quality of service and local conditions. Theoretically, air-vent one and two-pipe and vapor and vacuum return line systems are substantially on a par as to heating efficiency; that is to say, the major portion of the heat delivered is, or should be, dissipated by the heating unit.

It is essential that any system circulate steam uniformly throughout the entire installation, as too often certain defective features of a system will require that heat be kept on longer or to a greater degree than would

TABLE 9. PIPE SIZES FOR ONE-PIPE AIR-VENT LOW PRESSURE STEAM HEATING SYSTEM, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO THE FARTHEST RADIATOR DOES NOT EXCEED 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

Based on Total Pressure Drop of 1 oz. per 100 ft.

Pipe Size Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate flowing in the same direction.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Wet Return Main	Dry Return Main	Radiator Valve Sizes and Vertical Connections
A	*B*	*C*	*D*[a]	*E*	*F*	*G*
¾	.....	25	.....	.....	.....	.....
1	56	45	20	700	320	20
1¼	122	98	55	1200	670	55
1½	190	152	81	1900	1058	81
2	386	288	165	4000	2300	165
2½	635	464	260	6700	3800	.....
3	1163	799	475	10,700	7000	.....
3½	1737	1144	745	.....	10,000	.....
4	2457	1520	1110	.....	.....	.....
5	4546	.....	2180	.....	.....	.....
6	7462	.....	.....	.....	.....	.....

INSTRUCTIONS FOR USING TABLE 9

[a]1. Radiator branches more than 8 ft. in length should be one size larger than shown in Col. *D*.

2. These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made. (See Tables 7 and 8).

3. Capacities based on ¼ lb. condensation per square foot per hour equivalent radiation and actual diameter of standard pipe.

4. Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 4).

5. Where it is necessary to drip a steam main, branch to riser or risers, same should be dripped separately into wet return.

6. Pitch of mains should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators and risers at least ½ in. in 10 ft.

7. In general it is desirable not to have a supply main smaller than 2 in. in diameter. When the supply main is larger than 2½ in. at the beginning, it is desirable that it shall not be smaller than 2½ in. at the end.

otherwise be required uniformly and satisfactorily to heat the building. This will result in waste and overheating. The one important thing to be remembered in connection with all systems is that they shall circulate steam freely and uniformly to the heating units and shall remove and return the condensation noiselessly.

The following should be kept in mind in laying out any type of system:

1. The initial pressure should be kept as low as possible, not exceeding 5 lb. gage.

2. The drop in pressure in the mains and riser to the farthest heating unit should not exceed 1 oz. per 100 ft. of straight pipe or its equivalent length, with a lower rate of drop for systems with long runs.

3. In small installations, such as residences, where the longest actual run is seldom over 200 ft. and where the firing periods extend over several hours, resulting in boiler pressure, fluctuating from zero to about 1 lb., the total pressure drop should not exceed 2 oz. for gravity systems. In large buildings, where boilers are under the constant care of a fireman and a uniform pressure is maintained, and where the water-line difference will permit, the total drop in pressure may range from 3 to 8 oz., depending upon the equivalent length of the longest run.

4. The total allowable drop in pressure depends upon (*a*) the water-line difference, (*b*) the equivalent length of main and riser from the boiler to the farthest heating unit, and (*c*) the regularity of the pressure maintained at the boiler or source of steam supply.

5. The water-line difference, or distance between the water line of the boiler and the low point of steam main and dry return main should be not less than 24 in., because of the heavy drop in pressure from condensation in heating up a cold system. This difference should be increased 2 in. for every ounce pressure-drop in the system. If the total pressure-drop were 6 oz., the water-line difference should be $6 \times 2 + 24$ or 36 in.

6. There should be a nearly uniform drop in pressure between the source of steam supply and the farthest heating unit on every riser. Care should be taken, however, to see that the maximum allowable velocity for smooth operation is not exceeded.

7. In using this method of proportioning a system, care must be exercised to see that no pipe carrying condensate counter to the steam is loaded to a capacity above the maximum for the particular part of a system in question.

Air-Vent One-Pipe System

The air-vent one-pipe system (Fig. 1) is considered by many engineers to be the simplest steam circulating system. It may be either of the atmospheric or of the vacuum type depending on whether or not vacuum-type or non-return air valves are used on radiators and return mains. If vacuum-type air valves are used the entire system must be tight and reasonably free from air leaks through supply valves, piping and boiler trimmings.

Each radiator has but a single pipe connection, through which steam must enter and through which the condensation also must return, flowing in the opposite direction to the steam flow. The main from the boiler should pitch downward from the highest point above the boiler, and at the end of this main it should drop down and be sealed independently below the boiler water line. This may be done at the remote end of the main or the main may loop back, above the boiler water line, to a point near the boiler, where it may be more convenient to seal it. Steam and condensation flow in the same direction in this supply main and the branches from the main are taken off the top.

The ends of the supply mains, before they are sealed below the water line, must be vented. Each radiator must have an air valve. Perfect grading of the mains and radiators so that no pools of water will lie in depressions in the pipes is imperative with this system, since these water