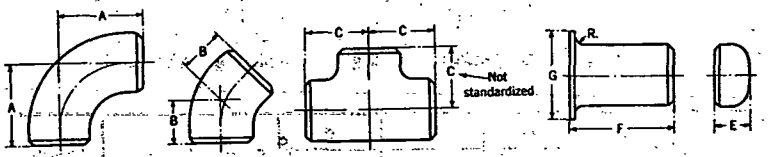
Fittings for copper pipe of *IPS* dimensions are available in screwed or soldered types of connection. Table 5 from *ASA* Standard A40.3-1941 contains dimensions for soldered joint elbows, tees, crosses, and 45 deg elbows.

The compression type fitting is generally limited to smaller size tubing, while the flared and soldered types are used in both large and small sizes. An American Standard, *ASA* A40.2-1936 has been prepared to standardize dimensions for brass fittings for flared copper water tubes. Flared tube fittings are widely used in refrigerating work where *S.A.E.* dimensions

TABLE 8. AMERICAN STANDARD DIMENSIONS FOR BUTT-WELDING ELBOWS, TEES, CAPS, AND LAPPED-JOINT STUB ENDS, *ASA* B16.9-1940



Nominal Pipe Size	Outside Diameter	Center-to-End			Caps	Lapped-Joint Stub Ends		
		90-Deg Elbows A	45-Deg Elbows B	Of Run Tee C	E [b, c]	Length F [b]	Radius of Fillet R	Diam. of Lap G [d]
1	1.315	1½	⅞	1½	1½	4	⅛	2
1¼	1.660	1⅞	1	1⅞	1½	4	3/16	2½
1½	1.900	2¼	1⅛	2¼	1½	4	¼	2⅞
2	2.375	3	1⅜	2½	1½	6	5/16	3⅝
2½	2.875	3¾	1¾	3	1½	6	5/16	4⅛
3	3.500	4½	2	3⅜	2	6	⅜	5
3½	4.000	5¼	2¼	3¾	2½	6	⅜	5½
4	4.500	6	2½	4⅛	2½	6	7/16	6⅜16
5	5.563	7½	3⅛	4⅞	3	8	7/16	7⅝16
6	6.625	9	3¾	5⅝	3½	8	½	8½
8	8.625	12	5	7	4	8	½	10⅝
10	10.750	15	6¼	8½	5	10	½	12¾
12	12.750	18	7½	10	6	10	½	15

All dimensions given in inches.

[a] The dimensions of welding tees cover those which have side outlets from one size less than half the size of the run-way opening of the tees to full size.

[b] Dimensions *E* and *F* are applicable only to these fittings in schedules up to and including Schedule 80, *A.S.A.* Standard B36.10-1939.

[c] The shape of these caps shall be ellipsoidal and shall conform to the requirements of the *A.S.M.E.* Boiler Construction Code.

[d] This dimension is for standard machined facings in accordance with American Standard for Steel Pipe Flanges and Flanged Fittings (*A.S.A.* B16e-1939). The back face of the lap shall be machined to conform to the surface of the flange on which it seats. Where ring joint facings are to be applied, use dimension *K* as given in *ASA* B16e-1939.

and a 45-deg flare render most fittings interchangeable, although for refrigeration use, thread fits and tolerances on thread gages must be maintained within close limits. Brass fittings with *S.A.E.* dimensions are not interchangeable with the American Standard fittings for water tubes.

Ammonia pipe fittings made of cast-iron were formerly used extensively in handling refrigerants in large installations. Replacement of ammonia by other refrigerants operating at lower pressures has seriously curtailed the market for these fittings. For this reason formulation of an American Standard for these fittings was abandoned by the *ASA* in 1936.

FLANGE FACINGS AND GASKETS

A number of different flange facings in common use are plain face, raised face, tongue and groove, and male and female. Cast-iron fittings for 125 psi and below are normally furnished with a plain face, while the 250 lb cast-iron fittings are supplied with a $\frac{1}{16}$-in. raised face. The standard facing for steel flanged fittings for 150 and 300 psi is a $\frac{1}{16}$-in. raised face although these fittings are obtainable with a variety of facings. The gasket surface of the raised face may be finished smooth or may be machined with concentric or spiral grooves often referred to as serrated face or phonograph finish, respectively.

The dimensions of elbows, tees, and crosses for 125 lb cast-iron screwed fittings are given in Table 6, whereas the dimensions for 125 lb cast-iron flanged fittings are given in Table 7.

For low temperature service not to exceed about 220 F, a number of paper or vegetable fiber gasket materials will prove satisfactory; for plain raised face flanges, rubber or rubber inserted gaskets are commonly employed. Asbestos composition gaskets are probably the most widely used, particularly where the temperature exceeds 250 F. Jacketed asbestos and metallic gaskets may be used for any pressure and temperature conditions, but preferably only with a narrow recessed facing.

WELDING

Erection of piping in heating and ventilating installations by means of fusion welding has been commonly accepted in the past few years as an alternate method to the screwed and flanged joint. Since the question of economy of welding as against the use of screwed and flanged fittings is dependent on the individual job, the use of welding is generally recommended on the basis of a greatly reduced cost of maintenance and repair, of less weight resulting from the use of a lighter-weight pipe, and of increased economy in pipe insulation, hangers, and supports rather than on the basis of any economy that might be effected in actual erection by welding on low to medium pressure heating jobs.

Fusion welding, commonly used in erection of piping, is defined as the process of joining metal parts in the molten, or molten and vapor states, without the application of mechanical pressure or blows. Fusion welding embraces gas welding and electric arc welding, both of which are commonly used to produce acceptable welds. Welding processes and procedure are described in various publications.

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.

Rules for fusion welding of pipe joints, the qualification of welding operators, welding procedures and the testing theoreof, are contained in the Standard Manual on Pipe Welding of the *Heating, Piping & Air Conditioning Contractors National Association*, and other nationally recognized groups.[3, 4, 5] In general, the wall thickness and chemical