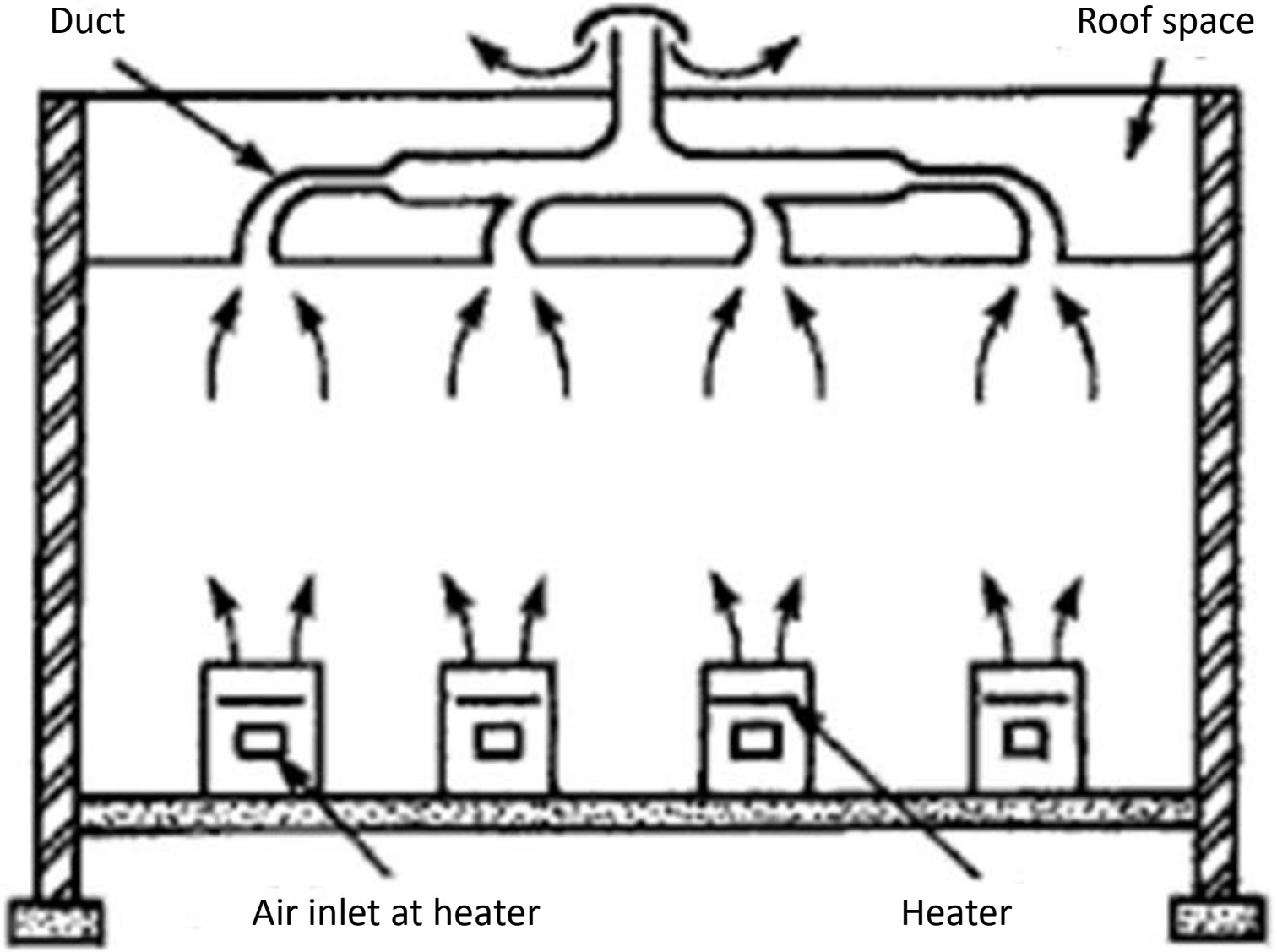


Wind pressure diagram for flat roofs

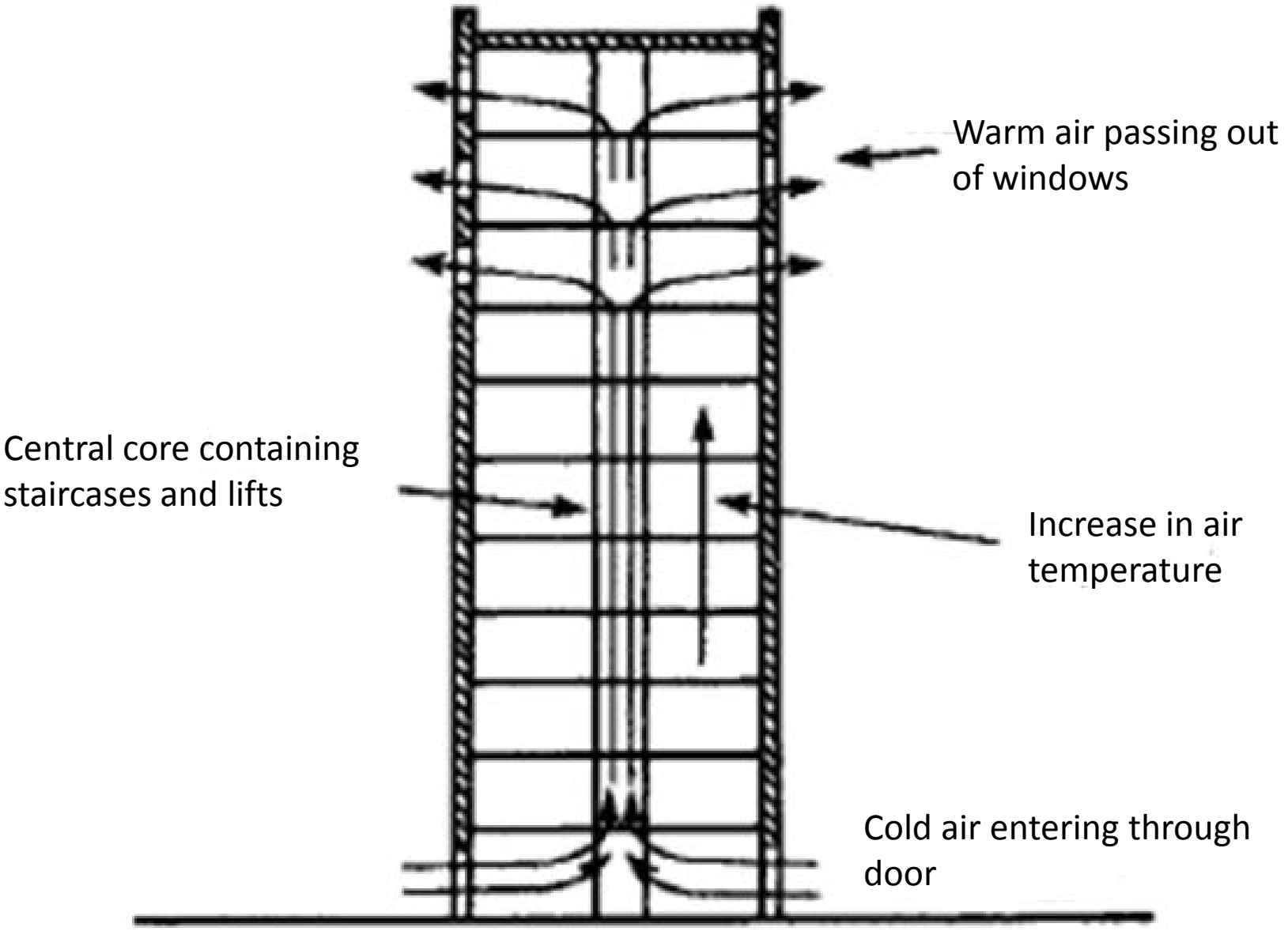
A and B are the heights of the cool and warm air stacks respectively



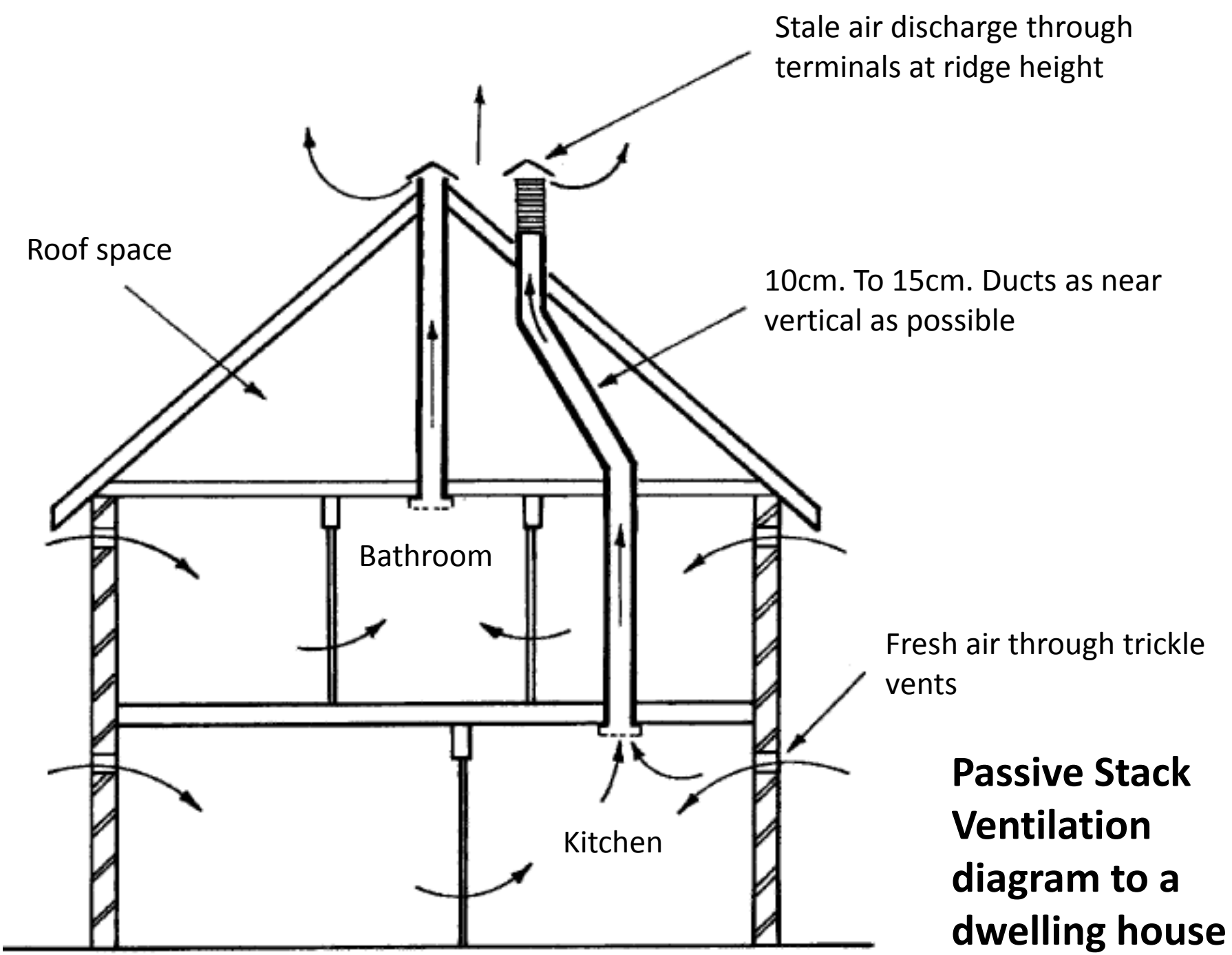
Stack pressure causing cross ventilation



Ventilation for an assembly hall by passing fresh air through heat emitters



Stack pressure in a tall building

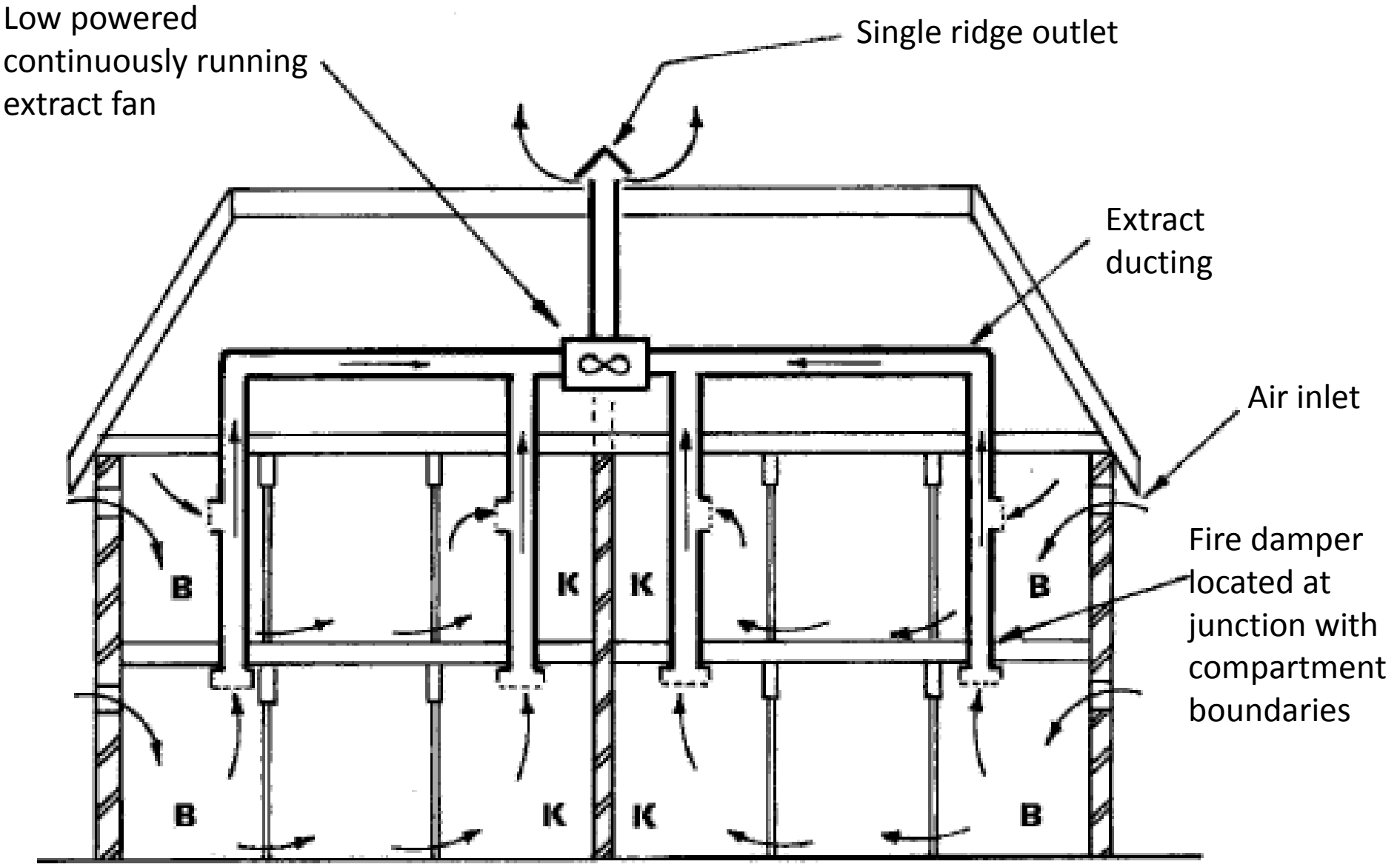


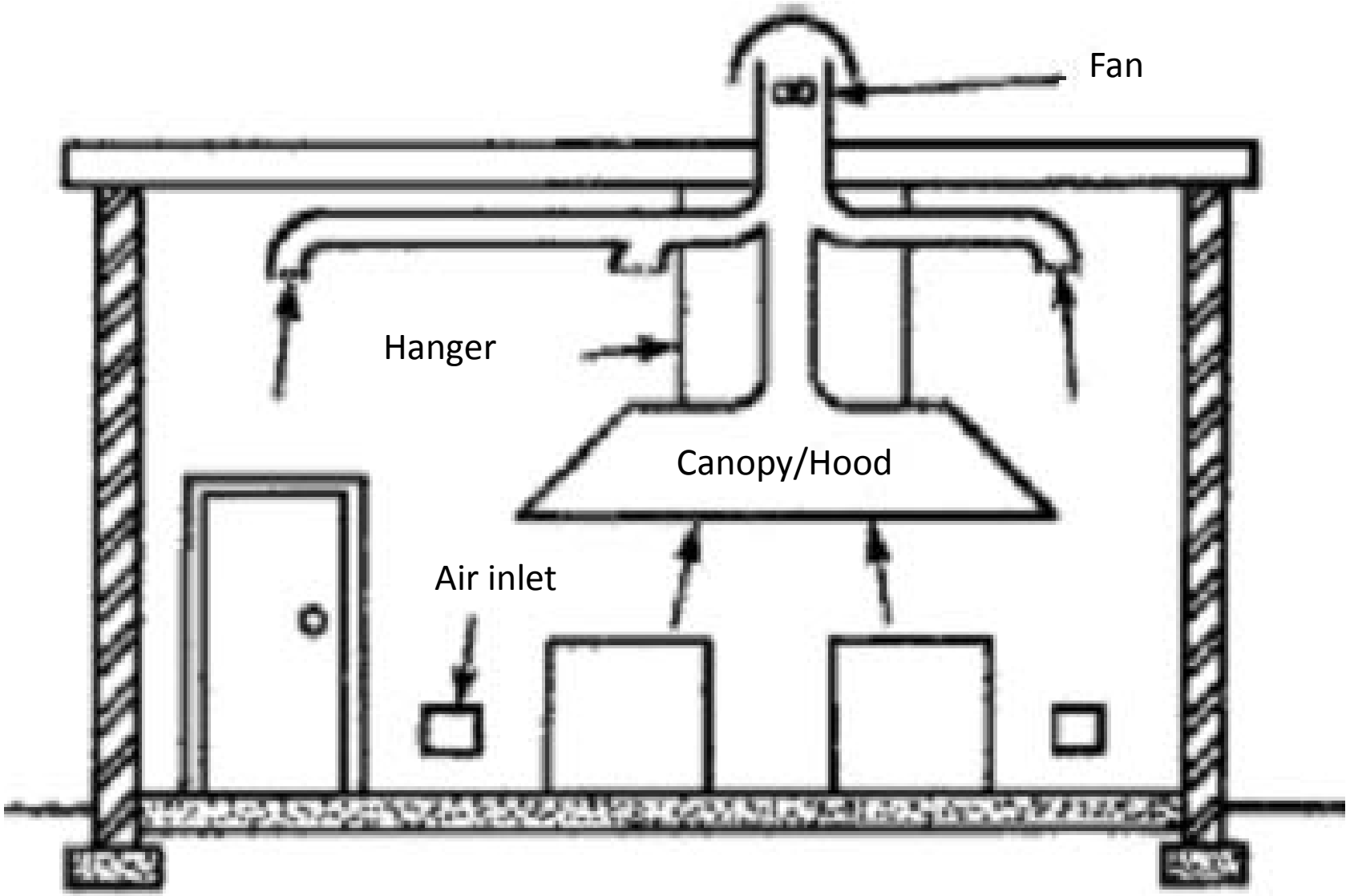
Passive Stack Ventilation diagram to a dwelling house


Non-power ventilator

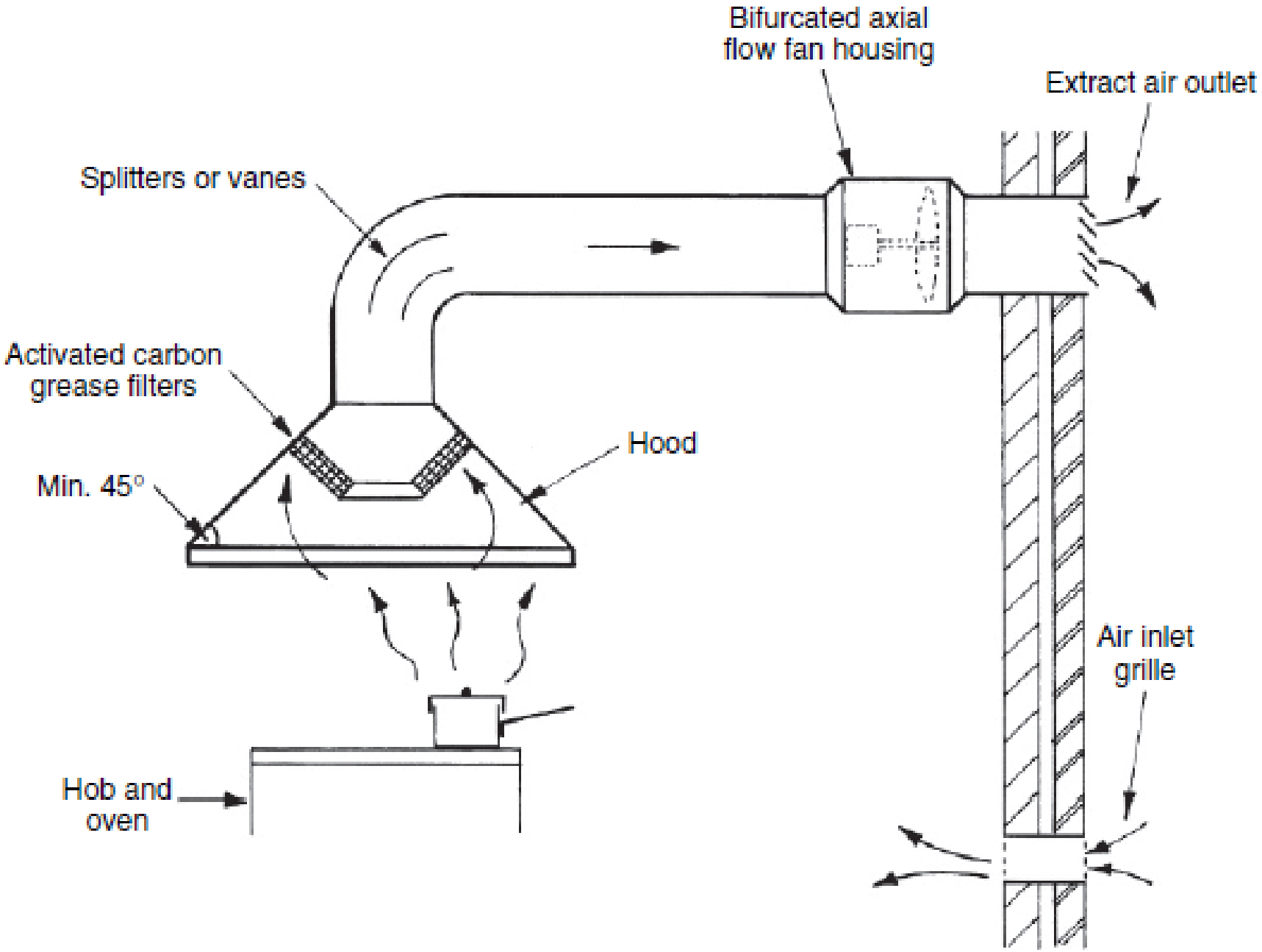

Shanghai TR Steel Building Products Co.,Ltd
Powered by DIYTrade.com

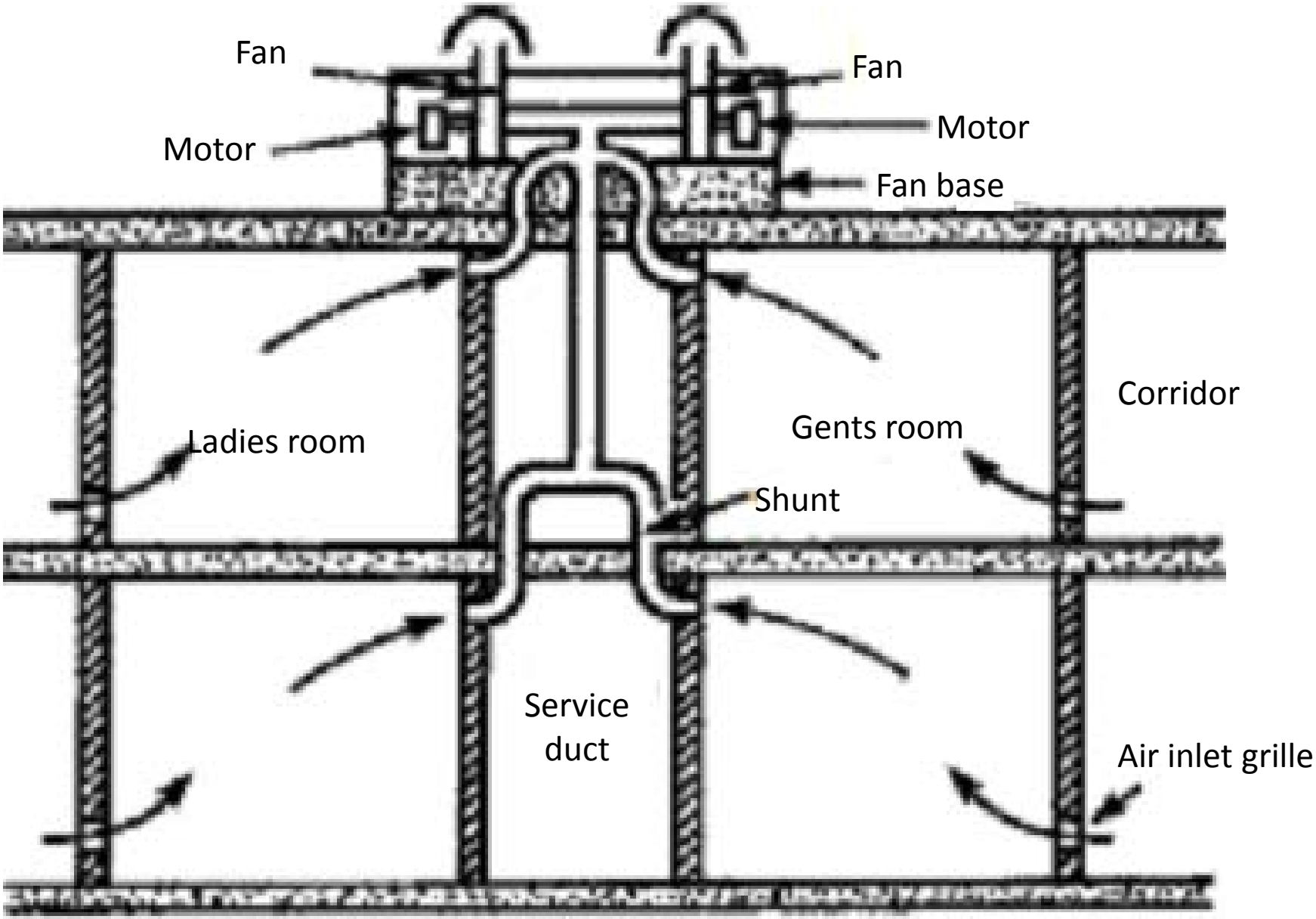
- **Mechanical Ventilation – is a ventilation of a building** through an **air handling unit** or direct injection to a space by a fan. A local exhaust fan can enhance infiltration or natural ventilation, thus increasing the ventilation air flow rate.


Low powered continuously running extract fan
Single ridge outlet
Extract ducting
Air inlet
Fire damper located at junction with compartment boundaries
B
K
K
B
B
K
K
B

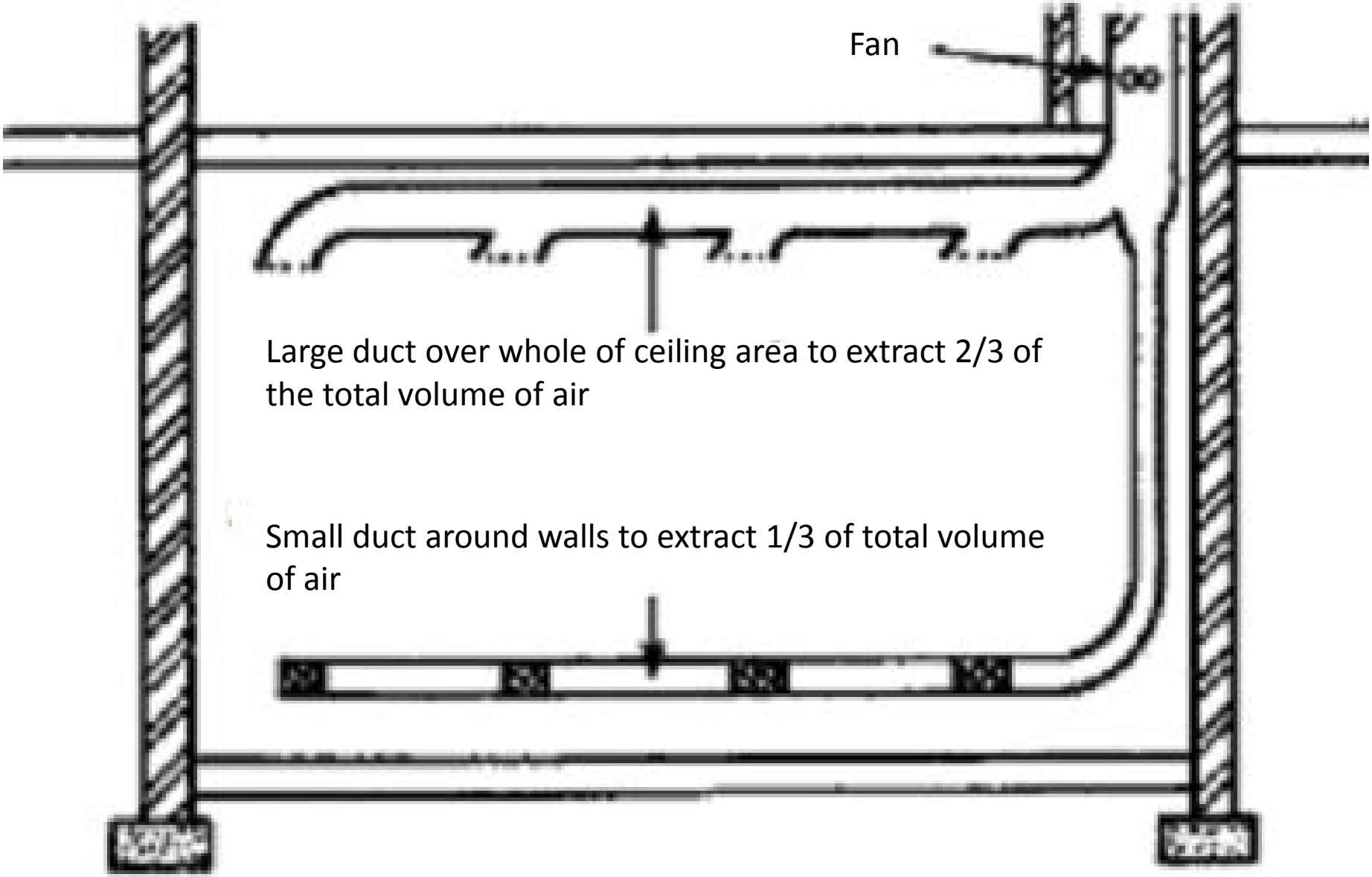


Kitchen

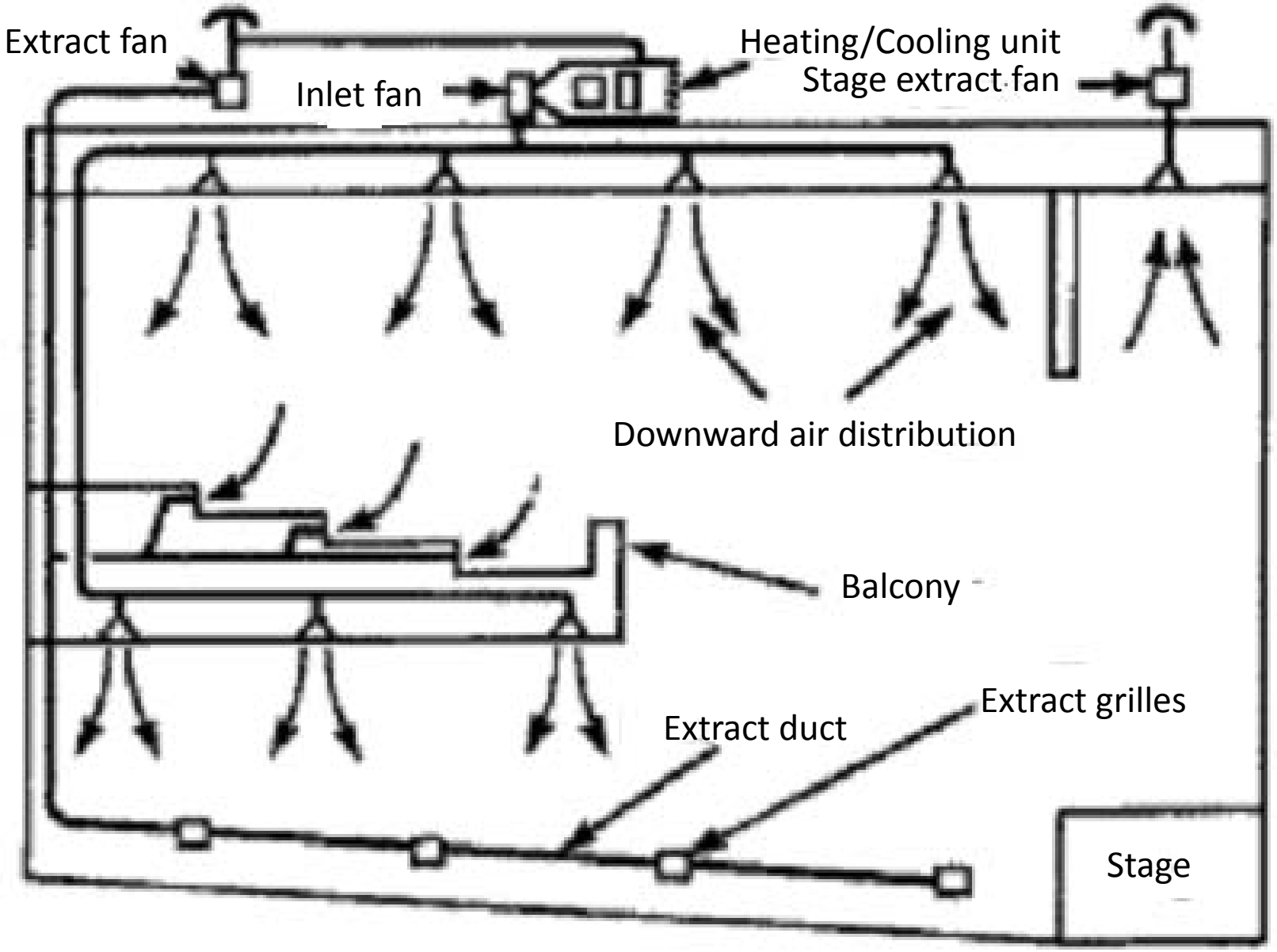

Bifurcated axial
flow fan housing
Extract air outlet
Splitters or vanes
Activated carbon
grease filters
Hood
Min. 45°
Air inlet
grille
Hob and
oven



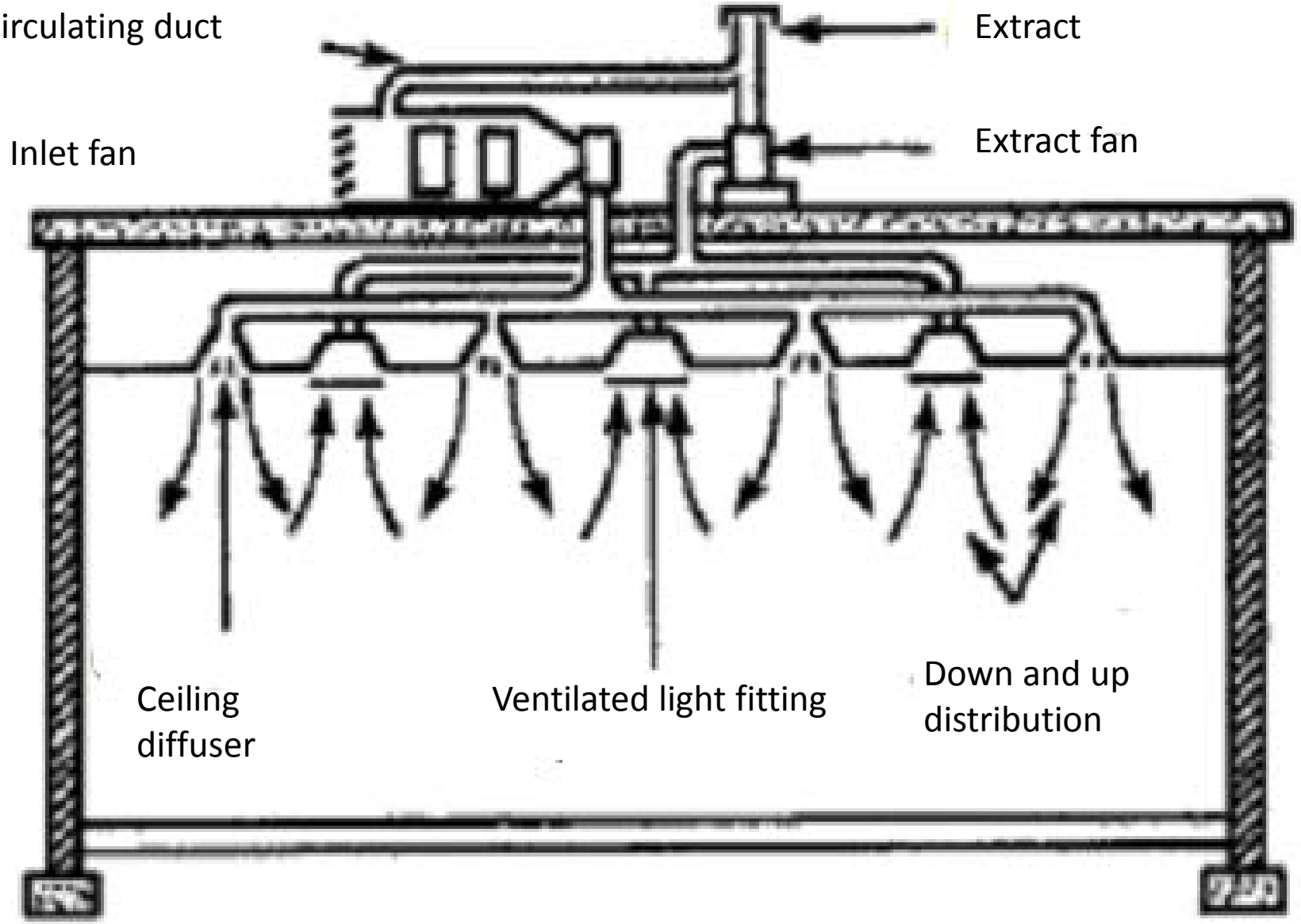
Internal sanitary accommodation



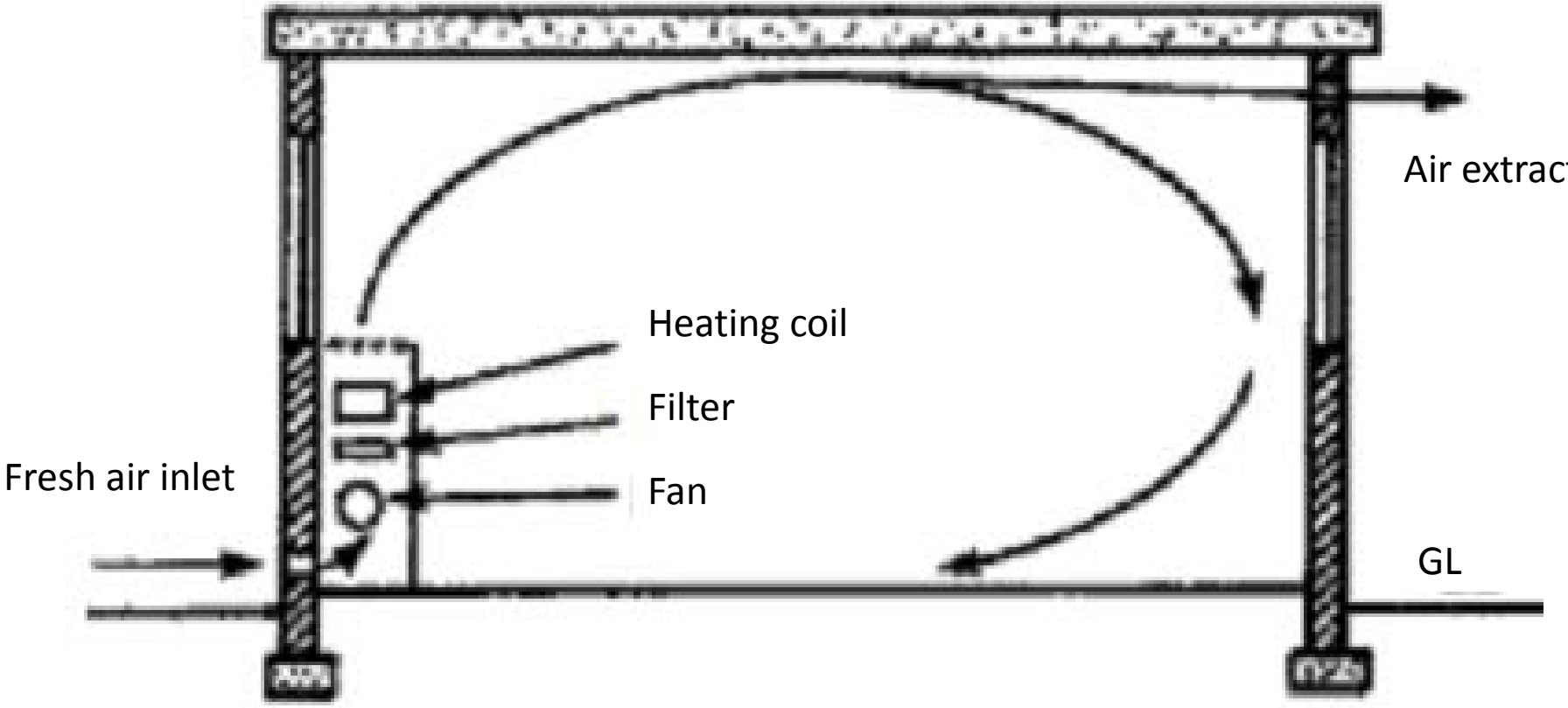
Car parking (Basement)



Mechanical inlet and mechanical extract for theatre



Mechanical inlet and mechanical extract for an open plan space



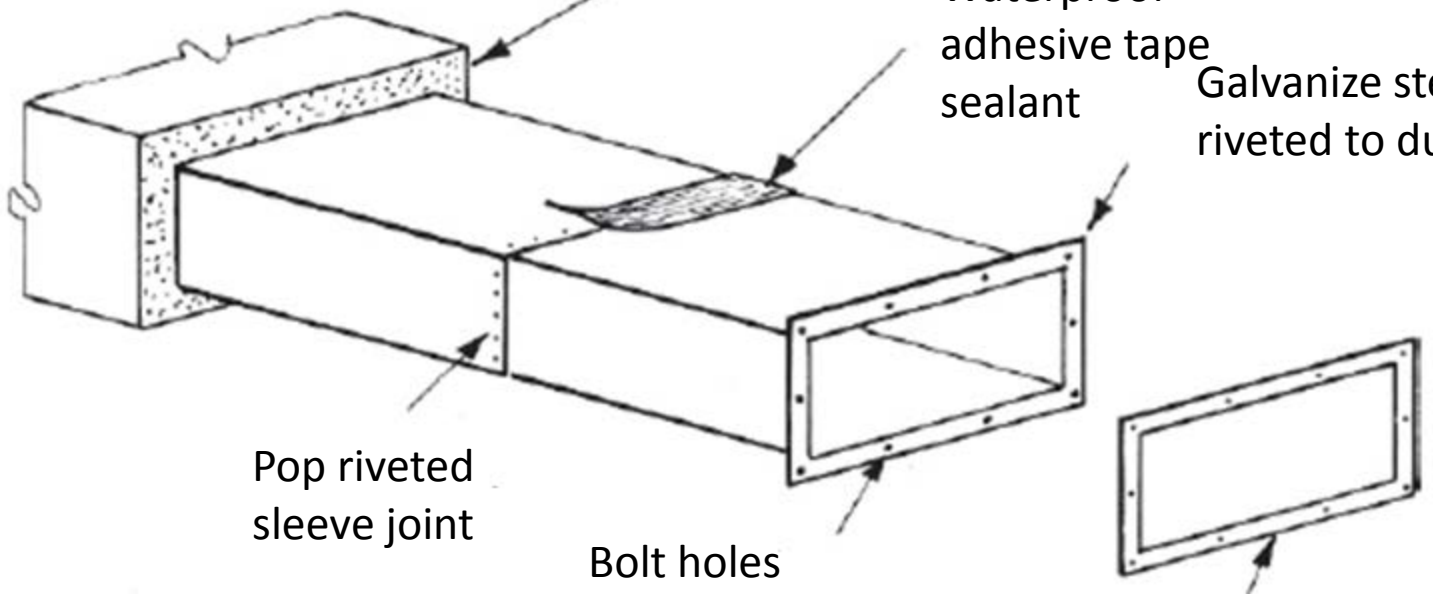
Mechanical inlet and natural extract

Square/Rectangular steel duct

Resin bonded glass fiber or other insulation

Waterproof adhesive tape sealant

Galvanize steel angle riveted to duct



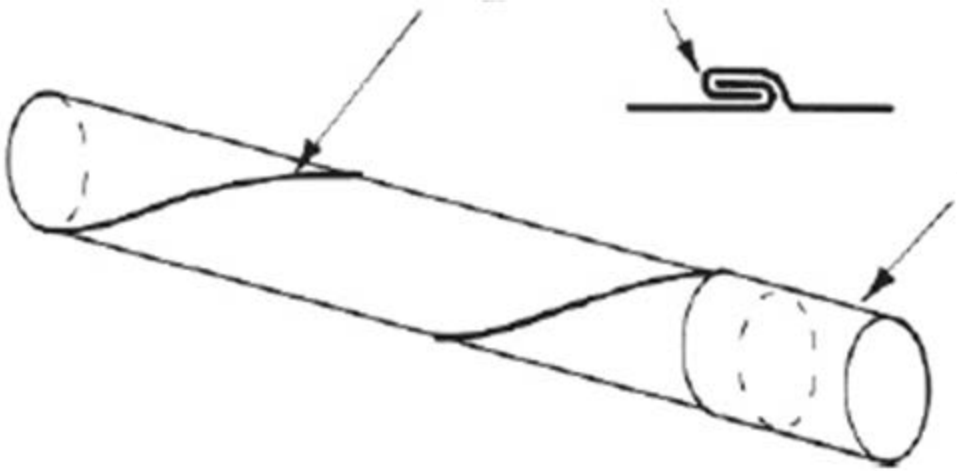
Pop riveted sleeve joint

Bolt holes

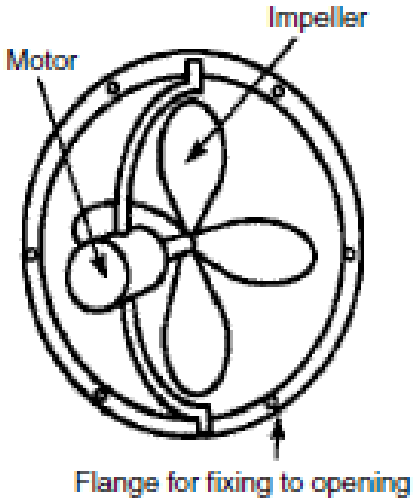
Rubber gasket between steel flanges

Circular spirally bounded steel duct

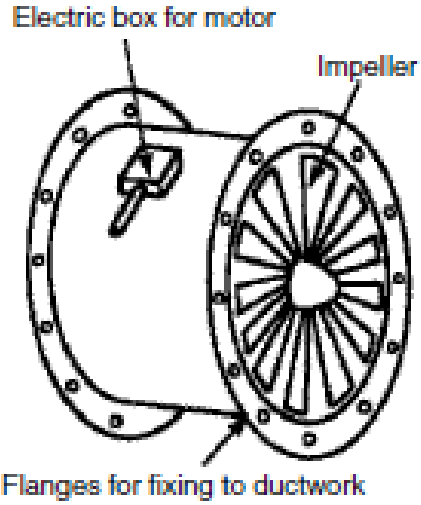
Continuous welt



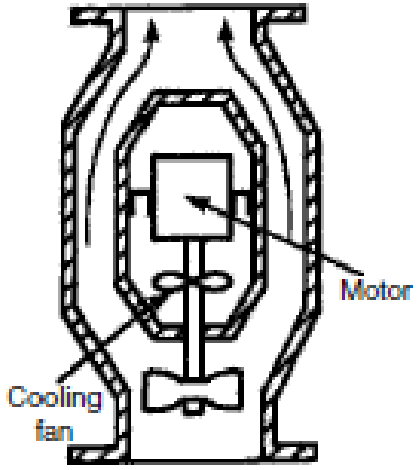
Taped sleeve socket joint or push fit self sealing joint



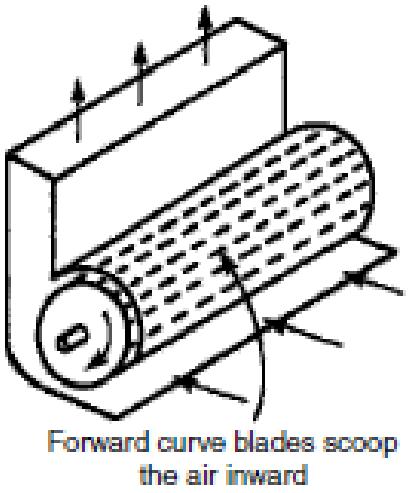
Propeller fan



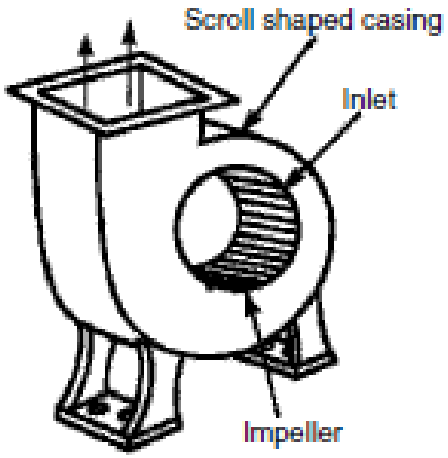
Axial flow fan



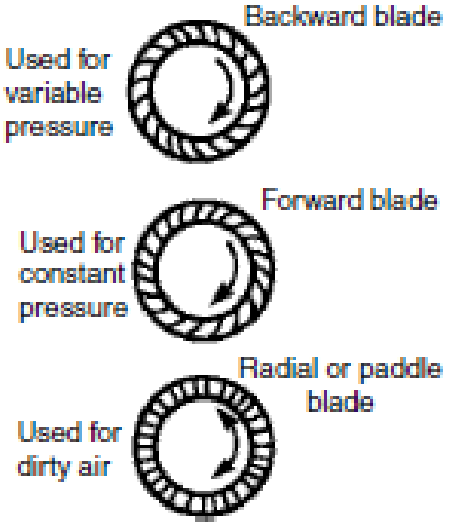
Bifurcated axial flow fan



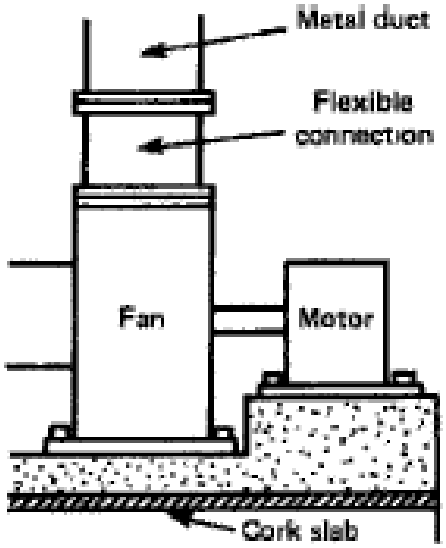
Cross-flow fan



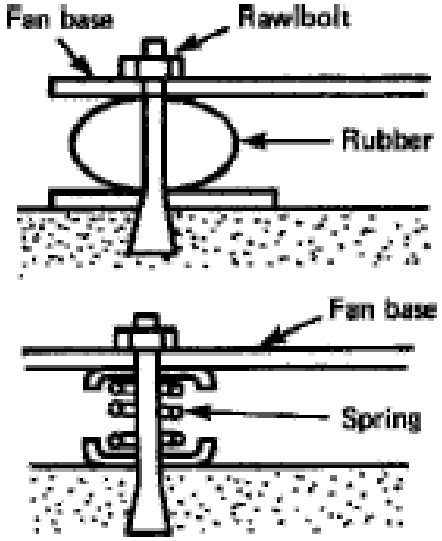
Centrifugal fan



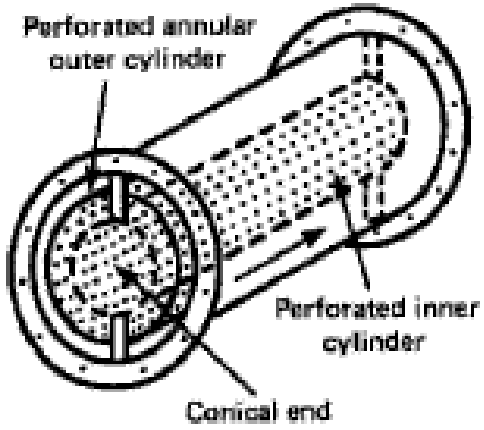
Types of impeller used with centrifugal fans



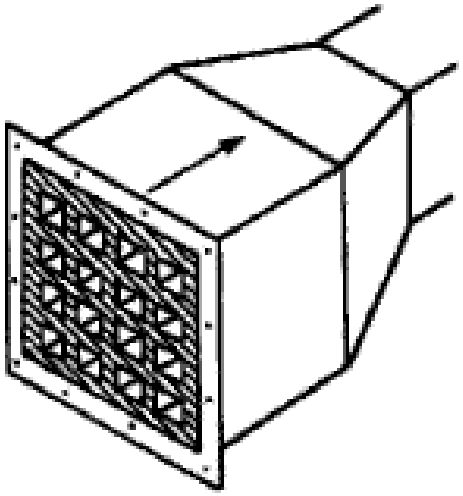
Use of cork slab and flexible connection



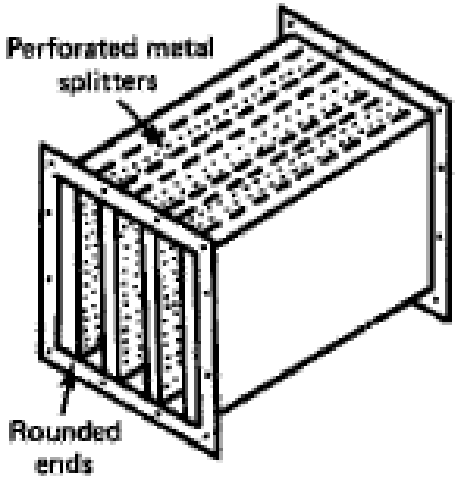
Use of rubber or spring mountings



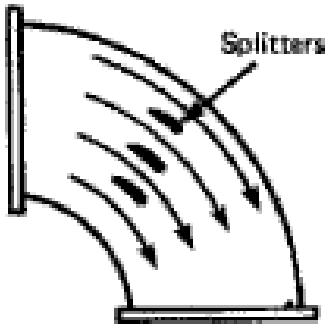
Use of perforated metal cylinder



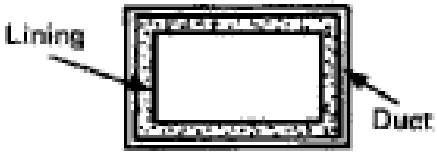
Use of acoustically absorbent honeycomb



Use of perforated metal splitters



Use of splitters to give streamline flow



Use of acoustically absorbent lining of mineral wool

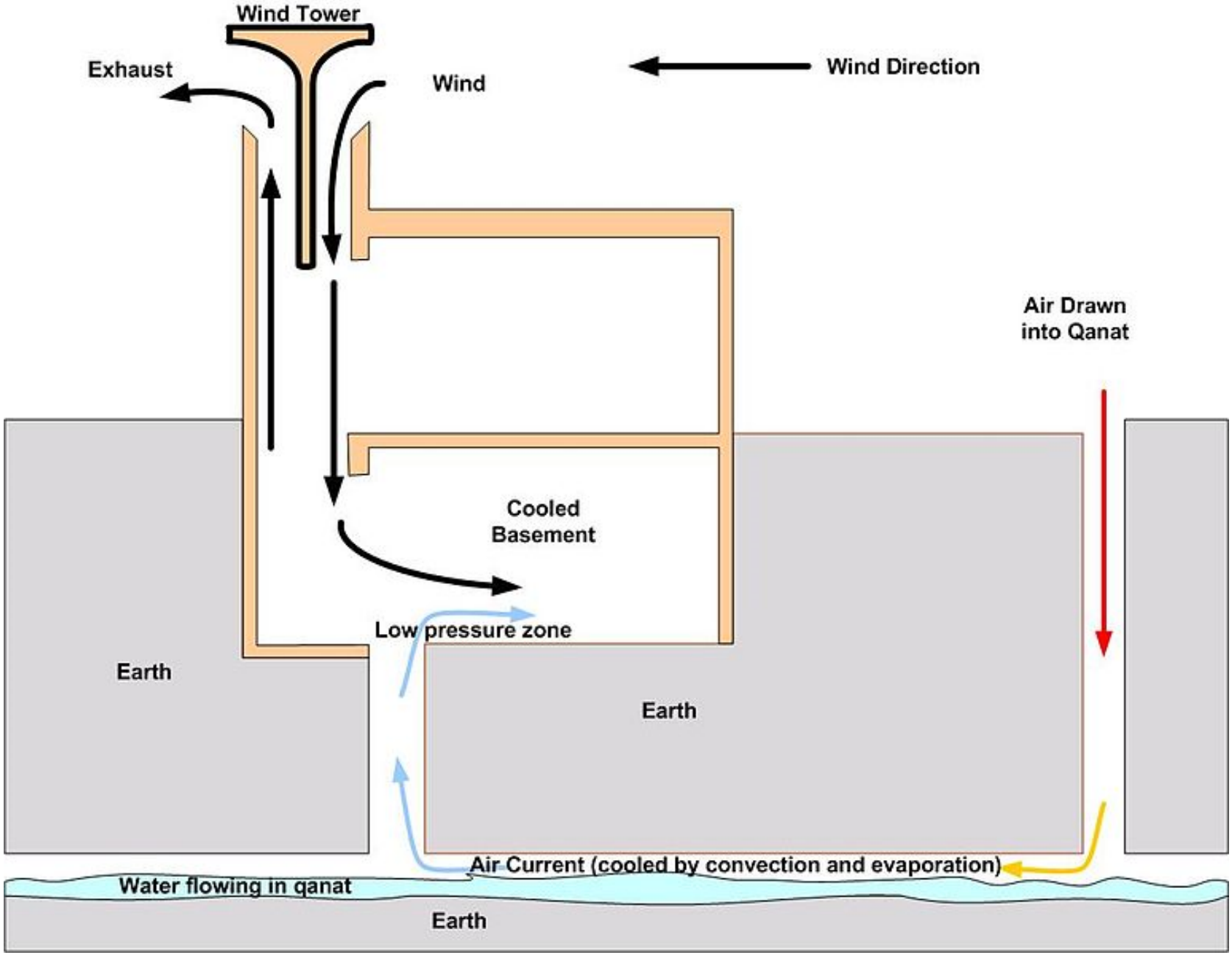
ARCHITECTURAL SCIENCE
(HVAC)

Cooling - **A heat-removal process usually accomplished with air-conditioning equipment.**

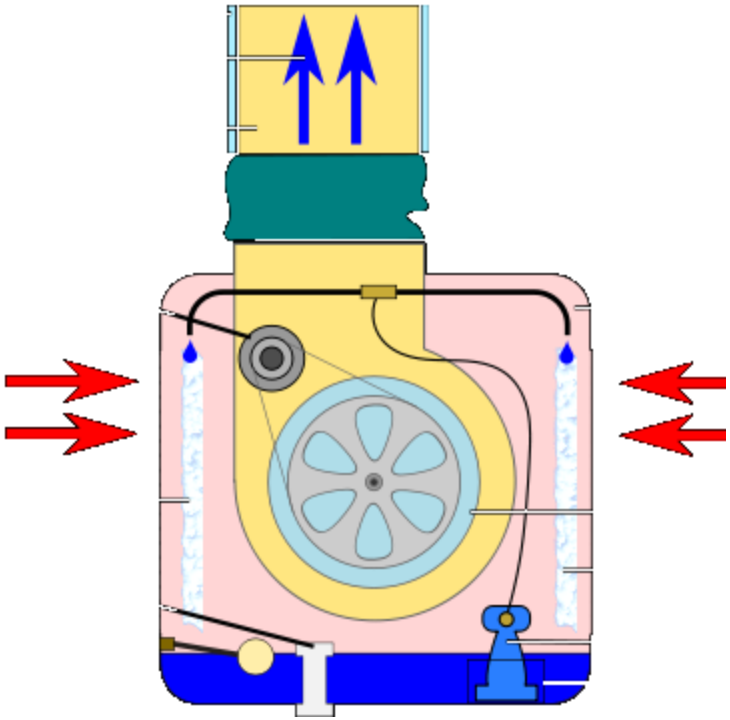
Types of Cooling System:

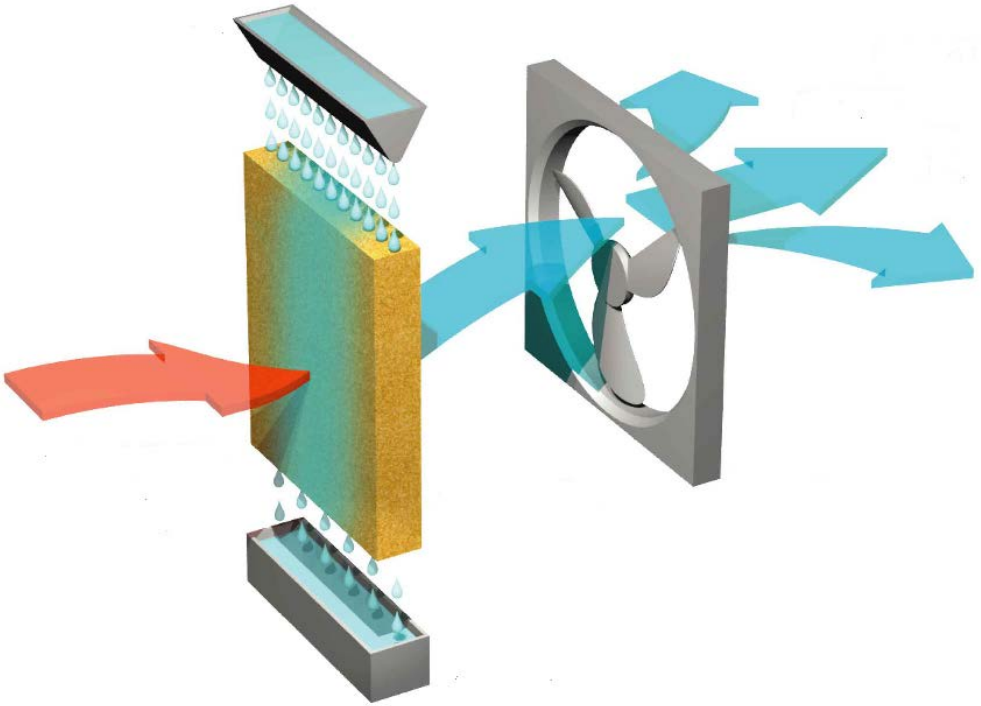
1. **Evaporative/Swamp Cooler**
2. **Compressive Refrigeration**
   - **2.1 Window AC**
   - **2.2 Split AC**
     - **2.2.1 DX System**
     - **2.2.2 Package Water Cooled System**
     - **2.2.3 Package Chilled Water System**
   - **2.3 Central AC System**

     Distribution Systems:
     - **2.3.1 All Air System**
     - **2.3.2 All Water System**
     - **2.3.3 Air Water System**
3. **Absorption Cooling**


Wind Tower
Exhaust
Wind
Wind Direction
Air Drawn into Qanat
Cooled Basement
Low pressure zone
Earth
Earth
Air Current (cooled by convection and evaporation)
Water flowing in qanat
Earth

1. **Evaporative/Swamp Cooler** - is a device that cools air through the evaporation of water. It draws inside/outside air through a wet pad, such as a large sponge soaked with water.






AirConditioning-Systems.com


AOLAN
EVAPORATIVE AIR COOLER
TradeTT.com


oolingpad.

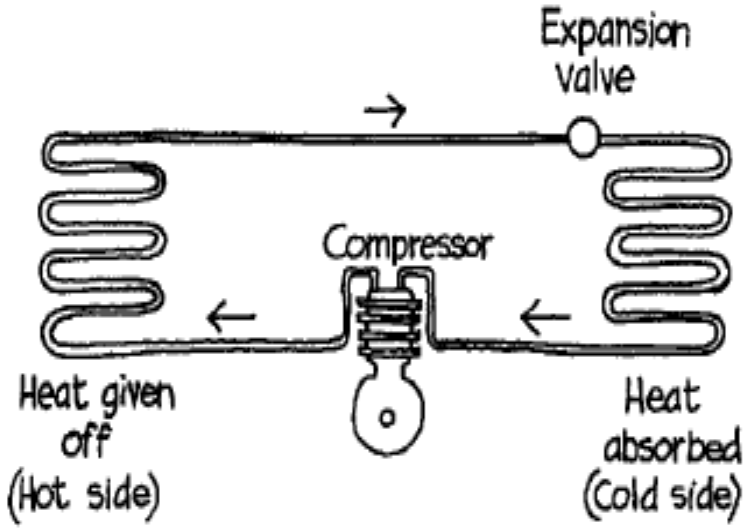
- **Misting fans**

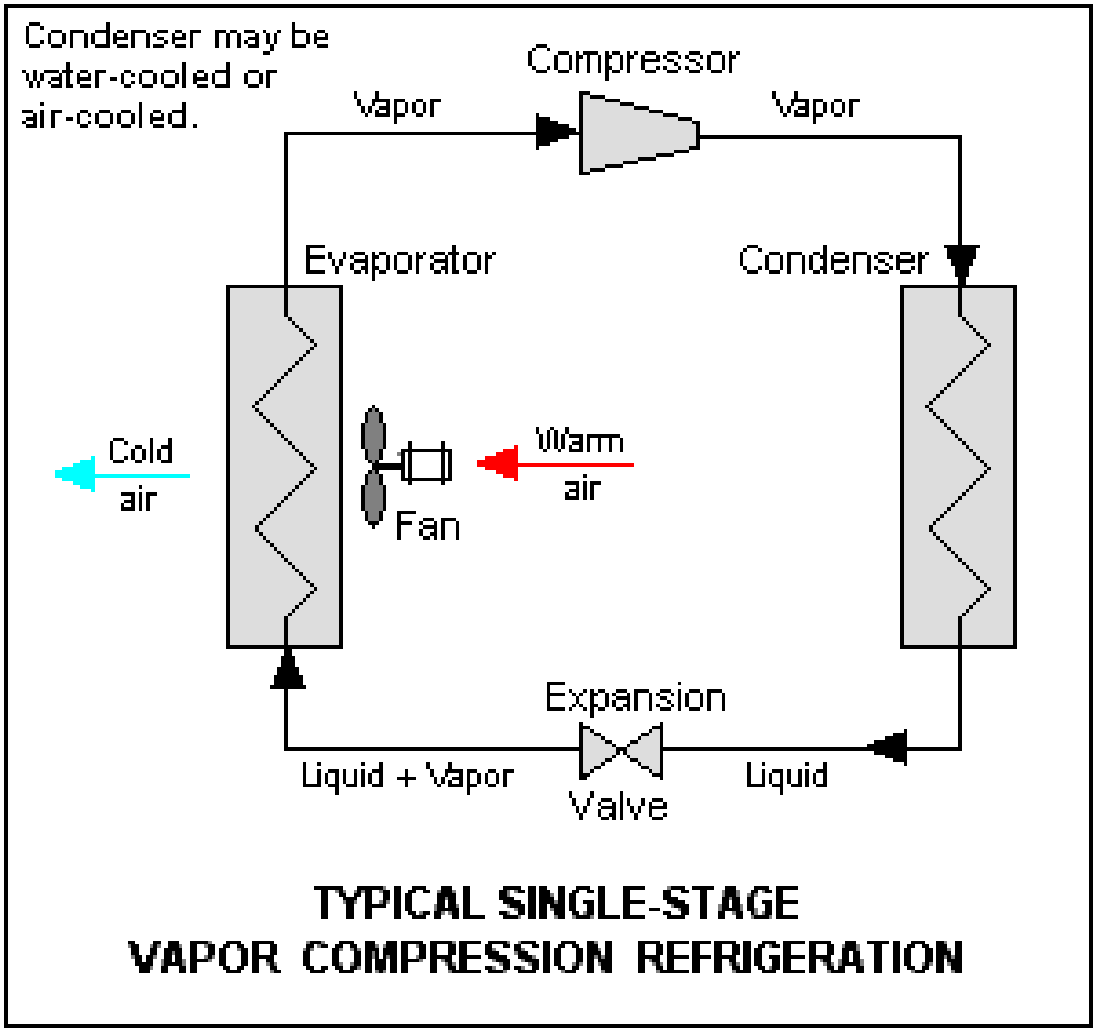
A misting fan is similar to a humidifier. A fan blows a fine mist of water into the air. If the air is not too humid, the water evaporates, absorbing heat from the air, allowing the misting fan to also work as an air cooler. A misting fan may be used outdoors, especially in a dry climate.

Misting Fans

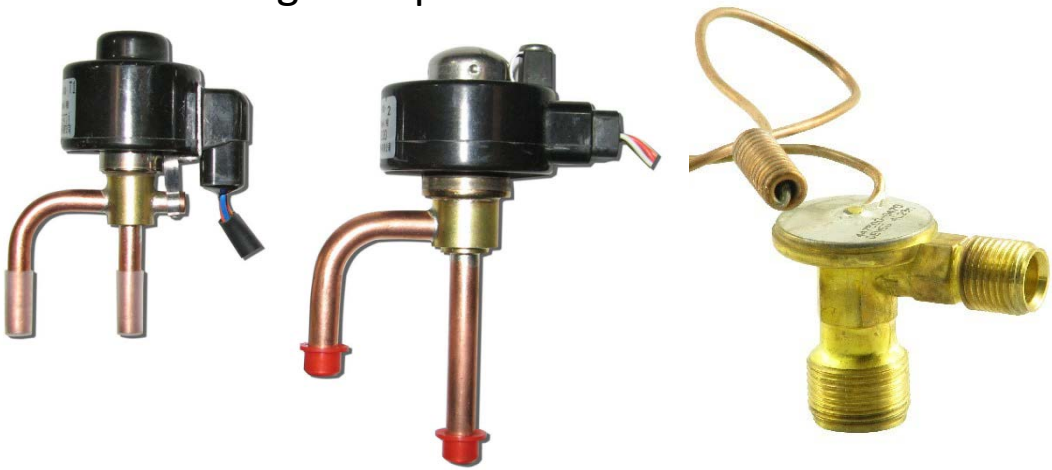
- **Compressive Refrigeration** – is a process in which cooling is affected by vaporization and expansion of liquid refrigerant.
- Basic Parts of Compressive Refrigeration System:

1. Compressor
2. Expansion valve
3. Evaporator
4. Condenser
5. Fan/Blower
6. Tubes/Pipes
7. Thermostat





Compressor squeezes the vapor into a smaller volume at high temperature.



Expansion Valve is a devices used to control the refrigerant flow in a refrigeration system.


greatcool.en.ahbab.com


SHANGHAI MELUCK
ZHEJIANG BINGFENG

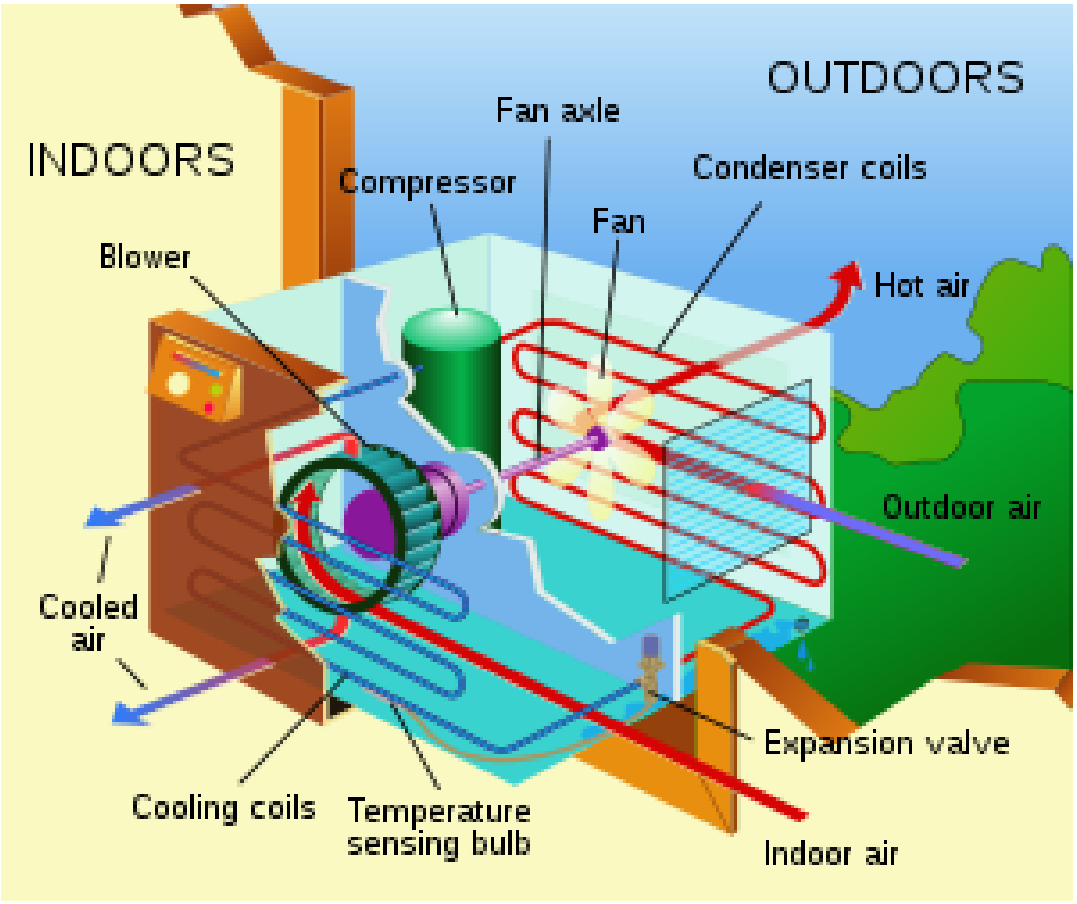

zjkaidi.en.alibaba.com

Thermostat is a component of a control system which senses the temperature of a system so that the system's temperature is maintained near a desired set point.

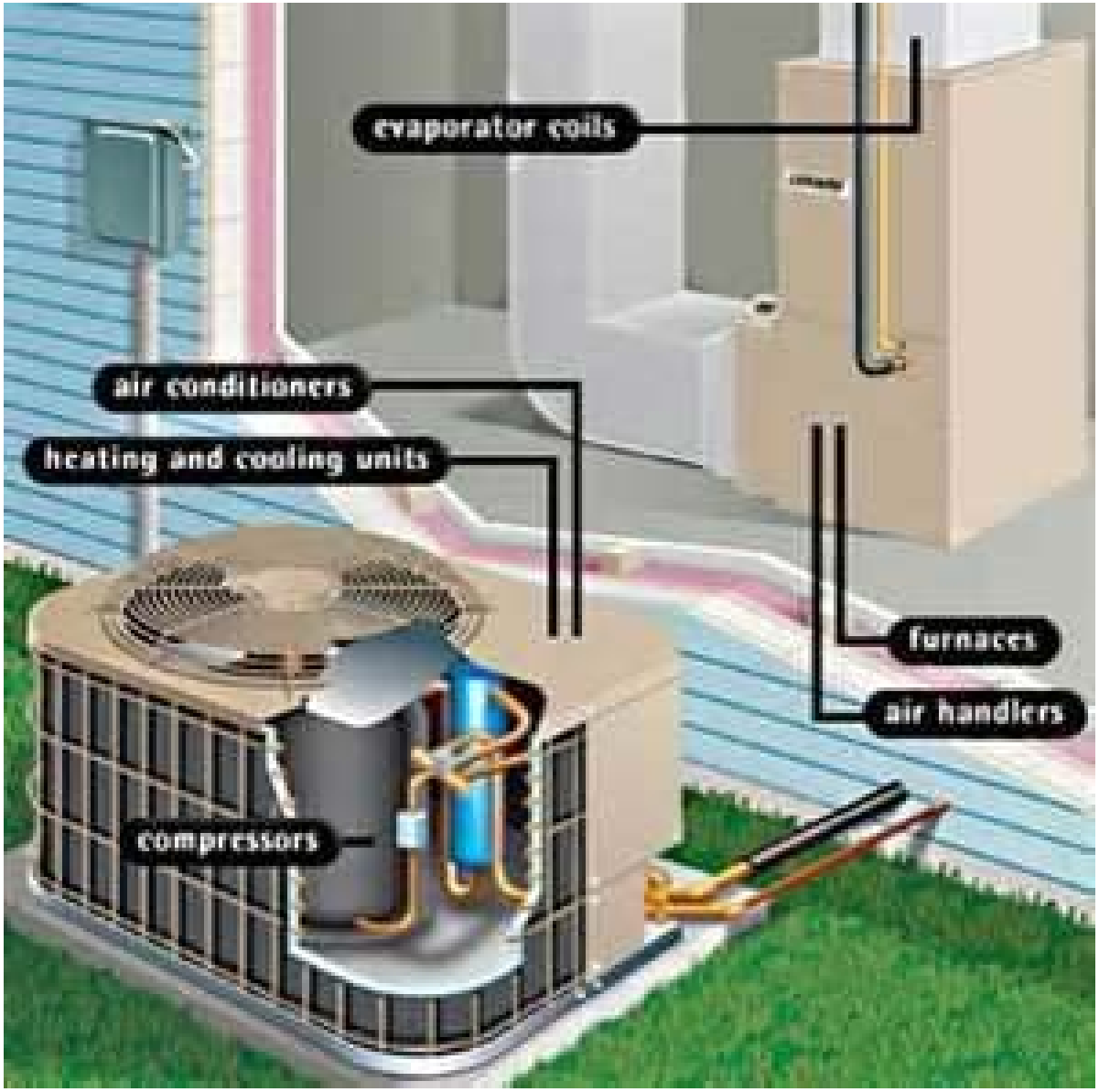
- **Air Conditioning** - The process of altering air supply to control simultaneously its humidity, temperature, cleanliness, and distribution to meet specific criteria for a space. Air conditioning may either increase or decrease the space temperature.
- **Types of Air-Conditioner**

1. Window AC
2. Split AC
3. Central AC

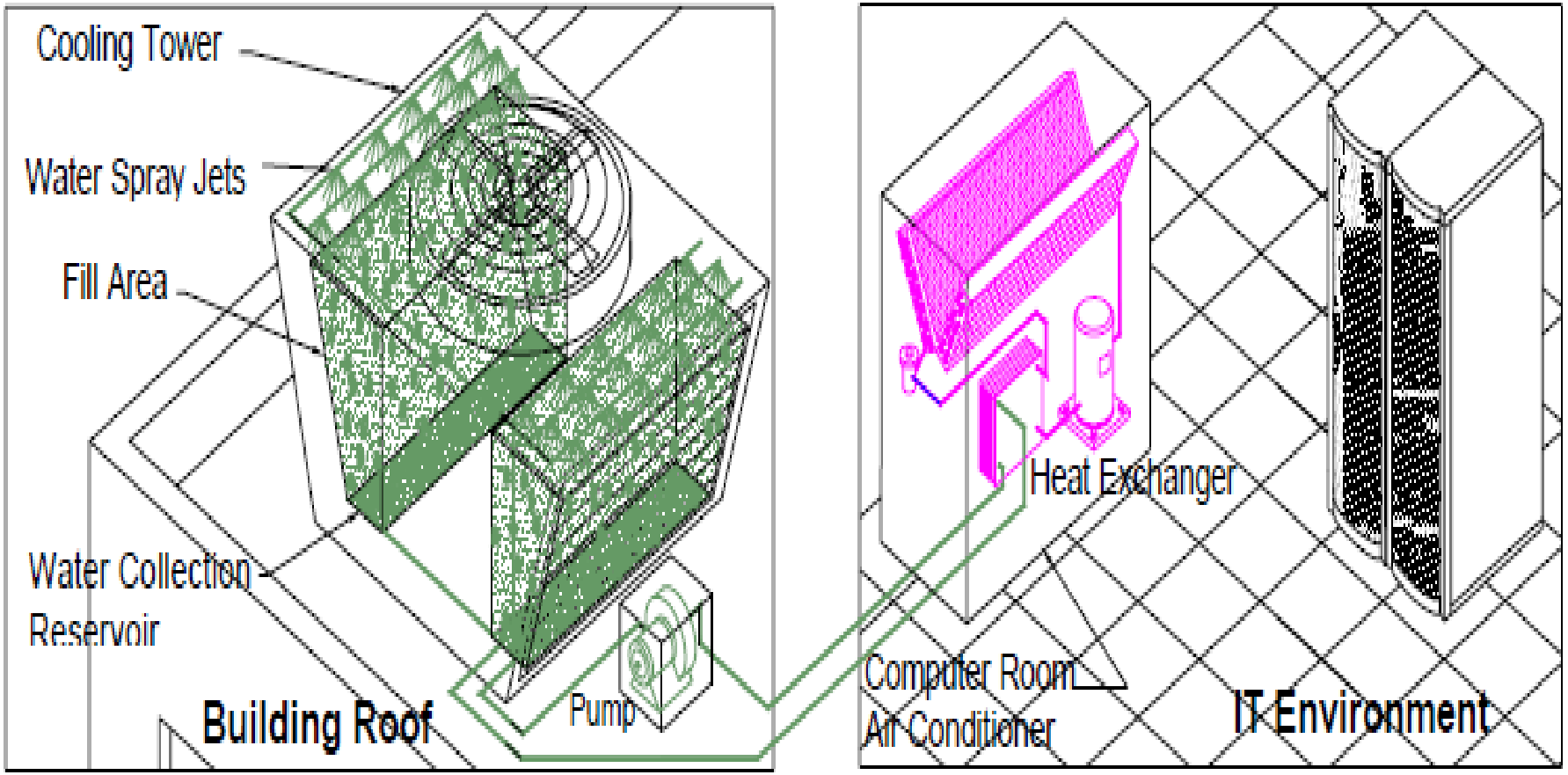
- **Window type AC** - is the most commonly used air conditioner for single rooms. In this air conditioner all the components, namely the compressor, condenser, expansion valve or coil, evaporator and cooling coil are enclosed in a single box. This unit is fitted in a slot made in the wall of the room, or often a window sill.


OUTDOORS
INDOORS
Fan axle
Compressor
Condenser coils
Fan
Blower
Hot air
Outdoor air
Cooled air
Expansion valve
Cooling coils
Temperature sensing bulb
Indoor air

- **Split type AC-** comprises of two parts: the outdoor unit and the indoor unit. The outdoor unit, fitted outside the room, houses components like the compressor, condenser and expansion valve. The indoor unit comprises the evaporator or cooling coil and the cooling fan. Further, the present day split units have aesthetic looks and add to the beauty of the room. The split air conditioner can be used to cool one or two rooms.


evaporator coils
air conditioners
heating and cooling units
furnaces
air handlers
compressors


Carrier



Water Cooled System

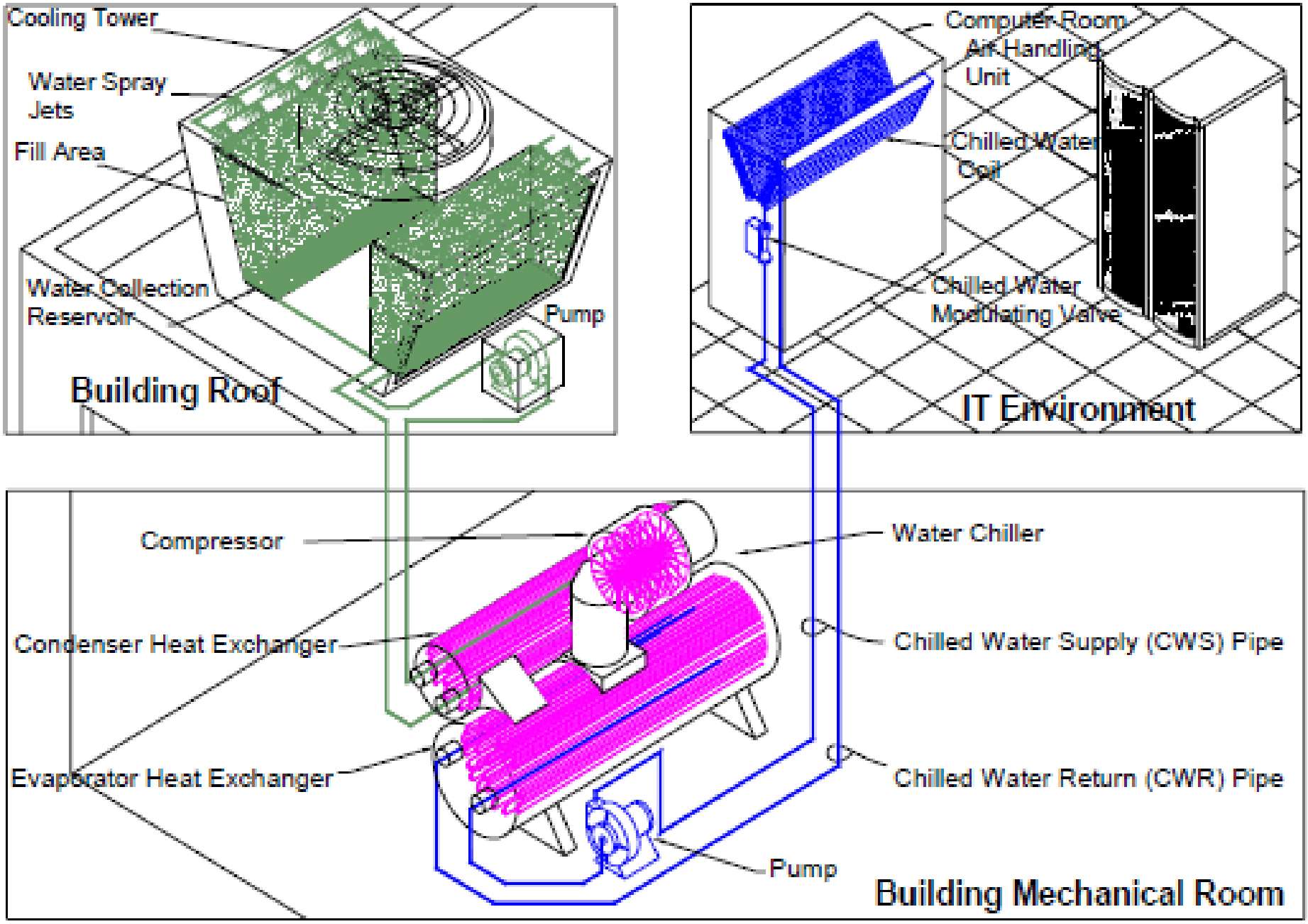
- **Advantages:**

1. All refrigeration cycle components are contained inside the a/c unit in a room.
2. Usage of the building's condenser water is generally less expensive than chilled water.
3. Condenser water piping loops are easily run long distances and almost always service many a/c room units from one cooling tower.

- **Disadvantages:**

1. High initial cost for cooling tower, pump and piping system.
2. High maintenance cost due to frequent cleaning and water treatment requirements.

- **Central AC/Plant System** - The central air conditioning system is used for cooling big buildings, houses, offices, entire hotels, gyms, movie theaters, factories etc. If the whole building is to be air conditioned, HVAC engineers find that putting individual units in each of the rooms is very expensive initially as well in the long run. The central air conditioning system is comprised of a huge compressor that has the capacity to produce hundreds of tons of air conditioning. Cooling big halls, malls, huge spaces, galleries etc is usually only feasible with central conditioning units.



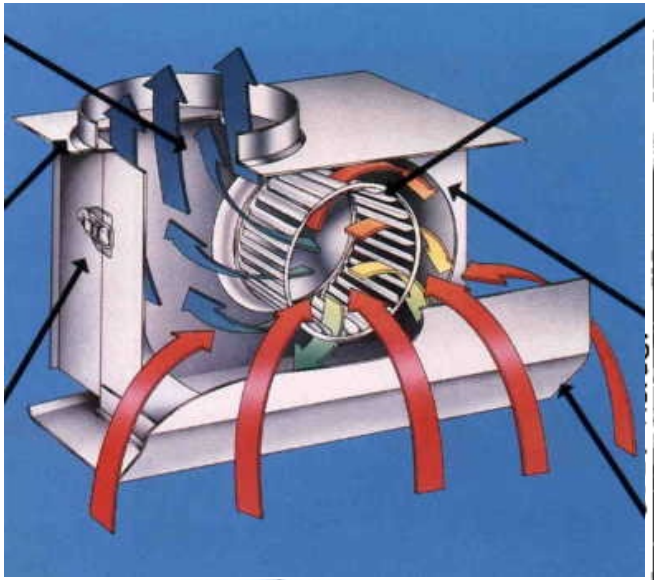
Chilled Water System

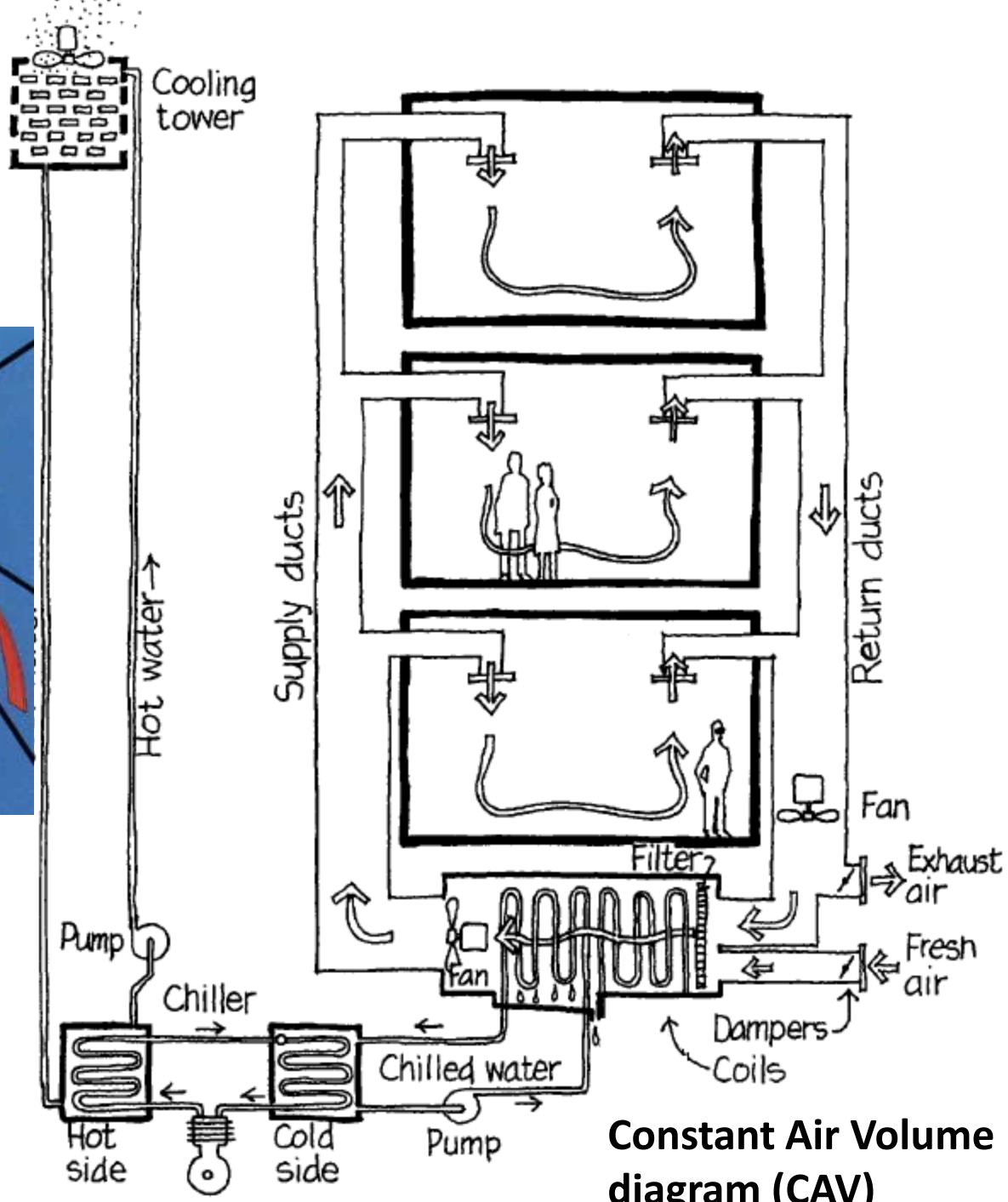
- **Advantages:**

1. Computer air handlers generally cost less, contain fewer parts, and have greater heat removal capacity any room a/c unit with the same footprints.
2. Chilled water piping loops are easily run very long distances and can service many rooms from one chiller plant.
3. Chilled water system have the lowest cost per kW for large installations.

- **Disadvantages:**

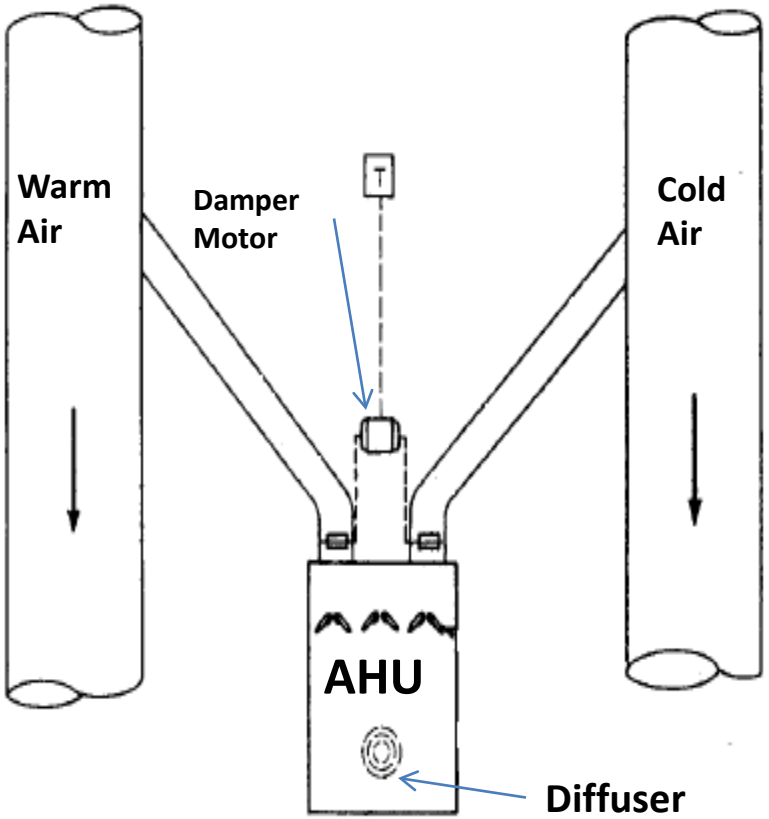
1. Chilled water system generally have the highest capital cost for installation below 100kW of electrical load.

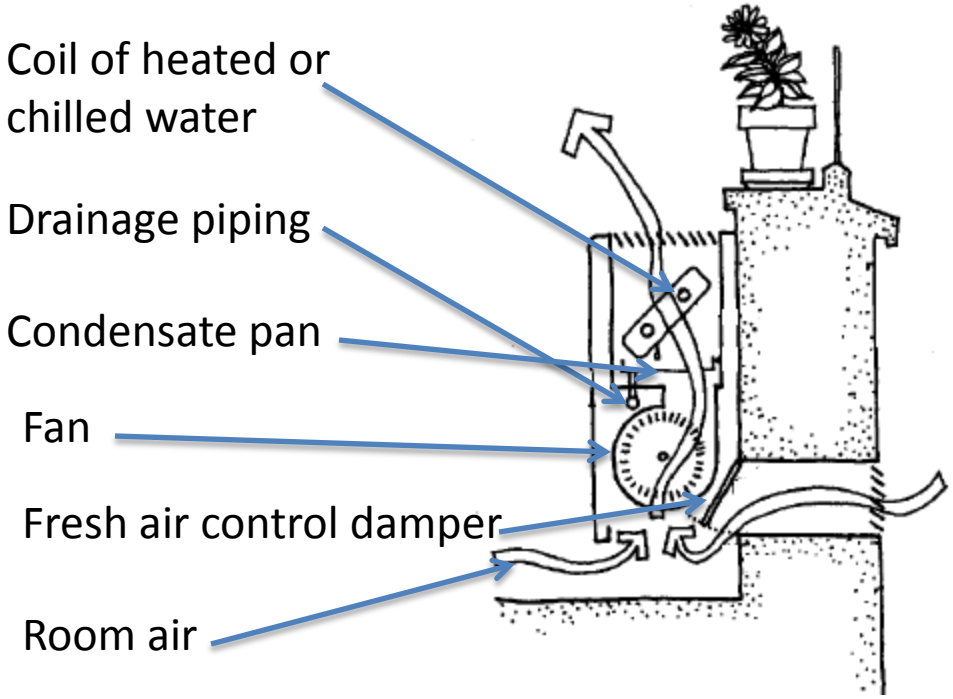




Constant Air Volume diagram (CAV)

- **Air Handling Unit (AHU)-** is a box proportion to blend the warm and cold air to reach the desired temperature before distributing the blended air to the enclosed space.





Unit Ventilator

- **Heat Pump** - " is a term for a type of air conditioner in which the refrigeration cycle can be reversed, producing heating instead of cooling in the indoor environment. They are also commonly referred to, and marketed as, a "reverse cycle air conditioner". Using an air conditioner in this way to produce heat is significantly more energy efficient than electric resistance heating.

- # Distribution System:

1**. All Air System**

CAV system

- A single-duct, constant-air-volume (CAV) system delivers conditioned air at a constant temperature through a low-velocity duct system to served spaces.

- in a single-zone, a master thermostat regulates the temperature for entire building.

- in a multizone system, separate ducts from a central air-handling unit serve each of a number zone.

VAV system

- A single-duct, variable-air-volume (VAV) system uses dampers at the terminal outlets to control the flow of conditioned air according to the temperature requirements of each zone or space.

Dual-duct system

- A dual-duct system uses separate ducts to deliver warm air and cool air to mixing boxes, which contain thermostatically controlled dampers.

Terminal Reheat system

- offers more flexibility in meeting changing space requirements. It supplies air at about (12deg. Celsius) to terminals equipped with electric or hot-water reheat coils, which regulates the temperature of the air being furnished to each individually controlled space.

2. All Water System

- pipes are used in this system, which require less installation space than air ducts, deliver hot or chilled water to fan-coil units in the served space.

Two-pipe system

- A two-pipe system uses one pipe to supply hot or chilled water to each fan coil unit and other to return it to the boiler or chilled water plant.

Four-pipe system

- A four-pipe system uses two separate piping circuits – one for hot water and one for chilled water – to provide simultaneous heating and cooling as needed to the various space of a building.

Fan-coils/unit ventilator contain an air filter and centrifugal fan for drawing mixture of room air and outside air over coils of heater or chilled water and then blowing it back in the space.

Ventilation is provided through wall opening, by infiltration, or by separate duct system.

3. Air-Water System

- this system use high-velocity ducts to supply conditioned primary air from a central plant to each space or zone, where it mixes with room air and is further heated or cooled in induction units.

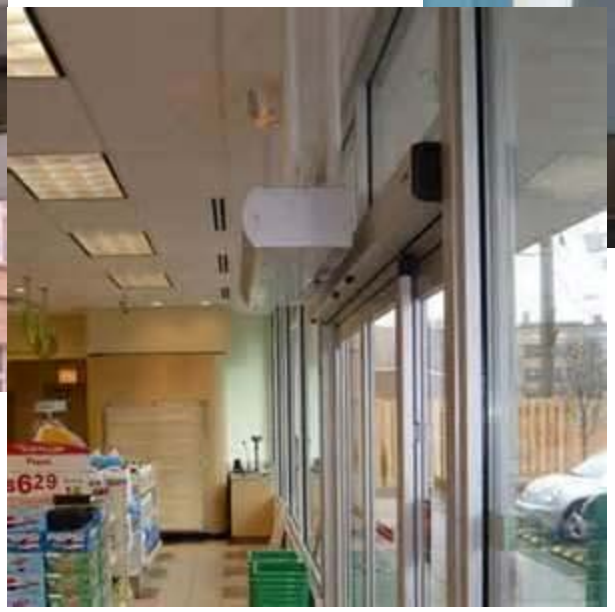
- the primary air draws in room air through a filter and the mixture passes over coils that are heated or chilled by secondary water piped from boiler or chilled water plant.

- local thermostats control water flow over the coils to regulate air temperature.

- **Air Curtain/Air Door** - an air curtain is a continuous broad stream of air circulated across a doorway of a conditioned space. It reduces penetration of insects and unconditioned air into a conditioned space by forcing an air stream over the entire entrance. The air stream layer moves with a velocity and angle such that any air that tries to penetrate the curtain is entrained. Air curtain effectiveness in penetrating infiltration through an entrance generally ranges from 60 to 80%".


MOUNTING ON OUTSIDE OF EXTERIOR WALL
WALL
VELOCITY CONTROL LOUVERS
DIRECTIONAL CONTROL VANES
EXTERIOR DUST & INSECTS
CLEAN INTERIOR


EZ-AIR



Factors to consider in the selection, design, and installation of heating, ventilating, and air-conditioning system:

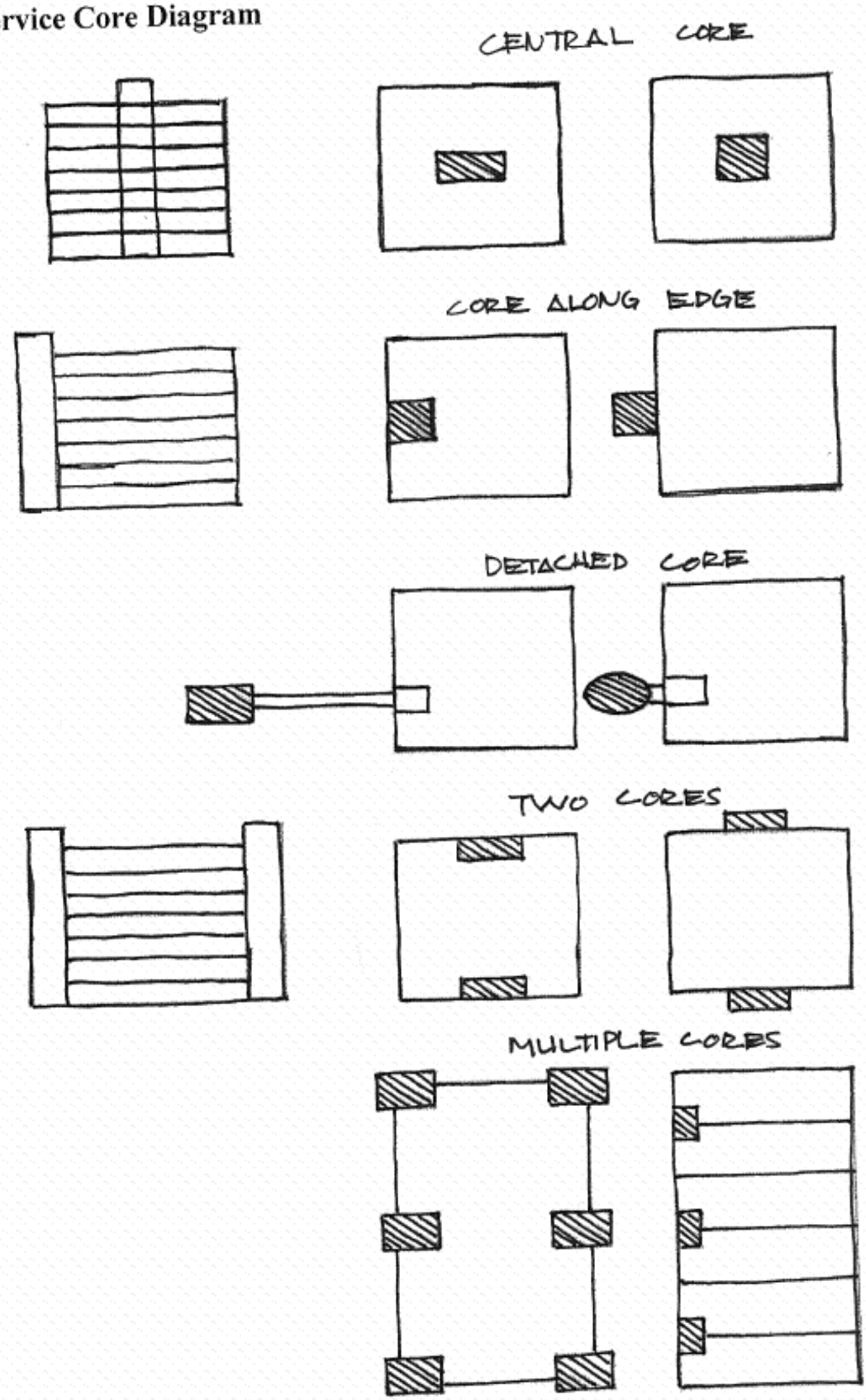
- Performance, efficiency and both the initial and life cost of the system
- Fuel, power, air, and water required and the means for their delivery and storage: some equipment may require direct access to outdoors
- Flexibility of the system to service different zones of a building, which may have different demands because of use or site orientation. Decentralized or local system are economical to install, require short, distribution runs, and allow each space or zone to have individual temperature control, while central system are generally more energy efficient, easier to service and offer better control of air quality.
- Type and layout of the distribution system used for the heating and cooling media. To minimize friction loss, ductwork and piping should have short, direct runs with a minimum of turns and offsets.
- Space requirements for mechanical equipment and its distribution systems. The heating, ventilating and air-conditioning equipment of a building can often occupy 10%-15% of the area of the building; some pieces of equipment also require space or a domain for access, service, and maintenance. Air ducts system require more space than either pipes carrying hot or chilled water or wiring for electric resistance heating. Duct work should therefore be carefully laid out to be integrated with the structure and spaces of a building, as well as with its plumbing and electrical system.
- Access required for service and maintenance.
- Construction requirements for enclosure of the plant, fire resistance, and noise and vibration control.
- Structural requirements imposed by the weight of the equipment.
- Degree of visibility, whether concealed with the construction or exposed to view. If ductwork is to be left exposed, the layout should have a visually coherent order and be coordinated with the physical elements of the space.

Service core

The service core or cores of the building house the vertical distribution of mechanical and electrical services, elevators shafts, and exit stairways. These cores must be coordinated with the structural layout of columns, bearing walls, and shear walls or lateral bracing as well as with the desired patterns of space, use, and activity.

- A single core is often used in high-rise building to leave a maximum amount of unobstructed rentable area.
- Central locations are ideal for short runs and efficient distribution pattern.
- Placing the core along an edge leaves an unobstructed floor space but occupies portion of the daylight perimeter.
- Detached cores leave a maximum amount of floor space but require long service runs and cannot serve as lateral bracing.
- Two cores may be symmetrically placed to reduce service runs and to serve effectively as lateral bracing, but the remaining floor area losses some flexibility in layout and use.
- Multiple cores are often used in broad, low-rise buildings in order to avoid long horizontal runs.
- The cores may be dispersed to better serve spaces or zones that have different demands and load requirements.
- In apartment buildings and other structures housing repetitive units, the cores may be situated between the units or along interior corridors.

Service Core Diagram



Heating and Cooling Distribution Diagram: