ments of apparatus to be served. If steam has been passed through electrical generating units, the pressure will be considerably lower than if live steam, direct from the boilers, is used.

The advantages of low pressure distribution (2 to 30 psi) are: (1) smaller heat loss per square foot of pipe surface, (2) less trouble with traps and valves, (3) simpler problems in pressure reduction at the buildings, and (4) general reduction in maintenance costs. With distribution pressures not exceeding 40 psi there is little danger even if the full distribution pressure should build up in the radiators through the faulty operation of a reducing valve; but with pressures higher than 50 psi a second reducing valve or some form of emergency relief is usually desirable to prevent excessive pressures in the radiators.

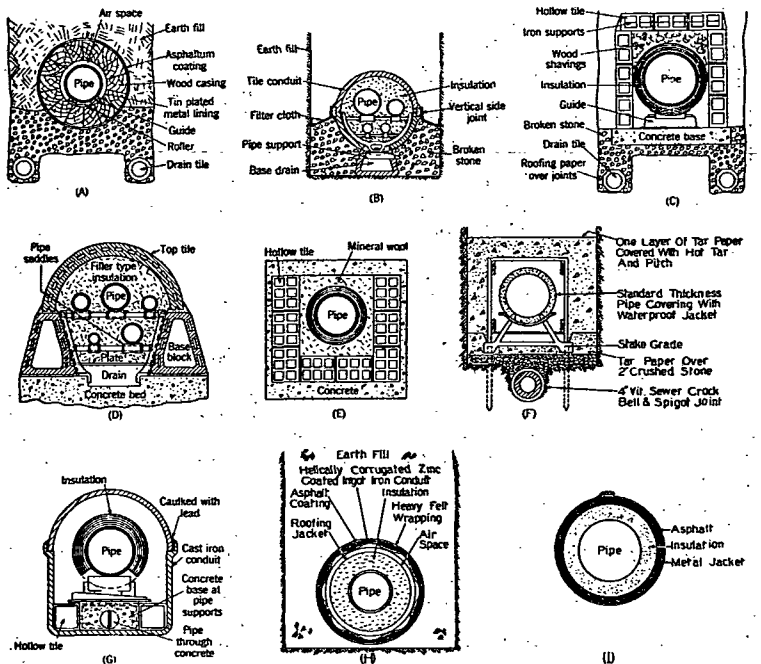

FIG. 1. CONSTRUCTION DETAILS OF CONDUITS COMMONLY USED

The advantages of high pressure distribution are: (1) smaller pipe sizes and (2) greater adaptability of the steam to various operations other than building heating, (3) wider flexibility as to allowance for maximum pressure drop and ability to serve equipment requiring higher pressures.

Frequently the different kinds of apparatus which must be served require various minimum pressures. Kitchen equipment requires from 5 to 15 psi, the higher pressures being necessary for apparatus in which water is boiled, such as stock kettles and coffee urns. An increased amount of heating surface, which is easily obtained in some kinds of apparatus, results in quicker and more satisfactory operation at low pressures. For laundry equipment, particularly the mangle, a pressure of 75 psi is usually demanded, although 30 psi is sufficient if the flat work ironer is equipped with a large number of rolls and if a slower rate of operation is permissible. Pressing machines and hospital sterilizers require about 50 psi. Where pressures are not as high as desired higher pressures can be obtained by a steam compressor.

PIPE SIZES

The lengths of pipe, steam quantities, and initial and terminal pressures having been chosen, the pipe sizes can readily be calculated by means of Babcock's pressure drop formula:

$$P = 0.0000000367\left(1+\frac{3.6}{D}\right)\frac{W^2L}{dD^5}$$

$$W = 5220\sqrt{\frac{PdD^5}{\left(1+\frac{3.6}{D}\right)L}}$$

Numerical values of the various factors are given in Table 2, Chapter 20.

CONDUITS FOR PIPING

Conduits for steam pipes buried underground should be reasonably waterproof, able to withstand earth loads and to take care of the expansion and contraction of the piping without strain or stress on the couplings, or without affecting the insulation or conduit. Expansion of the piping must be carefully controlled by means of anchors and expansion joints or bends so that the pipes can never come in contact with the conduit. Anchors can be anchor fittings or U-shaped steel straps which partially encircle the pipes and are firmly bolted to a short length of structural or cast steel set in concrete. In general, cast steel is preferable to structural steel.

Important points in laying out underground conduits are:

1. The depth of the buried conduit should be kept at a minimum. Excavation costs are a large factor in the total cost.

2. An expansion joint, offset, or bend should be placed between each two anchors. Advantage should be taken of the flexibility of piping to absorb expansion wherever possible. Information on provisions for expansion will be found in Chapter 26.

3. A proper hydrostatic test should be made on the assembled line before the insulation and the top of the conduit are applied. The hydrostatic test pressure should be one and one-half times the maximum service pressure and it should be held for a period of at least two hours without evidence of leakage.

There are many types of conduits, some of which are manufactured products and some of which are built in the field. Some of the more common forms are illustrated in Fig. 1.

The conduit (A) is of a wood casing construction which has been widely used in the past. The wood casing is segmented, lined with tin, and bound with wire. The outside of the conduit is coated with asphaltum. It is not suitable for high temperatures or poorly drained soils.

In Fig. 1 (B), (C), (D), (H) and (I) are patented forms of conduits. The insulation is sometimes a loose filler packed into the conduit. Con-