Figs. 36 and 37 show typical connections to indirect cast iron convector heaters, and apply to vapor and vacuum systems especially. Figs. 38 and 38 show duct connections to such heaters.

Pipe Coil Connections

Fig. 39 shows practicable piping connections to pipe coils. It is important that the supply valves for all radiators which come below the supply mains shall be above these mains, or that there shall be a drainage connection consisting of a trap or of a pipe leading to the wet return, depending on the type of system, above these supply valves. Without such provision water will condense above the valves when they are closed and this may cause objectionable noise or damage when the valves are opened.

Blast Heater Connections

Fig. 40 shows vacuum system returns for fan-blast heaters with the auxiliary air vent piping and air-line valves usually required with these heaters, especially when they are of cast iron.

Fig. 41 illustrates another typical blast heater piping hook-up frequently encountered, but with which only the return ends have auxiliary air vents. It is to be noted that while the two super-imposed heaters may drain to a trap common to both, the successive layers of heaters with reference to the air flow from the fan should each have a separate trap, since the condensation rate varies in each successive layer after its predecessor has warmed the entering air.

Unit Heater Connections

When unit heaters are used with steam heating systems the designer must always take into consideration the great condensing capacity of these devices. They must be placed high enough above the boiler water line to compensate for the pressure drop or must be used with systems having pumps or other positive return devices, and must always have pipe connections proportional to their maximum heat emission.* Some typical details of unit heater connections are shown in Chapter 9, Unit Heating and Ventilating Machines.

IMPORTANCE OF LAYOUT

With the increasing use of automatic temperature control, the proper layout of the steam mains to secure even distribution of the steam to all the radiators is of importance. It is not sufficient that the pipes be properly designated to carry the maximum amount of steam. Steam heating systems are operated at their maximum capacity only for a fraction of the time and they should be designed to distribute evenly at reduced capacity. Almost any piping layout will give heat in sufficient quantities to all the radiators for zero weather if the pipes are large enough, but this is only one of the requirements; the system must be capable of operating efficiently at reduced capacities. Hence the importance of careful and intelligent arrangement of the steam mains.

Chapter 11

HOT WATER HEATING

Gravity and Forced Circulation; Maximum Water Temperature; Temperature Drop through Radiator; Arrangement of Piping; Pipe Sizes; Changing a System from Gravity to Forced Circulation; Relative Economy of Gravity and Forced Circulation.

HOT water heating systems are of two general types, namely, (1) *gravity* systems which depend for circulation upon the different density of the water columns in the flow and return lines and (2) *forced circulation* systems, the circulation being maintained by means of a pump. The heat losses from buildings heated by direct hot water heating systems are determined in the manner indicated in Chapter 5. The amount of radiation to be installed in buildings heated by direct hot water heating depends upon the total heat loss from the building and the type and operating characteristics of the radiation to be used.

Several different piping systems may be designed for any given combination of heater and radiator. The general rule to apply to the design of a pipe system is that *the friction head leading from the heater to a radiator and back again must equal the pressure head causing the water to flow for that particular circuit.* This rule is based on the condition that the water in the system is circulating with a uniform velocity as is the case when the radiators (and piping) dissipate exactly the same quantity of heat in a given period of time as is delivered to the water in the heater.

The principal factors to be considered in the design of the piping system are:

1. The heat losses of the rooms or spaces to be heated.
2. The location and type of radiators.
3. Arrangement of the circuits of the system, including length of pipe and number and type of fittings.
4. The temperature of the water in the flow and return risers.
5. Whether gravity or forced circulation is to be used.

GRAVITY SYSTEMS

Before undertaking the design of a pipe system, it is necessary to assume:

1. The maximum temperature of the water leaving the heater when the outside temperature is the minimum for which the system is to be designed.
2. The drop in the temperature of the water while it is flowing through the radiator.
3. The arrangement of the pipe connecting the heater with the several radiators.