the building for recirculation of the air when desired, and a duct system attached to the fan outlet to convey and distribute the air to various parts of the building to be warmed by the apparatus. The fan is ordinarily motor-driven; there are, however, many cases when a direct-connected steam engine may be used to advantage. In this event the exhaust from the engine can be connected to one or more sections of the heater, depending upon the condensation rate of the engine. The recirculation duct connected with the opening in the suction duct, should be extended to a point as near the floor as possible.

When ventilation is not a requirement or is considered relatively unimportant, as in shop and factory heating, and the number of persons vitiating the air is small compared with the cubical contents of the building or the process does not generate obnoxious gas or vapors, the air may be recirculated, sufficient outside air for ventilation being supplied by infiltration. The amount of heat to be supplied the heater in this case is the same as would be required for a direct radiation installation.

When ventilation is a requirement to be met, an arrangement similar to that shown by Fig. 10 may be employed. Since the amount of air necessary for heating is generally in excess of the amount required for ventilation, considerable fuel economy may be effected by recirculating a portion of the air. In this case only sufficient outside air is drawn into the system to meet the ventilation requirement and the remainder of the air, required for heating, is recirculated. This may be readily effected by an arrangement of ducts and dampers on the suction side of the fan as previously mentioned. If the outside air introduced is to be washed or conditioned the washer or humidifier and tempering coil may be added between the inlet for the recirculated air and the fresh air intake. (See Chapter 30).

The draw-through apparatus is employed on account of its compactness as well as the advantage gained by connecting the fan directly to the duct system. In this case the temperature of the air delivered will be the same to all parts of the building. The blow-through apparatus, Fig. 9, is sometimes used where different temperatures and independent temperature regulation are required for different rooms of the building. Modern practice, however, seems to favor the draw-through system, delivering the air to all rooms at the same temperature, and taking care of varying temperature requirements by the use of booster coils located in the various ducts. The use of the bypass around the heating coils permits the mixture of hot and cold air in any desired proportions, by the use of a mixing damper at the point where the two ducts from the heater, and from the bypass, join to form one duct leading to the room. In the case of public buildings, the fan frequently blows the warm air into a plenum chamber, from which the air ducts radiate to the various rooms of the building; this arrangement is sometimes called the *plenum system*.

Heating Units for Fan Steam Systems

The heating surface for fan steam systems in use at the present time consists either of pipe coils, finned tubes of steel, copper, brass or other metal, cast-iron sections with extended surfaces, or cellular type of heating units. Steam is passed through these heating units and the air to be heated is passed over the exterior heating surface.

In selecting a heater for any particular service, the choice should be based on the desired requirements as follows:

1. Final temperature desired.
2. Loss in air pressure (or friction) through the heater.
3. Velocity through the heater.
4. Free area or face area of heater.
5. Ratio of heating surface to net free (or face) area.
6. Air volume required.
7. Rows deep of pipe, tubes or sections.
8. Amount of heating surface.

Final Temperature Desired. The choice of a heater is largely influenced by the final temperature desired, when the entering air temperature and steam pressure available at the heaters are specified. These data are obtainable from manufacturers' catalogs for various types of heaters.

Loss in Air Pressure (or Friction). The allowable friction through the heater is one of the first factors to be determined in the selection of the apparatus. The velocities of air through various types of heaters will not necessarily be the same, but for any particular job the velocity through the heater should be a secondary consideration and the allowable friction or air pressure loss should be fixed approximately before proceeding with the selection of the heater. The loss in air pressure (or friction) through the heater should not exceed a pre-determined maximum allowable amount for economical operation and for moderate size and first cost of installation.

In public building work, the maximum allowable friction through both tempering coil and reheater coils should never exceed $\frac{5}{8}$ in. of water and it is advisable that the friction be kept considerably lower than this figure if possible. A tempering coil friction ranging from 0.10 to 0.20 in. of water is considered satisfactory. The air pressure loss for reheaters ordinarily ranges from 0.20 to 0.40 in. of water. In factory work, the maximum friction through the heater should never exceed 0.8 in. or 1 in. of water and it is advisable to figure the heaters at lower frictions if possible.

Velocity through Heater. This velocity has generally been given in manufacturers' tables as being measured at 70 F and in most cases refers to the velocity through the net free area of the heater, or through the net space between the pipes, tubes or sections. Although most manufacturers give suitable velocities measured at 70 F, certain manufacturers show velocities measured at 65 F and others indicate velocities measured at the average air temperature through the heater. Many new heaters, however, specify net face areas with corresponding velocities, instead of velocities through net free areas. In either case, manufacturers publish the corresponding friction or air-pressure loss in tables.

Temperature Control of Fan Steam System

Control of the temperature can be accomplished in a simple manner by a single thermostat placed in a suitable position in the heated space and actuating steam valves on the heater sections. A popular method of controlling the temperature is by mixing dampers, permitting the bypassing of a certain amount of air around the heaters and mixing with the