rod, by the welding flame. The molten metal will flow together with the aid of mechanical manipulation by the workman so that when cooled there is a single continuous unit. Welding application is made by either the oxy-acetylene or electric arc processes, and the two processes are given equal rating when used under proper control standards and intelligent supervision.

The welding process is applied with equal efficiency and economy in high and low pressure service, and thru the range of all pipe sizes. A correct understanding of the diversified application of welding will in most cases reflect lower initial costs and complete elimination of maintenance. Reduction in weight, adaptability to space allowance, saving in supplemental materials such as pipe covering, hangers, and supports, and finished appearance are other distinct advantages in favor of welding which have contributed to its wide and economical use.

Welding application requires the same basic knowledge of design as do the other types of assembly, but in addition, requires a generous knowledge of the sciences involved, particularly as to welding qualities of metal, their reaction to extremely high temperatures, and the ability to determine and use only the best quality welding rods. This requirement applies equally to employer and employee with the employer accepting all of the responsibility. Thus the employer should select his welding mechanics with good judgment, provide them with first-class equipment and tools, arrange for their training and use of acceptable workmanship standards, and at regular intervals subject their work to prescribed tests. Industry will not accept the employment of mechanics of undetermined ability nor on the basis of past experience. Neither does industry accept the statement that a weld is only as good as the workman who makes it. The control Codes now in process of adoption will be the law governing the use of the welding process. These Codes prohibit individual practices contrary to their specified procedure and rules of control, and this is predicated upon the sound requirement that the employer must assume full responsibility for the deposited weld.

It is advisable that this management responsibility be included in all welding specifications and that authoritative standards of workmanship also be specified. The standards of workmanship for this industry are as set forth in the *Standard Manual on Pipe Welding* of the *Heating, Piping and Air Conditioning Contractors National Association.*

A complete line of manufactured steel welding fittings is now available with plain ends machine beveled for welding and with radii similar to short and long radius flanged fittings. Some typical types of these fittings are shown in Fig. 2. They are made in pipe sizes ¾ to 24 in., standard and extra heavy, in steel, wrought iron, brass, copper, and special alloys.



Chapter 35

# HEAT LOSSES FROM BARE AND INSULATED PIPES

***Heat Losses from Bare Pipes, Steam and Hot Water Lines, Low Temperature Pipe Insulation, Pipe Sweating, Heat Losses from Pipe Surfaces, Thickness of Pipe Insulation, Underground Insulation***

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 types and thicknesses 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 LOSSES FROM 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. For additional information on this subject refer to paper entitled Heat Emission from Iron and Copper Pipe[1], by F. C. Houghten and Carl Gutberlet.

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

[1]A.S.H.V.E. Transactions, Vol. 38, 1932.