It is important to keep the lowest points of the steam mains and heating units sufficiently above the water line of the boiler to prevent flooding. The minimum water line difference depends on the initial steam pressure and piping pressure drop plus a safety factor for heating up.

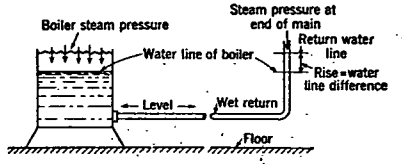


FIG. 5. DIFFERENCE IN STEAM PRESSURE ON WATER IN BOILER AND AT END OF STEAM MAIN

Referring to Fig. 5 it will be noted that the water in the wet return is a U-shaped container, with the boiler steam pressure on the top of the water at one end and the steam main pressure on the top of the water at the other end. The difference between these two pressures is the *pressure drop* in the system, *i.e.*, the friction and resistance to the flow of steam in passing from the boiler to the far end of the main and the pressure reduction in consequence of the condensation occurring in the system. The water in the far end will

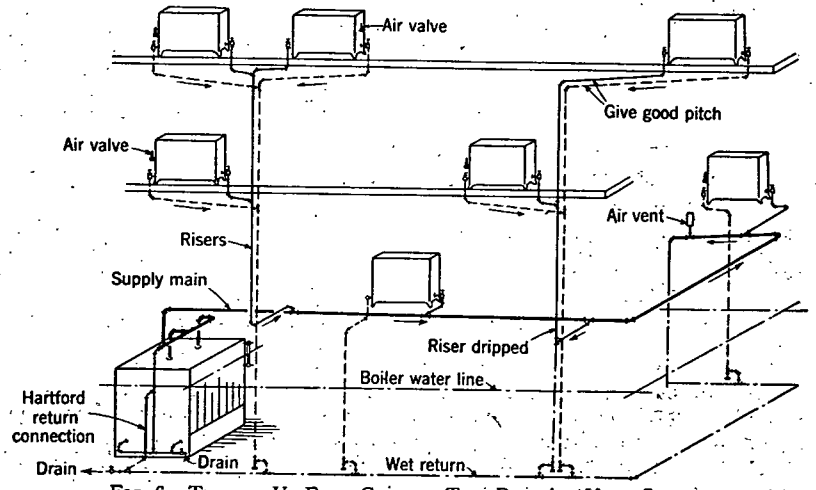


FIG. 6. TYPICAL UP-FEED GRAVITY TWO-PIPE AIR-VENT SYSTEM

rise sufficiently to overcome this difference in order to balance the pressures, and it will rise far enough to produce a flow through the return pipe and overcome the resistance of check valves if installed.

If a one-pipe steam system is designed, for example, for a total pressure drop of ⅛ lb, and utilizes an Underwriters' Loop instead of a check valve on the return, the rise in the water level at the far end of the return due to the difference in steam pressure would be ⅛ of 28 in. (28 in. head being equal to one pound per square inch), or 3½ in. Adding 3 in. to overcome the resistance of the return main and 6 in. as a factor of safety for heating up gives 12½ in. as the distance; the bottom of the lowest part of the steam main and all heating units must be above the boiler water line. The same system, however, installed and sized for a total pressure drop of ½ lb, and with a check in the return,

would require ½ of 28 in., or 14 in. for the difference in steam pressure, 3 in. for the flow through the return, 4 in. to operate the check, and 6 in. for a factor of safety, making a total of 27 in. as the required distance. Higher pressure drops would increase the distance accordingly.

GRAVITY TWO-PIPE AIR-VENT SYSTEMS

The gravity two-pipe system indicated in Fig. 6 is now considered obsolete although many of these systems are still in use in older buildings. The same general principles governing its piping design are used when connecting radiators as in other types of gravity systems where they must discharge their condensation to the wet return pipe. Separate supply and return mains and connections are required for each heating unit. Radiator valves are required in both the supply and return connection to the radiator, and air valves are installed on the heating units and the mains. Where the return main has to be located high to function as a

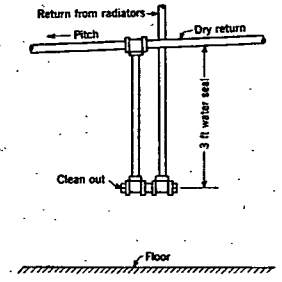


FIG. 7. METHOD OF CONNECTING TWO-PIPE GRAVITY RETURNS TO DRY RETURN MAIN

dry return, it is advisable to connect the return risers to the dry return main through water seals, as shown in Fig. 7, to prevent steam from one riser entering another.

The steam main in the down-feed system is carried to the top of the building, and the piping of the steam side is arranged as in the down-feed one-pipe gravity system. On the return side of the system, the piping is arranged in exactly the same manner as the up-feed gravity two-pipe system.

AIR LINE HEATING SYSTEMS

Both one- and two-pipe systems are at times provided with air valves which, instead of venting to the atmosphere direct, vent to a return pipe system of small size, which in turn is vented to atmosphere or connected to a vacuum pump. These are known as *one-pipe* and *two-pipe* air line systems. Where the air line is exhausted by a vacuum pump they are termed *one-pipe* or *two-pipe vacuum air line systems*.

ONE-PIPE VAPOR SYSTEM

The one-pipe vapor system operates under pressures at or near atmospheric and returns its condensation to the boiler by gravity. In this