To bring this about, it is necessary in some cases to minimize the friction, *i.e.*, to make the pipe line as short as possible and to provide as few fittings as possible; and in other cases it is necessary to increase the length of the pipe and the number of fittings so that, for every circuit, the friction head will be equal to the available pressure head.

The connections from the boiler to the mains should be short and direct, to reduce the friction head. It is frequently possible to avoid an elbow and to reduce the length of the pipe by running the pipe in a diagonal direction, either in a horizontal or in a vertical plane.

The mains and branches should pitch up and away from the heater, generally not less than 1 in. in 10 ft. The flow main should always be covered; the return main should be covered except where it is to provide the heating surface for the basement.

The connections from mains to branches and to risers should be such that circulation through the risers will start in the right direction. Hence, in a one-pipe system the flow connection must be nearer the heater than the return connection. In a correctly-designed two-pipe system, the pressure in the flow main is higher than that in the return

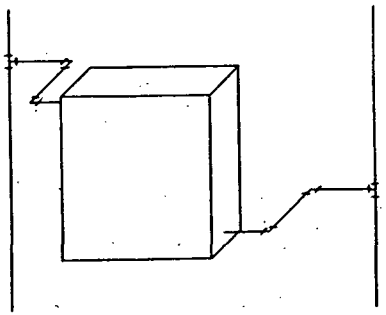

FIG. 11. METHOD OF CONNECTING RADIATOR TO ALLOW FOR EXPANSION OF PIPE

main, and a slight variation in the distances of the flow and return connections from the heater is not material; but it is generally best to have the two connections about equally distant from the heater.

In some cases it may be advisable to take the flow connection off the top of the main and the return connection from the side, but in most cases both connections should be at an angle of 45 deg. This method shortens the lines and substitutes 45-deg ells for 90-deg ells.

Preferably, connection of the flow riser to a radiator should be to the upper tapping, and connection of the return riser to a radiator should be to the lower tapping. When hot water enters at the top of a radiator it will distribute itself along the entire length of the radiator, and as it cools it will settle gradually to the bottom; the cool water may then be taken out of the radiator at either end.

With forced circulation and high velocities, it is advisable to let the water enter at the top of the radiator and leave at the bottom of the opposite end. With gravity circulation and low velocities it makes little difference whether the water leaves at the end at which it enters or at the opposite end.

The connections of the risers to the radiators should be such that provision is made for the vertical expansion of the risers. This can be accomplished as indicated in Fig. 11 by using one tee and two ells for each connection. These connections should be pitched upward or downward, whichever may be necessary to prevent the formation of air pockets and to permit draining.

Chapter 34

PIPE, FITTINGS, WELDING

Designation of Pipe, Types of Pipe, Expansion and Contraction, Fittings, Valves, Corrosion, Pipe Welding

PIPE used for heating and ventilating installations is made either by shaping sheets of metal into cylindrical form and welding the edges together, or by forming or drawing from a solid billet. In the latter case, it is termed *seamless tubing* or *seamless pipe*. Welded pipe usually is made by either the forge lap-weld or butt-weld process, depending upon the size.

DESIGNATION OF PIPE

Wrought pipe up to 12 in. in diameter is usually designated by its nominal internal diameter which is slightly different from its actual internal diameter, being considerably less in the smaller sizes than the actual dimension. There are three weights of wrought iron and steel pipe commonly used, known as *standard*, *extra strong*, and *double-extra strong*. Because of the necessity of maintaining the same external diameter in all three weights, for the same nominal size, the added wall thickness is obtained by decreasing the internal diameter.

The term *full weight*, when applied to sizes below 8 in., means that the pipe is up to the nominal weight per foot. When applied to sizes between 8 and 12 in., inclusive, it often indicates that the pipe has the heaviest of the various wall thicknesses listed. In sizes 14 in. and upward pipe is designated by its outside diameter (O.D.) and the wall thickness is specified. The dimensions of standard and extra strong pipe are given in Tables 1 and 2. The use of double-extra strong pipe is limited almost entirely to high pressure hydraulic work.

TYPES OF PIPE

Wrought-Steel Pipe. Because of its low price, the great bulk of wrought pipe used at the present time is of wrought steel. The material used for steel pipe is a mild steel made either by the Bessemer or basic open-hearth process or by the electric furnace.

Wrought-Iron Pipe. The correct definition of wrought iron as suggested by the *International Society for Testing Materials* is "malleable iron which is aggregated from pasty particles without subsequent fusion and contains so little carbon that it does not harden usefully when cooled rapidly."

Identification of Wrought-Iron and Steel Pipe. Wrought-iron pipe is marked at the mill with a spiral line the entire length of each bar, either knurled into the metal or painted in red or other bright color. Otherwise