UNIT-VI: Air Conditioning

Requirements of human comfort and

concept of effective temperature-

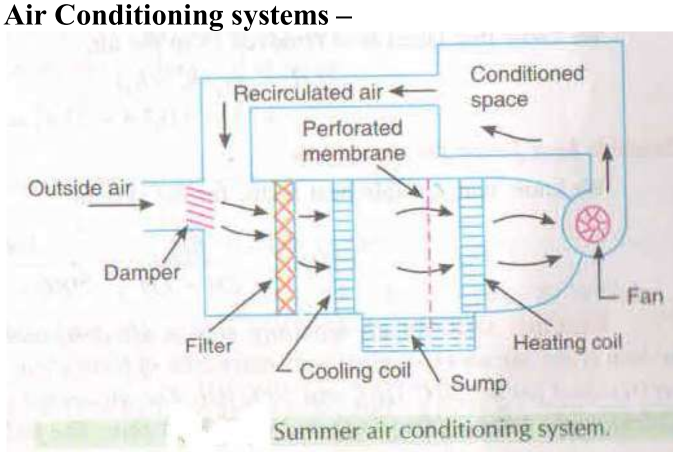
Comfort chart –

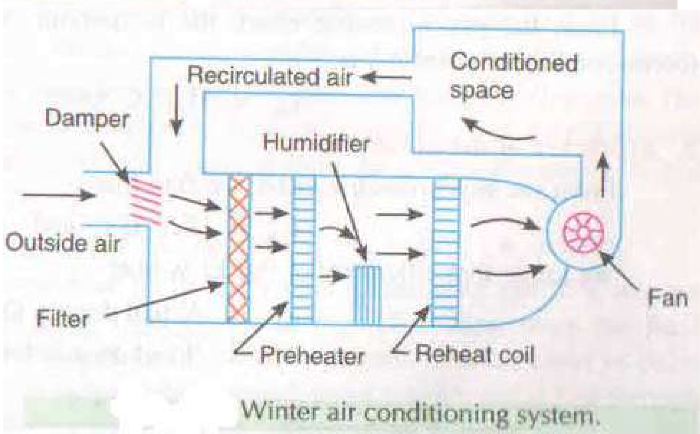
Comfort Air conditioning –

Requirements of Industrial air conditioning ,

Air conditioning Load Calculations

Air Conditioning systems –





Classification of equipment,

Cooling,

Heating

Humidification and

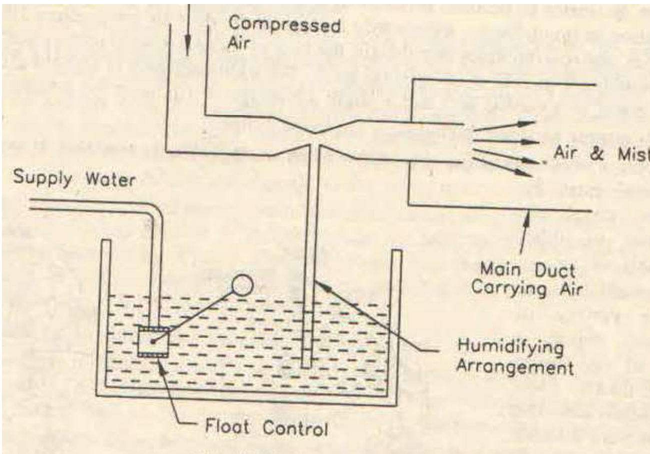


Fig. 25.10. Atomization type humidifier.

ımidifier does not add heat to the room.

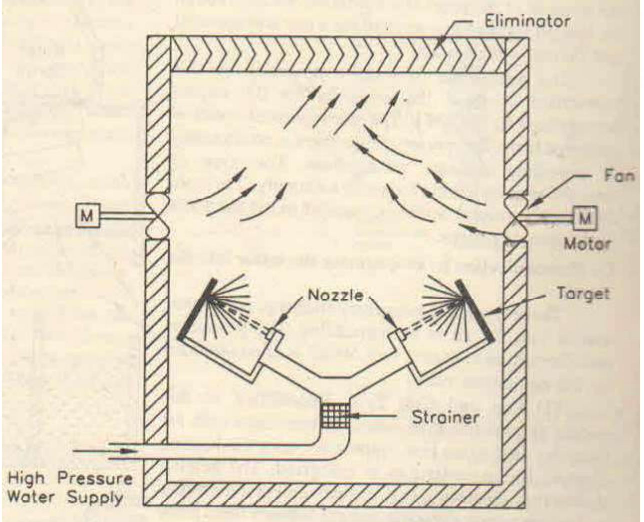
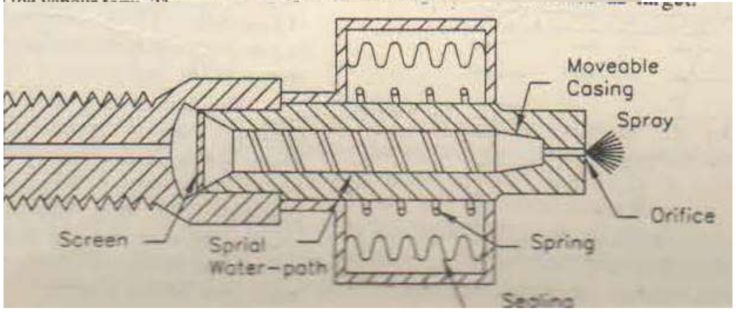
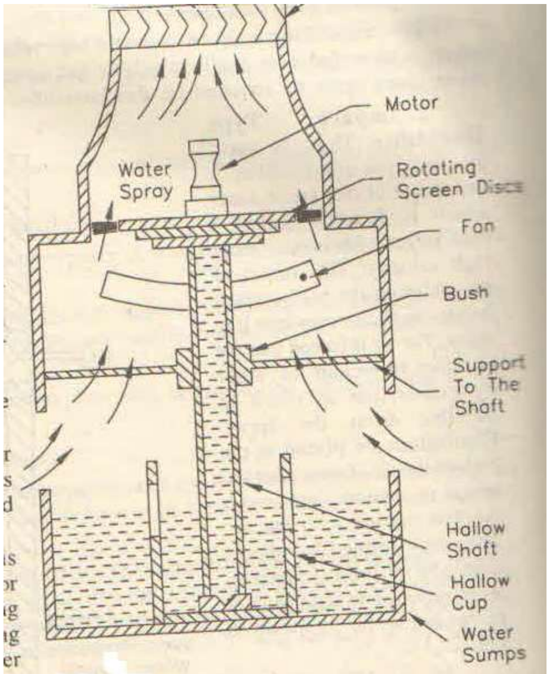


Fig. 25.11. Impact type humidifier.





Mechanical Separation Humidifier.

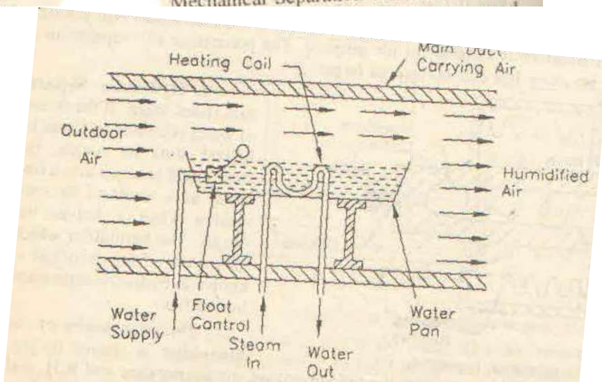
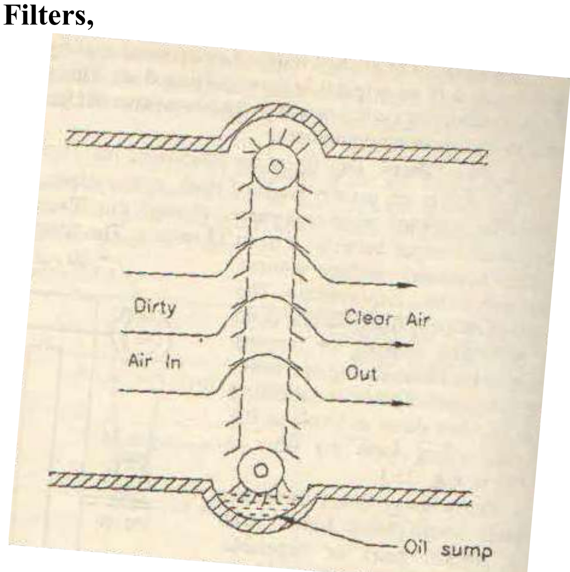
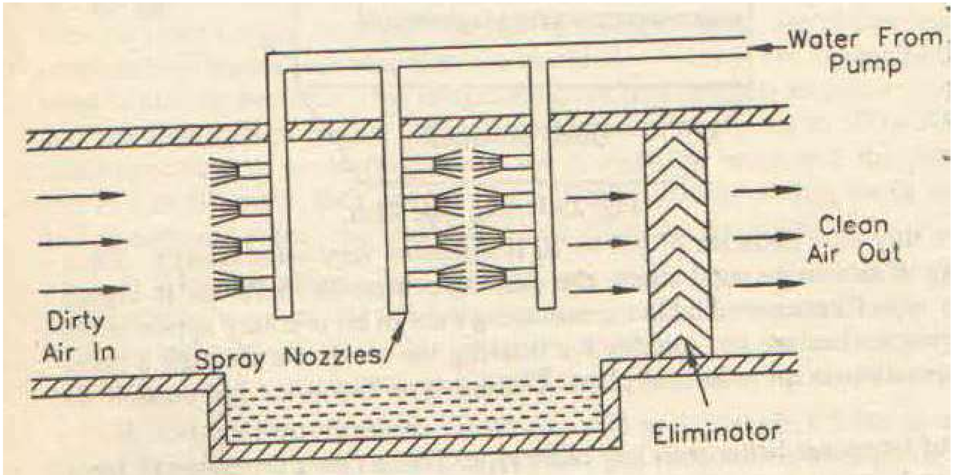


Fig. 25.14. Forced Evaporation Humidifier.

Dehumidification,

Filters,





Grills and

Registers,

Fans and Blowers.

Types of Fans

The various mechanical devices used to move the air in heating, ventilating, and air-conditioning installations are known as fans, blowers, exhausts, or propellers. Every fan is equipped with an impeller, which forces (impels) the airflow. The manner in which air flows through the impeller provides the basis for the following two general classifications of fans:

1. Centrifugal fans
2. Axial-flow fans

In a *centrifugal* (or *radial flow*) *fan* (see Figure 7-1), the air flows radially (that is, diverging from the center) through the impeller, which is mounted in a scroll-type housing. Centrifugal fans are further subdivided into a number of different types depending on several design variations, such as the forward or backward inclination of the blade.

An *axial-flow fan* is mounted within a cylinder or ring, and the air flows axially (that is, parallel to the main axis) through the impeller. Depending on the design of the enclosure and impeller, axial-flow fans can be subdivided into the following types:

1. Tubeaxial fans
2. Vaneaxial fans
3. Propeller fans

A *tubeaxial fan* consists of an axial-flow wheel within a cylinder (see Figure 7-2). These fans are available in a number of different types depending on the design and construction of the impeller blades.

A *vaneaxial fan* also consists of an axial-flow wheel but differs from a tubeaxial fan in that it uses a set of vanes to guide the airflow and increase efficiency (see Figure 7-3).

A *propeller fan* consists of a propeller or disc wheel within a ring casing or plate. These fans are by far the simplest in construction and operate best against low resistance (see Figure 7-4).

Furnace Blowers

The blower used in a forced warm-air furnace is similar to the centrifugal fan used in ducts and other types of applications. Most blowers are designed with a belt drive, although some are equipped with a direct drive to the motor.

Basic Fan Laws

The performance of fans and their relationship to the ventilation system are governed by definite principles of fluid dynamics. An understanding of these principles is useful to anyone designing a ventilation system because they make possible the prediction of effects resulting from altered operating conditions. The principles (and formulas) associated with fan and ventilation system engineering are referred to collectively as *basic fan laws.* The basic fan laws used in calculating fan performance depend on the fact that the mechanical efficiency (ME) of a fan remains constant

throughout its useful range of operating speeds (that is, the fan rpm). They also apply only to fans that are geometrically similar.
A current edition of the *ASHRAE Guide* will contain detailed explanations of the principles and formulas associated with basic fan laws. A typical example is the production of fan speed (rpm), static pressure (SP), and horsepower when the volume of air moved

Fan Selection
The following information is generally required for the selection of a suitable fan:
1. Volume of air required (cfm)
2. Static pressure (SP)
3. Type of application or service
4. Maximum tolerable noise level
5. Nature of load and available drive
6. Ambient and airstream temperature
7. Mounting arrangement of the system
8. Available line voltage
The *volume of air required* refers to the volume of air that must be moved by the fan to meet the needs of the building or space. It is expressed in cubic feet per minute and is determined by dividing the total cubic feet of air space by the required number of air changes necessary to give proper ventilation.
The *static pressure* of a fan may be defined as the total pressure diminished by the fan velocity. In other words, it is the resistance offered by the system (ducts, air intakes, and so on) to the flow of air. After the duct sizes have been determined, it is necessary to calculate the static pressure of the system so that the proper fan can be selected which will handle the desired volume of air (that is, the required cfm) against the static pressure of the system.
The various fan manufacturers provide tables indicating the operating characteristics of various-size fans against a wide range of static pressures.
These tables list static pressures for different sizes of various fans.

The *type of application* (or service) is often an important consideration in what kind of fan is used in an installation. For example, a duct system will offer sufficient resistance to require a centrifugal, tubeaxial, or vaneaxial fan. A propeller fan is usually recommended for an installation without a duct system. Other factors, such as the volume of air that must be moved, the allowable noise level, the air temperature, use for general or local ventilation, and cost, are alsoimportant considerations in fan selection.
The *maximum tolerable noise level* is the highest acceptablenoise level associated with air exchange equipment. The fan should be of suitable size and capacity to obtain a reasonable operating speed without overworking.
The *nature of load and available drive* is an important factor in controlling the noise level. High-speed motors are usually quieter than low-speed ones. Either belt- or direct-drive units are used in fan installations, and a high-speed motor connected to the fan witha V-belt offers the quietest operation.
The dry-bulb temperature of either ambient air or exhaust stream air (*ambient or airstream temperature*) is a determining factor in selecting a suitable fan. Most fans operate satisfactorily at temperatures up to about 104°F (40°C). Special fans that can operate at higher temperatures are also available. For example, standard belt-driven tubeaxial fans are usable for temperatures up to 200°F (where the motor is out of the airstream).
The *mounting arrangement of the system* is directly determined by the application or service of the fan. Certain types of fans will prove to be more suitable than others, depending on the kind of installation. Fan manufacturers often offer useful recommendations for mounting arrangements.
The *available line voltage* will determine the size and type of fan motor most suitable for the installation. Motor voltage designations conform to the following system of voltages now used throughout the country: 115 volts, 230 volts, and 460 volts. Motors for special voltages (that is, 117, 480, or 575 volts) are available on special order.
Fan manufacturers provide information and assistance in selecting the most suitable fan or fans for your installation. Rememberthat ventilation requirements vary under different climatic conditions,

and it is impossible to provide exact rules for determining the variables of local climate and topography (see Table 7-9). Allowances must be made for these climatic variables.

Table 7.9 Minimum Fan Capacity (CFM) for Various Sections of the Country

Approx. Volume of House (ft³)		Minimum Fan Capacity Needed For Satisfactory Results (CFM)							
		North			Central			South	
3000		1000			2000		24"	3000	
4000		1320			2640			4000	
5000		1650			3300			5000	30"
6000		2000		24"	4000			6000	
7000		2310			4620	30"		7000	
8000		2540			5280		36'	8000	
9000		3000			6000			9000	
10,000		3330			6660			10,000	42"
11,000		3630			7260			11,000	
12,000	24"	4000		36"	8000			12,000	
13,000		4290			8580		48"	13,000	
14,000		4620	30"		9240			14,000	
15,000		5000			10,000	42"		15,000	
16,000		5280			10,560			16,000	
17,000		5610			11,220			17,000	
18,000		6000			12,000			18,000	
19,000		6270			12,540			19,000	
20,000		6660			13,320			20,000	
21,000		7000			14,000			21,000	
22,000		7260			14,520			22,000	

The following suggestions are offered only as a general guide to the selection of a fan and should not be construed as applying in every situation.

Heat Pump –

A *heat pump* is a refrigeration device used to transfer heat from one room or space to another. The heat pump is designed to take heat from a medium-temperature source, such as outdoor air, and convert it to higher-temperature heat for distribution within a structure. By means of a specifically designed reversing valve, the heat pump can also extract heat from the indoor air and expel it outdoors. Because a heat pump system uses the reverse-cycle principle of operation, its operating principle is sometimes referred to as *reversecycle conditioning* or *reverse-cycle refrigeration.*

The latter term is not correct because there are fundamental differences between the operating principles of a heat pump and a true refrigeration unit. The confusion probably stems from the fact that during the cooling cycle, the operation of a heat pump is identical to that of the mechanical refrigeration cycle in a packaged air-conditioning unit. The indoor coil functions as an evaporator, cooling the indoor air. The outdoor coil is a condenser, in which the hot refrigerant gas releases heat to the outside air.

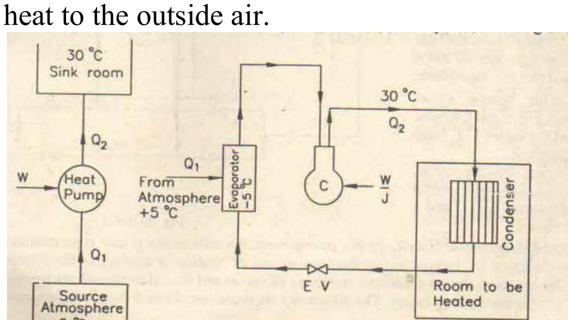


Fig. 29.1.

Heat Pump Operating Principles

The two principal phases of heat pump operation are the heating and cooling cycles. A third phase, the defrost cycle, is used to protect the coils from excessive frost build up.

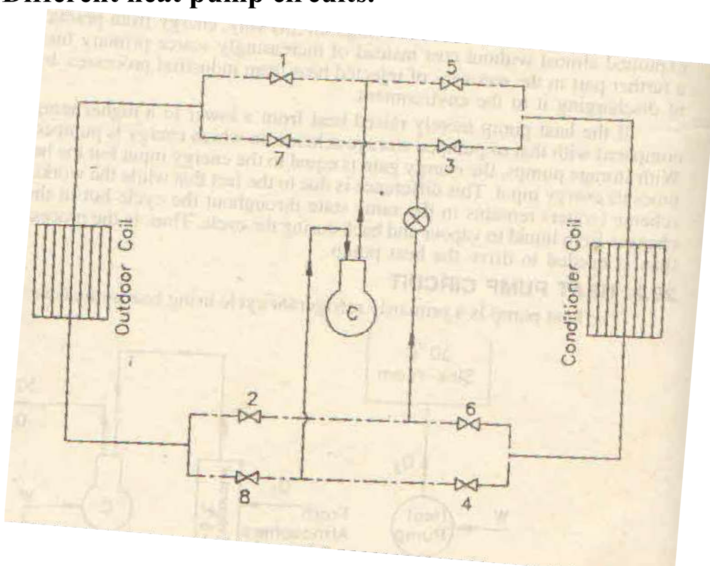
Heating Cycle

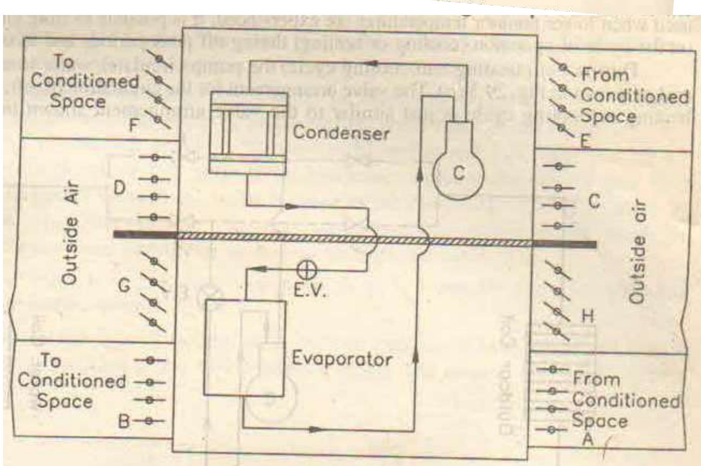
The heating cycle of a heat pump begins with the circulation of a refrigerant through the outdoor coils (see Figure 10-1). Initially, the refrigerant is in a low-pressure, low-temperature liquid state, but it soon absorbs enough heat from the outdoor air to raise its temperature to the boiling point. Upon reaching the boiling point, the refrigerant changes into a hot vapor or gas. This gas is then compressed by the compressor and circulated under higher pressure and temperature through the indoor coils, where it comes into contact with the cooler room air that circulates around the coils. The cooler air causes the gas to cool, condense, and return to the liquid state. The condensation of the refrigerant vapor releases heat to the interior of the structure. After the refrigerant has returned to a liquid state, it passes through a special pressure-reducing device (an expansion valve) and then back through the outdoor coils where the heating cycle begins all over again. The temperature of the room air hat originally cooled the higher-temperature refrigerant vapor is itself increased by the process of heat transfer and recirculated throughout the room to provide the necessary heat.

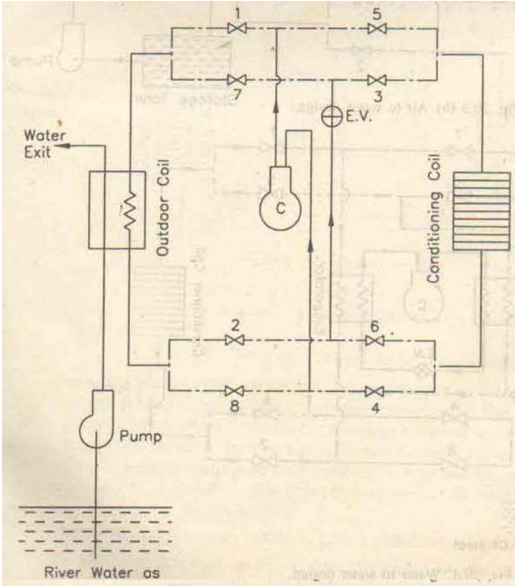
A heat pump is designed to reverse the action or direction of heat transfer depending on whether heating or cooling is desired.As a result, the indoor and outdoor coils change their functions based on the heating or cooling cycle. The outdoor coil becomes the condenser in the cooling cycle and the evaporator in the heating cycle.The indoor coil, on the other hand, becomes the evaporator in the cooling cycle and the condenser coil in the heating cycle.

Heat sources –

Different heat pump circuits.







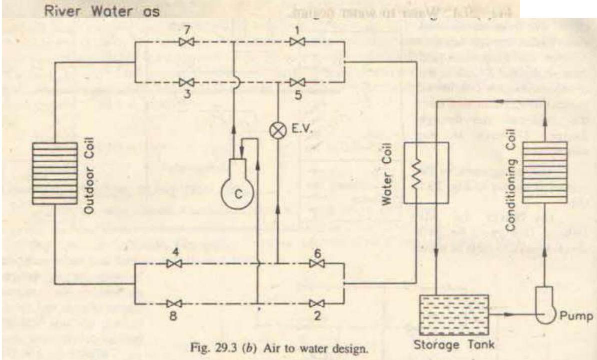


Fig. 29.3 (b) Air to water design.

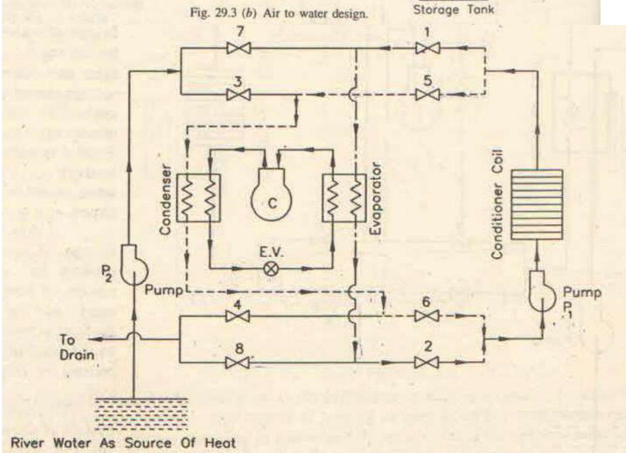


Fig. 29.4. Water to water design.

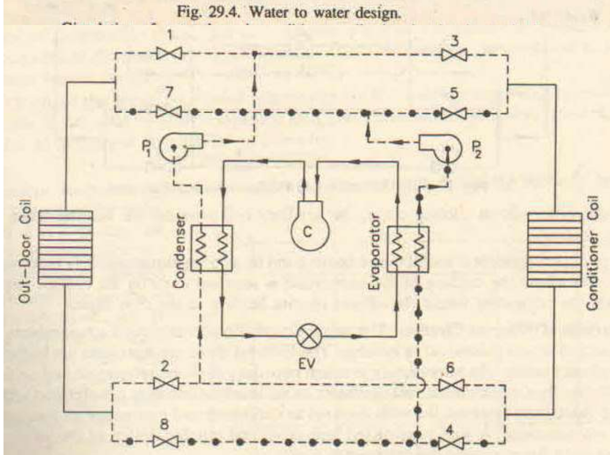


Fig. 29.5 (a) Air to Liquid Design.

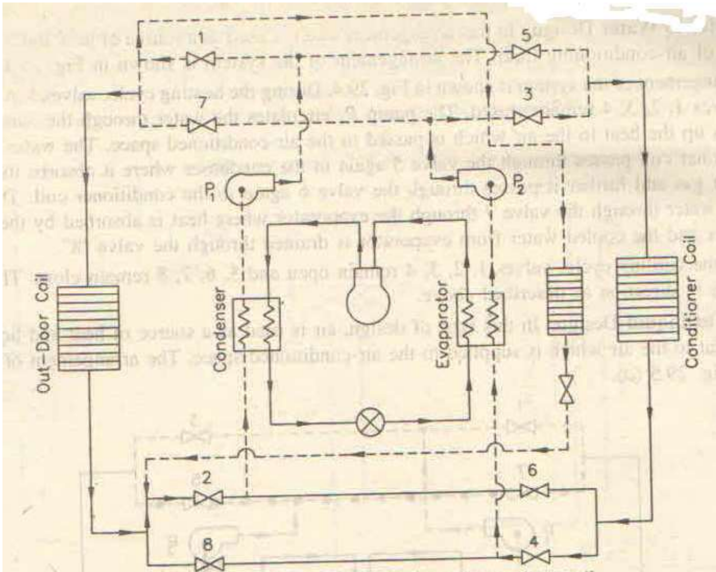


Fig. 29.5 (*b*) Air to Liquid Design with auxiliary coil.