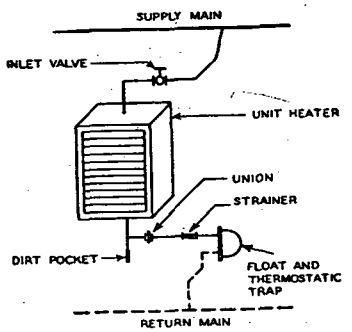


FIG. 53. TYPICAL UNIT HEATER CONNECTIONS FOR TWO-PIPE SYSTEM

be used for throttling. Angle globe valves and straight globe valves should be used for throttling in such cases as by-passes around pressure reducing valves or on by-passes around traps.

## REFERENCES

[1] A.S.H.V.E. RESEARCH REPORT No. 954—Condensate and Air Return in Steam Heating Systems, by F. C. Houghten and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 199).

[2] Pipe size tables in this chapter have been compiled in simplified and condensed form for the convenience of the user; at the same time all of the information contained in previous editions of THE GUIDE has been retained.

[3] A.S.H.V.E. Standard Code for Testing and Rating Return Line Low Vacuum Heating Pumps (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 33).

CHAPTER 22

# HOT WATER HEATING SYSTEMS

Available Head; Friction Loss; Classification; System Design; Examples of Piping Design; One-Pipe Gravity, One-Pipe Forced Circulation, Two-Pipe Gravity, and Two-Pipe Forced Circulation Systems, Expansion Tanks, Installation Details, Zoning of Systems, High Temperature Systems

A HEATING system is called a hot water system if water is used to convey heat by flowing through pipes connecting a boiler or water heater with radiators, convectors or other suitable heat dispensing means. There are two types: the gravity system in which the water flows by virtue of thermo-syphon action, and the forced system in which a pump, usually driven by an electric motor, sometimes by a steam turbine or other means, maintains the necessary flow. Most panel heating systems (see Chapter 24) fall into the category of forced hot water systems, and the design procedures pertaining to pipe sizing and friction contained in this chapter are largely applicable to such systems.

Historically, the gravity system is much the older, and many such systems have been in satisfactory operation for several decades. Operation depends on the difference in density of the water due to difference in temperature in the flow and return pipes. The available head is therefore limited, and the pipes must be ample in size to permit adequate flow of water. In the forced system, the pipes, valves and fittings can be much smaller, with a resultant saving in the cost of installation, since the available head is limited only by consideration of economy in pumping the water. With the forced system, higher boiler temperatures and automatic control of the pump or circulator make possible the use of indirect water heaters with hot water systems when that is desirable. (See Chapter 49.)

## AVAILABLE CIRCULATION HEAD

The available head in a gravity circulation system may be found from the equation:

$$h_a = \frac{\rho_2 - \rho_1}{144} \times 2.31 \times 12{,}000 \qquad (1)$$

*where*

$h_a$ = available head per foot of height, milinches (1 milinch = 1/1000 of 1 in. of water).

$\rho_1$ = average density of flow water, pounds per cubic foot.

$\rho_2$ = average density of return, pounds per cubic foot.

144 = square inches per square foot.

2.31 = height of water column equivalent to 1 psi, feet.

12,000 = milinches equivalent of 1 ft of water column.

The available head may also be found from Fig. 1. For example, at a flow temperature of 200 F and a 35 deg drop, and with the mains located 4 ft above the center line of the boiler, the available head is 600 milinches. This is found by following the 200 F flow riser line in Fig. 1 to its intersection with the 165 F return riser line, and then reading, horizontally, a head