welding will obviously produce the best finished job. If regular welding tees are not used, however, templates should be used for cutting the hole through the wall of the main pipe and for preparing the end of the branch pipe. The branch pipe should not project inside the main but should fit snugly against the main so that with the process of welding no surplus metal will drop into the interior of the main. Any droppings should of course be removed.

When a branch is taken off from a main line and there is very little room for expansion it is good practice to weld in a reinforcing brace between the branch and the main line. This is particularly true on large piping where high temperatures occur.

In changing the direction of the run of pipe it is better to use bends than to use fittings and nipples.

Special manufactured welding fittings as illustrated in Fig. 2 are available. Most of them can be obtained in all regular pipe sizes and frequently lend themselves to economical and practical application.

Welding rods of high grade material should be used on all welds. The more complicated the turn and the more severe the strain and service the better quality the rod must be. Expert workmanship and correct engineering are of no avail if the welding rod is of improper character.

Since welding is a comparatively new industry there is some danger that failures may occur unless great care is taken with the workmanship. The following rules are basic in welding practice and should be followed rigidly:

1. A skilled operator with the torch or arc, should be employed.
2. The proper welding rod and electrode must be supplied.
3. Regular fittings for welding should preferably be used wherever possible. (See Fig. 2).
4. The choice of oxygen-acetylene or electric arc will be governed by the adaptability of each for the particular installation.
5. Templates shall be used for all cuts, with joints which are to be welded fitted closely, prior to starting the welding.
6. Standard welding tools and equipment of recognized make should be used.

A considerable reduction in weight is made where welding is used, due to the elimination of cast fittings and flanges. There is thus an indirect saving resulting from the lighter supports and hangers required.

Maintenance is kept at a minimum with a properly welded installation. This is especially true in concealed or hard-to-get-at places where repairs would be very expensive. Saving of space in cramped quarters is frequently rendered much simpler by welding. For further information on welding, see *Standard Manual on Pipe Welding* published by the *Heating and Piping Contractors National Association.*

Chapter 12

PIPE INSULATION

Heat Transfer through Bare Pipes; Insulation of Hot Water; Low and High Pressure Steam Lines; Insulation for Cold Surfaces; Effect of Air Velocity on Surface Losses; Economic Thickness of Pipe Insulation; Underground Insulation.

THIS chapter contains essential data for estimating the proper thickness of pipe or surface insulation for various conditions. When steam or hot water are conveyed from one part of a building to another, it usually is desirable that the loss of heat from the pipes through which these heating media pass, be reduced to an economic minimum by means of the proper type and thickness of insulation. Pipe insulation is also used to reduce the absorption of heat by cold pipes as well as to prevent condensation on the outer surfaces.

HEAT TRANSFER THROUGH BARE PIPES

Heat losses from horizontal bare iron pipes, based on data obtained from tests conducted at the Mellon Institute, are given in Table 1. These losses are expressed in Btu per hour per linear foot of pipe per degree Fahrenheit difference in temperature between the steam or hot water in the pipe and the air surrounding the pipe. The monetary value of the loss of heat given in Table 1 may be obtained by means of Fig. 1 for various heating system efficiencies, temperature differences and calorific values and costs of coal. To solve a problem, select the proper heat loss coefficient from Table 1 and locate this value on the upper left hand margin of the chart. Then draw lines in the order indicated by the dotted lines, the dollar value of the heat loss per 100 linear feet of pipe per 1000 hours being given on the upper right hand scale. In using this chart, the cost of coal should also include the labor for handling it, boiler room expense, etc.

In order to determine heat losses per linear foot of pipe from known losses per square foot, it is necessary to know the area in square feet per linear foot of pipe. Table 2 gives these areas for various standard pipe sizes while Table 3 gives the area in square feet for flanges and fittings for various standard pipe sizes.

Very often, even where pipes are thoroughly insulated, flanges and fittings are left bare due to the belief that the losses from these parts are not large. However, the fact that a pair of 9-in. standard flanges having an area of 3.00 sq ft would lose, at 100 lb steam pressure, an amount of heat equivalent to more than a ton of coal per year shows the necessity