mechanical condensate return devices in common use: (*a*) the alternating return trap, (*b*) the condensate return pump, and (*c*) the vacuum return pump.

In systems where pressure conditions in the system vary between that of a gravity return and a forced return system, a boiler return trap or alternating receiver is employed and the system may be known as an *alternating return system.*

When condensate is pumped to the boiler under pressures of the atmosphere or above, the system is known as a *condensate pump return system.*

When condensate is pumped to the boiler under vacuum conditions, the system is known as a *vacuum return system.*

In either the *condensate* or *vacuum pump systems* it is highly desirable to arrange for gravity flow to a receiver and to the pump. The pump then forces condensate into the boiler against its pressure.

ONE-PIPE SYSTEMS

One-pipe systems, as previously defined, are systems in which steam and condensate flow in the same pipe. Radiators and other heating units, in general, have only one piping connection from main to unit, although it is possible to employ two connections to the same main as indicated in Fig. 2. Unit heaters in one-pipe systems may also have separate connections to the wet-return.

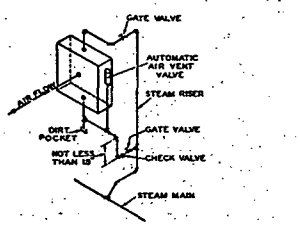


Fig. 2 .... Typical Two-Pipe Connections to Unit Heaters in One-Pipe Air-Vent Systems

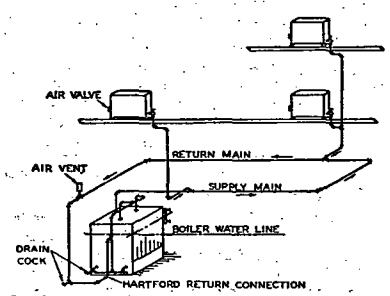


Fig. 3 .... Typical Up-Feed Gravity One-Pipe Air-Vent System

There are several variations in the piping arrangement of a one-pipe system as follows:

1. *Up-feed one-pipe systems where the radiators and other heating units are located above the supply mains.* The mains in this instance convey both steam and condensate. Therefore, it is preferable to limit this design to systems with a connected load under 2500 sq ft EDR. Such a system is illustrated in Fig. 3. Typical connections to radiator or risers are illustrated in Figs. 4 and 5 and method of changing sizes of mains in Fig. 6.

Branches from steam mains in one-pipe gravity steam systems should use the *preferred* connection shown in Fig. 7, but where radiator condensate does not flow back into the main, the *acceptable* method shown in the same figure may be used. This acceptable method has the advantage of giving a perfect swing joint when connected to the vertical riser or radiator connection, whereas the preferred connection does not give this swing without distorting the angle of the pipe. Runouts are usually made about 5 ft long to provide flexibility for movement in the main.

2. *Up-feed one-pipe system with a connected load in excess of 2500 sq ft EDR, where radiators and other heating units are located above the mains, as illustrated in Fig. 8.* It will be noted that the mains are dripped at each riser connection to a wet-return, as indicated in Fig. 5, so that the mains carry a minimum of the condensation. This feature is always desirable in the design of any one-pipe steam system. Radiators immediately above the mains may be connected as shown in Fig. 4. Up-feed systems are not recommended for systems higher than four or five stories.

3. *Down-feed one-pipe systems, where the radiators and other heating units are located below the supply main.* In this

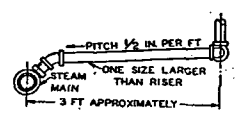


Fig. 4 .... Typical Steam Runout where Risers Are Not Dripped

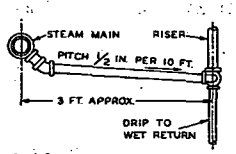


Fig. 5 .... Typical Steam Runout where Risers are Dripped

Fig. 6 .... Method of Changing Size of Steam Main when Runouts are Taken from Top

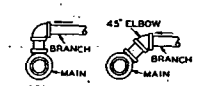


Fig. 7 .... Methods of Taking Branch from Main

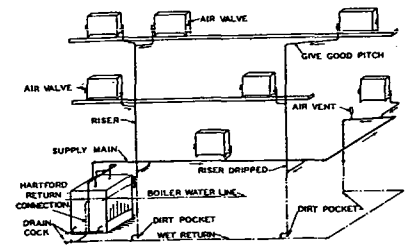


Fig. 8 .... Preferred Up-Feed Gravity One-Pipe Air-Vent System

arrangement only risers and connections to heating units convey both steam and condensate, and both are flowing in the same direction. The steam main is kept relatively free of condensate by dripping through 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. 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 subatmospheric pressures, and at consequent lower temperatures. Systems which use vacuum valves are known as *vapor* or *vacuum*

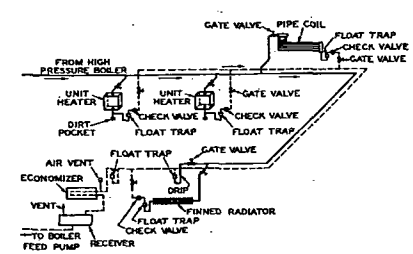


Fig. 9 .... Typical High-Pressure Heating System

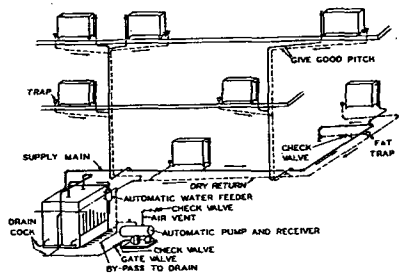


Fig. 10 .... Typical Installation Using Condensate Pump

one-pipe systems. The vapor or vacuum systems will maintain a more uniform temperature condition than the pressure systems.

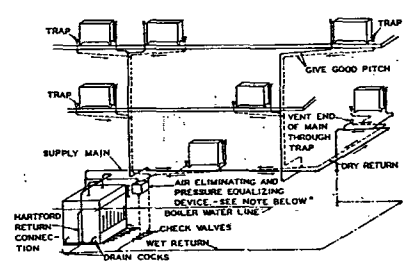
Each heating unit in a one-pipe system may also be provided with a valve on the connection to the unit, although this is not essential except to shut the unit off when it is not desired for heating. Valves on one-pipe systems must be either fully opened or fully closed. No throttling or modulating position 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 waterlogged 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 buildings, which are equipped



** Proper piping connections are essential with special appliances for pressure equalizing and air elimination.*

Fig. 11 .... Typical Up-Feed Two-Pipe System with Automatic Return Trap*