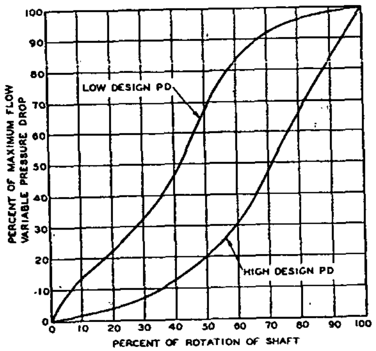

Fig. 9 . . . . Effect of Pressure Drop Selection on Opposed-Blade Damper Performance

velocity coil section where it would have a design pressure drop of less than 0.1 in. water, if it is expected to control with 2 to 3 in. pressure drop during periods of low flow. It should be placed in a high-velocity section where the design pressure drop will be 0.5 in. water or more, careful consideration being given to avoid excessive turbulence on either entering or leaving side of the damper.

ZONE CONTROL

Zone control for any heating, ventilating, or air-conditioning system is employed where it is desired to control, by one set of controls, the heating or cooling effect in a number of rooms or areas, having similar orientation or occupancy. For zone control to be successful the requirements must be approximately consistent throughout the extent of the zone. Whether zoning a building for heating or cooling, the following factors should be considered in determining the number and arrangement of the zones:

1. *Exposure*. Solar effect, prevailing winds, and the shelter afforded by surrounding structures affect the heat gain or loss.
2. *Occupancy*. Indoor temperature requirements for the various activities carried on in different portions of the building and the hours of occupancy of the various spaces impose definite control problems.
3. *Building Structure*. The physical characteristics of the building will influence the subdivisions of the system into zones since satisfactory temperature conditions throughout a single zone of given extent may not be obtainable equally in buildings of dissimilar types of construction. Other factors are the height of the building and its horizontal extent and form.
4. *Floors*. Even though several floors have the same wall exposure, it is advisable to have separate zones on the lowest and highest floors due to variations of basement or ground floor requirements and the effect of roof exposure. It is also desirable to have a separate zone or zones for the intermediate floors.

The initial investment will often influence the decision as to the final number of zones to be employed. In larger buildings accepted practice is to have at least one zone for each exposure. Each exposure may require subdivision vertically into two or more zones for the higher structures. Also, the presence of two or more wings having the same general exposure may suggest the desirability of more restrictive zoning. When the street floor or any other portion of the building is used for public occupancy or activities which differ from those carried on in the remainder of the building, it is desirable to provide separate thermostats and controls for each individual area.

Zone controls alone may not provide satisfactory temperature conditions in all rooms or areas within the zone because occupancy, lighting load, space arrangements, and similar factors cannot always be predicted with accuracy. A combination of zone controls with individual room control in critical areas may be necessary to achieve complete satisfaction.

INDIVIDUAL ROOM CONTROL

The ideal temperature control system for any building is one that promotes maintenance of the desired temperature in every room at all times regardless of location and occupancy. Individual room temperature control is desirable for securing proper thermal environment in schools, hospitals, and offices.

Control of the temperature in each room, or possibly of adjacent rooms having the same orientation (as in an apartment), overcomes many of the problems encountered when attempting to regulate the temperature of a building as a whole or of large areas or zones. Each individual thermostat controls the heat input to its particular space regardless of occupancy or exposure to sun and wind. The advantage of individual room control is in fuel economy and comfort for the occupants. Each room should have a thermostat that controls valves or dampers on all the controllable sources of heating and cooling. One such uncontrolled source may prevent proper operation of the control system.

PART III—CONTROL APPLICATIONS

Applications of controls to systems or apparatus of a general nature will be found in this section. Applications pertaining to specific systems or apparatus will be found in the chapters covering these subjects. The application of controls may conveniently be considered for the three divisions of a system indicated in Fig. 10: (1) *primary source apparatus*, (2) *distribution system*, and (3) *terminal equipment*.

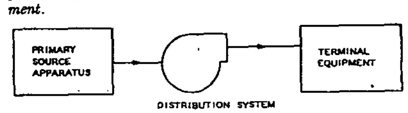

Fig. 10 . . . . Three General Divisions of Control Applications

PRIMARY SOURCE APPARATUS

The control of *primary source apparatus* is described in the following chapters: Chapter 18, Warm Air Heating Systems, Chapter 34, Automatic Fuel-burning Equipment, Chapter 39, The Heat Pump, and Chapter 38, Refrigeration. The second and third divisions are considered in this section.

DISTRIBUTION SYSTEMS

The control of distribution systems is discussed separately for central fan systems, hot water systems, zoned steam systems, and zoned hot water systems, due to the difference in these systems.

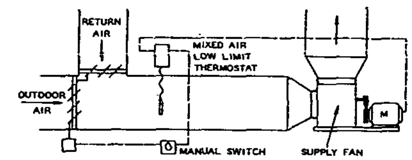

Fig. 11 . . . . Manual Adjustment of Outdoor-Air Quantity With Low-Limit Control of Mixture Temperature

CENTRAL FAN SYSTEMS

Refer to Chapter 19 for additional material on control for a typical central fan system.

Since there are numerous control combinations that can be employed with central fan systems, the following sections will deal with only a few of the typical combinations for controlling outdoor- and return-air dampers, preheat coils, heating coils, cooling coils, and humidity control. The complete control system is obtained by combining the selected method for each item into an integrated set of controls. Proper consideration must be given to the interrelation of the several parts and the sequence of operation, etc.

Outdoor-Air Damper Control

Outdoor air for ventilation is usually controlled by a damper arrangement providing a homogeneous mixture of outdoor air and recirculated air. Outdoor air to meet minimum ventilation requirements should be available whenever the fan is running and is usually provided in one of the following ways:

a. By a minimum outdoor-air damper which is fully open when the fan is started. A maximum outdoor-air damper may also be provided if additional outdoor air for natural cooling is desired.

b. By an outdoor-air damper which opens to a minimum position when the fan is started. Additional outdoor air is provided by further opening of the damper under automatic control.

Recirculated-air and exhaust-air dampers are synchronized to operate with the outdoor-air dampers. Mechanical interconnections are preferable but separate operators on each of the dampers can be used when mechanical interconnections are impractical. In most arrangements provisions are made to prevent admission of more than the minimum outdoor air required for ventilation both during heating operation and when the outdoor-air temperature is too high to

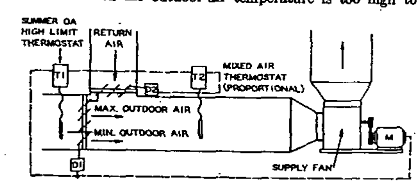

Fig. 12 . . . . All-Season Ventilation Control With Fixed Minimum Outdoor Air Plus Additional Outdoor Air When Practicable

provide some natural cooling. Provisions should also be made to close the outdoor-air and exhaust-air dampers and open the return-air damper whenever the fan is stopped.

Fig. 11 shows a system having manual adjustment for maximum outdoor air and having an optional, but very desirable, mixed-air thermostat. This thermostat overrides the manual switch whenever the mixed-air temperature drops below its set point. This provides for a minimum mixed-air temperature for safety of downstream equipment. Whenever the fan motor is stopped the outdoor-air and exhaust-air dampers close while the return-air damper opens.

Fig. 12 shows an all-season ventilation control system with a fixed minimum quantity of outdoor air and automatic control of maximum outdoor- and return-air dampers. This arrangement is sometimes referred to as an economizer control of outdoor air. With outdoor-air temperatures below the set point of the summer thermostat, the mixed-air thermostat positions the outdoor- and return-air dampers. When outdoor-air temperature rises to the set point of the outdoor high-limit thermostat, usually about 70 F, the maximum outdoor-air damper is closed and the return-air damper opened. The minimum quantity of outdoor air is assured by the separate minimum outdoor-air damper. Both outdoor-air dampers are closed and the return-air damper opened whenever the fan motor is stopped. By adding a thermostat in the conditioned space or in the return-air duct the opening of the maximum outdoor-air damper can be limited to only the desired minimum quantity of outdoor air until the space heating requirements are satisfied. This feature is desirable for quick warm-up during winter heating.

Preheater Coil Control

The function of a preheater is to temper the outdoor air to prevent the possibility of freezing beyond the coil. Care must be taken to avoid freezing in the coil itself. The proper selection, installation, and sizing of steam traps are very important to assure rapid elimination of condensate to prevent freezing. Other important considerations are vacuum breakers to insure condensate removal, provisions for rapid air elimination from coil, and the use of vertical rather than horizontal tubes wherever possible.

Fig. 13 shows a simple application of an outdoor thermostat usually set for 35 F controlling the preheat coil valve. Careful sizing of the coil is very important with this type of control. The temperature rise through the coil should be limited to a maximum of 30 deg when the entering air is 35 F. A higher temperature rise will very likely cause overheating of the space. If more than a 30-deg temperature rise is needed then multiple coils should be used and their control valves operated in sequence at selected outdoor temperatures.

Fig. 14 offers a method of control which reduces the

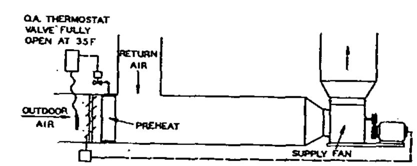

Fig. 13 . . . . Control of Preheat Coil From Outdoor Air