though it so happens that the values in Columns *D* and *H* for small systems correspond. This will not hold true in larger systems.

For vapor systems over 200 ft of equivalent length, the drop should not exceed 1/8 psi to 1/4 psi, if possible. Thus, for a 400 ft equivalent run the drop per 100 ft should be not over 1/8 psi divided by 4, or 1/32 psi. In this case the steam mains would be sized from Column *B*, the radiator and undripped riser runouts from Column *I*; the risers from Column *B*, because Column *H* gives a drop in excess of 1/32 psi. On a down-feed system, Column *B* would have to be used for both the main riser and the smaller risers feeding the radiators in order not to increase the drop over 1/32 psi. The return risers would be sized from the lower portion of Column *O* and the dry return main from the upper portion of the same column, while any wet returns would be sized from Column *N*. The same pressure drop is applied on both the steam and the return sides of the system.

Notes on Vapor Systems

1. Pitch of mains should not be less than 1/4 in. in 10 ft.
2. Pitch of horizontal runouts to risers and radiators should not be less than 1/2 in. per ft. Where this pitch cannot be obtained, runouts over 8 ft in length should be one size larger than called for in the table.
3. It is not desirable to have a supply main smaller than 2 in.
4. When necessary, supply main, supply risers, or runouts to supply risers should be dripped separately into a wet-return, or may be connected into the dry-return through a thermostatic drip trap.

SIZING PIPING FOR TWO-PIPE VACUUM SYSTEMS

Vacuum, atmospheric, sub-atmospheric and orifice systems are usually employed in large installations and have total drops varying from 1/4 to 1/2 psi. Systems in which the maximum equivalent length does not exceed 200 ft preferably employ the smaller pressure drop, while systems over 200 ft equivalent length of run, more frequently are designed for the higher drop, owing to the relatively greater saving in pipe sizes. For example, a system with 1200 ft longest equivalent length of run would employ a drop per 100 ft of 1/2 psi divided by 12, or 1/24 psi. In this case, the steam main would be sized from Column *C*, Table 5, and the risers also from Column *C* (Column *H* could be used as far as critical velocity is concerned, but the drop would exceed the limit of 1/24 psi). Riser runouts, if dripped, would use Column *C* but, if undripped, would use Column *I*; radiator runouts, Column *I*; return risers, lower part of Column *S*, Tables 6 and 7; return runouts to radiators, one pipe size larger than the radiator trap connections.

Notes on Vacuum Systems

1. It is not generally considered good practice to exceed 1/2 psi drop per 100 ft of equivalent run, nor to exceed 1 psi total pressure drop in any system.
2. Pitch of mains should not be less than 1/4 in. in 10 ft.
3. Pitch of horizontal runouts to risers and radiators should not be less than 1/2 in. per ft. Where this pitch cannot be obtained, runouts over 8 ft in length should be one size larger than called for in the table.
4. In general, it is not considered desirable to have a supply main smaller than 2 in.
5. When necessary, the supply main, supply riser, or runout to a supply riser should be dripped separately through a trap into the vacuum return. A connection should not be made between the steam and return sides of a vacuum system without interposing a trap to prevent the steam from entering the return line.
6. Lifts should be avoided if possible, but when they cannot be eliminated they should be made in the manner described in this chapter.
7. No lifts can be used in orifice and atmospheric systems.

SIZING PIPING FOR INDIRECT HEATING UNITS

Pipe connections and mains for indirect heating units are sized according to the quantity of steam condensed by each unit. The condensation per unit depends upon the entering temperature and the air velocity, and may be obtained from manufacturers' rating tables. Where two or more units are placed in series, the entering air temperature for any unit will be the leaving temperature for the preceding unit.

When the amount of condensation has been obtained for each unit, the pipe sizes should be based on the length of run and the pressure drop desired, as in the case of radiators. It is generally desirable to place the indirect heating units on a separate piping system rather than to connect them to the piping which supplies direct radiation. For type of connections see section on Connections to Heating Units.

PRESSURE REDUCING VALVES

While the illustrations given in Figs. 3 to 20 inclusive, indicate the various systems to be supplied by separate boiler plants, it is also possible to have steam supplied at high pressure by a remote boiler plant.

Where steam is supplied by a district heating system instead of an individual boiler plant, the connections to the heating system are made as explained in Chapter 28.

Where steam is supplied from a boiler delivering steam at pressures higher than required for the heating system, one or more pressure reducing valves (pressure regulators) are required. These are used in two classes of service, one where the steam must be shut off tight to prevent the low pressure side from building up at time of no load, and the other where the low pressure lines will condense enough steam to offset normal leakage through the valve. In the first case single seated valves, either direct operated or pilot controlled, should be used and in the latter case double seated valves, either direct operated or pilot controlled, may be used. The direct operated, double seated valve is less affected by varying inlet steam pressure than the direct operated, single seated valve. Pilot controlled valves, either single or double seated, eliminate any effect or variable inlet pressures.

Valves that shut off all steam are called *dead end* type. They are single seated, and some of them have pilot operation that provides close control of the reduced pressure. If a thermostatically controlled valve is installed down, after, and near, a reducing valve in such a manner as to cut off the passage of steam, the dead end type should be used. If a one-stage reduction is desired, it is necessary to use a pilot controlled pressure reducing valve, where low pressures are to be maintained closely.

It is common practice, when the inlet steam pressure is 100 psig or higher, to install two-stage reduction. If the radiation served is of cast iron and the inlet pressure exceeds 50 psig, the *ASME* code requires the installation of pressure relief valves where the inlet pressure exceeds the safe working pressure of the steam-using equipment, except where two reducing valves are installed in series and *both* are set at or below the safe working pressure of the equipment serviced.

Two-stage reduction makes a quieter condition of steam flow, as it is apparent that with one reduction, as for example from 150 to 2 psig, there is a smaller opening with greater velocity across the reducing valve and, consequently, more noise. A two-stage reduction also introduces a source of safety, since if one reducing valve were to build up its discharge pressure,