ucts and some of which are built in the field. The more common forms are illustrated in Fig. 1.

Conduits B and C are prefabricated. In conduit C the pipe is insulated and then placed concentrically within the metal jacket. The intervening space between jacket and insulation is filled with high-melting-point asphalt which becomes the protective medium for the insulation. Conduit B has spirally corrugated galvanized ingot iron surrounding the insulation and high-melting-point asphalt is applied to the outside of the conduit. The pipe is supported by precast rings to maintain alignment and to prevent pressure on the insulation.

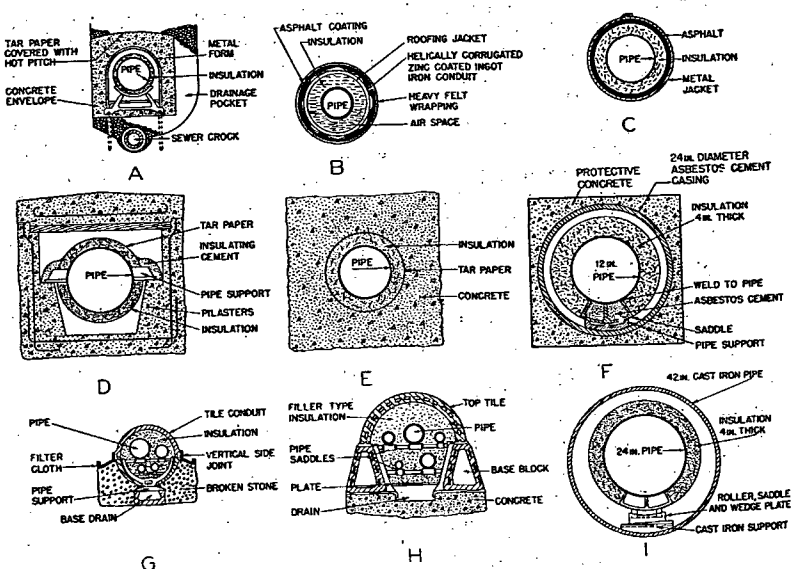

FIG. 1. CONSTRUCTION DETAILS OF CONDUITS[a]

[a] From *District Heating Handbook, Third Edition.*

Conduits A and D are of concrete-box construction and are typical of conduits built of common materials.

Conduit E is of solid-pour construction wherein concrete is poured around an insulated steam pipe. If insulation is of a rigid type it can support the pipe; otherwise, the pipe should be supported independently. A space may be left around the pipe by using insulation larger than the outside diameter of the pipe, the space helping to avoid crushing of insulation if the pipe tends to rise when steam is admitted to a cold line.

Conduit F is made of asbestos-cement pipe joined together with special couplings and enclosed in a protective concrete envelope. The steam pipe is supported within the conduit on specially-designed slip-type supports with saddles welded to the line.

Conduits G and H are constructed of specially-shaped, vitrified bell and spigot tile. Conduit G is also available in cast iron. This construction

is intended for the support of excessive loads and to withstand shocks, such as are found beneath railroad tracks.

Conduit I is of cast-iron construction with lead-caulked joints. It is watertight and intended for special applications.

There are, in addition to those mentioned, several conduits which use an insulating concrete as pipe insulation. The insulating effect of the concrete is obtained through air cells formed by a special process or by a mixture of an insulating material with cement. An insulating hydrocarbon in granular form is available for trench fill around underground lines This material fuses to the lines with application of heat, forming a semi-plastic, waterproof zone next to the pipe.

ACCESSORY EQUIPMENT

Provision should be made to take care of expansion and contraction of the piping in order to prevent stress in the pipe or fittings. Anchors can be special fittings or U-shaped steel straps which partially encircle the pipes, and are firmly bolted to a short length of cast or stainless steel set in concrete.

An expansion joint, offset, or bend should be placed at or between each two anchors. *Advantage should be taken of the flexibility of piping to absorb expansion wherever feasible.* Information on provisions for expansion will be found in Chapter 27. The section on Pipe Tunnels in this chapter contains further comment on expansion joints and anchors. Manholes for expansion joints should be kept free of water by proper drainage and should be of adequate size. Small manholes discourage proper maintenance.

Pipe lines should be of welded steel construction, flanges being used only to permit removal of equipment in accessible places. Piping should be properly supported and equipped with guides to prevent pipe deviation from a straight line between expansion devices.

A proper hydrostatic test should be made on the assembled line before the pipe welds and other joints are insulated. The hydrostatic test pressure should be at least 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.

INSULATION

Insulating materials constitute a primary element of district steam distribution structures and must be suitable for underground service. Insulation should be noncombustible, vermin-proof, moisture-resistant, durable, non corrosive to steel pipe when wet, and able to retain its position in relation to the pipe line without service maintenance. It should be relatively unaffected by such chemicals as are usually found in ground or other contaminated waters. It should have the lowest practical heat conductivity consistent with the given requirements. Underground insulation can be applied directly to the pipe or poured as a monolithic structure in a suitable duct. Insulation is discussed further in Chapter 28.

RETURN OF CONDENSATE

If the condensate can be returned to the plant to be used for boiler feed water at an overall cost less than that required to process raw water, the installation of return lines parallel to the steam supply lines should be given consideration.

Where steam and return piping are installed in the same conduit, the