

3. It has been proposed to obtain heat by freezing water but this is still in the experimental stage.

Some of the other factors which act as limitations are: the large temperature spread when using air as a source of heat and when attempting to cool with even moderately low outside temperatures, the frequent disparity between the size of the cooling load and heating load requiring extra equipment for a complete heating load, and the relatively high initial cost of equipment as compared to that at present available for heating by conventional means.

Because of these limitations, the present application of the system is largely limited to temperate climates, such as Florida and Southern California, or to heating only for intermediate seasons, or to other localities which have peculiar advantages as, for instance, the ready availability

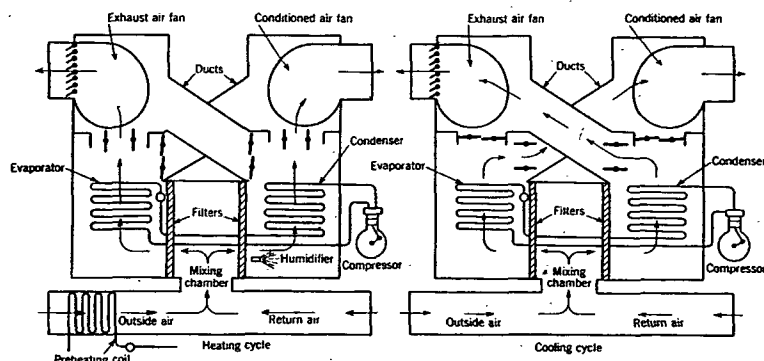


FIG. 5. SCHEMATIC OPERATION OF REVERSED CYCLE CONDITIONING SYSTEM

of well water. In these locations it is frequently possible to do all of the heating necessary with the refrigeration equipment so that the extra cost is only that of reversing the functions of the condenser and evaporator.

There are a number of reversed systems now in operation, particularly among utility companies, using well water as the source of heat. These systems range in size up to 320 hp. In the case of the largest system in operation at present, the cost of the electrical energy would have to be approximately 0.7 cents per kilowatthour in order to compete with oil at 6 cents per gallon.

A typical arrangement of a reversed cycle conditioning system where air is used as a source of heat is shown in Fig. 5. If the air seldom drops below freezing, heat is often required in the morning and cooling during the afternoon in order to maintain comfortable conditions in such a system. The arrangement as shown lends itself to automatically changing over as required.

REFRIGERATION EQUIPMENT AND ARRANGEMENTS

Types of Compressors

There are many different types of compressors, using various refrigerants. Each type has its advantages for its particular application,

and those generally used for air conditioning are of the following types:

1. Reciprocating compressors (commonly referred to as piston type).
2. Centrifugal compressors.

Reciprocating compressors are available in a wide range of sizes and types. Any of a number of refrigerants, including dichlorodifluoromethane (F-12), methyl chloride, ammonia, carbon dioxide, and sulphur dioxide may be used in reciprocating machines. The first of these is used extensively in direct expansion systems of comfort air conditioning.

Compressors may be classified into two general types, (a) open type, (b) enclosed type. If the driving mechanism is external to the compressor, then the shaft must be brought out through the crankcase and a shaft seal or stuffing box must be used to prevent escape of the refrigerant. This type of compressor is known as an open-type compressor. When the driving mechanism is located within the crankcase of the compressor in such a way as to avoid the necessity of a shaft seal, the compressor is known as the completely enclosed or hermetically sealed type.

Open-type compressors may be further classified as belt driven and directly connected. A great number of direct-driven units are now being used which generally operate at higher rotational speeds than the belt-driven type.

The present tendency is toward forced lubrication of the bearings of compressors by means of an oil pump driven from the crankshaft, although there are many splash lubricated compressors on the market. The chief advantages of the forced lubricated compressor are that the lubrication system requires less energy for its operation than the splash type, the oil can be easily filtered before it enters the bearings, and less oil is usually required.

The compressor capacity must be selected for and matched to the maximum load for the installation on which it is to be used. Air-conditioning loads, however, vary over a wide range, and a wide fluctuation in air conditions may result during periods of light load if on-and-off control of full compressor capacity is used. To prevent such undesirable fluctuation, several methods are employed to vary the capacity of reciprocating compressors, such as:

1. By-passing one or more cylinders, of a multi-cylinder compressor, from discharge to suction.
2. Rendering the suction valves of one or more cylinders of a multi-cylinder compressor inoperative. This is usually accomplished by depressing the suction valves.
3. Varying the speed of the compressor, usually by using variable speed or two-speed electric motors.
4. Using clearance pockets to control the quantity of refrigerant pumped.
5. Restricting the suction inlet to one or more of the cylinders of a multi-cylinder compressor either by an automatic modulating valve or by an on and off valve.

All of these methods, with the exception of variable speed, result in a slightly lowered over-all compressor efficiency when in use, since the mechanical losses remain constant whereas the quantity of refrigerant pumped is lowered.

Centrifugal compressors are used with very low pressure refrigerants; usually both evaporator and condenser work below atmospheric pressure. Water and monofluorotrichloromethane (F-11) are the refrigerants commonly used in centrifugal machines.

Compression of the refrigerant is accomplished by means of centrifugal