motor is stopped, the outside air damper is completely closed. Thermostat 4 in the incoming air is connected to controller 2 in such a manner that, regardless of thermostat 1, when the outside air is above the setting of this thermostat, the outside air damper will be closed to whatever minimum is set by the requirements of a code or the particular use of the system. Thermostat 5 is located at approximately the same point as 1, but controls valve 6 on the preheater so that if the temperature at thermostat 5 falls below its setting (which should be lower than the setting of thermostat 1), the recirculated air will be reheated so that the mixture will rise above this setting. Both controller 2 and valve 6 should be modulating type. The preheater may be placed in the outside air instead of in the recirculated air, but if this is done an additional thermostat will ordinarily be required in the outside air in order to prevent the possibility of freezing the preheater. Room thermostat 7 governs controller 8, which operates a face and by-pass damper as shown, and valve 9 on the reheater coil. The connection is such that if the room temperature is below the setting of thermostat 7, the by-pass damper will be closed and the face damper opened and, if necessary, more steam admitted to the reheater coil. Duct thermostat 10 inserted in the fan discharge is connected with thermostat 7 so that if the fan discharge temperature falls below the setting of thermostat 10, controller 8 and valve 9 will be moved in the direction to deliver more heat. Both controller 8 and valve 9 should be modulating type. Room thermostat 11 and duct thermostat 12 together control the cooling equipment which is shown as a relay to start the compressor. These thermostats must be respectively set for higher temperatures than thermostats 7 and 10. They are arranged so that if the temperature of the room exceeds the setting of thermostat 11, the cooling will be initiated unless the temperature of the fan discharge is below the setting of thermostat 12. Hygrostat 14 is also arranged to control relay 16 but in such a manner that if the relative humidity is above the setting of hygrostat 14, the cooling will be initiated regardless of the temperature in the fan discharge. In this case, the fan discharge temperature will be controlled by thermostat 10. Hygrostat 15, set much lower than hygrostat 14, is shown controlling a valve 13 for a spray type humidifier.

Heating Season Operation

Temperatures indicated in Fig. 11 will be used in the following description of operation as they are fairly indicative of an average installation of this type. The temperature at thermostats 1 and 5 will be maintained at 60 F if the weather is not too severe (below about 15 F if a minimum of 25 per cent outside air is required) by movement of the outside air and recirculated air dampers through the medium of controller 2. If the weather is extremely cold, the temperature at this point will be maintained at 55 F by means of thermostat 5. If the room temperature is below 72 F (the setting of thermostat 7), controller 8 and valve 9 will move in the direction to increase the heat until thermostat 7 is satisfied, after which they will move in the direction to decrease the heat until the duct temperature falls to 60 F. Hygrostat 15 will introduce moisture if the relative humidity in the room falls below 30 per cent.

Even in rather cold weather cooling is sometimes required, but will be

supplied without artificial refrigeration since the thermostat 7 will be above its setting and the fan discharge will be held at 60 F. The starting of the compressor will be prevented by thermostat 12 even if the room temperature goes above 75 F.

Cooling Season Operation

If the weather is very warm, thermostat 4 will close the outside air damper to its minimum position, and thermostat 1 will no longer be in control. If the compressor is stopped, the temperature at thermostat 12 will exceed 62 F which will cause the compressor to start provided the room temperature is above 75 F (the setting of thermostat 11). However, if the relative humidity exceeds 55 per cent, the temperature of the air leaving the cooling coils should be reduced as much as possible, and under this condition hygrostat 14 (as previously described) causes the compressor to run continuously. If sufficient cooling capacity is provided, the temperature leaving the cooling coils will fall below 60 F (the setting of thermostat 10) which will cause controller 8 and valve 9 to reheat the air to 60 F, thus providing maximum dehumidification and a satisfactory entering air temperature.

If cooling is required in mild weather (for example, 55 F outside), the control functions as before except that thermostat 1 is in control of the outside air and recirculated air damper, and sufficient cooling and dehumidification may be provided by the outside air alone. However, if insufficient cooling or insufficient dehumidification (or both) can be obtained in this manner, the fan discharge temperature will exceed 62 F with the room thermostat 11 above its setting, or the relative humidity will exceed the setting of hygrostat 14, and the artificial refrigerating system will again come into operation.

PROBLEMS IN PRACTICE

1 ● What important functions of heating, ventilating, and air conditioning systems do automatic controls fulfill?

Controls are applied to maintain adequate requirements for human confort and efficiency; to maintain requirements for industrial processes; to obtain economy in operation; and to provide necessary safety measures.

2 ● How may temperature control be obtained in a room heated by a unit heater?

With constant steam supply, the unit heater motor may be started or stopped by a thermostat, either directly or through a relay. With intermittent steam supply, operation of the motor by thermostat can be limited to the time that steam is available, by using a reverse-acting temperature or pressure limit switch.

3 ● How may temperature control be provided in a room heated and ventilated by a unit ventilator which includes two extended-surface units?

Operation of the unit for service during occupancy of the room may be manual, by switch, or by time clock. When the desired temperature level is reached, the outside air intake may be controlled by a damper motor coupled with the fan motor circuit by means of a thermostat. The outside air damper will operate to a given position in either case.

Air passing through the unit may be preheated through the first heating coil to a definite temperature by a control valve on the steam supply governed by a temperature controller reacting to the temperature of the air on the outlet side of the convector. The second