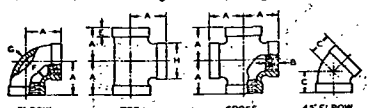
Table 13 .... Dimensions of Malleable 90-Deg Elbows, Tees, Crosses, and 45-Deg Elbows (Straight Sizes, 150 Lb)

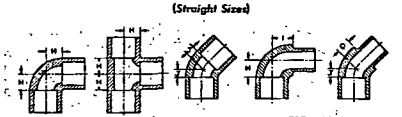


Nominal Pipe Size	Center to End, Elbows, Tees, and Crosses A	Center to End, 45-Deg Elbows C	Length of Thread, Min B	Width of Band, Min E	Inside Diameter of Fitting Min F	Inside Diameter of Fitting Max F	Metal Thickness G	Outside Diameter of Band, Min H
⅛	0.69	....	0.25	0.200	0.405	0.435	0.090	0.693
¼	0.81	0.73	0.32	0.215	0.540	0.584	0.095	0.844
⅜	0.95	0.80	0.36	0.230	0.675	0.719	0.100	1.015
½	1.12	0.88	0.43	0.249	0.840	0.897	0.105	1.197
¾	1.31	0.98	0.50	0.273	1.050	1.107	0.120	1.458
1	1.50	1.12	0.58	0.302	1.315	1.385	0.134	1.771
1¼	1.75	1.29	0.67	0.341	1.660	1.730	0.145	2.153
1½	1.94	1.43	0.70	0.368	1.900	1.970	0.155	2.427
2	2.25	1.68	0.75	0.422	2.375	2.445	0.173	2.963
2½	2.70	1.95	0.92	0.478	2.875	2.975	0.210	3.589
3	3.08	2.17	0.98	0.548	3.500	3.600	0.231	4.235
3½	3.42	2.39	1.03	0.604	4.000	4.100	0.248	4.843
4	3.79	2.61	1.08	0.661	4.500	4.600	0.265	5.401
5	4.50	3.05	1.18	0.780	5.563	5.663	0.300	6.583
6	5.13	3.46	1.28	0.900	6.625	6.725	0.336	7.767

From *American Standard for Malleable-Iron Screwed Fittings*, 150 Lb, *ASA* B16.3-1951. All dimensions given in inches.

Table 14 .... Dimensions of Cast-Brass Solder-Joint Elbows, Tees, and 45-Deg Elbows

(*Straight Sizes*)



Standard Water Tube Size H	Laying Length* Tee and Elbow H	Center to External Shoulder 90-Deg Street Elbow I	Laying Length 45-Deg Elbow J	Center to External Shoulder 45-Deg Street Elbow Q
¼	¼	⅜	....	....
⅜	⅜	7/16	5/16	5/16
½	7/16	9/16	5/16	5/16
¾	9/16	11/16	¼	⅜
1	¾	⅞	5/16	7/16
1¼	⅞	1	7/16	5/16
1½	1	1⅛	½	⅜
2	1¼	1⅜	5/16	¾
2½	1½	1⅝	⅝	....
3	1¾	1⅞	¾	....
3½	2	....	⅞	....
4	2¼	2⅜	1 5/16	....
5	3⅛	....	1 7/16	....
6	3⅝	....	1⅝	....
8	4⅞	....	2⅛	....

From *American Standard for Cast-Brass Solder-Joint Fittings*, *ASA* B16.18-1963. All dimensions given in inches.

* Not standardized for *wrought* fittings. Consult manufacturer for dimensions.

3. *Welding Ends:* Available in steel only. Generally employed for high-temperature, high-pressure work. Difficult to disassemble in a welded line. This type includes butt-welding or socket-welding. See Tables 10 and 12 for size of fittings available in each class. The valves are made in the same range.

4. *Brazing Ends:* These ends are available on brass valves. The ends have a special shape to facilitate use of brazing alloys. These valves are used for higher temperatures than solder end valves.

5. *Solder Ends:* For use with copper tube in plumbing, heating, and air conditioning. Should not be used at high temperatures.

6. *Flared Ends:* For use with light-wall tubing, either metal or plastic, and for sizes 2 in. and below. A flaring tool flares the tube end, and a ring nut pulls the flared tubing up against a seat on the valve. This makes a lap joint.

7. *Hub Ends:* Generally used for water supply and sewage piping. This type joint is used with cast-iron pipe. The joint is a socket type, made by inserting the pipe in the hub, then caulking with oakum. After being caulked, the joint is sealed with molten lead.

Valves are made of brass, iron, steel, and to some extent malleable iron. Brass should not be used for work requiring temperatures above 550 F. The brass used in valves is similar to that used in brass pipe and contains some tin and lead as well as copper and zinc.

Cast iron is generally provided in some alloyed state, especially in the larger sizes. Cast iron alone is not suitable for service (above 450 F).

Malleable iron, which is a cast iron heat-treated to provide some ductility, is used to some extent, primarily in place of cast iron.

Steel is used either in the cast or forged state. For corrosive service, alloy and stainless steel are used. Steel is used for high temperature, high-pressure work. Steel is the only valve material that can stand appreciable expansion stresses.

The characteristics of valves restrict their use. The five main uses for valves are listed below:

1. *Stopping flow:* The most general use for valves. *Gate* valves are generally used for this purpose, except in refrigeration piping. The gate valve operates by moving a disc at right angles to the path of the fluid. The fluid flows straight through the valve, therefore, a gate valve offers the minimum resistance when it is fully open. The gate is moved by a stem screw attached to the handle. Gate valves are poor regulators because, at nearly closed position (where best regulation is obtained), the fluid velocity either causes vibration and noise or tends to erode the disc.

2. *Throttling flow:* This is generally accomplished by *globe* or *angle* valves. These valves cause the fluid to change direction, and consequently, offer considerable fluid resistance even when in the open position. Both the globe and angle valves operate by closing a plug into a fitted seat. The angle valve is similar to the globe valve except that the outlet face is at an angle of 90 deg from the inlet face. An angle valve takes the place of a globe valve and an elbow.

3. *Checking flow:* Preventing back flow is called checking, hence, a *check* valve is used. The basic principle of all check valves is that a reversal of flow will close the valve. Check valves are either *swing check* or *lift check*. With a swing check, the fluid presses on a hinged flap. If the flow stops or reverses, the flap swings down and seats itself to close the valve. A lift check operates similarly, except that the flap is replaced by a plug that is lifted, through guides, by the force of the fluid flow. The fluid changes direction of flow, as in a globe valve, and transmits a vertical thrust. If the flow stops, gravity pulls the plug downward and closes the valve. A reversal of flow will close the valve. Spring-loaded check valves are also widely used in refrigeration systems.

Two other types of valves are the relief valve and the pressure regulating valve. Relief valves are usually spring loaded in order that some predetermined pressure can force the valve to open and relieve the pressure. Pressure regulators are used to reduce a high incoming pressure to a required service pressure but may also be used to control the inlet pressure. These valves are designed to eliminate a fluctuation in the incoming pressure and thereby maintain a steady, lower service pressure (see Chapter 8, 1964 Guide And Data Book).

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 versus the use of screwed and flanged fittings is dependent on the individual job, the use of welding is generally recommended on the basis of: greatly reduced cost of maintenance and repair, reduced weight resulting from the use of a lighter-weight pipe, or increased economy in pipe insulation, hangers, and supports, rather than on 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 procedures are described in various publications.[5]

Welding application requires the same basic knowledge of design as do the other types of assembly, but, in addition, it requires an extensive knowledge of welding principles, particularly the welding qualities of metal and its reaction to extremely high temperatures. The ability to select and use the proper welding rods is important. This requirement applies equally to employer and employee, with the employer accepting all of the responsibility. Thus the employer should use good judgement in selecting his welding mechanics, 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 testing are contained in the *Standard Manual on Pipe Welding*[2] and in publications of other groups.[1,4,5] In general, the wall thickness and chemical analysis of the pipe are the governing factors, not the working pressure. There are a number of safety codes which govern the installation of welded piping in many cities and states.

A complete line of manufactured steel-welding fittings is now available, and a dimensional standard has been prepared according to the procedure of the American Standards Association (see Table 10), to unify heretofore divergent dimensions for the same type welding fittings produced by different manufacturers. Standard dimensions for steel butt-welding elbows and tees are given in Table 10. Dimensions for eccentric and concentric reducers, caps, and lapped-joint stub ends are not shown in Table 10, but are included in the standard.

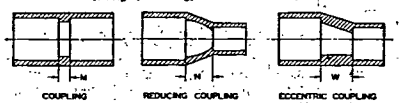
Steel butt-welding fittings have beveled ends. For wall thicknesses less than 5/16 in., the bevel may be either 37½ deg or cut square. For wall thickness of 5/16 in. to and including ¼ in. the bevel is 37½ deg. For walls larger than ¼ in. but not greater than 1¼ in., the bevel is U-shaped, with a slope of 20 deg above the 5/16 in. radius fillet. For walls greater than 1¼ in., the welding ends are prepared as agreed between the manufacturer and the purchaser.

Flange fittings may be welded from sizes ½ to 24 in., inclusive.

Socket-welding fittings also are commercially available. These fittings have a machined recess for inserting the pipe which is attached by a fillet weld between the pipe wall and socket end. Use of socket-welding fittings generally is re-

Table 15 .... Dimensions of Cast-Brass Solder-Joint Couplings

(*Straight, Reducing, and Eccentric Sizes*)



STRAIGHT Standard Water Tube Size M	STRAIGHT Laying Length* M	REDUCING Standard Water Tube Size N	REDUCING Laying Length* N	ECCENTRIC Standard Water Tube Size W	ECCENTRIC Laying Length* W
¼	1/16	¾ x ½	5/16	¾ x ½	⅝
⅜	1/16	1 x ¾	⅝	1 x ¾	1 1/16
½	⅛	1¼ x 1	⅝	1¼ x 1	¾
¾	⅛	1¼ x ¾	⅝	1¼ x ¾	¾
1	⅛	1½ x 1¼	⅝	1½ x 1¼	1 1/16
1¼	⅛	1½ x 1	⅝	1½ x 1	1 1/16
1½	⅛	1¼ x ¾	7/16	2 x 1½	1⅛
2	5/16	2 x 1½	½	2 x 1¼	1 5/16
2½	5/16	2 x 1¼	½	2½ x 2	1 5/16
3	5/16	2 x 1	½	3 x 2½	1¼
3½	¼	2 x ¾	½	3 x 2	1 5/16
4	¼	2½ x 2	5/16	4 x 3	2
5	¼	2½ x 1½	5/16	....	....
6	¼	2½ x 1¼	⅝	....	....
8	⅜	2½ x 1	⅝	....	....
....	....	3 x 2½	⅝	....	....
....	....	3 x 2	⅝	....	....
....	....	4 x 3	1 1/16	....	....
....	....	4 x 2½	1⅛	....	....
....	....	4 x 2	1 5/16	....	....
....	....	6 x 4	1 5/16	....	....
....	....	8 x 6	1⅜	....	....

From *American Standard for Cast-Brass Solder-Joint Fittings*, *ASA* B16.18-1963. All dimensions given in inches.

* Not standardized for *wrought* fittings. Consult manufacturer for dimensions.