the drop risers. Drain valves should be installed on all wet return mains and on the return header at the boiler.

Each radiator or heating unit in a one-pipe system must be supplied with a thermostatic air valve which functions to relieve air from the heating unit under pressure, and to close when steam itself heats the thermostatic element of the valve.

To improve steam circulation in one-pipe systems quick-vent air valves should be provided at the ends and at intermediate points where the steam main is brought to a higher elevation, or where dropped below the water line. It is desirable to install the air-vent valves about a foot ahead of the drips, as indicated in Fig. 8, to prevent possible damage to their mechanisms by water.

Air valves are of two general types, the pressure and the vacuum types. The pressure type permits the inflow of atmospheric air to the system when the steam pressure in the system falls below atmospheric pressure.

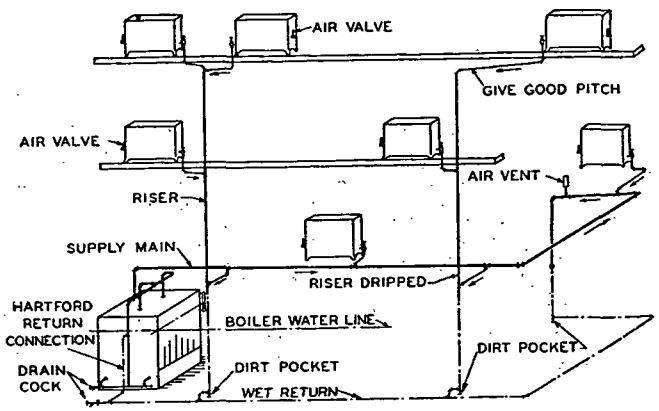

FIG. 8. PREFERRED UP-FEED GRAVITY ONE-PIPE AIR-VENT SYSTEM

The vacuum type, which contains a small check valve, prevents the air from flowing back to the system and thereby maintains vacuum conditions in the system, and a consequent evaporation or generation of steam or vapor at sub-atmospheric pressures, and at consequent lower temperatures. Systems which use vacuum valves are known as *vapor* or *vacuum one-pipe systems*. The vapor or vacuum systems will maintain a more uniform temperature condition than the pressure systems.

Each heating unit in a one-pipe system may also be provided with a valve on the connection to the unit, although this is not essential except to shut the unit off in case it is not desired for heating. Valves on one-pipe systems must be either fully opened or fully closed. No throttling or modulating position can be maintained since, if a valve is partially closed, condensate will not drain from the unit. This condition is dangerous because it may create a low water condition in the boiler with consequent burning or cracking of the boiler, or create a hazard due to the freezing of the water-logged heating unit itself.

TWO-PIPE SYSTEMS

Two-pipe systems, as previously defined, are systems in which steam and condensate flow in separate pipes. Two-pipe systems may operate under high pressure, low pressure, vapor, or vacuum conditions. Either the up-flow or the down-flow arrangement of mains may be employed.

Two-Pipe High Pressure Systems

Two-pipe high pressure systems operate at pressures above 15 psig, usually from 30 to 150 psig. They are usually used in large industrial type buildings, which are equipped with unit heaters or large built-up fan units, or in which high pressure steam is required for process work.

Fig. 9 illustrates a typical high pressure system. Because of the high pressures and the great differential between steam and return mains, it is possible to locate returns above the heating units and lift the condensate to these returns.

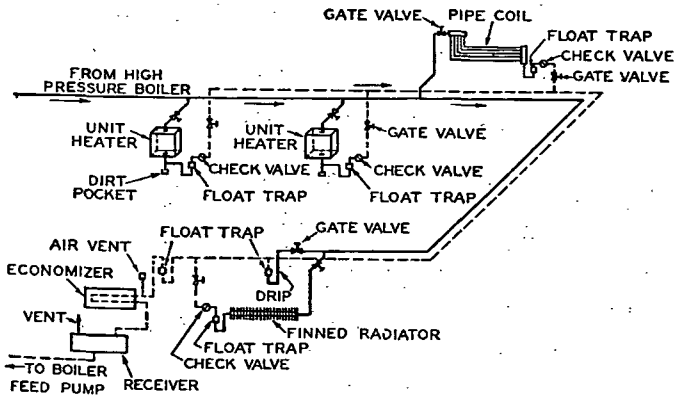

FIG. 9. TYPICAL HIGH PRESSURE HEATING SYSTEM

The condensate can be flashed into steam in low pressure mains if any are available, or passed through an economizer heater before being discharged to a vented receiver. It is, of course, necessary to provide for the elimination of air from high pressure systems, the same as in low pressure systems.

Return traps used on high pressure systems are usually of the bucket, inverted bucket, float or impulse type. They are described on pages 539 to 540.

Two-Pipe Low Pressure Systems

Low pressure systems operate at pressures of 0 to 15 psig. The piping arrangement of both up-feed and down-feed low pressure systems is identical with those of two-pipe vapor systems described in the following section. The only difference between the two systems is in the type of air valve used. The air valves used in low pressure systems usually do not contain the check discs and hence, the system cannot operate under a