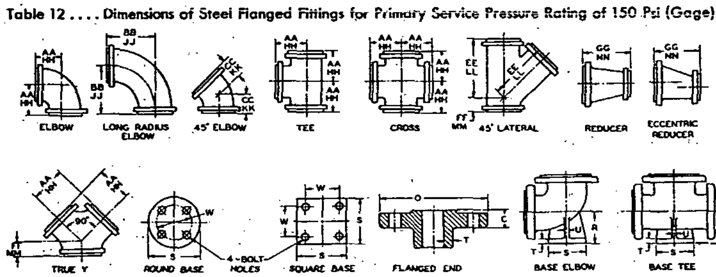
Table 12 . . . . Dimensions of Steel Flanged Fittings for Primary Service Pressure Rating of 150 Psi (Gage)



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			1/16 In. Raised Face (Flange Edge)						Ring Joint									Base Drilling	
Nominal* Pipe Size	Outside Diameter of Flange	Thickness of Flange, Min	Center to Contact Surface of Raised Face, Elbow, Tee, Cross, and True Y	Center to Contact Surface of Raised Face, Long Radius Ell	Center to Contact Surface of Raised Face 45° Ell	Long Center to Contact Surface of Raised Face, Lateral	Short Center to Contact Surface of Raised Face, Lateral, and True Y	Contact Surface to Contact Surface of Raised Face, Reducer	Center to End, Elbow, Tee, Cross, and True Y	Center to End, Long Radius Ell	Center to End, 45-Deg Elbow	Long Center to End, Lateral	Short Center to End, Lateral, and True Y	Center to Base	Dia. of Round Base or Width of Square Base	Thickness of Base	Thickness of Ribs	Bolt Circle or Bolt Spacing	Dia. of Drilled Holes
	O	C	AA	BB	CC	EE	FF	GG	HH	JJ	KK	LL	MM	R	S	T	U	W	
1	4¼	7/16	3½	5	1¾	5¾	1¾	4½	3¾	5¼	2	6	2						
1¼	4⅝	½	3¾	5½	2	6¼	1¾	4½	4	5¾	2¼	6½	2						
1½	5	9/16	4	6	2¼	7	2	4½	4¼	6¼	2½	7¼	2¼						
2	6	⅝	4½	6½	2½	8	2½	5	4¾	6¾	2¾	8¼	2¾	4⅛	4⅝	½	½	3½	⅝
2½	7	11/16	5	7	3	9½	2½	5½	5¼	7¼	3¼	9¾	2¾	4½	4⅝	½	½	3½	⅝
3	7½	¾	5½	7¾	3	10	3	6	5¾	8	3¼	10¼	3¼	4⅞	5	9/16	½	3⅞	⅝
3½	8½	13/16	6	8½	3½	11½	3	6½	6¼	8¾	3¾	11¾	3¼	5¼	5	9/16	½	3⅞	⅝
4	9	15/16	6½	9	4	12	3	7	6¾	9¼	4¼	12¼	3¼	5½	6	⅝	½	4¾	¾
5	10	15/16	7½	10¼	4½	13½	3½	8	7¾	10½	4¾	13¾	3¾	6¼	7	11/16	⅝	5½	¾
6	11	1	8	11½	5	14½	3½	9	8¾	11¾	5¼	14¾	3¾	7	7	11/16	⅝	5½	¾
8	13½	1⅛	9	14	5½	17½	4½	11	9¾	14¼	5¾	17¾	4¾	8⅜	9	15/16	⅞	7½	¾
10	16	1 3/16	11	16½	6½	20½	5	12	11¼	16¾	6¾	20¾	5¼	9¾	9	15/16	⅞	7½	¾
12	19	1¼	12	19	7½	24½	5½	14	12¼	19¼	7¾	24¾	5¾	11¼	11	1	1	9½	⅞
14	21	1⅜	14	21½	7½	27	6	16	14¼	21¾	7¾	27¼	6¼	12½	11	1	1	9½	⅞
16	23½	1 7/16	15	24	8	30	6½	18	15¼	24¼	8¼	30¼	6¾	13¾	11	1	1	9½	⅞
18	25	1 9/16	16½	26½	8½	32	7	19	16¾	26¾	8¾	32¼	7¼	15	13½	1⅛	1⅛	11¾	⅞
20	27½	1 11/16	18	29	9½	35	8	20	18¼	29¼	9¾	35¼	8¼	16	13½	1⅛	1⅛	11¾	⅞
24	32	1⅞	22	34	11	40½	9	24	22¼	34¼	11¼	40¾	9¼	18½	13½	1⅛	1⅛	11¾	⅞

From *American Standard for Steel Pipe Flanges and Flanged Fittings*, 150, 300, 400, 600, 900, 1500, and 2500 Lb. *ASA* B16.5-1953. All dimensions given in inches.

* Actual diameter is same for sizes 1 to 12 in. and is ¼ in. less than nominal for sizes 14 to 24 in.

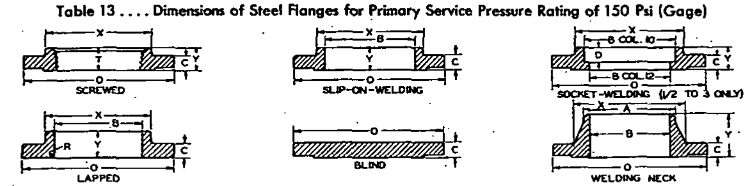
Flange fittings may be welded from sizes ½ to 24 in. inclusive (see Table 13).

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 restricted to nominal pipe sizes 3 in. and smaller in which range commercial fittings are available. This type of fitting has gained rapid acceptance owing to its ease of installation, low cost, and ability to make a pressure-tight joint without weakening the pipe, as is the case with threading. Dimensions for socket-welding fittings, in accordance with ASA Standard B16.11-1946, are given in Table 14.

EXPANSION AND FLEXIBILITY

Changes in temperature cause a change in dimensions of any matter. The metals that are used for pipe have the same characteristics in that they expand with increasing temperature. If the metal is constrained so that it cannot expand, then an internal compressive stress is set up in the material.

Table 13 . . . . Dimensions of Steel Flanges for Primary Service Pressure Rating of 150 Psi (Gage)



1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Length Through Hub Y				Bore B				
Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange, Min	Diameter of Hub	Hub Diameter Beginning of Chamfer Welding Neck	Screwed slip-on socket welding	Lapped	Welding neck	Thread Length Screwed	Slip-on socket welding, min	Lapped, min	Welding neck socket welding	Corner Radius of Bore of Lapped Flange and Pipe	Depth of Socket
	O	C	X	A				T				R	D
½	3½	7/16	1 3/16	0.84	⅝	⅝	1⅞	⅝	0.88	0.90	0.62	⅛	⅜
¾	3⅞	½	1½	1.05	⅝	⅝	2 1/16	⅝	1.09	1.11	0.82	⅛	7/16
1	4¼	9/16	1 15/16	1.32	11/16	11/16	2 3/16	11/16	1.36	1.38	1.05	⅛	½
1¼	4⅝	⅝	2 5/16	1.66	13/16	13/16	2¼	13/16	1.70	1.72	1.38	3/16	9/16
1½	5	11/16	2 9/16	1.90	⅞	⅞	2 7/16	⅞	1.95	1.97	1.61	¼	⅝
2	6	¾	3 1/16	2.38	1	1	2½	1	2.44	2.46	2.07	5/16	11/16
2½	7	⅞	3 9/16	2.88	1⅛	1⅛	2¾	1⅛	2.94	2.97	2.47	5/16	¾
3	7½	15/16	4¼	3.50	1 3/16	1 3/16	2¾	1 3/16	3.57	3.60	3.07	⅜	13/16
3½	8½	15/16	4 13/16	4.00	1¼	1¼	2 13/16	1¼	4.07	4.10	3.55	⅜	
4	9	15/16	5 5/16	4.50	1 5/16	1 5/16	3	1 5/16	4.57	4.60	4.03	7/16	
5	10	15/16	6 7/16	5.56	1 7/16	1 7/16	3½	1 7/16	5.66	5.69	5.05	7/16	
6	11	1	7 9/16	6.63	1 9/16	1 9/16	3½	1 9/16	6.72	6.75	6.07	½	
8	13½	1⅛	9 11/16	8.63	1¾	1¾	4	1¾	8.72	8.75	7.98	½	
10	16	1 3/16	12	10.75	1 15/16	1 15/16	4	1 15/16	10.88	10.92	10.02	½	
12	19	1¼	14⅜	12.75	2 3/16	2 3/16	4½	2 3/16	12.88	12.92	12.00	½	
14	21	1⅜	15¾	14.00	2¼	3⅛	5	2¼	14.14	14.18	To be	½	
16	23½	1 7/16	18	16.00	2½	3 7/16	5	2½	16.16	16.19	speci-	½	
18	25	1 9/16	19⅞	18.00	2 11/16	3 13/16	5½	2 11/16	18.18	18.20	fied by	½	
20	27½	1 11/16	22	20.00	2⅞	4 1/16	5 11/16	2⅞	20.20	20.25	pur-	½	
24	32	1⅞	26⅛	24.00	3¼	4⅜	6	3¼	24.25	24.25	chaser	½	

From *American Standard for Steel Pipe Flanges and Flanged Fittings, ASA* B16.5-1953. All dimensions given in inches.

This stress can be calculated, just as any other stress, by using Hooke's Law.

$$F = \frac{eEA}{L} \quad (1)$$

where

F = Force of constraint, pounds.
e = Deformation, inches.
E = Modulus of elasticity, pounds per square inch.
A = Area of metal, square inches.
L = Length of metal, inches.

This equation is valuable in determining the internal stress of the pipe and also the constraining force on the anchors. This equation assumes that the stress is less than the yield strength of the metal. In other words, the metal will return to its original dimension when the temperature returns to its original level.

Materials such as cast iron are not ductile, hence the *yield strength* is approximately equal to the ultimate strength. These materials have excellent compressive strength but poor tensile strength. For this reason, it is difficult to bend these materials appreciably. Cast iron, for example, could be put in tension and, from Table 20, it is seen that for a temperature change of 100 deg, a compressive stress of 7140 psi would be developed. If the pipe were straight, this stress would be handled easily. If, however, the stress caused a bending moment, then fracture might occur.

The values of stress found in Table 20 were determined by using Equation 1 and substituting Equation 2 for e

$$e = \alpha L \Delta t \quad (2)$$

where

α = coefficient of linear expansion, inches per inch.
Δt = temperature change, Fahrenheit degrees.