nized that heat storage devices may be used with any of these systems involving either a single or a dual heat source. One promising possibility involves the utilization of a storage pit or cistern operating upon a heat of fusion cycle and supplied by supplementary heat from air or solar sources. Heat of fusion may, for example, also be utilized with city water and sewage disposal to increase the practicability of these sources.

When heat is to be obtained from a ground coil it should be emphasized that, in general, the heat extracted must be replaced by heat from the sun, received by radiation to the ground or by heat carried into the ground by rain.

Combinations of heat sources, such as air and water, air and ground, air and solar energy, or ground and solar energy, may also be used and will frequently improve the coefficient of performance over an entire heating season; but they will probably result in considerably greater initial cost.

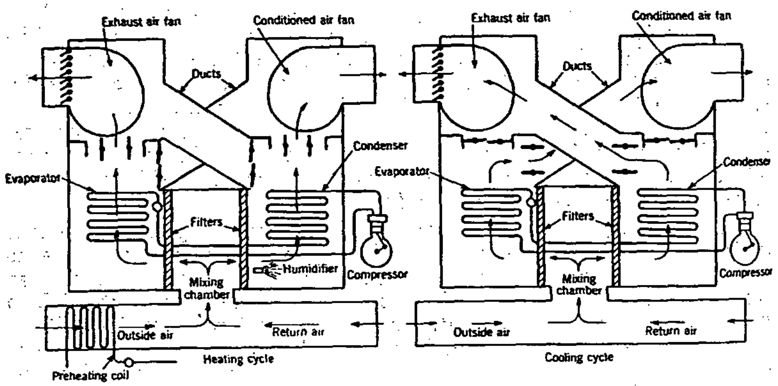

Fig. 9. Schematic Operation of Reversed Cycle Conditioning System

A typical arrangement of a heat pump system with air as the heat source is shown in Fig. 9.

Both water and air are practical media to which the condenser heat may be rejected; but the generation of steam requires too high a condenser temperature. Practical operation, therefore, dictates that the heat pump be used in conjunction with either an air or water heating system with actual distribution of the heat to the rooms through either air ducts, convection radiators, or panels.

In general, it is believed that the future of this device is very promising, and it is recognized that there are a number of practical and economical systems in operation at the present time. However, design data for the majority of types of systems are inadequate, and it is therefore recommended that the enthusiasm and the interest which have greeted the emergence of the heat pump from the category of a scientific toy to one of practical application, should be tempered with caution, since it will probably be several years before proper development and design information will enable the widespread satisfactory application of the heat pump. It is for this reason that no design information is presented at this time in The Guide. A wealth of literature concerning individual installations is available, and reference to the many articles which have appeared

in current technical magazines should form sufficient information for those interested in the development of this type of heating.

BASIC REFRIGERATION EQUIPMENT

Compression Refrigeration Machines

Compression of the refrigerant gas drawn from the evaporator may be accomplished by one of several means. Positive displacement may be used as in the reciprocating, rotary or gear types of compressors; centrifugal force may be applied as in the centrifugal compressor; an ejector may be used as in the steam jet refrigeration cycle; or absorption of a low pressure refrigerant gas in a secondary fluid, followed by the absorbent's release upon application of heat, may be utilized. A detailed discussion of the equipment required for each of these types of systems is beyond the scope of this chapter. For a more comprehensive treatment, reference may be made to the bibliography. The present discussion is limited to positive displacement reciprocating compressors, rotary compressors and centrifugal compressors.

Reciprocating Compressors

Reciprocating compressors may be classified according to (a) cylinder design, (b) compressor drive, (c) valves, and (d) lubrication and cooling.

Cylinder Design. Cylinder design may vary as to number, arrangement, and action (*i.e.*, single-acting or double-acting). Single-acting compressors usually have their cylinders arranged vertically, radially, or in a V or W shaped arrangement. Double-acting compressors, with refrigerant gas drawn in, and compressed on both the head and crank ends of the cylinder, are usually arranged horizontally. Reciprocating units are available with from one to sixteen cylinders with the V, W, or radial arrangements best adapted to the greatest numbers. The present trend is toward higher operating speeds with a low displacement per cylinder, together with an increase in the number of cylinders. Whereas the original reciprocating compressors were slow speed (50 to 55 rpm) steam driven devices, modern electric motor-driven compressors range up to 3500 rpm. Cylinder heads are usually bolted tight to the cylinders, but in some large compressors where there is danger of wet compression or of foreign materials entering the compressor space, a secondary head known as a safety head, may be seated at the end of the cylinder and held in position with heavy springs. Normally, this head remains stationary, but excessive pressures in the clearance space are relieved by movement of the safety head, and thus prevent damage to the cylinder.

Compressor Drives. Reciprocating compressors may be subdivided on the basis of source of motive power, and whether they are open or hermetic. Practically all modern compressors are electric motor-driven, although a few large, steam-driven compressors are still being installed where steam forms the most economical source of energy. In a few cases, as with truck transportation, the compressor may be driven by an internal-combustion engine.

The division of compressors into open or closed types is dependent upon whether the motive power is received from an external source, or whether the motor is direct drive and sealed within the housing. In the open type, power is received from an external source with one end of the compressor crankshaft extending through the crankcase, and usually V-belt driven. The point of emergence of the shaft from the crankcase forms a weak point of refrigerant leakage, and is most frequently sealed with a bellows type crankshaft seal. Horizontal double-acting compressors operate with a sliding piston rod, moving back and forth through a stuffing box. If the motor is direct-drive and enclosed within the compressor housing, the compressor is classified as closed or hermetic. This eliminates the necessity of any shaft seal, and not only prevents refrigerant leakage at this point, but reduces operating noise. One disadvantage is the inaccessibility of moving parts for repairs, but lubrication is greatly simplified since both the motor and compressor operate in a sealed space with the lubricating oil.

Compressor Valves. All refrigeration compressor valves are dependent for their