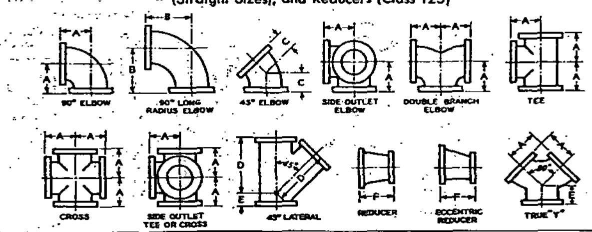
Table 10 . . . Dimensions of Flanged Cast-Iron Elbows, Double Branch Elbows, Tees, Crosses, Laterals, True Y's (Straight Sizes), and Reducers (Class 125)



Nominal Pipe Size	Inside Dia of Fittings	Center to Face 90 Deg Elbow, Tees, Crosses, True Y, and Double Branch Elbow A	Center to Face 90 Deg Long Radius Elbow B	Center to Face 45 Deg Elbow C	Center to Face Lateral D	Short Center to Face True Y and Lateral E	Face to Face Reducer F	Dia of Flange	Thickness of Flange (Min)	Wall Thickness
1	1	3 1/2	5	1 3/4	5 3/4	1 3/4	....	4 1/4	7/16	5/16
1 1/4	1 1/4	3 3/4	5 1/2	2	6 1/4	1 3/4	....	4 5/8	1/2	5/16
1 1/2	1 1/2	4	6	2 1/4	7	2	....	5	9/16	5/16
2	2	4 1/2	6 1/2	2 1/2	8	2 1/2	5	6	5/8	5/16
2 1/2	2 1/2	5	7	3	9 1/2	2 1/2	5 1/2	7	11/16	5/16
3	3	5 1/2	7 3/4	3	10	3	6	7 1/2	3/4	3/8
3 1/2	3 1/2	6	8 1/2	3 1/2	11 1/2	3	6 1/2	8 1/2	13/16	7/16
4	4	6 1/2	9	4	12	3	7	9	15/16	1/2
5	5	7 1/2	10 1/4	4 1/2	13 1/2	3 1/2	8	10	15/16	1/2
6	6	8	11 1/2	5	14 1/2	3 1/2	9	11	1	9/16
8	8	9	14	5 1/2	17 1/2	4 1/2	11	13 1/2	1 1/8	5/8
10	10	11	16 1/2	6 1/2	20 1/2	5	12	16	1 3/16	3/4
12	12	12	19	7 1/2	24 1/2	5 1/2	14	19	1 1/4	13/16
14 OD	14	14	21 1/2	7 1/2	27	6	16	21	1 3/8	7/8
16 OD	16	15	24	8	30	6 1/2	18	23 1/2	1 7/16	1
18 OD	18	16 1/2	26 1/2	8 1/2	32	7	19	25	1 9/16	1 1/16
20 OD	20	18	29	9 1/2	35	8	20	27 1/2	1 11/16	1 1/8
24 OD	24	22	34	11	40 1/2	9	24	32	1 7/8	1 1/4
30 OD	30	25	41 1/2	15	49	10	30	38 3/4	2 1/8	1 7/16
36 OD	36	28*	49	18	....	....	36	46	2 3/8	1 5/8
42 OD	42	31*	56 1/2	21	....	....	42	53	2 5/8	1 13/16
48 OD	48	34*	64	24	....	....	48	59 1/2	2 3/4	2

From *American Standard for Cast Iron Pipe Flanges and Flanged Fittings*, Class 125, *ASA* B16.1-1948. All dimensions given are in inches.
* Does not apply to true Y's or double-flanged elbows.

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 caulking, 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).

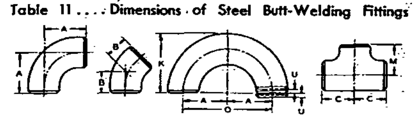
Malleable iron, which is a cast iron heat-treated to provide some ductility, is used to some extent, primarily in place of cast iron.

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. The gate valve operates by a disc moving at right angles to the path of the

Table 11 . . . Dimensions of Steel Butt-Welding Fittings



Nominal Pipe Size	Long Radius Elbows: Outside Diameter at Bevel	Long Radius Elbows: Center-to-End 90-Deg Elbows A	Long Radius Elbows: Center-to-End 45-Deg Elbows B	180 Deg Returns: Outside Diameter at Bevel	180 Deg Returns: Center-to-Center O	180 Deg Returns: Back to Face K	Straight Tees: Outside Diameter at Bevel	Straight Tees: Center-to-End Run C	Straight Tees: Center-to-End Outlet M
1	1.315	1 1/2	7/8	1.315	3	2 3/16	1.315	1 1/2	1 1/2
1 1/4	1.660	1 7/8	1	1.660	3 3/4	2 3/4	1.660	1 7/8	1 7/8
1 1/2	1.900	2 1/4	1 1/8	1.900	4 1/2	3 1/4	1.900	2 1/4	2 1/4
2	2.375	3	1 3/8	2.375	6	4 3/16	2.375	2 1/2	2 1/2
2 1/2	2.875	3 3/4	1 3/4	2.875	7 1/2	5 3/16	2.875	3	3
3	3.500	4 1/2	2	3.500	9	6 1/4	3.500	3 3/8	3 3/8
3 1/2	4.000	5 1/4	2 1/4	4.000	10 1/2	7 1/4	4.000	3 3/4	3 3/4
4	4.500	6	2 1/2	4.500	12	8 1/4	4.500	4 1/8	4 1/8
5	5.563	7 1/2	3 1/8	5.563	15	10 5/16	5.563	4 7/8	4 7/8
6	6.625	9	3 3/4	6.625	18	12 5/16	6.625	5 5/8	5 5/8
8	8.625	12	5	8.625	24	16 5/16	8.625	7	7
10	10.750	15	6 1/4	10.750	30	20 3/8	10.750	8 1/2	8 1/2
12	12.750	18	7 1/2	12.750	36	24 3/8	12.750	10	10
14	14.000	21	8 3/4	14.000	42	28	14.000	11	
16	16.000	24	10	16.000	48	32	16.000	12	Not
18	18.000	27	11 1/4	18.000	54	36	18.000	13 1/2	stand-
20	20.000	30	12 1/2	20.000	60	40	20.000	15	ard
24	24.000	36	15	24.000	72	48	24.000	17	

From *American Standard for Steel Butt-Welding Fittings*, *ASA* B16.9-1951. All dimensions are in inches. Dimension A is equal to ½ of dimension O.

fluid. The fluid flows straight through the valve, hence, 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 else tends to erode the disc.

2. *Throttling flow:* This is best 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.

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. These valves are designed to eliminate a fluctuation in the incoming pressure and thereby maintain a steady, lower service pressure (see Chapter 26).

Table 19 contains data on the dimensions of flanged and welding end valves. Dimensions of other type valves can be obtained by writing to the Manufacturers Standardization Society of the Valve and Fitting Industry.

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: 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 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.[3]

Welding application requires the same basic knowledge of design as do the other types of assembly, but, in addition, requires a generous knowledge of welding principles and 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 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 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 under the procedure of the American Standards Association, (see Table 11) to unify heretofore divergent dimensions for the same type welding fittings produced by different manufacturers. Standard dimensions for steel butt-welding elbows, tees, caps, and lapped-joint stub ends are given in Table 11. Dimensions for eccentric and concentric reducers are not shown in Table 11, but are included in the standard.

Steel butt-welding fittings have beveled ends. For wall thicknesses less than 3/16 in., the bevel may be either 37½ deg. or cut square. For wall thicknesses of 3/16 in. to and including ¾ in. the bevel is 37½ deg. For walls larger than ¾ in. but not greater than 1¾ in., the bevel is U-shaped with a slope of 20 deg above the 5/16 in. radius fillet. For walls greater than 1¾ in., the welding ends are prepared as agreed between the manufacturer and the purchaser.