When selecting the type of piping arrangement; such as, one-pipe, two-pipe, series-loop, upfeed, and downfeed, the adaptability of each arrangement for proper hydraulic balance should be considered.

Air Elimination

If air and various other gases which occur in hot water heating systems are not eliminated from the flow circuit, they may collect in the heating units or piping and reduce the flow of water and the heat output. These gases, designated *air* in this text, are in the piping before it is filled with water, are introduced with the water used to fill and replenish the system, and also are formed to a limited degree from chemical action inside the system and from the movement of low temperature air-saturated water from the expansion tank to the system.[13]

The air is eliminated from the flow circuits by trapping it into the expansion tank as explained in connection with discussion of *dip tubes* in the

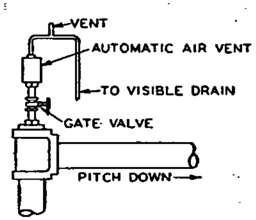

Fig. 12. Typical Automatic Air Vent Valve Installation

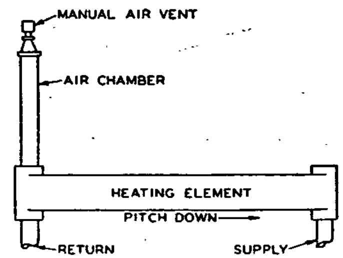

Fig. 13. Typical Air Vent Valve Installation on Heating Element

section Boiler Room Piping and by the installation of manual or automatic air vent valves at all high points in the system.

Automatic air vent valves may be used to eliminate air from the mains and major equipment. Like other mechanical devices, they are subject to malfunction. Small pieces of dirt or scale can lodge on the valve seat, causing it to leak. Corrosion, scale, or sludge in the valve can prevent the valve from opening to eliminate air. All systems should be designed to have a minimum number of automatic air vent valves, but where a valve is required there should be no hesitancy about using it. In large systems where large numbers of automatic air vent valves are necessary, provision should be made for service of each valve without draining the system, Fig. 12. The drip from each air vent valve should be piped to a drain to prevent building damage and facilitate inspection for leakage. Automatic air vent valves should not be installed in piping where temperatures in excess of 215 F can occur without careful analysis of possible temperature-pressure effects.

Each unit of radiation which can act as an air trap should be provided with an air chamber and air vent valve, Fig. 13. The use of manual air vent valves or porous plug or disc type manual-automatic valves is recommended for radiation.

Piping Principles

Piping should be pitched up in the direction of flow in all cases when pump operation is constant, and wherever possible when pump operation is intermittent to assure consistent air elimination during conditions of either flow or no-flow. Piping is pitched ¼ in. per 10 ft as standard practice.

When changing the size of pipe in horizontal runs, eccentric reducers should be used to keep the top of the pipes in line.

A means of manual capacity adjustment should be provided for each heating unit. Manual valves or adjusting cocks are frequently provided for this purpose. Dampers at the heating element or at the outlet of convection type units may be used. The heating unit located in the area of a zone thermostat should be equipped with a key-operated adjusting device to discourage tampering by unauthorized personnel.

The piping should be installed to provide for thermal expansion of the pipe without imposing undue stress on connections or equipment. Spring pieces of sufficient length, as required by the diameter of the runout and the amount of expansion to be absorbed, should be installed at connections to radiators and risers. Expansion joints or loops and properly located anchors should be used where required. See Chapter 26, Pipe, Fittings, Welding.

All mains and risers located in exterior walls should be covered with sufficient insulation to prevent freezing. Trunk mains running between buildings must be protected by conduit or installed in trenches below the frost line and properly insulated. When heating mains are run in locations where they could possibly be immersed in water, the conduit should be water tight.

Circulating Pumps

Circulating pumps used in hot water heating systems can vary from small ⅙ hp booster type pumps with a capacity of 5 gpm at 6 or 7 ft head to pumps handling hundreds, even thousands, of gallons per minute at heads limited only by the pressure characteristics of the system. The selection of a pump for a system is based on an analysis of operational characteristics of the pump and system. Both first cost and operating cost are involved. See discussion under Pipe Sizing Methods, Expansion Tanks and System Pressure Control. Pumps with mechanical seals have found wide acceptance in hot water heating. Pump characteristics as affected by system characteristics, should be given consideration to insure non-overloading conditions in pump motor operation.

Any given pump, when operated with a given fixed head system, will operate at only one point on its curve; the intersection of the pump curve with the system curve. Pump curves may be obtained from manufacturers. System curves can be constructed by plotting head versus gpm for different flow rates. The head for various flow rates can be estimated by use of the equation:

$$\frac{H_2}{H_1} = \left[\frac{G_2}{G_1}\right]^2 \quad \text{or} \quad H_2 = H_1\left[\frac{G_2}{G_1}\right]^2 \qquad (3)$$

where

H_1 = calculated system head.
H_2 = head at new flow rate.
G_1 = calculated flow rate.
G_2 = assumed new flow rate.

For economic or for operational reasons two similar pumps are sometimes used in parallel on a single circuit. When so used the combined pump curve showing the relationship of flow to head due to operation of both