ture at the air conditioner outlet. A dry-bulb thermostat is located in the room to maintain a constant dry-bulb temperature, which in combination with a constant wet-bulb temperature fixes the relative humidity.

3. A differential thermostat may be used to control relative humidity. This instrument consists of two thermostatic elements, one of which is in the path of the air leaving the conditioner, and the other under the influence of the dry-bulb temperature in the room. Instruments of this kind maintain a constant relative humidity by maintaining a constant difference between the dew-point temperature and the dry-bulb temperature in the room. (See Item 2 under Air Conditioning Systems.) One thermostatic element may be equipped with a moistening device to permit it to operate on wet-bulb temperatures. Such an instrument can be used to control the wet-bulb depression and thus the relative humidity.

4. A humidistat which responds directly to changes in humidity may be used to maintain a predetermined relative humidity with constant or with varying temperature. It may do this by varying the dew-point temperature of air leaving a conditioner; by varying, with dampers, the proportion of moist and dry air; by varying the amount of moisture otherwise added to the air; or by varying the dry-bulb temperature.

Humidification for Residences

The principles underlying humidity requirements and limitations for residences are summarized in *University of Illinois Bulletin No. 48*[1], as follows:

1. Optimum comfort is the most tangible criterion for determining the air conditions within a residence.

2. An effective temperature of 65 deg[2] represents the optimum comfort for the majority of people. Under the conditions in the average residence a dry-bulb temperature of 69.5 F with relative humidity of 40 per cent is the most practical for the attainment of 65-deg effective temperature.

3. Evaporation requirements to maintain a relative humidity of 40 per cent in zero weather depend on the amount of air inleakage to the average residence, and vary from practically nothing to 24 gal of water per 24 hours.

4. Relative humidity of 40 per cent indoors cannot be maintained in rigorous climates without excessive condensation on the windows unless tight-fitting storm sash or the equivalent is installed.

5. The problems of humidity requirements and limitations cannot be separated from considerations of good building construction, and the latter should receive serious attention in the installation of humidifying apparatus.

The following conclusions were drawn from the experimental results reported in the aforementioned bulletin:

1. None of the types of warm air furnace water pans tested proved adequate to evaporate sufficient water to maintain 40 per cent relative humidity in the Research Residence except only in moderately cold weather.

2. The water pans used in the radiator shields tested did not prove adequate to maintain 40 per cent relative humidity in a residence similar to the Research Residence when the outdoor temperature approximated zero degrees Fahrenheit.

Central Fan Air Conditioning Systems

In central fan air conditioning systems as described in Chapters 9 and 22, varying amounts of outside and recirculated air are used, except where contamination prevents re-use, and in general for obtaining humidity control under winter conditions heat is supplied to the air after it has passed the air washer. There are many control variations in use, and

[1]See Humidification for Residences, by A. P. Kratz (*University of Illinois, Bulletin No. 48*).

[2]Sixty-six deg is the optimum winter effective temperature recommended by the A.S.H.V.E. Committee on Ventilation Standards. See Chapter 2.

Fig. 9 shows a composite diagram, rather than a system of control for a single installation. The control valves for a dehumidifying air washer are shown in Fig. 10. The functions of the control devices shown in Figs. 9 and 10 are as follows:

Winter Operation (With Steam)

1. Thermostat *A* opens a direct-acting valve in the steam supply to a low-capacity tempering coil *P*. The thermostat is set at 35 F.

2. Thermostat *B* in the path of the air leaving the second tempering coil *Q* controls a valve in the steam supply to the coil *Q* at 45 F.

3. Thermostat *C* controls the intake *M* and return air *N* dampers at 50 F. This location of thermostat *C* is primarily for operation with steam heating and at such times as by-pass damper *O* is closed. See discussion under the heading *Spring and Fall Operation*.

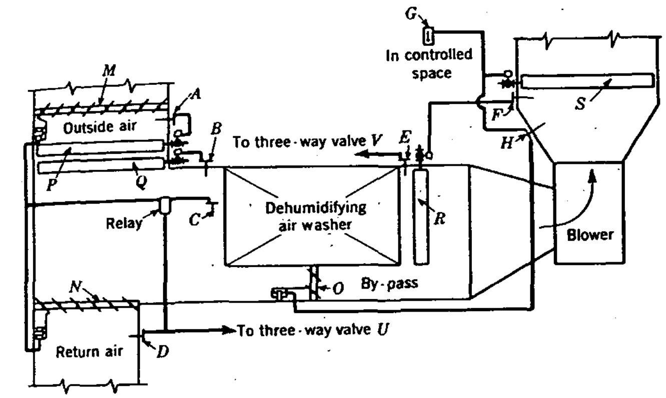

Fig. 9. Diagrammatic Arrangement of Various Phases of Control for a Central Fan Air Conditioning System

4. Humidistat or wet-bulb thermostat *D* in the return air, acting through a relay, causes *C* to call for outside air when the relative humidity rises above 55 per cent or the wet-bulb temperature rises above 60 F; also, if necessary, thermostat *D* shuts off the water supply to the spray heads in the air washer and opens the supply to the flooding nozzles at the eliminator plates, by operating the three-way valve *U* (Fig. 10). The relative humidity must, of course, be changed to suit the requirements. It must be maintained low enough to avoid condensation on walls or windows.[3]

5. Thermostat *E* in the discharge end of the air washer operates a three-way valve (*V*, Fig. 10) in the water circulating line so as to cause water to pass through or around a heating unit in order to produce the correct dew-point temperature by adding any necessary heat to the water. It may also operate a reverse valve *W* (Fig. 10) in the steam supply to the heating unit. The heat added may be only that sufficient to make up the temperature drop through the washer caused by evaporation. This thermostat is reverse-acting to prevent over-humidification in case of failure of the motive power.

6. Thermostat *F* in the fan discharge operates a valve in the steam supply to the heater *R* in order to produce the lowest temperature at which air can be introduced into the conditioned space, without complaints of draft. This varies from 60 F to 70 F, depending on the velocity through the supply grilles and their location.

[3]See discussion of condensation in Chapter 7. Also see paper entitled Frost and Condensation on Windows, by L. W. Leonhard and J. A. Grant (A.S.H.V.E. Transactions, Vol. 35, 1929).