
CHAPTER 24

UNTHREADED FASTENERS

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24.1 RIVETS

A *rivet* is a fastener that has a head and a shank and is made of a deformable material. It is used to join several parts by placing the shank into holes through the several parts and creating another head by upsetting or deforming the projecting shank.

During World War II, Rosie the Riveter was a popular cartoon character in the United States. No better image can illustrate the advantages of riveted joints. These are

1. Low cost
2. Fast automatic or repetitive assembly
3. Permanent joints
4. Usable for joints of unlike materials such as metals and plastics
5. Wide range of rivet shapes and materials
6. Large selection of riveting methods, tools, and machines

Riveted joints, however, are not as strong under tension loading as are bolted joints (see Chap. 22), and the joints may loosen under the action of vibratory tensile or shear forces acting on the members of the joint. Unlike with welded joints, special sealing methods must be used when riveted joints are to resist the leakage of gas or fluids.

24.1.1 Head Shapes

A group of typical rivet-head styles is shown in Figs. 24.1 and 24.2. Note that the button head, the oval head, and the truss head are similar. Of the three, the oval head has an intermediate thickness.

24.1

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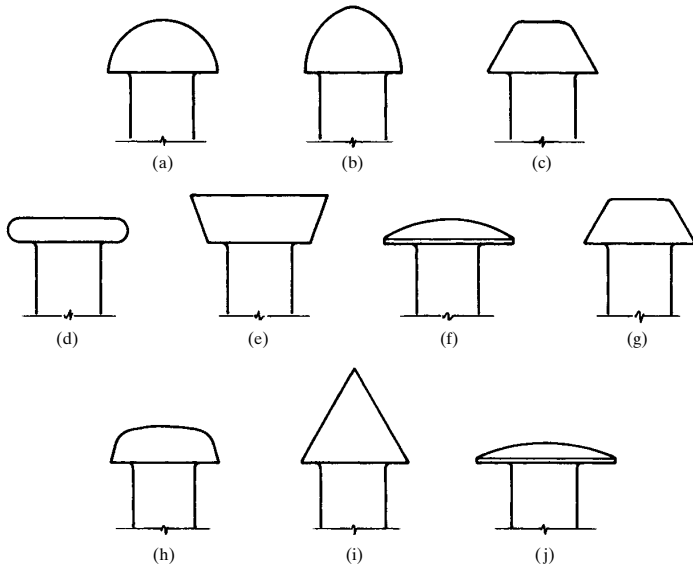


FIGURE 24.1 Standard rivet heads with flat bearing surfaces. (a) Button or round head; (b) high button or acorn head; (c) cone head; (d) flat head; (e) machine head; (f) oval head; (g) large pan head; (h) small pan head; (i) steeple head; (j) truss head, thinner than oval head.

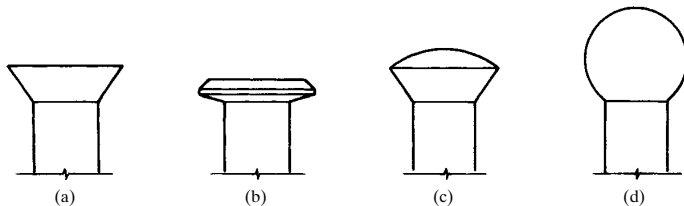


FIGURE 24.2 Various rivet heads. (a) Countersunk head; (b) countersunk head with chamfered top; (c) countersunk head with round top; (d) globe head.

A large rivet is one that has a shank diameter of $\frac{1}{2}$ in or more; such rivets are mostly hot-driven. Head styles for these are button, high button, cone, countersunk, and pan. Smaller rivets are usually cold-driven. The countersunk head with chamfered flat top and the countersunk head with round top are normally used only on large rivets.

24.1.2 Rivet Types

The standard structural or machine rivet has a cylindrical shank and is either hot- or cold-driven.

A *boiler rivet* is simply a large rivet with a cone head.

A *cooper's rivet*, used for barrel-hoop joints, is a solid rivet with a head like that in Fig. 24.2b which has a shank end that is chamfered.

A *shoulder rivet* has a shoulder under the head.

A *tank rivet*, used for sheet-metal work, is a solid rivet with a button, countersunk, flat, or truss head.

A *tinner's rivet*, used for sheet-metal work, is a small solid rivet with a large flat head (Fig. 24.1d).

A *belt rivet*, shown in Fig. 24.3a, has a *riveting burr* and is used for leather or fabric joints.

A *compression* or *cutlery rivet*, shown in Fig. 24.3b, consists of a tubular rivet and a solid rivet. The hole and shank are sized to produce a drive fit when the joint is assembled.

A *split or bifurcated rivet*, shown in Fig. 24.3c, is a small rivet with an oval or countersunk head. The prongs cut their own holes when driven through softer metals or fibrous materials such as wood.

A *swell-neck rivet*, shown in Fig. 24.3d, is a large rivet which is used when a tight fit with the hole is desired.

A *tubular rivet*, shown in Fig. 24.3e, is a small rivet with a hole in the shank end. The rivet is cold-driven with a punchlike tool that expands or curls the shank end. *Semitubular rivets* are classified as those having hole depths less than 112 percent of the shank diameter.

A *blind rivet* is intended for use where only one side of the joint is within reach. The blind side is the side that is not accessible. However, blind rivets are also used where both sides of the joint can be accessed because of the simplicity of the assembly, the appearance of the completed joint, and the portability of the riveting tools. The rivets shown in Figs. 24.4 to 24.8 are typical of the varieties available.

24.1.3 Sizes and Materials

Large rivets are standardized in sizes from $\frac{1}{8}$ to $1\frac{1}{4}$ in in $\frac{1}{8}$ -in increments. The nominal head dimensions may be calculated using the formulas in Table 24.1. The tolerances are found in Ref. [24.2]. The materials available are specified according to the following ASTM Specifications:

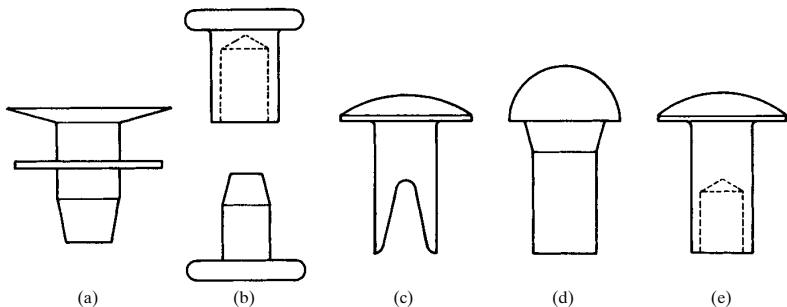


FIGURE 24.3 (a) Belt rivet; (b) compression rivet; (c) split rivet; (d) swell-neck rivet; (e) tubular rivet.

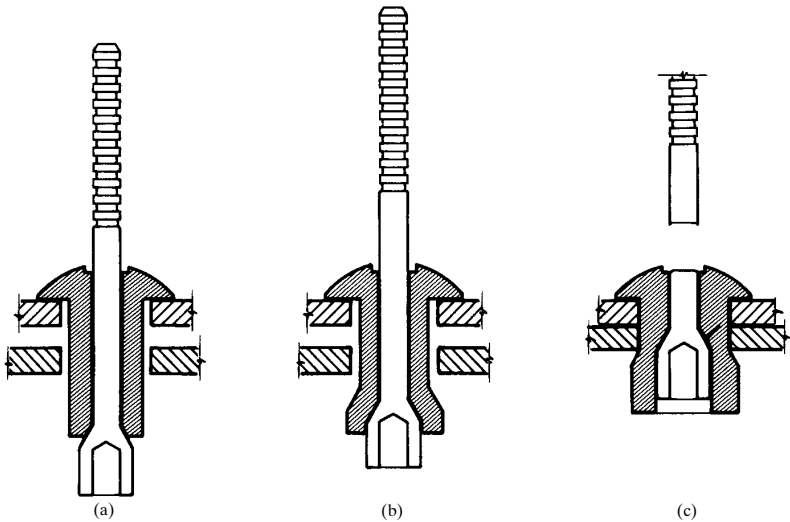


FIGURE 24.7 Self-plugging blind rivet. (a) Rivet inserted into prepared hole with power tool; (b) axial pull with power tool fills holes completely and clamps work pieces together; (c) stem separates flush with head and remaining section is locked in place. (Avdel Corporation.)

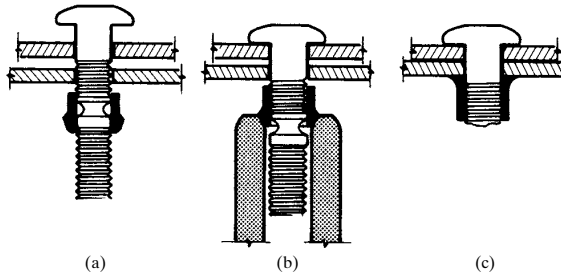


FIGURE 24.8 Lock-bolt or collar-type blind rivet. (a) Pin inserted through holes and collar placed over the pin tail; (b) nose tool pulls on the pin and reacts against the collar, clamping the work tightly; (c) installation finished by swaging the collar into the annular locking grooves and separating the pin at the breaker groove. (Avdel Corporation.)

A31 Boiler rivet steel.

A131 Rivet steel for ships.

A152 Wrought-iron rivets.

A502 Grade 1 carbon structural steel for general purposes. Grade 2 carbon-manganese steel for use with high-strength carbon and low-alloy steels.

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FASTENING, JOINING, AND CONNECTING

TABLE 24.1 Head Dimensions for Large Rivets

Type of head	Diameter,† in		Height, in	Radius, in
	Major	Minor		
Button	1.750 <i>D</i>		0.750 <i>D</i>	0.885 <i>D</i>
High button‡	1.500 <i>D</i> + 0.031		0.750 <i>D</i> + 0.125	0.750 <i>D</i> + 0.281
Cone	1.750 <i>D</i>	0.938 <i>D</i>	0.875 <i>D</i>	
Flat countersunk	1.810 <i>D</i>		0.483 <i>D</i> §	
Oval countersunk¶	1.810 <i>D</i>		0.483 <i>D</i> §	2.250 <i>D</i>
Pan	1.600 <i>D</i>	1.000 <i>D</i>	0.700 <i>D</i>	

†The nominal rivet diameter is *D*.

‡Side radius is 0.750*D* − 0.281.

§Varies, depending on shank and head diameters and the included angle.

¶Crown radius is 0.190*D*.

SOURCE: From Ref. [24.2].

Small solid rivets are standardized in sizes from $\frac{1}{16}$ to $\frac{1}{2}$ in in increments of $\frac{1}{16}$ in. Note that some of these are not included in the table of preferred sizes (Table A.4). Table 24.2 is a tabulation of standard head styles available and formulas for head dimensions. ASTM standard A31 Grade A or the SAE standard J430 Grade 0 are used for small steel rivets. But other materials, such as stainless steel, brass, or aluminum may also be specified.

Tinner's and cooper's rivets are sized according to the weight of 1000 rivets. A 5-lb rivet has a shank diameter of about $\frac{3}{16}$ in. See Ref. [24.1] for sizes and head dimensions.

Belt rivets are standardized in gauge sizes from No. 14 to No. 4 using the Stubs iron-wire gauge (Table A.17).

Tubular rivets are standardized in decimals of an inch; sizes corresponding to various head styles are listed in Tables 24.3 and 24.4. These are used with rivet caps, which are available in several styles and diameters for each rivet size. These rivets are manufactured from ductile wire using a cold-heading process. Thus any ductile material, such as steel, brass, copper, aluminum, etc., can be used. For standard tolerances, see Ref. [24.3].

Split rivet sizes are shown in Table 24.5. Split rivets are available in the same materials as tubular rivets and may be used with rivet caps too.

Some types of *blind rivets* are available in sizes from $\frac{1}{32}$ to $\frac{1}{2}$ in in diameter. The usual materials are carbon steel, stainless steel, brass, and aluminum. A variety of

TABLE 24.2 Head Dimensions for Small Solid Rivets

Head type	Diameter,† in	Height, in	Radius, in
Flat	2.000 <i>D</i>	0.330 <i>D</i>	
Flat countersunk	1.850 <i>D</i>	0.425 <i>D</i>	
Button	1.750 <i>D</i>	0.750 <i>D</i>	0.885 <i>D</i>
Pan	1.720 <i>D</i>	0.570 <i>D</i>	3.430 <i>D</i> ‡
Truss	2.300 <i>D</i>	0.330 <i>D</i>	2.512 <i>D</i>

TABLE 24.3 Sizes of Standard Semitubular Rivets[†]

Nominal size	Oval head		Truss head		Flat countersunk [‡]		Hole diameter [§]	Length increment
	Diameter	Thickness	Diameter	Thickness	Diameter	Thickness		
0.061	0.114	0.019	0.130	0.019	...	...	0.046	0.016
0.089	0.152	0.026	0.192	0.026	0.223	0.039	0.068	0.016
0.099	0.192	0.032	...	...	...	...	0.076	0.016
0.123	0.223	0.038	0.286	0.038	0.271	0.043	0.095	0.016
0.146	0.239	0.045	0.318	0.045	0.337	0.056	0.112	0.031
0.188	0.318	0.065	0.381	0.065	0.404	0.063	0.145	0.031
0.217	0.444	0.075	...	...	0.472	0.075	0.166	0.062
0.252	0.507	0.085	...	...	0.540	0.084	0.191	0.062
0.310	0.570	0.100	...	...	...	...	0.235	0.062

[†]Dimensions in inches; all values are maximums.[‡]120-degree included angle; also available in 150-degree angle with chamfered top for friction materials.[§]For Type T tapered hole; diameter is at end of rivet; also available as Type S straight hole.

SOURCE: From Ref. [24.3].

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TABLE 24.4 Sizes of Standard Full Tubular Rivets[†]

Head shape	Nominal size	Head		Hole diameter
		Diameter	Thickness	
Oval	0.146	0.239	0.045	0.107
Truss	0.146	0.318	0.045	0.107
	0.188	0.381	0.065	0.141
Flat countersunk	0.146	0.317	0.050	0.107
	0.188	0.364	0.060	0.141

[†]Dimensions in inches; all values are maximum; maximum hole depth is to head.

[‡]Chamfered.

SOURCE: From Ref. [24.3].

TABLE 24.5 Sizes of Standard Split Rivets[†]

Nominal size	Oval head		Flat countersunk head	
	Diameter	Thickness	Diameter	Thickness
0.092	0.152	0.026		
0.125	0.223	0.035	0.223	0.036
0.152	0.318	0.045	0.317	0.053
0.152			0.380 [‡]	0.062 [‡]
0.190	0.349	0.055	0.443	0.061

[†]Dimensions in inches; all values are maximum.

[‡]Designates a large flat countersunk head rivet.

SOURCE: From Ref. [24.3].

head styles are available, but many of these are modifications of the countersunk head, the truss head, and the pan head. Head dimensions, lengths, and grips may be found in the manufacturer's catalogs.

24.2 PINS

When a joint is to be assembled in which the principal loading is shear, then the use of a pin should be considered because it may be the most cost-effective method. While a special pin can be designed and manufactured for any situation, the use of a standard pin will be cheaper.

Taper pins (Fig. 24.9a) are sized according to the diameter at the large end, as shown in Table 24.6. The diameter at the small end can be calculated from the equation

$$d = D - 0.208L$$