Please read the following information carefully and refer to it often throughout the building process. It contains information on corrosion protection, drilling, deburring, gusset building etc. Also included is a section on bolt and rivet selection to assist you in areas of the manual where bolt or rivet sizes have not been indicated.

1.1 Metal Surface Preparation

Some of our kits include the following chemicals to be used for surface preparation and treatment:

C-2200	MET-L-SOL Surface Cleaner
EP-420	Epoxy Chromate Metal Primer
EP-430	Epoxy Primer Catalyst

As a protective measure against corrosion, mating metal surfaces should be fully deburred, cleaned with C-2200, then coated liberally with epoxy chromate primer. This provides a seal between the surfaces to prevent corrosion and moisture buildup. It is a good practice to coat the end of the rivet on the inside surface after installation.

As an optional measure, the rivets can be dipped in chromate prior to installation. This provides protection inside the hole and seals out moisture. If the airframe is not to be painted be careful to avoid excess chromate on the exterior.

The epoxy primer is to be pre-mixed in accordance with the manufacturers directions as displayed on the containers. It is advisable to mix only the amount you need in a small container each time you work, however, larger amounts can be mixed and reused in a sealable container.

1.2 Drilling Holes

It is good practice to use a #40 drill when doing any assembly- if possible never drill to final hole size until assembly is complete. This allows for any movement between parts or adjustment you may want to make that may cause misalignment of the holes during assembly.

Always use a sharp drill bit as:

-A sharp bit will not wander as easily as a dull one.

-You can drill faster with a sharp bit.

-You don’t have to push as hard, risking bending flanges etc.

-Always be careful to drill squarely to the work surface.

-Always make sure when drilling through multiple parts or layers that they are clamped together tightly so as not to move around whole drilling.

-Always debur holes on both sides of each part before final assembly.

1.3 Bolts

Throughout the building process there will be instances where bolts are used to fasten parts or materials together. In some instances It may be for the builder to determine the correct length of the bolt to be used.

The "Rule of Thumb" for determining bolt length is that the bolt must be long enough to pass through the parts or material being fastened together so that:

1. The threaded part of the bolt is never in shear (no threads are allowed inside hole).

2. No more than three and no less than one thread must be showing when the nut is attached and tightened to the correct torque value.

3. At least on flat washer must be used under the nut and no more than three are allowed.

More precise determinations of Grip Length are found in a number of books including the Standard Aircraft Worker's Manual.

The following information is provided for reference when using AN grade hardware. Most of the time torque values are done to feel. But this table does provide a good outline. Occasionally bolts, other than a standard bolt will be called out for use in the manual. Please ensure that these bolts are used where called out. The Engineering Department selected these as they provide the strength for the connection where a standard bolt can not provide.

*1.4 Standard Torque Table (Inch Pounds) **

Fine Thread Series

Bolt Size	Standard Nuts (MS20365, AN310, AN315)	Shear Nuts (MS20364, AN320, AN316, AN23-31)
10-32	20-25	12-15
1/4-28	50-70	30-40
5/16-24	100-140	60-85
3/8-24	160-190	95-110
7/16-20	450-500	270-300
1/2-20	480-690	290-410
9/16-18	800-1000	480-600
5/8-18	1100-1300	660-740

Coarse Thread Series

Bolt Size	Standard Nuts (MS20365, AN310, AN315)	Shear Nuts (MS20364, AN320, AN316, AN23-31)
8-32	12-15	7-9
10-24	20-25	12-15
1/4-20	40-50	25-30
5/16-18	80-90	48-55
3/8-16	160-185	95-110
7/16-14	235-255	140-155
1/2-13	400-480	240-290
9/16-12	500-700	300-420
5/8-11	700-900	420-540

* The above calculations were obtained from the **Standard Aircraft Handbook**.

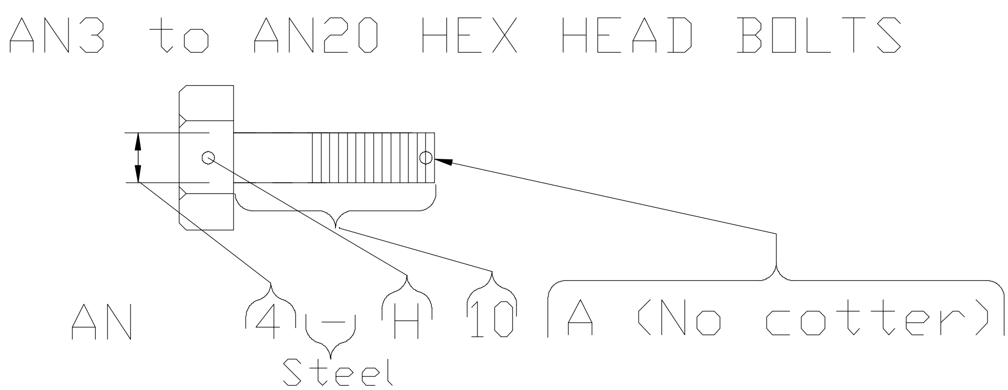


Figure 1.4.1

AN bolts may be obtained in the following materials. The coding symbols shown follow the basic dash number and identify the material required in the callout. Figure 1.4.1 shows how the material of the bolt may be distinguished by bolt head markings.

(-) = Steel, cadmium plated
C = Corrosion resisting steel
DD = Aluminum alloy

Example: AN4 - H10A

AN - Army Navy Standard
4 - Diameter in 1/16 inch increments or 1/4 inch diameter
(-) - Steel, cadmium plated
H - Bolt with drilled head and shank required; leave off if plain head required
10 - Refer to table 1 for bolt length and bolt thread corresponding to “10”
A - The adding of the letter A indicates that the cotter pin hole is not required

Note: To determine grip length, deduct the figure indicated below from the lengths shown in table 1.

AN3 - 13-32 AN8 - 25-32 AN14 - 1-1/4
AN4 - 15/32 AN9 - 29-32 AN16 - 1-3/8
AN5 - 17/32 AN10 - 61/64 AN18 - 1-1/2
AN6 - 41/64 AN12 - 1-3/32 AN20 - 1-11/16
AN7 - 21/32

1.5 AN3-AN20 Hex Head Bolt Length

TABLE 1 Bolts

Dash	AN3	AN4	AN5	AN6	AN7	AN8	AN9	AN10
Number	10-32	1/4-28	5/16-24	3/8-24	7/16-20	1/2-20	9/16/18	5/8-18
3	15/32	15/32						
4	17/32	17/32	19/32					
5	21/32	21/32	23/32	45/64	23/32			
6	25/32	25/32	27/32	53/64	27/32	27/32	31/32	
7	29/32	29/32	31/32	61/64	31/32	31/32	1-1/32	1-1/64
10	1-1/32	1-1/32	1-3/32	1-5/64	1-3/32	1-3/32	1-5/32	1-9/64
11	1-5/32	1-5/32	1-7/32	1-13/64	1-7/32	1-7/32	1-9/32	1-17/64
12	1-9/32	1-9/32	1-11/32	1-21/64	1-11/32	1-11/32	1-13/32	1-25/64
13	1-13/32	1-13/32	1-15/32	1-29/64	1-15/32	1-15/32	1-17/32	1-33/64
14	1-17/32	1-17/32	1-19/32	1-37/64	1-19/32	1-19/32	1-21/32	1-41/64
15	1-21/32	1-21/32	1-23/32	1-45/64	1-23/32	1-23/32	1-25/32	1-49/64
16	1-25/32	1-25/32	1-27/32	1-53/64	1-27/32	1-27/32	1-29/32	1-57/64
17	1-29/32	1-29/32	1-31/32	1-61/64	1-31/32	1-31/32	2-1/32	2-1/64
20	2-1/32	2-1/32	2/3-32	2-5/64	2-332	2-3/32	2-5/32	2-9/64

Table 2 Screws

Recommended Hole Sizes for Self-tapping Sheet Metal Screws

Metal		Clearance Drill for Sheet Metal Screws							
Thickness	Material.	#2	#4	#6	#7	#8	#10	#12	#14
0.015	Steel Alum.	52	44	37					
0.018	Steel Alum.	52	44	37	33				
0.024	Steel Alum.	51 52	43	36	32	27	19		
0.03	Steel Alum.	50 52	42 44	36 37	32 33	31 32	27	19	13
0.036	Steel Alum.	49 52	42 44	35 37	32 33	31 31	26 27	19	13
0.048	Steel Alum.	49 51	41 44	34 37	31 32	30 30	24 27	18 20	11
0.06	Steel Alum.	48 50	39 43	32 36	30 31	29 29	24 27	16 19	8 8
0.075	Steel Alum.		38 43	31 35	29 30	28 28	22 26	14 17	6 7
0.105	Steel Alum.		 42	30 34	28 29	25 26	20 26	13 15	4 6
0.125	Steel Alum.			 31	 29	25 26	18 23	9 14	1 4
0.135	Steel Alum.			 31	 29	24 25	18 23	9 14	1 4
0.164	Steel Alum.			 31	 29	 24	17 21	7 12	15/64 3
0.187	Steel Alum.			 31	 29	 24	17 21	7 12	15/64 3

Table 3 Clearance Drill Sizes for AN Bolts, Screws and Cotter Pins

AN BOLTS		AN SCREWS		COTTER PINS	
Bolt Size	Drill	Size	Drill	Size	Drill
#10	#11	#4	#32	1/16	#48
1/4	1/4	#6	#28	3/32	#36
5/16	5/16	#8	#19	1/8	#28
3/8	3/8	#10	#11	5/32	#16
7/16	7/16	1/4	1/4	3/16	#4
1/2	1/2	5/16	5/16	1/4	#1
9/16	9/16				
5/8	5/8				
11/16	11/16				
3/4	3/4				
7/8	7/8				
1	1				

1.6 Nuts

AN310 CASTELLATED NUT

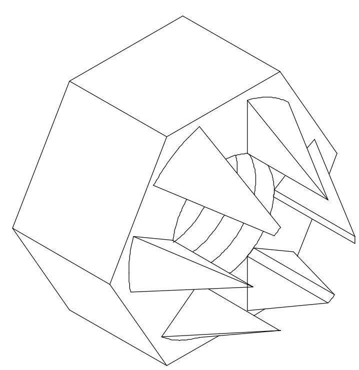


Figure 1.6.1

The AN310 Castle Nut is designed to be used in conjunction with a cotter pin for safetying. The nut may be used in tension and on assemblies that turn on the bolt or vice versa. This nut is used primarily with the AN3 to AN20 series bolt.

Example Callout:

AN310D4 An AN310 aluminum nut (D) for use on a 1/4 in (4) bolt. Thread from table - 1/4-28NF-3.

AN315 PLAIN NUT

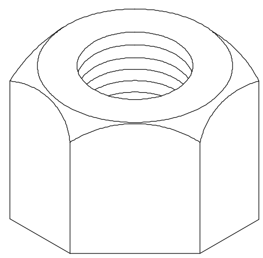


Figure 1.6.2

The AN315 Plain Nut may be safetied through the use of a shakeproof or lock washer - may be used in conjunction with the AN3 to AN16 series bolt. The nut may be had in right (R) or left (L) hand thread (see example callout).

AN316 CHECK NUT

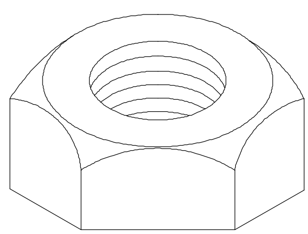


Figure 1.6.3

This nut is used as a check nut to eliminate travel of other nuts or parts on the threads of a bolt or rod. This nut must not be used in tension or shear. The AN316 nut may be had in either right (R) or left (L) hand thread (see callout).

UNF-3 THREAD SIZE														
6-40	8-36	10-32	1/4-28	5/16-24	3/8-24	7/16-20	1/2-20	9/16-18	5/8-18	3/4-16	7/8-14	1-14	1-1/8-12	1-1/4-12
		-3	-4	-5	-6	-7	-8	-9	-10	-12	-14	-16	-18	-20
		-3	-4	-5	-6	-7	-8	-9	-10	-12	-14	-16	-18	-20
			-4	-5		-7	-8	-9	-10	-12	-14		-18	-20
-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-12	-14	-16	-18	-20

AN365 SELF-LOCKING FIBRENUT

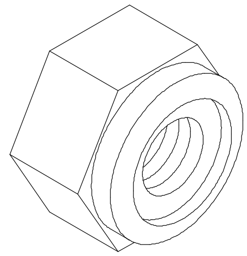


Figure 1.6.4

The Fibrenut is used extensively throughout the aircraft. Because of the locking ability of the fibre in the nut cotterpins or lock washers are not needed. Do not use the same fibrenut over and over as the nylon wears with each tightening and does not give the same locking strength. If you come to a step that calls for repeated nut use on the same bolt use a plain nut until the final install.

1.7 Washers

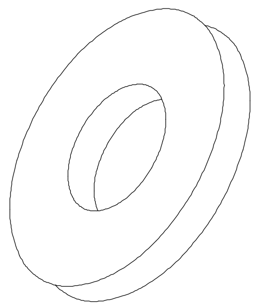


Figure 1.7.1

The AN960 plain washer is furnished in the following materials: Steel (Cadmium plated), Aluminum alloy (D), Brass (B), and corrosion resistant Steel (C). The code letter (none for steel) follows the basic number.

The inside diameter is indicated by the last dash number which is expressed in screw sizes as #6, #8 and #10, or; AN960-6, AN960-8, AN960-10. Washers requiring an I.D. or 3/8, 7/16 or 1/2 inch are called out as AN960-616, AN960-716, and AN960-816.

The washer is made in a regular and light (L) series in all metals indicated except brass. If the washer is of the light (L) series, the “L” will follow the dash number.

Add the letter “P” before the dash number to obtain aluminum washers that have been anodized.

The AN-970 washer provides a greater bearing area than the plain type, and is used to prevent local crushing of the surface.

1.8 Plastic Coating

The plastic film on the aluminum should be left on for as long as possible during the assembly of your aircraft. This helps to prevent the aluminum from being scratched.

1.9 Layouts

Use a ‘fine tip’ felt pen for accuracy (some felt pens will not write on aluminum). It will show up well and does not wipe off easily.

After layouts are no longer needed, clean off felt pen marks with solvent (M.E.K. works well) before final assembly as some inks may be corrosive if left on.

1.10 Deburring

Holes can be deburred with a deburring tool or a drill bit of a larger size than the hole being deburred - **BY HAND ONLY! NOT IN A DRILL!** Simply put the drill bit into the hole and twist just enough (usually one rotation) to remove burr only. Don’t go too deep. See figure 1.10.1. A cordless screwdriver with a drill bit installed will speed things up here, but be careful not to over do it!

With the swivel deburring too from Murphy aircraft, insert tool into hole and turn once. Generally the tool only deburrs one side, so you may have to repeat it for the opposite side.

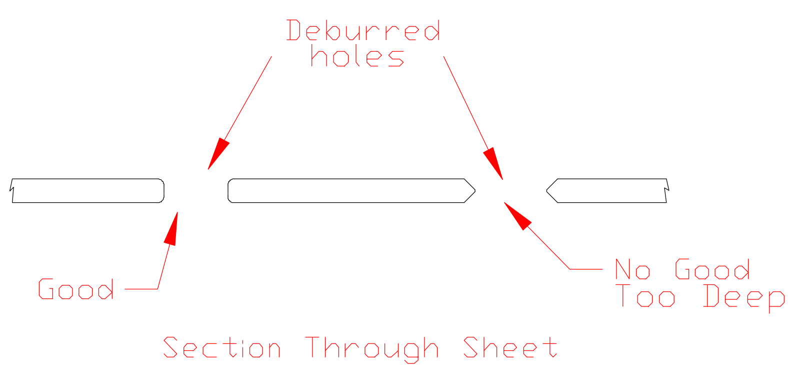


Figure 1.10.1

1.11 Edges

All edges should be filed to remove shear or tin snip marks then have the corners 'Chamfered', as shown in Figure 1.11.1, with a file.

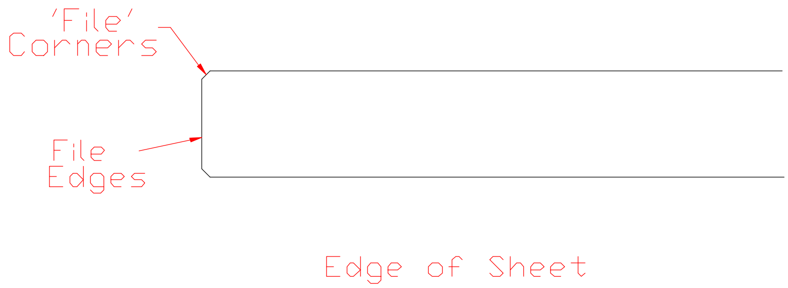


Figure 1.11.1

All flange ends should have corners rounded or at least be cut at 45 degrees, then filed. See Figure 1.11.2.

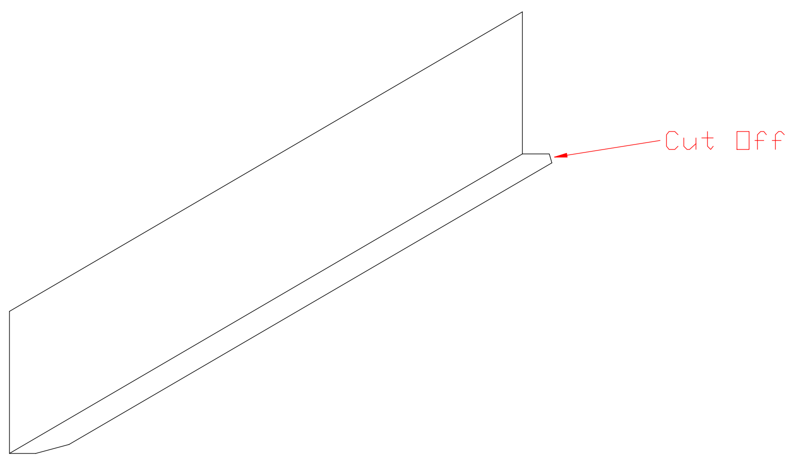


Figure 1.11.2

1.12 Inside Corners

Should always have the largest possible radius in the corner. Shown in Figure 1.12.1.

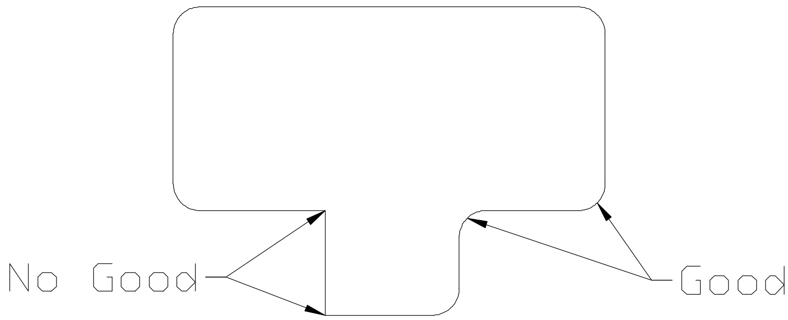


Figure 1.12.1

1.13 Riveting

The standard rivet used in the aircraft is the avex rivet. Many people mistakenly refer to them as pop rivets. “Pop” is a brand name and the correct terminology is blind rivet which simply means it can be used from one side only. There are considerable differences between the avex rivet and the more common pop rivet. Never substitute a pop type rivet for the avex rivets.

In the kit there are two diameters of rivets and various lengths. Both countersunk and domed head avex rivets are used. Stainless steel rivets are used in a few location, normally in high shear application. Check carefully with the instructions on where to use the different types, lengths and heads.

In your kit you will also find a number of large head all aluminum rivets. These rivets are non-structural and are used in installing the windows.

- Always check that you are using the proper grip length rivet for the job you are doing.

I.E.: 1/8: X 1/8” rivet refers to ‘Diameter’ and ‘Grip’ length will secure only up to 1/8” of material thickness, just as a 1/4” grip length rivet will secure only up to 1/4” of material.

- Make sue the rivet is all the way into the hole and that the parts being riveted have not pulled away from each other or separated.

- Keep rivet gun square to the work when pulling rivets.

- See next section on edge distance

1.14 Edge Distance

Edge distance is simply the distance from the center of the rivet or bolt to the edge of the skin or fitting. The proper edge distance is required to ensure that the rivets or bolts are not ripped from the skin/fitting because of inadequate shear strength.

The rule of thumb is that edge distance from center line hole to edge of material should always equal twice the rivet/bolt diameter. At Murphy Aircraft we normally add 1/16” in case we have to drill to the next size or too much material is trimmed off. To go any greater dimension than this does not increase the strength, it just adds extra weight and is unsightly. A *circle template* will assist you and is very cheap and easily purchased. Most office or school supply stores carry them.

- Always make sure that you have adequate edge distance on your parts. Rule of thumb for edge distance is:

  * Rivet/bolt diameter X2 or....
  * 1/8” rivet X2 = 1/4” edge distance
  * 3/16” bolt X2 = 3/8” edge distance

Never have less than 1 1/2 ties edge distance. Avoid more than 2 1/2 times edge distance.

Rivet Chart

Rivet Number	Rivet Diameter & Length
RV-1410	Rivet, 1/8" x 3/16" Avex
RV-1414	Rivet, 1/8" x 5/16" Avex
RV-1512	Rivet, 5/32" x 1/4" Avex
RV-1521	Rivet, 5/32" x 1/2" Avex
RV-1613	Rivet, 3/16" x 1/4" Avex
RV-1619	Rivet, 3/16" x 3/8" Avex
RV-1621	Rivet, 3/16" x 1/2" Avex
RV-1631	Rivet, 3/16" x .781 Avex
RV-2621	Rivet, 3/16" x 1/2" Avex LH
RV-2631	Rivet, 3/16" x .781 Avex LH
RV-4412	Rivet, 1/8" x 3/16" CSK Avex
RV-4621	Rivet, 3/16" x .500 CSK Avex
RV-4514	Rivet, 5/32" x 3/8" CSK Avex
RR-5402	Rivet, 1/8" x 1/8" S.S.
RR-5404	Rivet, 1/8" x 1/4" S.S.
RR-5406	Rivet, 1/8" x 3/8" S.S.
RR-5408	Rivet, 1/8" x 1/2" S.S.
RR-5602	Rivet, 3/16" x 1/8" S.S.
RR-5604	Rivet, 3/16" x 1/4" S.S.
RR-5606	Rivet, 3/16" x 3/8" S.S.
RR-6602	Rivet, 3/16 x 1/8 Closed End
RR-6406	Rivet, 1/8" x 3/8" Closed End
RR-6604	Rivet, 3/16 x 1/4 Closed End
RR-6606	Rivet, 3/16 x 3/8 Closed End
RV-6614	3/16" x 1/2 SS Varigrip
RR-7402L	Rivet, 1/8" x 1/8" Fabric
RR-7402L	Rivet, 1/8 x 1/4" Lg Hd Al.
RR-7408	Rivet, 1/8 x 1/2 " Aluminum
RR-8402	Rivet, 1/8 x 1/8 Al/SS

RR-6402	Rivet, 1/8 x 1/8" Closed End
RR-6403	Rivet, 1/8 x 3/16 Closed End
RR-6404	Rivet, 1/8 x 1/4 Closed End
MS2047OADS	Rivet, 1/8 " Solid Shank
RR-7604	Rivet, 3/16" x 1/4" Alum
RR-5608	Rivet, 3/16" x 1/2" S/S/
riv-1	Rivet, 1/8" x 5/16" SS
riv-2	Rivet, 5/32" x 1/4" SS

* Length is the Maximum material thickness that can be riveted.

In the above chart:

LH= LARGE HEAD
CKS= COUNTERSUNK OR FLUSH
S.S= STAINLESS STEEL
CLOSED END= TANK RIVET
ALUM= ALL ALUMINUM

1.15 Aircraft Solid-Shank Rivets

Only the solid-shank rivet increases, when it is properly installed, in size and strength. A steel bolt, for example, will actually decrease in diameter when it is installed and torqued. Some manufacturers of special fasteners attempt to duplicate the natural action of solid-shank rivets by putting expanding sections on the fasteners’ pulling stems. Most of these special fasteners only approximate the natural shank expansion of a driven solid-shank rivet.

Since pure aluminum weights one-third as much as steel, aluminum alloy solid-shank rivets are lighter than many other fasteners. Their lightness is an advantage, but it limits their usefulness: Solid-shank rivets greater than 1/2- inch in diameter are not used. However, the allowable range, 3/32 to 1/2- inch in diameter, is broad enough for the needs of most typical aircraft construction and repairs.

1.16 Riveting Solid Shank

Riveting is sometimes referred to as a “mushrooming” process. When the rivet is being driven, certain physical changes take place. The rivet diameter cross-sectional area increases, the hardness of the rivet increases due to coldworking, the manufactured head expands, and the shank expands to the size of the hole. The result of this mushrooming process is that the rivet is coldworked, changing its temper designation from T4 to T3.

There are tree steps involved in planning and executing a solid-shank rivet joint for structural repair: Layout, installation, and inspection.

Rivet Diameter	Drill Size	Cleco Color	Bucking Bar Weight	Edge Distance	Rivet Pitch
3/32	40	Silver	2-3.0 lbs	6/32	9/32
1/8	30	Copper	3-4.0 lbs	1/4	3/8
5/32	21	Black	3-4.5 lbs	10/32	15/32
3/16	11	Gold	4-5.0 lbs	6/16	9/16

In the chart above shows the rivet sizes, drill sizes, Cleco colors, bucking bar weights, minimum edge distances, and minimum rivet pitches for layout and installation of the commonly used solid-shank rivets.

Rivet spacing is important when laying out rivets to obtain a joint which is structurally sound and aesthetically balanced. The layout of rivets may be in rows abreast or transverse. One of the advantages of placing rivets in transverse row is that it reduces rivet failure along the metal's grain structure. Rivets laid out in rows abreast have a greater tendency to fail along the grain.

Rivet pitch is the distance between one rivet or row of rivets and the next rived or row of rivets. (Some handbooks refer to rivet pitch as gage.) Minimum rivet pitch is 3D, or 3 diameters, of the rivet being driven. (The diameter of a rivet is expressed as D and the length as L.) Average rivet pitch is 6 to 8 diameters. Maximum rivet pitch is 24 times the thickness of the top sheet of metal. Minimum transverse rivet pitch is 2.5 diameters of the rivet being driven. Figure 1.16.1.

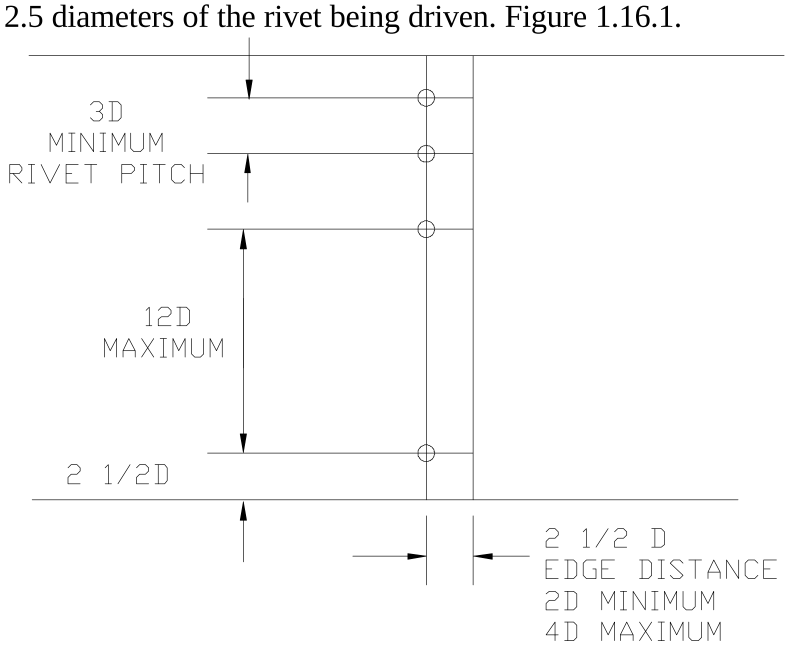


Figure 1.16.1

Edge distance is the distance from the edge of the metal to the center of the first rivet or row of rivets. On aircraft, the minimum edge distance is 2D and the maximum is 4D. If an edge distance is larger than

4D, the edges may curl upwards and not lie flat and binding. When aircraft rivets are installed using less that 2D edge distance, the bearing edge strength of the metal will weaken.

To select the correct drill, and to drill the holes to the proper size. All rivet holes must be center punched in order to prevent the drill from walking over the surface of the metal and defacing it. The indentation made by a center punch must be hard enough to catch the point of the drill, yet light enough to prevent denting the surrounding mental. Proper drill selection depends upon the size of the rivet being used. The hole for a solid-shank rivet is drilled approximately .002 to .004 of an inch larger than the nominal rivet diameter.

A rivet that is driven into a properly prepared hole needs to be sized according to diameter and length so that a correct size bucktail can be formed. Figure 1.16.2 shows the width and height of a normally driven bucktail.

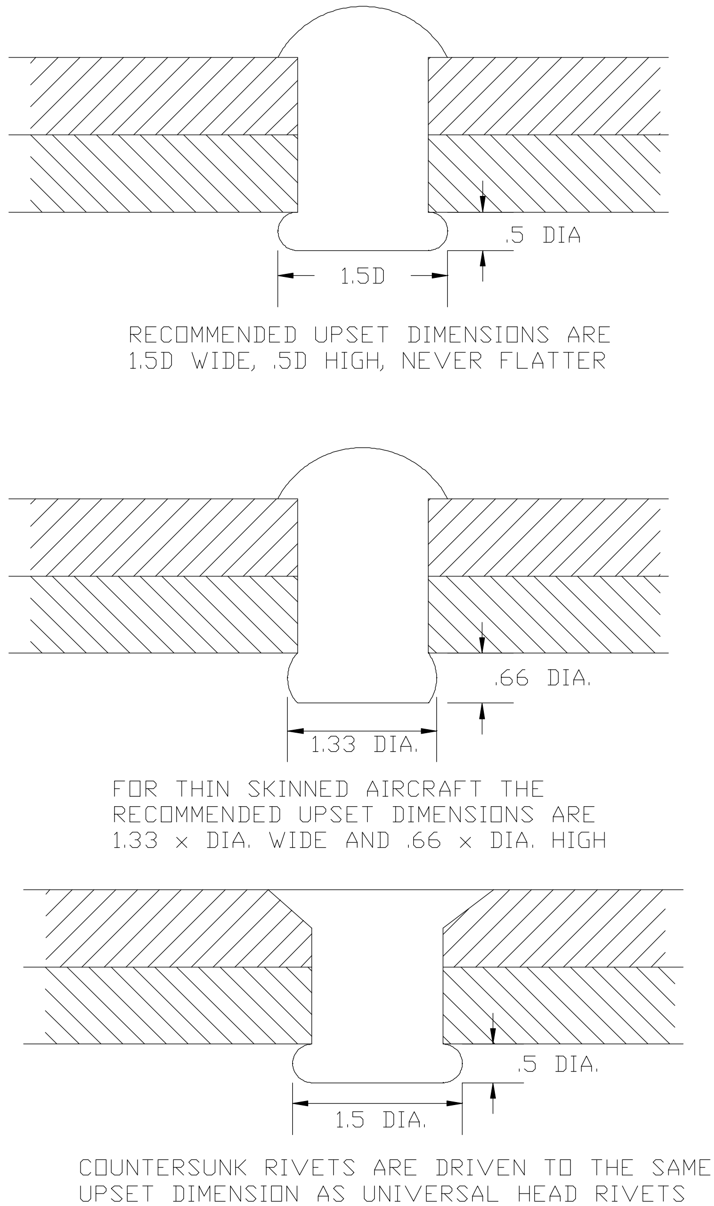


Figure 1.16.2

The use of thin skins on many light aircraft requires that the upset rivet head be .66 times the diameter of the rivet high, and 1.33 inches times the diameter of the rivet wide. To determine the rivet length for a particular job, the thickness of all the metal parts must be known. All the individual thickness of the metal are referred to as the grip length. The grip length plus 1.5D is the proper length of the rivet. Figure 1.16.3.

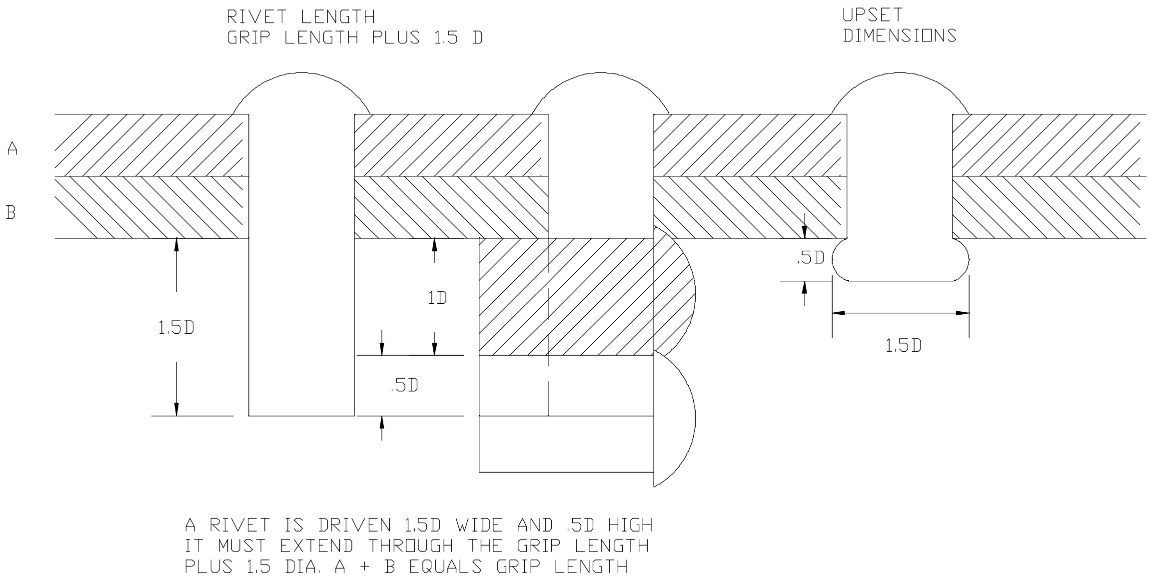


Figure 1.16.3

The hand tool used to drive a rivet is called a pneumatic rivet gun or rivet hammer. Rivet guns are normally powered by compressed air and are classified as light-, medium-, or heavy-hitting. A light-hitting gun is used to install 3/32 and 1/8 inch diameter rivets. Medium-hitting guns are used to install 5/32 and 3/16 inch diameter rivets. Heavy-hitting guns are used to install larger diameter rivets and some special fasteners,

There are two types of gun sets, one for universal head rivets and one for countersunk. The universal gun set is sized to fit the various shapes of manufactured heads on the rivet's driven end. The opposite end of the universal gun set fits into the rivet gun barrel and is held in place by a beehive retainer spring.

The countersunk gun set fits all sizes of flush head rivets. The countersunk rivet cannot use the beehive retainer ring. The countersunk rivet set uses a specially designed retainer spring.

1.17 Bucking Bars

The tool used to form an upset head while using a pneumatic rivet gun is a bucking bar. Bucking bars are made in various shapes, sizes and weights. The weight of the bucking bar must be proportional to the size of the rivet.

To obtain a proper upset head, a good technique to use is shown in Figure 1.17.1. As the gun is firing, press the bucking bar firmly against the forming rivet shank and roll the bar slightly. This rolling action will aid in the formation of a barrel-shaped bucktail. If the bucking bar is too light for the size of rivet and gun, the metal will bend toward the bucktail. If the bucking bar is not held firmly against the rivet shank, the metal will bend away from the gun.

The smooth face of the bucking bar must no be allowed to nick or scar. Nicks or scars on the face of the bucking bar will mar the bucktails and can lead to rivet failure. All scarred or marred bucktails must be drilled out and replaced with fresh, unmarked rivets.

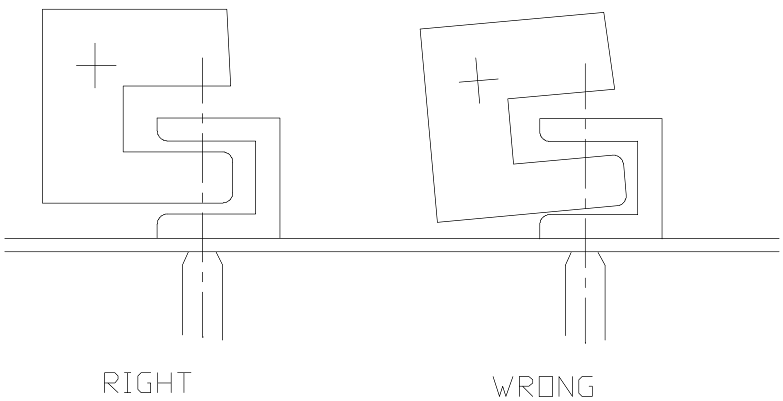


Figure 1.17.1

1.18 Rivet Codes and Identification

The manufacturing of all solid-shank rivets is governed by Federal Specifications and Standards QQ-A-430. Solid-shank rivets are identified and cataloged by head shape, alloy contend, shank diameter, and shank length. See Figure 1.18.1

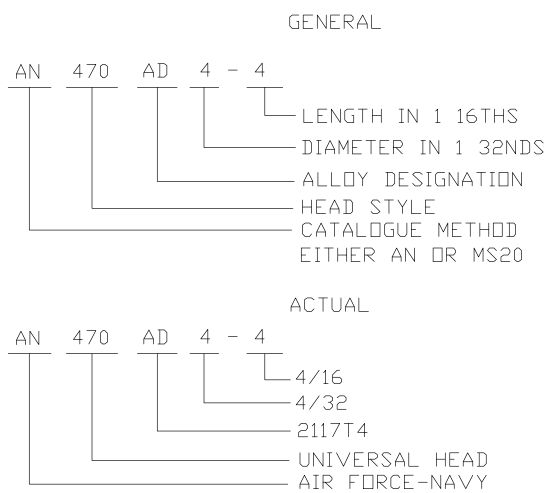


Figure 1.18.1

Two shorthand methods of coding are used to identify all aircraft rivets. An example is AN470AD4-5, or MS20470AD4-5. AN means Air Force-Navy and MS20 means Military Standards 20; 470 designates a universal style rivet head; AD refers to the alloy 2117T4: the hyphenated numbers designate the rivet diameter in thirty-seconds of an inch and the length in sixteenths of an inch. Thus, in the example, 4 means 4/32nds-inch diameter, and 5 means 5/16ths-inch length.

Although the AN and MS20 methods of cataloging rivets are similar, it is important to consistently use one of the two methods when ordering or identifying rivets. The rivet code is also used in blueprints, drawings, and technical manuals.

1.19 Rivet Head Styles

Four styles of rivet heads are used to construct an aircraft: round, flat, universal, and countersunk. The latter two are the most commonly used in the aircraft industry. Figure 1.19.1 is a cross-sectional view of the universal and countersunk head rivets, showing their diameters and lengths.

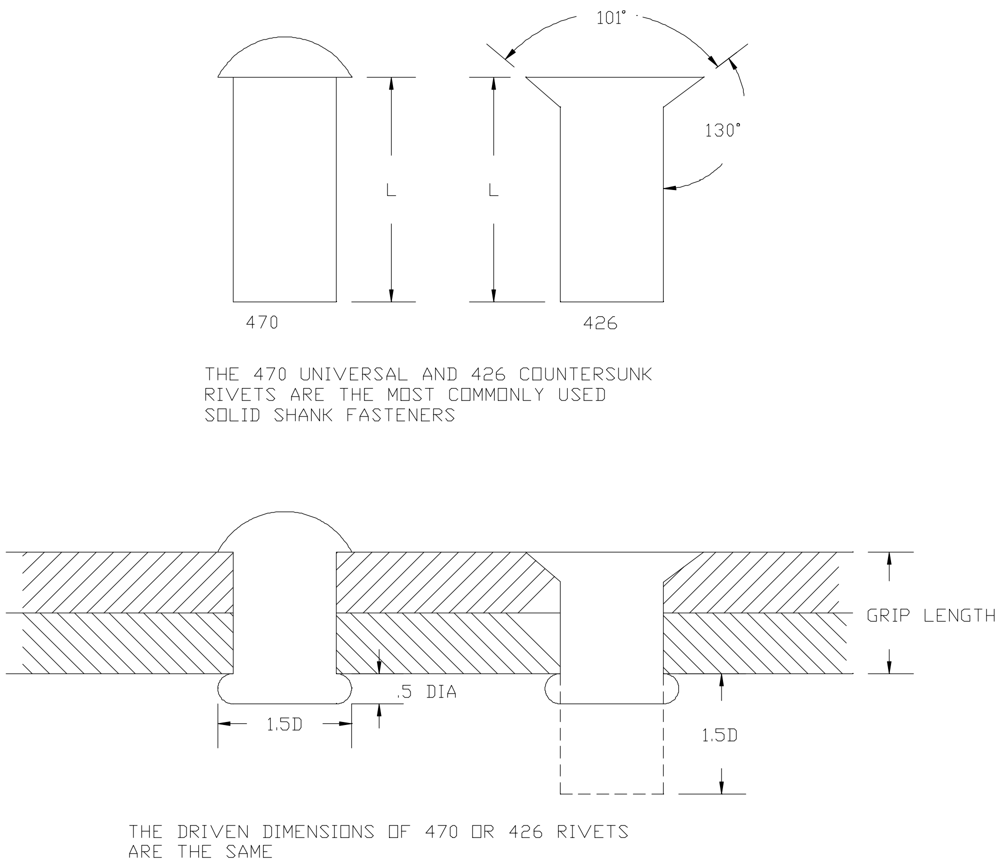


Figure 1.19.1

1.20 Universal Head Rivets

Universal head rivets, also called protruding head rivets, are used internally in structural areas and on the skin surfaces of low to medium speed aircraft. A universal head rivet can with stand a much stronger bearing load than a countersunk rivet because the head is installed flat and binding on the surface of the riveted metal while the countersunk rivet is installed into a machine-tapered will.

The universal head rivet is a combination of several older head styles. When rivets were first used, various rivet head styles were available. Round head (AN430) rivets were used internally on high strength structural areas. The flat head (AN442) rivet was used in tight areas where the round head could not be installed. Some modern jet aircraft still use round and flat head rivets in structural areas.

Aircraft built prior to World War II were low speed aircraft, so a smooth aerodynamic air flow over the wing was not a major concern. As the speed of the aircraft increased, the need for smaller protruding head rivets accounted for the development of a modified brazier head (456), which causes less drag than larger protruding head rivets. Today, brazier head rivet styles are likely to be found only on aircraft built before 1955. Because the rivet sets used to drive rivets other than universals are difficult to obtain today, the older styles can be replaced by universal head rivets. Advisory Circular 43.14-1 explains the procedure.

1.21 Countersunk Rivets

As aircraft speeds increased, the need for smooth airfoils led to the development of the countersunk rivet. After experimenting with head angles of 78^o, 90^o and on high-speed jet fighters, 110^o, the aircraft industry adopted a 100^o standard. All of these experiments were attempts to increase the bearing strength of the rivet head around the skin.

The countersunk rivet has to be installed in a depression in such a way as to be flush with the surface of the skins it is holding together. The depression in the skin is called a nest or a well. The well can be made using a freehand or microstop countersink cutter.

Whenever the metal is cut to form a well or nest, the area around the rivet head is weakened. To compensate for this loss of strength, aircraft manufactures must install a greater number of rivets in order to increase bearing and shearing strengths. Figure 1.21.1 shows how countersunk rivets re installed, by either machine or dimple methods

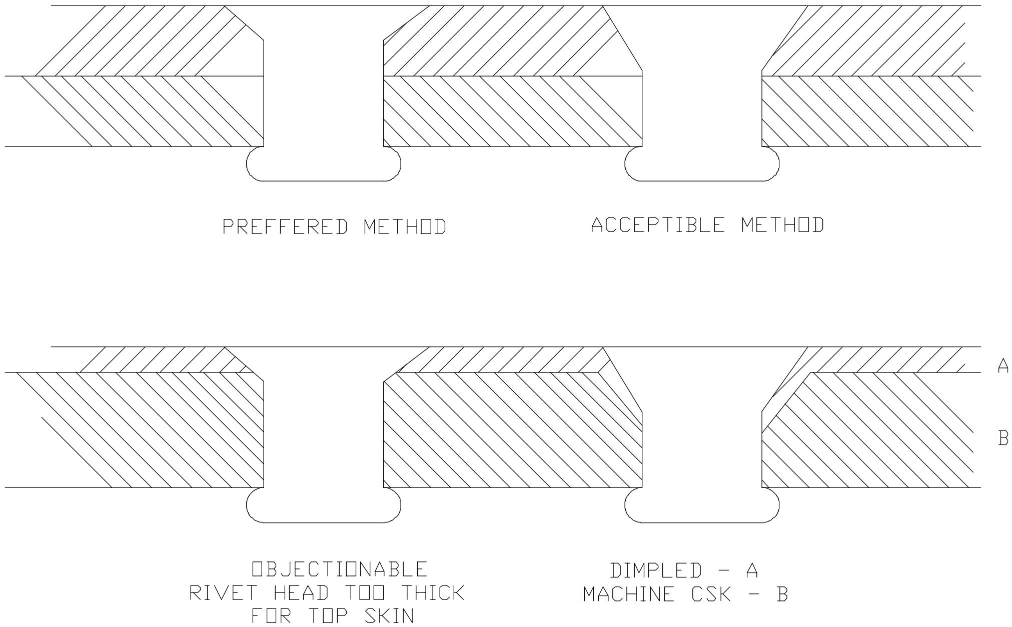


Figure 1.21.1

To remedy the loss in bearing strength caused by machine countersinking, the NACA (National Advisory Commission for Aeronautics) developed a method of countersinking that has been adopted by aircraft manufacturing companies.

Two different angles may be cut into the top skin, 60^o or 82^o. Military aircraft were the first to use the 60^o well, on some of the older jet fighters. The 82^o well is used when installing sing slugs on the Boeing 747. On some aircraft, a universal is installed from the inside of the wing and driven into an 82^o well.

Installing rivets using either the 60^o or 82^o NACA countersink method makes them as strong as universal head rivets. When coldworked, the bucktail formed in the 60^o or 82^o angle well is stronger than the conventional countersink riveting method because the driven head is packed into its well, creating a much stronger head than the regular countersunk rivet can produce.

1.22 Dimpling

Thin skins are never machine countersunk, because the cutter will go completely through the thin skin into the second skin and reduce the bearing strength around the countersunk rivet head. There is an alternative process call dimpling, which solves this problem.

Dimpling can be done in two ways, cold dimpling or hot dimpling. Cold dimpling of sheet metal skins is done on material less than .040 of an inch thick if countersunk rivets are required. The benefit of cold dimpling is that it produces stronger shearing and bearing strengths in the joint than would a driven universal head rivet of the same size.

Dimpling bars or sets can be made in the shop by cutting steel stock to the same size as the rivet to be used, and then setting a microstop countersink to cut about .015 of an inch deeper than the rivet head.

To use the dimpling bar, drill a hole into the sheet metal just as you would for a universal head rivet, place the dimpling bar under the rivet hole and insert a countersink rivet. Using a rivet gun with a mushroom head set or a ball peen hammer, tap the rivet head into the dimpled well. Because dimpling does not produce the flushness of a machine countersunk rivet, be careful not to hit the area around the head too hard, or the metal surrounding the rivet will stretch, creating a problem which could be difficult to remedy. Metal that becomes stretched must be removed and replaced either by a patch or by changing a complete skin panel.

1.23 Inspection of a Rivet Joint

There are three places to check when inspecting a rivet joint: The MFG. head, the shop head, and the skin around the rivet heads. Any damage to either of the two rivet heads is not critical because rivets can e drilled out and replaced.

Note: Never oversize the hole when drilling out a damaged rivet!

If skin damage is extensive, a new skin panel must be installed.

The procedures for removing rivets depends upon the situation. If, for example, an aircraft has extensive damage to a wing leading edge or a section of the spar, the mechanic will remove the damaged metal as well as some of the parts that are still useable. In removing rivets from reusable aircraft parts, it is essential that the rivet holes not be oversized.

The correct way to remove the rivets is to file a flat spot on all protruding head rivets except the 2117 rivets, to center punch each MFG. head, to back up each rivet with a bucking bar, to select a drill ONE SIZE SMALLER THAN THE RIVET BEING REMOVED, to drill only the depth of the MFG. head, to use a pin punch which is the same size as the drill, to snap off the drilled MFG. heads and to back up each remaining stem by tapping out the shank without stretching the metal.

A different procedure is followed in removing the occasional rivet badly driven during re-assembly. Such rivets should be removed by the same size drill as the rivets being installed. Drill the depth of the MFG. head only; then lightly tap off the MFG. head and gently knock out the remaining shank.

Figure 1.23.1 illustrates an assortment of faulty rivets which must be removed and replaced. The most troublesome rivet fault is a clinched rivet, which results from improper bucking action. The rivet forms to one side, which can lead to a corrosive condition at a later date. Rivets that crack do so because they became too hard while the bucktail was forming. This is a result of hitting the rivet too lightly or allowing an icebox rivet to recover its age hardening by keeping it out of the freezer too long before driving.

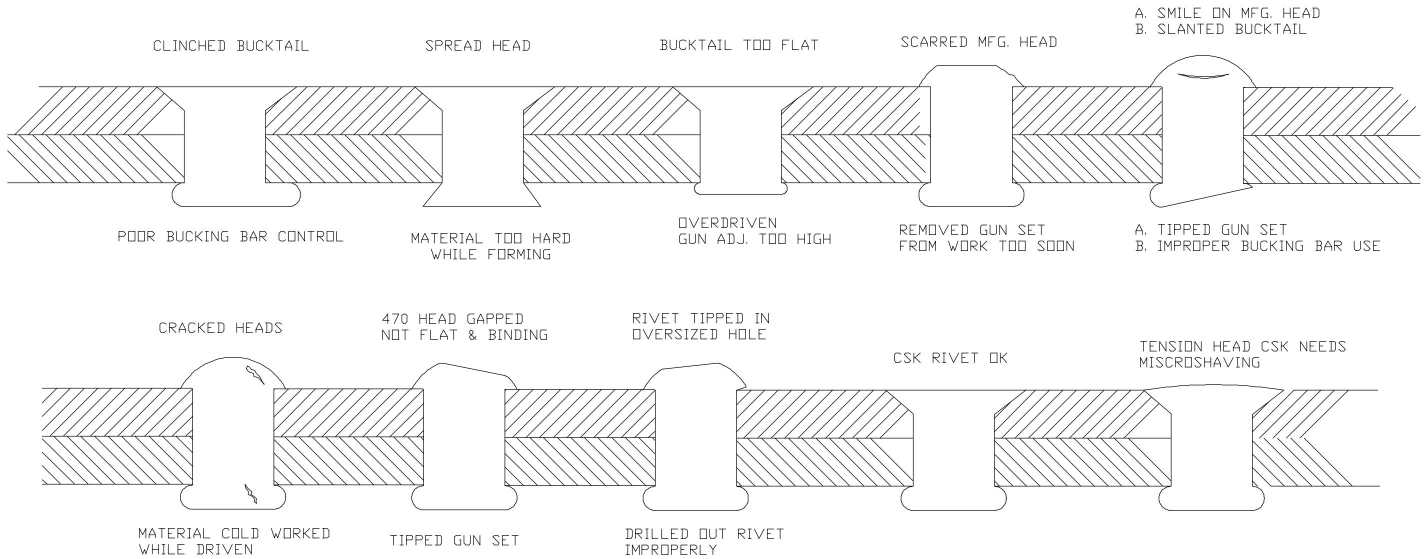


Figure 1.23.1

1.24 Fiberglass Construction

Towards the end of this manual, you will be constructing fiberglass fairings for your AIRCRAFT. You kit contains enough fiberglass cloth, resin and catalyst to complete this job. This is very easy process and one should have no trouble completing these fairing. The following list has some recommendations about using fiberglass. It is highly recommended that the builder review the fairing construction sections at this time in order to understand the work they need to perform.

1) Because the windshield installation involves the use of fiberglass, it is recommended that the builder install the windshield before working on the fairings. This will give the builder practice with fiberglass.

2) If a builder chooses to follow our instructions, a proven fairing will result, the builder may also employ some of his/her own creativity into the construction.

3) Keep the weave of the cloth straight and mark your cuts with a black felt pen. Cut the cloth with sharp scissors.

4) If the fiberglass lays smoothly while dry, it will easily conform to the mold when wetted out with resin.

5) Keep the fiberglass cloth clean. If possible, keep it in an area away from where you will be using the resin. Oil, dirt or solvents will deteriorate the cloth and prevent the resin from improperly bonding to the cloth.

6) It is much easier to handle fiberglass cloth if you spread it over a smooth slick surface. Keep the loose ends of the fiberglass trimmed if possible.

7) Keep all the necessary tools at hand. Ensure you have good light, work in a well ventilated and temperature controlled area. Keep the room temperature around 75 to 85 degree Fahrenheit. Always abide by the instructions and warning labels provided on the resin containers.

8) Allow yourself plenty of time to work with the fiberglass and resin.

If more information is required about the use of fiberglass or lay-up procedures, an excellent reference book is Sportplane Construction Techniques by Tony Bingelis. This book can be purchased at any EAA Bookstore or EAA Chapter.

1.25 Making Gussets

Instead of giving the builder a drawing of a Gusset Pattern with the dimensions and the hole spacing on it we will show you how to make a Gusset that will fit properly every time.

1) First, find the rivet hole that needs to be covered with a Gusset. Cut a piece out of the appropriate material to more than cover the rivet holes. See Figure 1.25.1.

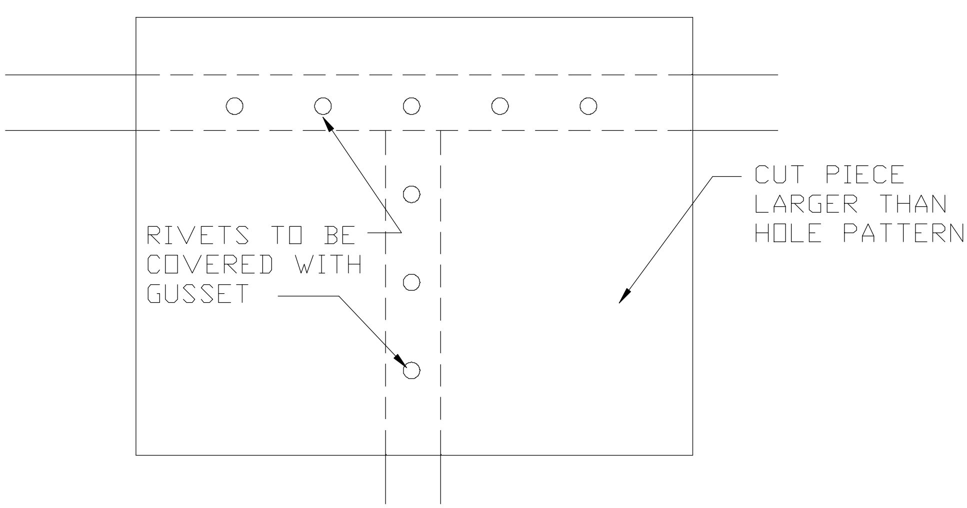


Figure 1.25.1

2) If possible, backdrill through the holes to be covered. Cleco while drilling.

3) Remove the Gusset.

4) Draw circles around the end holes to mark out the shape of the Gusset. As shown in Figure 1.25.2. The radius of the circle should be two times the rivet diameter.

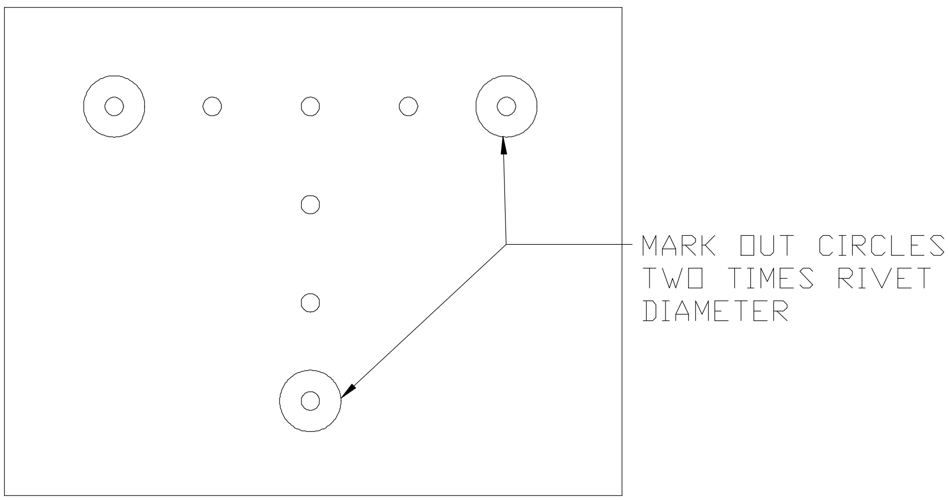


Figure 1.25.2

5) Draw tangent lines to the cicles. See Figure 1.25.3.

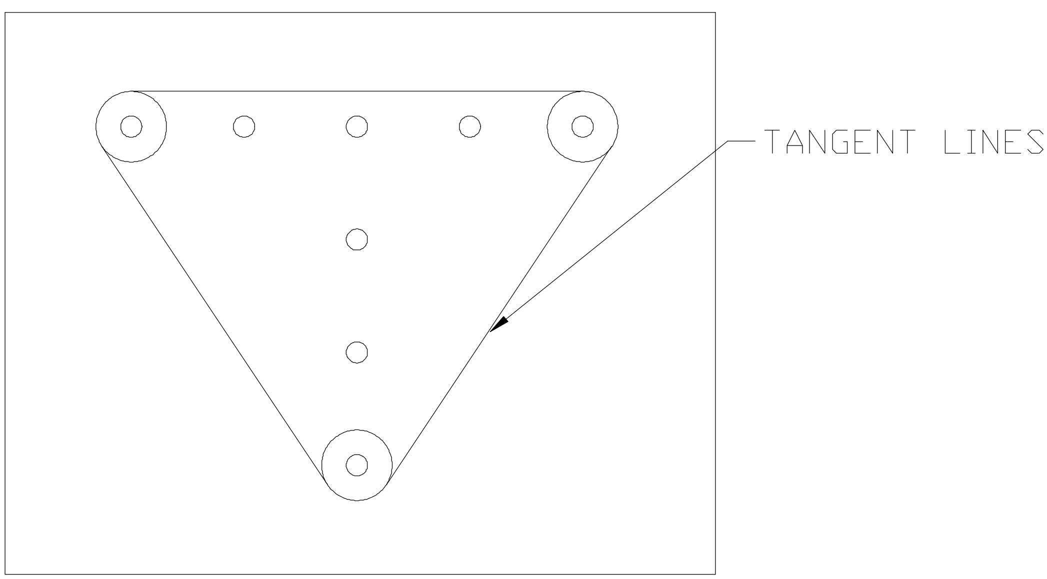


Figure 1.25.3

6) Cut out the Gusset following the lines you marked out. Debur all edges. Cleco the finished Gusset back in place.

NOTE: This method will work for odd shaped Gussets. Just find the rivet holes that mark the outside shape of the Gusset and mark circles around them**.**

1.26 Using Sealant

WARNING- Do not get sealant on your skin! Use rubber gloves! Good ventilation is also a good idea. Use a scotchbrite pad and soapy water to remove from your skin - not solvent, M.E.K. etc.

Clean all mating surfaces before applying sealant. Use a Scotchbrite pad and scuff surfaces well, wipe or blow dust away (do this immediately before applying sealant). **DO NOT USE ANY SOLVENT OR M.E.K. AFTER SCOTCHBRITING THE SURFACE**

The sealant supplied with this kit is a two part mixture. It is very important that the mix ration specified by the manufacturer is adhered to and that it be used at room temperature. Improper mix ration or too low a temperature may cause the sealant not to cure!

Only mix enough sealant to do the job, don’t waste it. It is better to under estimate and run out before completing an assembly. You can always mix a little more to finish up. Working time is about 2 hrs.

The best way to mix the sealant is on a flat sheet (aluminum is good). Use a putty knife or a piece of aluminum to mix. Scrape sealant up from mixing surface completely when mixing to make sure there is no uncatylized sealant underneath.

How much do I use? - After riveting you should see a small amount of sealer being squeezed out all along the joint.

1.27 Do’s and Don’ts in Handling Aluminum Sheets

Do- use a soft leaded pencil to mark aluminum sheet.
Don’t - use scribe

Don’t- scratch the surface of aluminum- protect sheet against abrasion

Do- bend aluminum where possible so the flange be bend line runs perpendicular to the metal grain (direction or rolling).

Do- use the recommended bend radius in bending aluminum sheet.

Do- use a protective layer between adjacent alclad sheets

Don’t-use a brown sulphite paper -this paper, when wet, will cause corrosion

Do- store aluminum sheet in a dry area - atmosphere must not be moist or humid

1.28 Castings

Castings may be made from both the heat-treatable and the non heat-treatable alloys. No general rules can be cited in determining the alloy composition, as each type (aluminum-silicon, aluminum-magnesium, etc.) has alloy compositions which are suited for most design considerations.

It can be stated, however, that many die cast and permanent mold castings are made from the non-heat-treatable alloys.

Heat-treatable castings are used where physical properties are required which are greater than those obtainable from the non-heat-treatable alloys. While the chemical compositions vary somewhat from those of corresponding wrought alloys, the method of heat-treatable castings is about the same as those used on wrought alloys.

1.29 Forgings and Extrusions

Forgings are usually made from the heat treatable wrought alloys. The most common forging alloys are 2014, 4032, 7075, 3003. They are made by the common methods used with other metals and are subject to the same kinds of defects. Extrusions are made by “squirting” an aluminum slug through a shaped hole in a die. Complex shapes can be made accurately to dimensions. Extruding can produce shapes (for example, finned tubing) which could not be made by rolling. Both heat treatable and not heat treatable alloys are extruded.

1.30 Heat Treatment of Aluminum Alloys

There are four types of heat treatment used in aluminum alloy fabrications, namely, Stress Relieving, Annealing, Solution Heat Treatment and Artificial Aging.

Stress Relieving is used on the non heat treatable alloys. To relieve stress, the part is heated to a temperature of 650º to 750º Fahrenheit and allowed to air cool. This is done to remove the effects of cold work stresses so that further forming may be done without cracking.

Annealing is used on the heat treatable aluminum alloys to remove the effects of solution heat treatment or artificial aging. It consists of heating the material to 750º to 800º Fahrenheit and followed by slow cooling to prevent the introduction of unnatural stresses. Both wrought and cast alloys are annealed to put them into the softest and most ductile condition for further work.

Solution Heat Treatment is used to harden and strengthen heat treatable alloys only. The metal is heated to a temperature usually between 870º and 980º Fahrenheit, depending on the alloy, and then rapidly cooled by either quenching in water or water spray. There is little effect immediately, but within minutes (unless refrigerated) the metal begins to harden at room temperature. The T4 condition is reached by this “natural” aging at room temperature.

Artificial Aging is used to obtain greater strength and hardness than will be developed by “natural” aging. It is produced by reheating following solution heat treatment. The recommended artificial aging is obtained by heating to 250º -375º Fahrenheit for 6 to 30 hours, and is designated as T6. Stabilizing (casting alloys only) consists in aging beyond that required for maximum strength in order to control growth and distortion.

1.31 Surface Protection of Aluminum Alloys

Although aluminum alloys have very good properties for corrosion resistance, it is necessary to provide additional protection where surfaces are in contact with other metals, or are subject to long periods of exposure to moisture or acid atmosphere.

This protection is obtained by Cladding, Painting, Anodizing or a combination of these processes. A brief explanation of each follows in Section 3 in Aircraft Process and Finishes.

1.32 Machining

While aluminum alloys are readily machined, the best machining is only obtained when proper speeds, feeds, and tool grinds are used. Compared to steel, the rake angles should be greater to give good chip removal. Higher speeds are used than common with steel, but feeds are light to medium, using large amounts of cutting fluids.

1.33 Forming

Wrought aluminum in “o” or “w” condition, and not heat treatable alloys in the “o” condition may be cold formed readily by any of the usual shop methods. Severe forming operations such as spinning and deep drawing will usually have to be done in two or more steps, each step followed by an anneal. the heating relieves work hardening of the metal and lessens chances of cracking.

Often small parts of limited quantity are made by hand, and in such cases, a fiber or rawhide hammer is used and a form of metal, plastic or wood.

Most large or severely formed parts are made on drop hammers or hydraulic presses. Dies are made of Kirksite, steel, cast iron, lead, or plastic. When hydraulic presses are used, the forming is usually in female dies with layers of gum rubber to act as male dies under very high pressure.

Bends and a number of other shapes are made by combining bending operations are usually made on the brake or on sets of rolls.

In any forming operation, working surfaces of the tools must be kept smooth and scratching of the aluminum must be avoided. Bends must have sufficient radius to avoid cracking. this radius depends upon the gage and temper of the material being formed.

The general rule for minimum bend radii of material is:

1 x thickness for O material

4 x thickness for T3 material or T4 material

In all forming of aluminum alloys, the natural springback of the metal must be taken into account. The metal must be overformed to give the desired final shape. O and H12 material has the least springback. As much forming of heat treatable alloys as is possible should be performed in the T4 or W condition in order to avoid the warping which occurs when formed parts are heat treated.

1.34 Steel

All of the steels used in aircraft must meet standard specifications for chemical composition in order to assure the design engineer that what he specifies will have uniform and proven physical properties.

Steel specification standards have been evolved by the AISI (American Iron and Steel Institute) working with the SAE (Society of Automotive Engineers).

Their identification system is based on a four-digit number which will immediately identify the steel for Chemical composition. The first and second digits indicate the principal alloying elements and the last two digits indicate nominal carbon content.

Example: 4130

4= Indicates molybdenum steel
1= Indicates % chromium
30= Indicates 30 pts. of carbon.

AISI AND SAE STEEL NUMBERING SYSTEM

Type of Steel	Aisi Number
Carbon Steel	1XXX
Plain Carbon	10XX
Carbon and Sulphur	11XX
Manganese Steel	13XX
Nickel Steel	2XXX
3.5% Nickel	23XX
5.0% Nickel	25XX
Nickel-Chromium Steel	3XXX
1.25% Nickel, 0.60% Chromium	31XX
1.75% Nickel, 1.00% Chromium	32XX
3.5% Nickel, 1.5% Chromium	33XX
Molybdenum Steel	4XXX
Chromium-Molybdenum	41XX
Chromium-Nickel-Molybdenum	43XX
Nickel (1.75%)-Molybdenum	46XX
Nickel (3.50%)-Molybdenum	48XX
Chromium Steel	5XXX
Low Chromium	51XX
Chromium 1.0%	52XX
Chromium -Vanadium Steel	6XXX
Chromium 1%	61XX
Nickel-Chromium-Molybdenum Steel	8XXX
Nickel 0.55%; Chromium 0.50%; Moly 0.20%	86XX
Nickel 0.55%; Chromium 0.50%; Moly. 0.25%	87XX
Silicon-Manganese Steel	9XXX
Boron and Nickel Steel	80BXX

1.35 Cable Rigging

The following are instructions for installing thimbles on the ends of the cables for rigging Elevator, etc. The instructions show a standard installation procedure for a 5/32” cable. The procedure is the same for the different size cables also for attaching cables to turnbuckles.

NOTE: You may have to drill out the hole on the end of the WT-06 Tang to fit the thimble through.

Put a 5/32” nico on the end of a 5/32” cable. Pass the end of the 5/32” cable through the WT-06 Tang and over the 5/32” thimble. (Figure 1.35.2). Thread the cable back through the nico (slide nico tight against thimble) and ‘press’ the nico, equally spaced, twice. Figure 1.35.1.

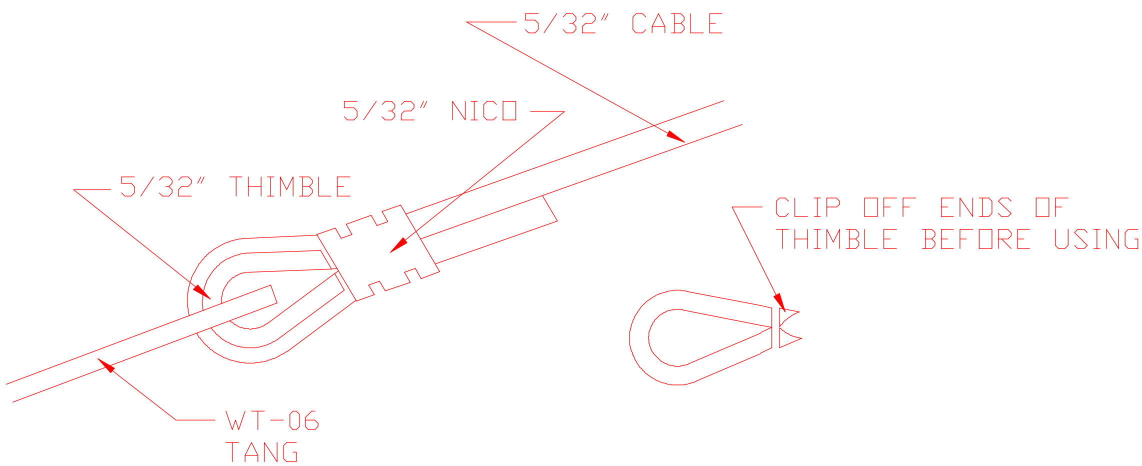


Figure 1.35.1

Cut a length of Heat Shrink Tubing and place it over the two cable ends close to the nico. Cut off excess cable and shrink the Heat Shrink Tubing. Figure 1.35.2.

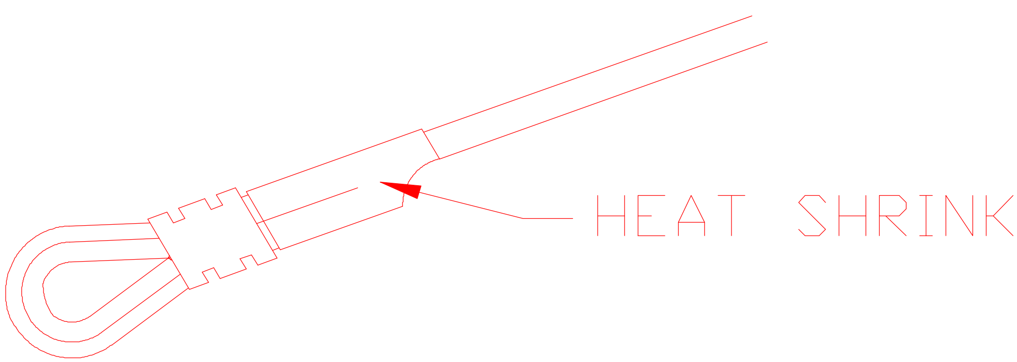


Figure 1.35.2

1.36 Push Pull Tube Fabrication

The following is a standard practice for manufacturing the push pull tubes used throughout the aircraft. The example shown is for the 1/4” (HM-4M) Rod End Bearing on 3/4” x .035 tubing. Other combinations are:

1) 1/4” HM-4M Rod End Bearing, AN316-4 Jam Nut and CC-29 End Plug for 3/4” x .035 tubing

2) 1/4” HM-4M Rod End Bearing, AN316-4 Jam Nut and CC-28 End Plug for 1” x .058 tubing

3) 5/16” HM-5M Rod End Bearing, AN316-5 Jam Nut and CC-30 End Plug for 1” x .058 tubing.

The length of the tubing will be determined by the distance between the two Rod End Bearings. Figure the total length between centers and subtract the head of the end plugs from both ends and the length of the End Bearings from the center of the hole back to the jam nut with three to five threads showing at the top of the bearing. Cut the tube. Debur the ends of the tubing and insert the appropriate CC End Plug. On the tube draw a line 3/8" in from the ends and layout an equally spaced rivet pattern for four (4) rivets. Drill #30 holes. Remove the End Plugs. Debur, zinc chromate and re-install the parts and rivet together using RR-5404 1/8" x 1/4" SS rivet. Figure 1.36.1.

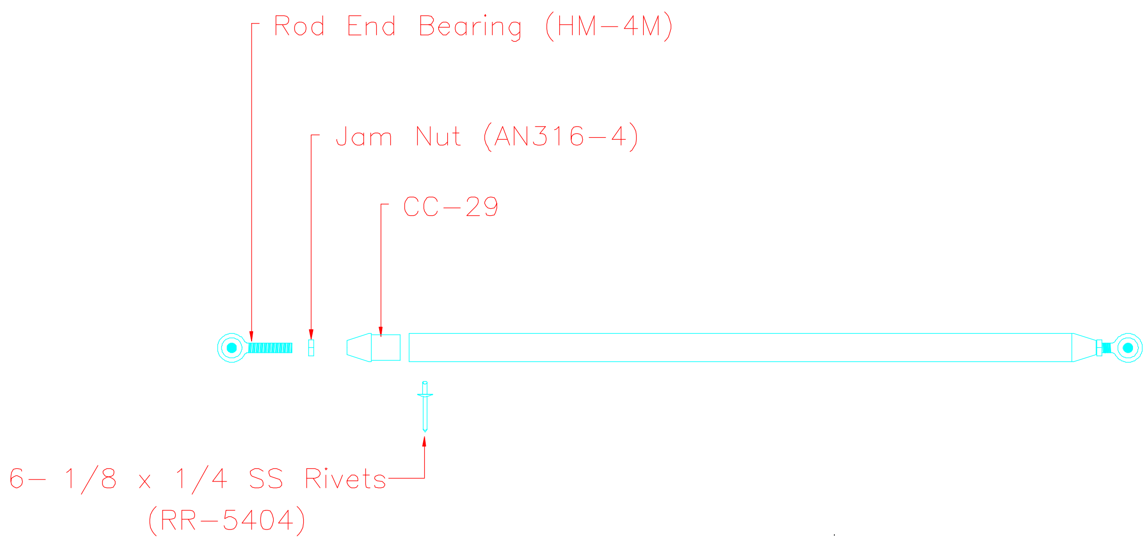


Figure 1.36.1

1.37 Metal Working Terms

DUCTILITY

The ability of a metal to be permanently deformed under tension without fracturing. A good example is wire which is drawn and stretched to dimension through a series of dies.

ELASTIC LIMIT

The maximum stress that a metal will withstand without permanent deformation.

ELONGATION

Elongation is a percentage figure determined by measuring the amount of stretch a material test specimen can be pulled after the elastic limit or yield point has been passed until the metal is fractured.

FATIGUE

A term used to describe the progressive failure of a metal part under conditions of cyclic loading.

MALLEABILITY
The ease with which a metal may be hammered or deformed under compression without cracking or fracturing.

HARDNESS
Hardness is the ability of a metal to resist indentation; or the ability to resist wear against other metals. Relative hardness may be determined by scratching one metal against another to see which is harder.

PLASTICITY
The degree of deformation a metal will withstand without permanent rupture.

TENSILE STRENGTH
The maximum unit stress that a material can be stretched to fracture-sometimes referred to as “ultimate strength”.

TOUGHNESS
That property in metal, relative to strength and ductility, which allows the metal to absorb work.

WORKABILITY
A general term applied to metals which refers to the ease with which a metal may be formed (worked).

YIELD POINT
The minimum unit loading which will produce permanent deformation.

1.38 Reamers

The reamer is a tool used to produce holes of very close tolerances. Reamers are available in a range of sizes and types to cover the various hole diameters. In using the reamer there are several pointers that bear mentioning: be sure the reamer is lined up perfectly with the hole; never remove more than .012 material in one operation; a reamer should never be turned backward after the reaming operation has been started.

1.39 Turnbuckle Assemblies

Turnbuckle assemblies are used with control cables to provide desired cable tension. They are made in a range of sizes and in both long “L” and short “S” assemblies.

The long assembly is indicated by the letter "L" following the dash number, and the short assembly is indicated by the letter "S". The size is given by the dash number indicating the rated strength of the assembly in hundreds of pounds. The assemblies are made up of three parts (1 barrel and 2 ends). The barrel is made of brass and the ends of 2330 nickel steel heat treated by 125,000 lbs. Per sq. In. And cadium plated. The threads on all parts are Class 3NF. Figure 1.39.1.

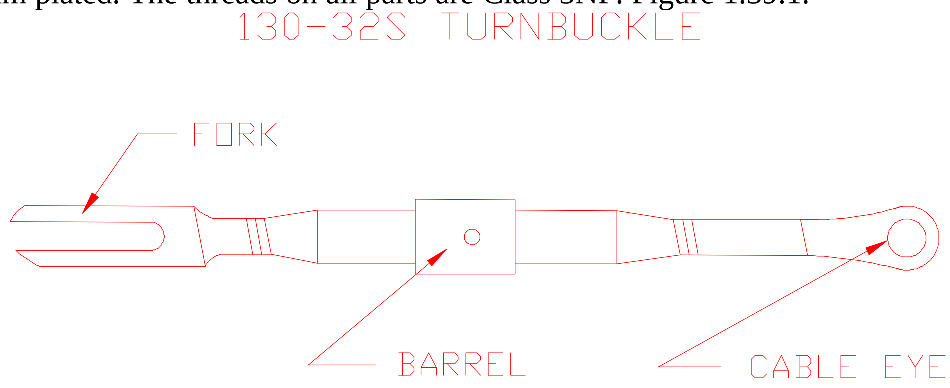


Figure 1.39.1

1.40 Safety Methods for Turnbuckles

General: Safety all turnbuckles with safety wire using either the double or single wrap method, or any appropriately approved special safetying device complying with the requirements of FAA Technical Standard Order TSO-C21. The swaged and unswaged turnbuckle assemblies are covered by AN Standard Drawings. Foe safety wire sizes and materials, refer to Figure 26. Do not reuse safety wire. Adjust the turnbuckle to the correct cable tension so that no more than three threads are exposed on either side of the turnbuckle barrel. Do not lubricate turnbuckles.

Double Wrap Method: Of the methods using safety wire for safetying turnbuckles, the method described here is preferred, although either of the other methods described is satisfactory. The method of double wrap safetying is shown in Figure 1.40.1. Use two separate lengths of the proper wire. Run one end of the wire through the hole in the barrel of the turnbuckle and bend the end of the wire towards opposite ends of the turnbuckle. Then pass the second length of the wire into the hole in the barrel and bend the ends along the barrel on the side opposite the first. Spiral the two wires in opposite directions around the barrel to cross each other twice between the center hole and the ends. Then pass the wires at the end of the turnbuckle in opposite directions through the holes in the turnbuckle eyes or between the jaws of the turnbuckle fork, as applicable, laying one wire along the barrel and wrapping the other at least four times around the shank of the turnbuckle and binding the laid wires in place before cutting the wrapped wire off. Wrap the remaining length of safety wire at least four turns around the shank and cut it off. Repeat the procedure at the opposite end of the turnbuckle.

When a swaged terminal is being safetied, pass the ends of both wires, if possible, through the hole provided in the terminal for this purpose and wrap both ends around the shank as described above. When the hole in the terminal is not large enough to accommodate the ends of both wires, the hole may be enlarged slightly. If the hole is not large enough to allow passage of both wires, pass the wire through the hole and loop it over the free end of the other wire, and then wrap both ends around the shank as described.

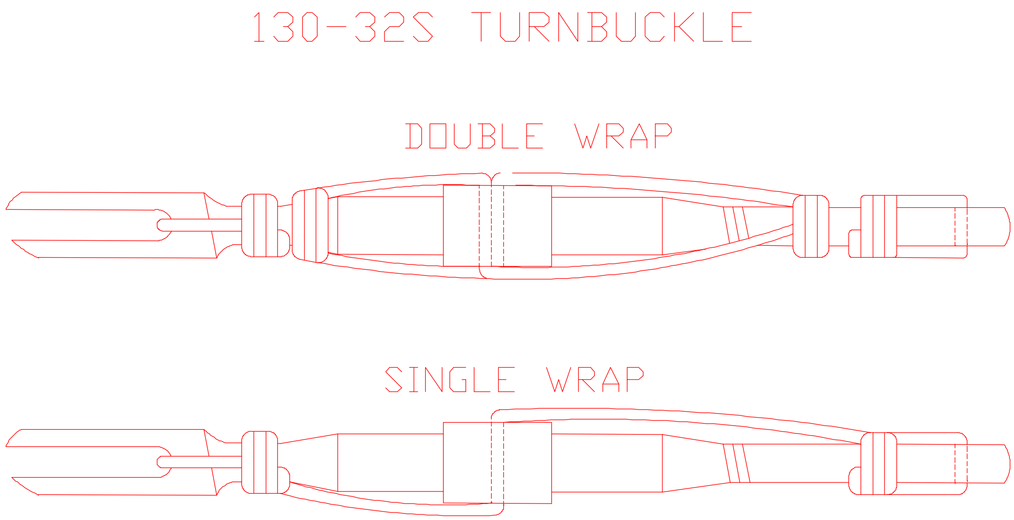


Figure 1.40.1

1.41 Aircraft Control Pulley

The dash number indicates the size of the pulley according to the table, used in conjunction with Figure 1.41.1.

Dash Number	**Cable Size**	**B +.010 Dia.**	**G**	**H +.0000 -.0005 Dia.**	**J +.000 -.005**
-1B	1/16, 5/64, 3/32	1.250	.250	.1900	.297
-2B	1/16, 5/64, 3/32	2.500	.250	.1900	.297
-3B	1/8, 5/32, 3/16	2.000	.422	.2500	.484
-4B	1/8, 5/32, 3/16	3.500	.422	.2500	.484
-5B	3/16, 7/32, 1/4	5.000	.500	.3750	.620
-6B	3/16, 7/32, 1/4	6.000	.500	.3750	.620
-10B	5/16, 3/8, 7/16	10.000	.875	.5000	1.125
-14B	7/16, 1/2	14.500	1.000	.625	1.245

Note: 1B and 3B pulleys shall not be installed on frequently used aircraft controls where a bend in the cable exceeds 15° from a straight line.

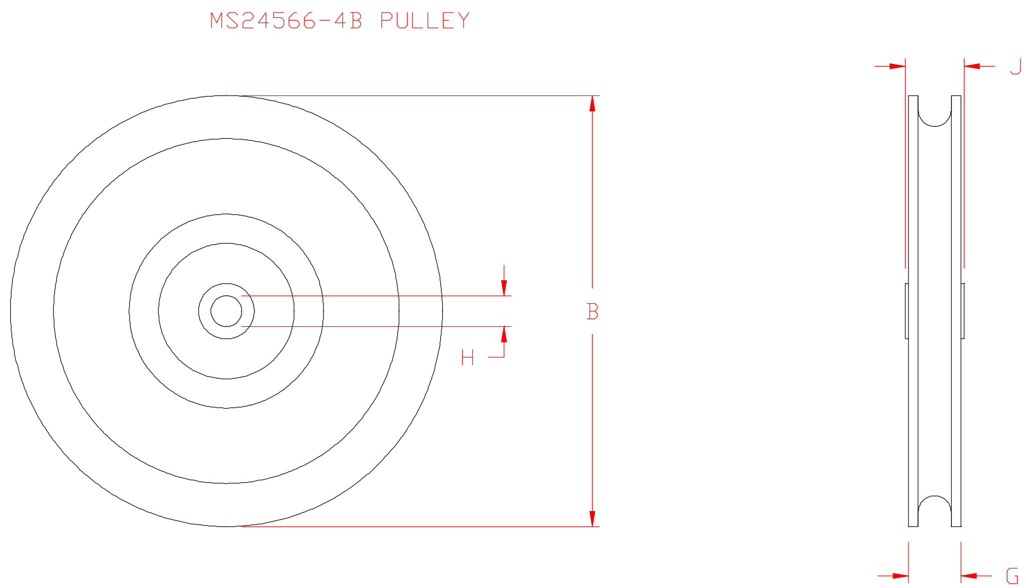


Figure 1.41.1

1.42 Continuous Hinge (Piano Hinge)

This continuous hinge is used in lightly loaded applications such as hinges for control surface tabs and small doors. It is available in either aluminum alloy or corrosion resistant steel material. Corrosion resistant steel is indicated by the letter "C" following the part number. The part is available either as a complete hinge as shown or as a half hinge without the pin. The letter "H" following the part number indicates a requirement for a half hinge. The first dash number indicates the available widths as shown in the table. Length is indicated by the 2nd dash number in inches and hundredths. Figure 1.42.1.

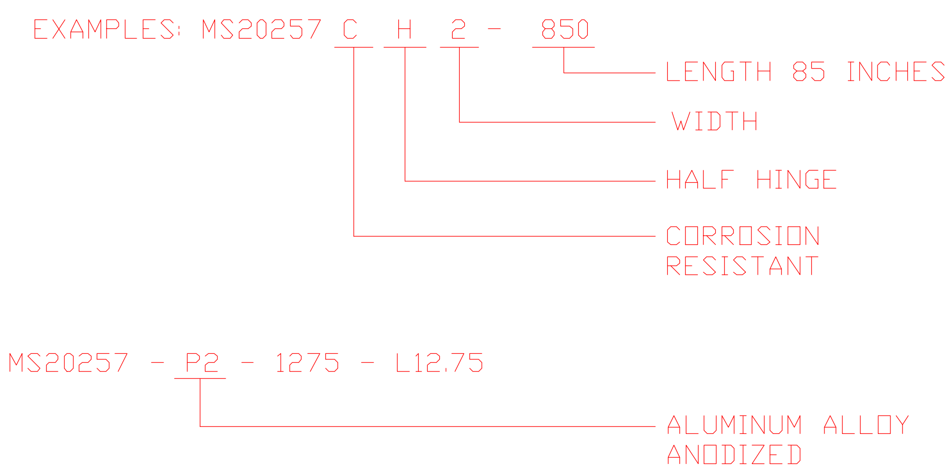
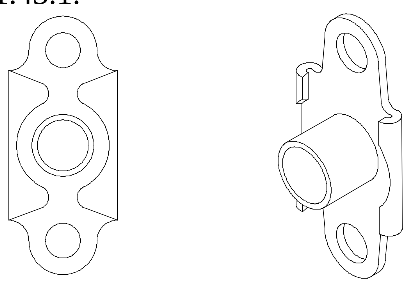


Figure 1.42.1

1.43 Nut Plates (Floating Anchor Nuts)

Nut Plates are used in areas where you need to frequently remove a plate or part for inspection purposes. **Installing Nut Plates:** To install use the appropriate size bolt to hold the nut in place. If a hole is not already in place, locate the area where you wish the nut, layout and drill a larger hole to accommodate the bolt. With the nut held in place drill #40 holes through the flanges on the nut. Remove the nut and drill the two flange holes out to #30. On your work area drill the two #40 holes out to #30 and countersink (or dimple) to accept a RV-4412 CSK rivet. Debur all parts. Cleco the nut plate on the back side of the work and rivet. Figure 1.43.1.



F5000-3

Figure 1.43.1

1.44 Some Final Thoughts...

The last page of this section contains instructions for building a work table, if you do not have one. Any table will do as long as it is sufficient in size to build all the components on. The most important and critical thing is to ensure that the table is absolutely flat, containing no twists. Any twist in the table will translate into twisted aircraft sections, which usually results in an aircraft that doesn't fly straight hands off.

When you are reading the instructions, you will see solid and dashed lines in some of the figures. Solid lines refer to the top most layer of material while dashed lines indicate a part or material beneath another.

A common request throughout the manual is for you to draw a center line down the flange of parts. This center line is used for lining up the part with a pre-punched hole in another part. This line, drawn with a felt pen, is for reference only and need not be 100% accurate. We have heard many stories of builders spending numerous hours measuring and drawing lines or creating apparatuses to do the same. Such extremes are not necessary. At Murphy Aircraft, we simply hold the felt pen between the thumb and forefinger and use the middle finger as a gauge. By eyeball estimating only, put the tip of the pen in the center of the flange and using the middle finger as a rule, slide the pen along the part, drawing your middle line. In other words, run the pen along with thumb and forefinger resting on the middle finger, which acts as the ruler while drawing the line.

Cleco, cleco pliers, #40 holes, #30 holes. If these are strange sounding words, about a thousand hours from now they will be second nature to you. A cleco is a temporary “clamp” that utilizes existing pre-punched holes to secure parts to each other. Cleco pliers are used to install/remove clecos. Clecos come in three colors to help differentiate between sizes. Silver clecos are 3/32” and are used in #40 holes. Brass clecos are 1/8” and are used in #30 holes. The dark brass (or brown) clecos are 3/16” and are used in #11 holes.

The majority of the pre-punched holes are #40 in size. These are pilot holes that using 3/32” clecos (silver) allow for aligning of parts for drilling. As you drill out the holes, try to place clecos every forth or fifth hole to ensure proper part alignment. When the #40 holes are drilled out to #30, use the 1/8” cleco (brass) to the parts before removing the next 3/32” cleco and drilling those holes out to #30.

Before beginning construction of each component, read the manual section covering that part twice. Once finished, read it again. Also, whenever possible, lay the parts out on the table as per the exploded drawings at the beginning of the section. The better you understand what you are building and the route to take, the less likely any errors will occur.