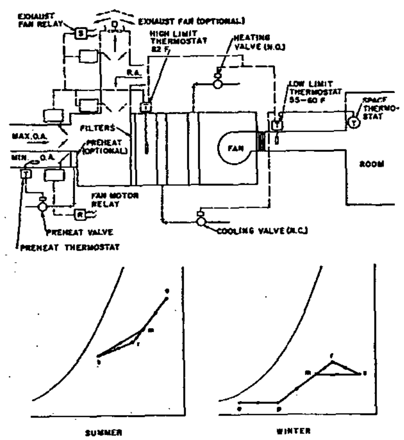

* No definite control of humidity level.

Fig. 4 .... Typical Equipment Arrangement and Psychrometric Process for Simple Heating and Cooling System (Single Zone)*

maximum outdoor air damper would be closed (minimum outdoor air open when fan operates) and the heating control valve open. If the outdoor air is below freezing the valve to the preheat coil would be full open and if above freezing, the preheat coil valve would be full closed. Proportional control of the preheat control valve can cause freeze-up of coil unless special types of coils and steam piping arrangements are used. For two-position control of preheat, the temperature rise through the coil should be a minimum to heat minimum outdoor air from outdoor winter design temperature to above freezing (35 F). For outdoor winter design below 0 F, and sometimes for a 0 F outdoor design, it is desirable to provide 2 preheat coils in series and controlled in sequence. For example, if a single preheat coil were provided for a −20 F outdoor design temperature, it would require a temperature rise of 55 F deg to obtain a leaving temperature of 35 F. On a mild day with 30 F entering the coil, the leaving temperature could be 85 F which would result in overheating. If minimum outdoor air and return air mixture is above freezing and can be arranged to give good mixing, the preheat coil can be eliminated. On a rise in space temperature, the heating valve would close and the maximum outdoor damper would open, limited by the low limit fan discharge controller. On a further rise in space temperature, the cooling valve would open, and if outdoor temperature increased to give a mixing temperature above the setting of the high limit controller, the maximum outdoor air damper would close. The high limit controller can be located directly in the outdoor air stream rather than the mixed air stream as shown in Fig. 4. For the control cycle indicated, it is necessary to have approximately 4 F deg throttling range in the room thermostat between full heating and full cooling and all valves and dampers should be the proportional type. Unless the valves and dampers are carefully sequenced, there would be a chance of heating and cooling simultaneously which would be expensive from an operating standpoint.

Many times it is desirable to provide a summer-winter switch requiring manual control for changeover, since a number of maintenance and checking operations should be accomplished, such as filling cooling tower, checking pumps, etc., before allowing refrigeration equipment to be operated.

The arrangement shown in Fig. 4 is for central station equipment with a single zone only, such as might be used in a large department store. It should be emphasized that the arrangement shown is satisfactory only when humidity control is *not* a requirement.

For obtaining control process No. 2 for cooling control with high limit humidity control in summer and no humidification in winter, there are several possible arrangements. One simple arrangement would be to use the equipment as shown in Fig. 4 and instead of controlling the cooling coil with the room thermostat, control the air leaving the coil at a constant temperature corresponding to the dew point required to pick up the maximum internal latent heat loads without exceeding the maximum desired room humidity. If there is only one unit, this could also be accomplished by regulating the chilled water temperature at the refrigeration machine, instead of reducing the flow. The room dry-bulb temperature would be controlled by reheating the air with the reheat coil as required by the room thermostat. Fig. 5 shows this psychrometric process.

Another method of obtaining controlled high limit for humidity is illustrated by Fig. 6 where only return air is allowed to bypass cooling coil and a minimum dehumidified air quantity of 25 to 50 percent of the total supply is established so that outdoor air and some return air is continuously being dehumidified. The reheat coil usually is placed in the return air bypass.

This scheme has several advantages over the process illustrated in Figs. 4 and 5. A considerable reduction of refrigeration load can be obtained when sensible loads decrease, thereby reducing operating cost. Also it is possible to have less pressure drop in such central station equipment since cooling and heating coils are in parallel rather than in series. By sizing the cooling coil on the basis of a fixed minimum bypass, a smaller face area cooling coil can be provided allowing a saving in initial cost of the coils. The temperature control is more responsive, since in addition to mixing dampers, reheat valves can be simultaneously actuated. Sprays can be added to provide some humidification in colder weather.

Where it is necessary to provide extremely low humidities on the cooling cycle, such as might be required by certain laboratory processes, the required dew point might be close to or below freezing. If the required coil surface temperature

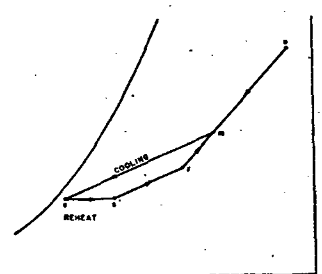

Fig. 5 .... Psychrometric Process for Cooling with Reheat Coil for Controlled High Limit for Humidity

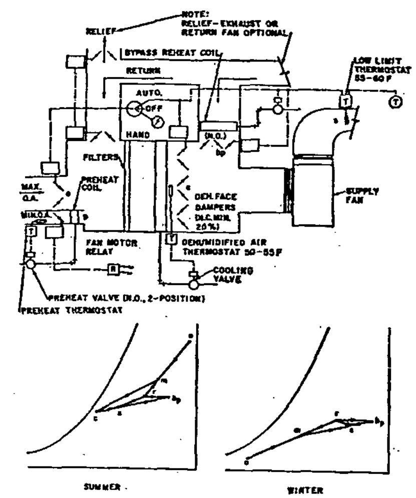

Fig. 6 .... Equipment Arrangement and Psychrometric Process for Bypass System with Controlled High Limit for Humidity

is below freezing, chemical drying or sorption equipment must be used in lieu of refrigeration for dehumidification. Fig. 7 shows a possible arrangement for a process of this nature.

For control cycle No. 3 (cooling and heating control with humidity maintained at a fixed level year-round) a means must be provided for humidification. This particular cycle is a standard requirement for hospital operating rooms and some industrial process air conditioning. Many designers prefer to avoid the use of a humidistat whenever possible, and if the internal latent loads are relatively small and not subject to a wide variation, satisfactory year-round humidity control could be accomplished by means of dew-point control as shown in Fig. 8. Fig. 8 is not intended to represent a hospital operating room application, for 100 percent outdoor air.

For the control cycle in Fig. 8, the sprayed coil dehumidifier must be able to provide air at a high degree of saturation (not less than 95 percent) and the cooling dehumidifier control valve and preheat control valve sequenced. When air leaves the dehumidifier below the dew-point control setting, the preheat valve is open and maximum outdoor air damper closes in winter. When the air leaves above the dew point, the cooling valve is open or in winter the maximum outdoor air damper opens.

If the internal latent heat load is large and subject to wide variation, the method of dew-point control shown by Fig. 8 would not provide close humidity control. For this case, a master room humidistat would be required to reset a submaster dew-point controller to take into account the variable internal latent load.

There are many possible arrangements for accomplishing the control process illustrated by Fig. 8. An air washer could be used in lieu of a sprayed coil dehumidifier. The winter dew-point control could be accomplished by heating the spray

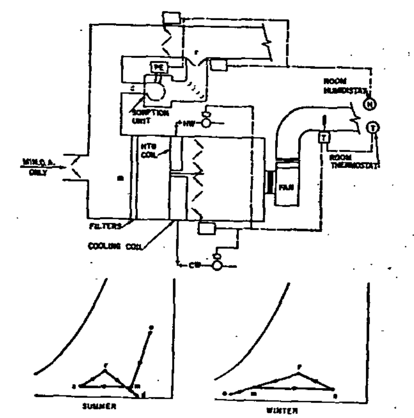

Fig. 7 .... Equipment Arrangement and Psychrometric Process for Chemical Drying or Sorption System

water. Humidification could be provided by steam pan type or steam grid humidifiers in lieu of sprays. The specified arrangement used should be decided on the basis of initial cost, operating and maintenance considerations and allowable variation in the humidity control.

In many air-conditioning processes requiring year around humidity control, it is desirable to lower the dew-point temperature in winter time to prevent condensation on windows or walls. There are several ways of accomplishnig this. One

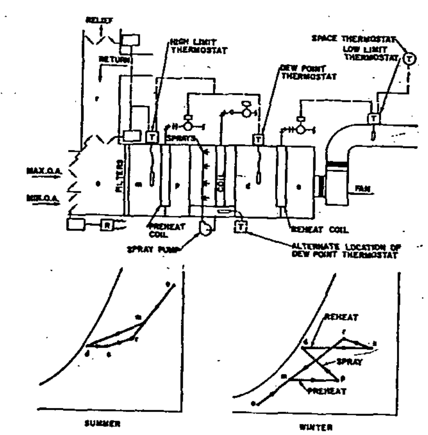

Fig. 8 .... Equipment Arrangement and Psychrometric Process for Year-round System with Sprayed Coil Dehumidifier