prevent the thermostat keeping the outside damper open until the temperature falls to the reduced setting.

The intake and recirculated air quantities are determined by a single damper or by a pair of dampers working together, and operated by a damper motor. Although this affects the temperature of the air delivered, the main heat control comes from the throttling of the steam supplied to the heating coil, with or without by-pass damper control. To prevent air being delivered at too low a temperature, a low limit thermostat is commonly installed in the air stream and set at some point between 55 and 70 F. The lower settings may cause discomfort, the higher ones overheating, depending on circumstances. The air stream thermostat can be used to turn on steam, reduce the amount of outside air, or both.

Rooms with unit ventilators frequently have auxiliary heating devices, such as direct radiators, convectors or unit heaters, all under control of a single room thermostat. A common control cycle for such rooms is composed of the following functions, assuming that 72 F is desired:

1. Below 70 F the unit ventilator intake damper is in full recirculating position and all heat is turned on.
2. At 70 F the intake damper moves to a position that will admit a predetermined minimum amount of air from outdoors.
3. At 71 F the auxiliary heating devices are shut off.
4. From 71 to 72.5 F, the heating effect of the unit ventilator is throttled.
5. From 72.5 to 74 F, the intake damper is gradually moved to increase the amount of outside air from the set minimum to 100 per cent.
6. If the room thermostat calls for too much cooling, the air stream thermostat holds the delivery temperature at a proper minimum.

Other similar cycles may be used. One additional feature is the use of an air stream thermostat that has its control point reset by the room thermostat. Then as the room temperature rises, the delivery temperature is gradually reduced from a maximum to a minimum.

CONTROL OF REFRIGERATION EQUIPMENT

The most common means of providing cooling for air conditioning may be divided into four general classifications as follows:

Refrigeration compressors may furnish refrigerant to direct expansion cooling coils through which air is being passed, or to coils in cooling tanks through which water is passed which is then pumped to air washers or cooling coils through which the air is passed.

In either case the compressor motor may be started and stopped in order to meet the demand for refrigeration or a pressure controller may be used to regulate the low side or suction pressure of the compressor. When the latter method is used, the flow of refrigerant to cooling coils may be regulated by the opening and closing of a solenoid refrigerant valve at the command of a temperature controller or thermostat.

A high pressure cutout as an individual unit or in combination with either a temperature or pressure controller provides a safety feature against excessive pressures on the high side of the compressor.

Many compressors may be *unloaded* by instruments sensing room or duct conditions, or by refrigerant pressures, thus reducing the frequency of starting and stopping. If two or more compressors are used for a single cooling system, *step controllers* are used to start them in sequence

at intervals of a few seconds to avoid the large momentary electric input that simultaneous starting would demand.

When condensers are water cooled, thermostatic control to vary the quantity of water is needed for economical operation. Mechanical air condensers may be started and stopped with temperature demands.

Chilled water may be stored in tanks at temperatures slightly lower than required for air cooling coils. The control of temperature for the water distribution system is as described for Ice Cooling.

When ice is used for the cooling or dehumidification of air, it is usually placed in bunkers and water is sprayed over it. This water, after being

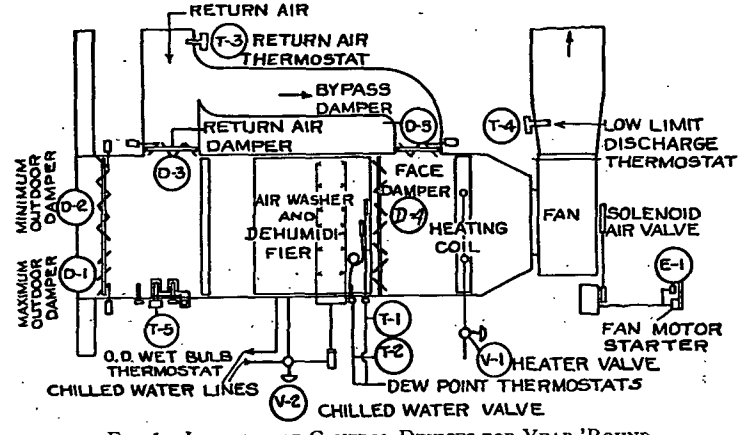

FIG. 1. LOCATION OF CONTROL DEVICES FOR YEAR 'ROUND AIR CONDITIONING SYSTEM

cooled, may be used in air washers or surface cooling coils and is usually returned to the bunker for additional cooling after being used.

Control of the water temperature leaving the cold water tank may be maintained by a temperature controller, which measures the temperature of the water in the tank and modulates a control valve in a by-pass which permits a portion of the return water to return directly to the tank instead of passing through the sprays.

A vacuum refrigerating system consists of an evaporator, compressor, condenser and auxiliaries. The refrigerant used is water, and water vapor (steam) is the power medium.

Water which has been passed through an air washer or cooling coil is sprayed directly into the evaporator or water cooler where it is cooled by its own evaporation. A condenser is attached directly to the compressor discharge and its function is to recondense the water vapor drawn from the evaporator, plus the steam which supplies the energy for compression.

The temperature of the cold water leaving the flash chamber should be measured by a temperature controller which will in turn operate a two-position or positive-control valve installed in the steam line to the jet so as to permit steam to flow only when cooling is required. If city water is