

Except for heating-up periods or other times when the heat gain is not greater than the heat loss, a system of this type can be operated without artificial heat, with outdoor temperatures as low as 40 F. For this reason it is economical to place a thermostat in the return air near *D* set to shut off a diaphragm valve in the main steam supply to the system at a temperature about 3 deg below that desired in the conditioned space. A pilot thermostat exposed to the outdoor temperature prevents the shut-off on days colder than 40 F.

As previously stated, there can be many variations from these descriptions, some of which are:

1. Tempering coils may consist of only one bank, *P* or *Q*, controlled by either *A* or *B* thermostat. In any case the capacity of the heating unit controlled by the outdoor temperature must be as low as feasible, otherwise if steam is supplied to it when the outdoor temperature is 30 F, the temperature of air entering the washer is likely to be too high to permit maintaining the proper dew-point temperature.

2. Both tempering coils may be omitted and return air mixed with outside air by

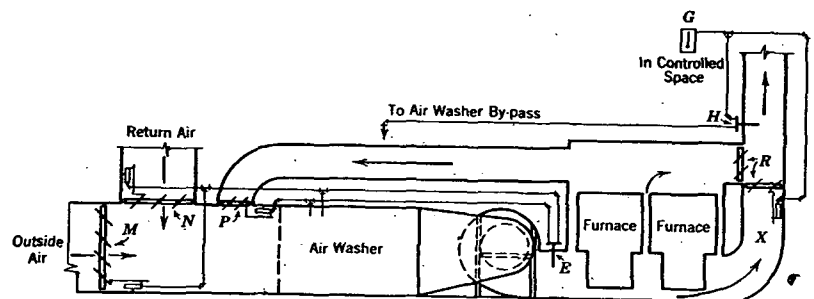


FIG. 16. DIAGRAMMATIC ARRANGEMENT OF CONTROL FOR A FAN-FURNACE AIR CONDITIONING SYSTEM

thermostat *C* so as to provide a proper temperature at the washer inlet. In this case, humidistat *D* should not act as a pilot.

3. The heating unit for the air washer water may be omitted, and the proper dew-point temperature maintained by placing thermostat *C* in the location of *E*. This requires additional heat from the tempering coils, or more return air to make up the loss due to evaporation in the washer.

4. Heating unit *S* may be combined with *R* in one or two banks and controlled by a one- or two-point thermostat at *F*, set for the minimum temperature at which air can be admitted into the conditioned space. For heating purposes, thermostat *G* then becomes a pilot for *F* so that these heating units are operating at full capacity when the space is cold, and are throttled by *F* when no heat is required.

5. A better arrangement than that described in the preceding paragraph is the use of an automatically readjustable thermostat at *F*, which can operate at any temperature between a proper minimum and a necessary maximum, depending on the temperature of the space. Thus for winter operation when the room temperature is 68 F, the blower delivers air sufficiently warm to supply the heat required under extreme conditions, and when it is 74 F, the delivery will be as cool as possible without complaint of drafts. A similar instrument can be used to replace *H*, and set to operate between 60 and 80 F for summer conditions.

6. For summer use, a remote readjustable thermostat can be located at *H*, and can be reset by a pilot exposed to the outdoor temperature. Thus as the outdoor temperature increases, the space temperature is maintained at a higher point.

7. A constant portion of the return air may be brought to a point between the air washer and the blower, and the temperature of the air leaving the washer regulated to give the proper result at *H*. The regulation is accomplished by shutting off one or more groups of sprays, or by changing the temperature of the spray water until the proper degree of cooling is secured.

8. Where an air washer is selected large enough to pass all the air handled by the fan, the by-pass and its damper *O* are not used. The washer sprays must then be divided into two side-by-side sections so that one section can be turned on or off by *H* to provide the proper temperature.

9. Where an ejector type heating unit is used for the spray water, a reverse-acting valve similar to *W* (Fig. 15) must be placed in the steam supply to be operated by thermostat *E*. In this case it is usual to install in this steam line another reverse-acting diaphragm valve to be operated directly by the water pressure in the pump discharge line. This automatically shuts off the steam when the water circulating pump is not in operation.

10. Based on the fact that the spray water in the air washer pan has practically the same temperature as the air leaving the washer, dew-point control can be accomplished by installing thermostat *E* in the water pan.

11. Where cold well-water is used for dehumidification, it is admitted to the sprays through a three-way valve similar to *V*, operated by thermostat *E*.

12. Control of steam heat is shown entirely by valves, although it is usual to install a by-pass damper around each heating unit and operate it, either with or without a damper over the face of the heating unit, in conjunction with the valve.

### Capacities to be Selected

In designing apparatus to be automatically controlled, it is advisable to select minimum capacities for desired results. This not only assists the control system, but tends to produce desirable economies in initial costs. For example, in Fig. 14 the heating unit *R* selected should be one having a capacity that will just raise the temperature from the lowest desired dew-point (about 40 F) to the highest dry-bulb temperature required at *F* (about 70 F). Similarly, heating unit *S* should be of sufficient capacity to raise the temperature only enough to provide the heat necessary for the space to be conditioned.

Dampers should be sized so that extreme conditions will require the full open and closed position. For example, if it is desired that some minimum amount of outside air be supplied constantly during operation of the plant, damper *M* should be divided into two parts, one of which is operated by the thermostat and the other, large enough to supply the constant minimum, is operated by a separate positive-acting switch.

### FAN-FURNACE AIR CONDITIONING SYSTEMS

The theory of control of mechanical warm air or fan furnace systems described in Chapter 23 is the same as for other types of central fan systems, but the methods are somewhat different. Fig. 16 shows the arrangement for winter operation.

#### Winter Operation

1. Thermostat *E* is a two-point instrument with one direct- and one reverse-acting relay. The former operates the normally-closed damper *M* and normally-open damper *N*, thus mixing return air to obtain the proper temperature (40 to 50 F) at the discharge