when the fan is stopped. This prevents evaporation of water which might later condense in the ductwork and cause damage. Since untreated city water is evaporated there are none of the objectionable odors usually caused by chemically treated boiler water. Such odors often are noticeable with steam jet humidifiers.

Control of steam jet humidifiers is the same as for pan humidifiers.

Control of atomizing water spray humidifiers also is the same as for pan humidifiers except that two-position valve action must be employed. This action is necessary in order to obtain efficient atomization.

Fig. 22 shows an example of winter dew-point control of an air washer humidifier. A space or return-air humidistat readjusts the set point of the dew-point controller to compensate for latent load changes. If the latent load of the space is constant then the humidistat can be omitted in which case the dew-point controller would control at a constant set point. The dew-point controller increases the temperature first by closing the maximum outdoor-air damper and then by gradually opening the water heater valve.

Static-Pressure Control

Since fans are selected to produce the desired results for a certain system characteristic, any change in the system characteristic will change the output of the fan. Such changes occur, for example, on single-duct systems in which the volume of air delivered is varied and in double-duct systems where quantities of air are shifted from one duct to the other to obtain final space control. System characteristics may also change when the relative quantities of outdoor air and recirculated air are varied, when exhaust fans are run intermittently, and for other reasons. Such changes result in a changing static pressure in the system, a changing noise level, and changing velocities at air outlets which upset the air-flow patterns.

Static-pressure control of some form is usually required on such systems, and is accomplished by a static-pressure controller measuring the pressure at a selected point in the system with respect to an atmospheric reference point or some other point inside the building. It can be used to actuate a damper operator on fan inlet vanes, on a multiblade damper on the suction or discharge side of the fan, or on a damper in a bypass connection between the fan discharge and the fan suction.

Fig. 23 shows a simple method of static-pressure control. Here a differential-pressure controller measures the static pressure in the supply duct in relation to some reference space such as outdoors. With increase in duct static pressure due to throttling of space volume control dampers the controller throttles the static-pressure damper proportionately. For controlling system static pressure, louver dampers may be installed on either the suction or discharge side of the fan or fan inlet vanes may be employed. To control static pressures in various sections of a distribution system, louver dampers are installed in the inlets to the various sections, with separate static-pressure controllers for each section. Measuring tubes must be located within the system or section at a point where constant pressures are most desirable.

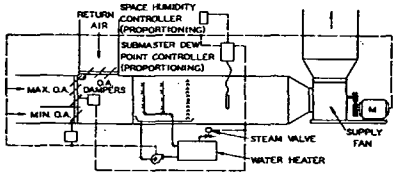

Fig. 22 .... Control of Air Washer Humidifier With Submaster Dew-Point Controller

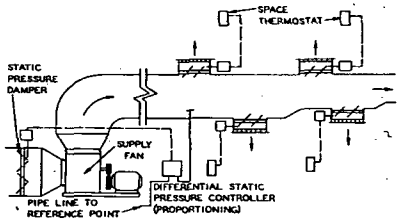

Fig. 23 .... Static-Pressure Control in Variable Volume System

Control of a Typical Central Fan System

Fig. 24 shows an example of control arrangement using some of the system components previously described and referred to in Part II of this chapter under Design Coordination. The controls can be pneumatic, electric, or electronic.

When the fan is started relay *E-1*, actuated by the fan-motor starter, opens outdoor-air damper *D-1*, places humidistat *H* in service, and allows insertion thermostat *T-1* to operate preheat coil valve *V-1*, maximum outdoor-air damper *D-2*, return-air damper *D-3*, and exhaust damper *D-4*. When the fan stops, *E-1* is de-energized thereby closing dampers *D-1*, *D-2*, and *D-4* while opening *D-3*. Humidifier valve *V-4* is closed and preheat valve *V-1* is opened.

The sequence of operation described will in general also apply to high-pressure fan systems except that it is considered desirable to open the outdoor-air damper before starting the fan. With this arrangement, a manual switch operates damper *D-1*. An auxiliary switch mounted on the damper starts the fan when the damper is *fully* open. It also stops the fan when the damper *starts* to close.

Insertion thermostat *T-1* maintains a temperature of 55 F at the preheat coil discharge by operating preheat coil valve *V-1*. This serves as a low limit for the fan discharge temperature during heating operation. When *V-1* is closed, thermostat *T-1* then gradually opens maximum outdoor-air damper *D-2* and closes return-air damper *D-3* proportionately. At 55 F outdoor temperature *D-2* is wide open and *D-3* is closed. Exhaust-air damper *D-4* opens and closes in synchronization with *D-2*. At about 70 F outdoors, when the outdoor air is no longer useful for natural cooling, *T-2* closes *D-2* and *D-4* and opens *D-3*.

Reheater coil valve *V-3* is controlled by submaster thermostat *T-3* in the fan discharge. This thermostat is automatically readjusted over an appropriate range of temperature by thermostat *T-4* so that the discharge temperature matches the space requirements. When the space temperature tends to rise above a predetermined value, *T-3* has been readjusted downward far enough to keep reheat valve *V-3* closed. *T-4* then controls cooling coil valve *V-2* directly to maintain the desired space temperature.

Humidistat *H* operates humidifier valve *V-4* to maintain the desired humidity in the conditioned space. It is usually adjusted to maintain 30 to 40 percent relative humidity, and therefore keeps the humidifier off during cooling operation when the humidity is higher.

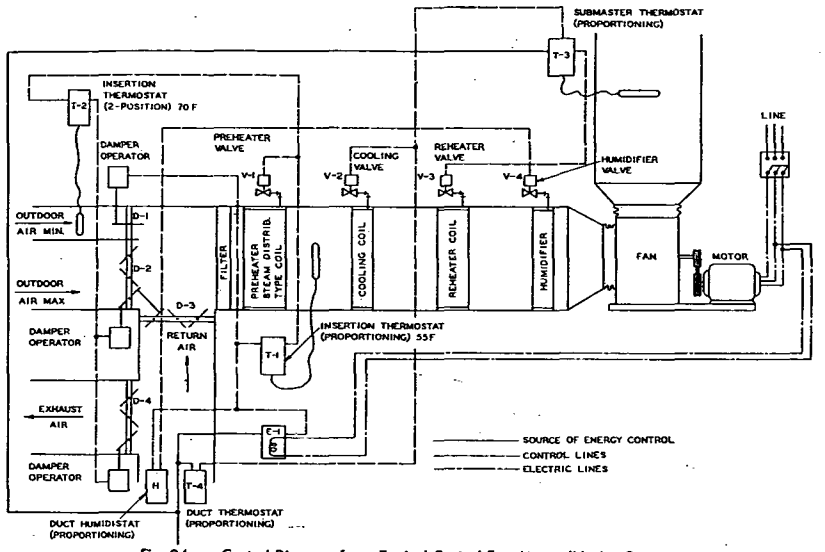

Fig. 24 .... Control Diagram for a Typical Central Fan Air-conditioning System

TEMPERATURE CONTROL IN HOT WATER SYSTEMS

Hot water heating systems permit use of relatively simple automatic temperature control for the purpose of reducing operating costs and providing comfortable temperatures. On installations not requiring different supply-water temperatures simultaneously and where the boiler is not used to heat domestic hot water, outdoor reset control of the supply-water temperature may be obtained by direct control of the burner from a thermostat that is located in the boiler water and is reset in accordance with outdoor temperatures. A seperate high limit control should be provided.

In systems using converters for a hot water supply, a controlling thermostat actuated by the leaving water temperature modulates the heat source to the converter. The set point of this supply-water thermostat can be readjusted in accordance with outdoor temperature.

In some systems a boiler or converter supplies water at a constant temperature, and three-way mixing valves are used to supply water at different temperatures for various uses or to multiple zones. In these cases, a three-way mixing valve under control of a thermostat in the valve discharge blends boiler water with return water to provide supply water at the desired temperature. The control setting of this thermostat in the valve discharge can be reset in accordance with outdoor temperatures.

On systems using outdoor-reset supply water and lowered night or week-end temperatures, provision should be made for warmup on restoration to day or normal operation. This can be accomplished by a program control, a warmup space thermostat, or some similar means of providing higher than normal water temperatures during the warmup period.

A measure of control can also be accomplished by use of a room thermostat to operate the burner. This type of control is applicable only to residences or very small commercial installations, where there is no great difference in heating requirement throughout the building. Where a difference in heating requirements throughout the building does exist, it is advisable to control the supply-water temperature with provision for automatic control or manual adjustment of heating unit output in individual spaces.

Economical zone control can be obtained by separate return or supply piping for zones, with a zone thermostat to operate zone pumps or automatic valves. The piping for each zone should be isolated to avoid a common return line, because in many cases the return water from one zone is warmer than required for the supply water to another zone.