EO 05-1-3/5

ROYAL CANADIAN AIR FORCE

RIVETS

(This EO replaces EO 05-1-3/5 dated 18 Nov 60.)

ISSUED ON AUTHORITY OF THE CHIEF OF THE DEFENCE STAFF

12 MAR 65

LIST OF RCAF REVISIONS

DATE	PAGE NO	DATE	PAGE NO

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont'd)

RIVETS

GENERAL

1 Aircraft rivets are divided into the following main groups:- Common solid-shank rivets which comprise 90% of all aircraft riveting, rivets for blind attachment (these may be of the chemically-expanded or mechanically expanded type) and Structural Fasteners, such as Hi-Shear, Lock-bolts etc., which employ the swaging of a locking device onto the shank or pin of the fastener.

SOLID RIVETS

RIVET FAILURE

General

2 Riveted joints are designed on the assumption that the total joint strength is the summation of the strength of the individual rivets. When any one rivet fails, its load must be immediately carried by the others; if they are unable to do so, progressive joint failure will take place. Stress concentrations usually cause one rivet to fail first. Visual detection of such a rivet in a joint indicates that it has been highly loaded, with the possibility that other rivets have partly failed.

Shear

3 Shear failure is a breakdown of the rivet shank by forces acting in the plane of two adjacent sheets, causing a slipping action which may be severe enough to break the rivet shank in two. If the shank has been loaded over the yield point of the material, a permanent deformation occurs and the shank of the rivet is joggled. Sheet displacement occurs and the rivet holes are no longer aligned.

Bearing

4 Bearing failure can occur in the sheet at the edge of the rivet hole if the rivet is excessively strong in shear. Large rivets in thin sheets cause such failures. The sheet is locally crushed, having been loaded beyond its yield point, and the resulting permanent distortion destroys the mechanical ridigity of the joint. If the hole elongation is slight, replace with the next size larger rivet. However, if failure occurs at the edge of the sheet, causing appreciable distortion out to the sheet edge, or if a complete tear-out has occured, replace the entire sheet.

Head Failure

5 Certain more complex loadings may be placed on a joint, causing tensions to be applied to the rivet head. Since rivets are not designed to withstand appreciable tension loads, the head may fail by shearing through the area corresponding to the rivet shank, or may fail through a prying action which causes failure of the head itself. Any visible head distortion is cause for replacement. This latter type of failure usually occurs with blind rivets (mechanically expanding and explosive) wherein the formed head is distorted by tension forces, allowing a cocking of the rivet which continues until a rivet tension failure occurs. This is especially true of single shear lap joints in the thicker sheet gauges.

Detecting Rivet Failures

6 Examine rivets for tipped heads and/or looseness, and for the presence of cracked paint around rivet heads. Chipped or cracked paint on or around the heads of the rivets may be indicative of slipped or loose rivets. Remove paint, if necessary, to determine accurately the true condition of the rivets. If the heads are tipped or rivets are loose due to excessive load, they will show up in groups of several consecutive rivets. The heads will be tipped in the same direction if bona fide tipping has occured. If the heads which appear to be tipped are not in groups and are not tipped in the same direction, tipping may have occurred during installation.

7 Rivets which are known to have been critically loaded, but which show no visible distortion may be inspected by drilling off the head and carefully punching out the shank. If the shank is joggled and the holes in the sheets misaligned, the rivet has obviously failed in shear. Flush rivets which show head slippage within the dimple or countersink, indicate either sheet bearing failure or rivet shear failure and must be removed for inspection and replacement.

8 If suspected failed rivets cannot be detected by visual inspection, the joint may be

checked by drilling and punching out several rivets. If the rivet shanks are joggled, showing partial shear failure, replace with the next size larger rivets. If the rivet holes show elongation, the sheet has failed locally in bearing and again the next size rivet must be used in replacement. Any deformation of the sheet surrounding the rivet head indicates a probably partial rivet failure. Sheet failures, such as tear-outs and cracks between rivets, usually indicate damaged rivets, and the complete repair of the joint may require replacement by next size larger rivets.

REMOVAL OF RIVETS

9 Remove rivets as follows:-

(a) Centre punch rivet head.

(b) Using a relatively long-pointed drill with a diameter slightly less than that of the rivet, carefully centre the drill and, with light pressure, slowly drill into the head of the rivet. Stop drilling just before the full diameter of the drill reaches the riveted skin.

(c) If the rivet head has not been twisted off by the drill, support the rivet, and tap off the head with a sharp-edged tool.

SELECTION OF RIVET

10 Wherever possible, the rivets used in repair are to be of the same type as those used in the original construction. The determination of the length of rivet is an important part of any repair. The length used depends on the grip or combined thickness of material to be riveted plus a minimum allowance of 1.5 diameters for upsetting the shank. For convenience in selecting the proper lengths, Figure 1 lists the grip lengths for rivets of common sizes. Use the nearest standard rivet length greater than the calculated sum.

11 A rivet shank will expand up to 15%. (Refer to EO 05-1-3/24, for dimensions.) If the original rivet hole is enlarged beyond this, replace with the next larger size of rivet (1/32 inch greater diameter) to obtain the required tightness. If this is not done, and the same size rivet is replaced in an elongated hole, the ability of the rivet to carry its share of the shear load is impaired, with consequent joint weakness. (The slight decrease in sheet area created by increasing the rivet diameter will not generally be critical.)

SUBSTITUTION

General

12 If a rivet is replaced by a rivet of lower strength material, the substitute rivet must be larger than the original rivet in order to have an equivalent strength in single shear. For a guide for such substitutions, see Figure 2. The rivets in any column may be replaced by the rivets shown in the major column immediately to the right of it. When making a substitution between materials other than shown in adjacent columns to the right, the shear strengths of the rivets, as shown in the table, will have to be compared to find the substitute of correct size.

13 When substitutions are made to the left of any column, use the same diameter rivet, irrespective of shear strength.

Heat Treatment

14 For heat treatment of rivets, refer to EO 05-1-3/4. The effects of heat-treatment on the characteristics of the rivet materials shown are as follows:-

2024 Rivets

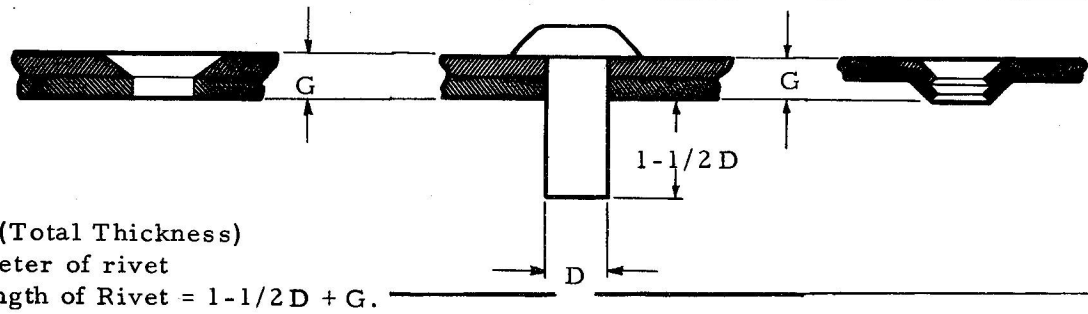
(a) 2024 rivets are normally heat treated and used within 10 minutes of their removal from quench. Aging may be delayed up to approximately 20 hours by refrigeration at 0° C (32° F).

(b) 2024-T31 rivets are very hard and, having a shear strength of 41,000 pounds per square inch (3,000 psi, above the next strongest rivet), may be substituted for any other Aluminum Alloy rivet with the following exceptions:-

CAUTION

These rivets may be subject to head cracking. Refer to Inspection of Riveting Paragraph 38.

(i) In tight corners and other places not easily accessible to the bucker.



G = Grip (Total Thickness)
D = Diameter of rivet
Total Length of Rivet = 1-1/2D + G.

		Universal Head Rivets					Countersunk Head Rivets				
Diameter In Inches		3/32	1/8	5/32	3/16	1/4	3/32	1/8	5/32	3/16	1/4
Length of Rivet In Inches	Dash No. for Rivet	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip	Max. Grip
1/8	2	0	0	0	0	0	0	0	0	0	0
3/16	3	.070	.031	0	0	0	.039	0	0	0	0
1/4	4	.133	.094	.055	.016	0	.102	.063	.024	0	0
5/16	5	.195	.156	.117	.078	0	.164	.125	.086	.047	0
3/8	6	.253	.219	.180	.141	.062	.222	.188	.149	.110	.031
7/16	7	.305	.281	.242	.203	.125	.274	.250	.211	.172	.094
1/2	8	.353	.344	.305	.266	.188	.322	.313	.274	.235	.157
9/16	9	.398	.406	.367	.328	.250	.367	.375	.336	.297	.219
5/8	10	.443	.464	.430	.391	.312	.412	.433	.399	.360	.281
11/16	11	.490	.516	.492	.453	.375	.459	.485	.461	.422	.344
3/4	12	.542	.564	.550	.516	.438	.511	.533	.519	.485	.407
13/16	13	.604	.606	.602	.578	.500	.573	.575	.571	.547	.469
7/8	14	.665	.644	.650	.641	.562	.634	.613	.619	.610	.531
15/16	15	.725	.685	.692	.698	.625	.694	.654	.661	.667	.594
1	16	.778	.731	.730	.746	.688	.757	.700	.699	.715	.657

When the grip length falls between those given in the tables, select the longer rivet. Grip = total material thickness. If rivet of proper length is not available, cut off longer rivet to exact length, not grip, required.

Figure 1 Rivet Dimensions

Rivet Material									
2024-T31		2017-T3 (Aged 4 Days)		2017-T3		2117-T3		5056	
Dia.	Shear Pound	Dia.	Shear Pound	Dia.	Shear Pound	Dia.	Shear Pound	Dia.	Shear Pound
								1/16	99
						1/16	106	3/32	203
				1/16	120	3/32	271	1/8	363
		1/16	135	3/32	247	1/8	388	5/32	556
1/16	145	3/32	275	1/8	442	5/32	596	3/16	802
3/32	296	1/8	494	5/32	675	3/16	862	1/4	1450
1/8	531	5/32	755	3/16	977	1/4	1550	5/16	2290
5/32	815	3/16	1090	1/4	1760	5/16	2460	3/8	3280
3/16	1180	1/4	1970	5/16	2790	3/8	3510		
1/4	2120	5/16	3110	3/8	3970				
5/16	3360	3/8	4450						
3/8	4800								

Figure 2 Permissible Rivet Substitutions and Single Shear Strengths

(ii) On thin skin assemblies, as the skin tends to become dished.

(iii) Where the head would be adjacent to soft material such as aluminum sheet 1100.

2017 Rivets

(c) 2017 rivets are usually furnished in the heat-treated condition. Generally however, they are re-heated and quenched immediately before use to avoid age hardening (2017-T31). Up to two hours after quenching, they are relatively soft, and may be driven in cold. At ordinary temperatures, they will age-harden in approximately four days (2017-T3). The higher strength properties of the 2117-T3 rivets result from the cold-working effect obtained when the rivet is driven in the aged condition. Age-hardening may be delayed for a limited time by storing 2017 rivets at low temperatures.

2117 Rivets

(d) 2117 rivets are furnished in heat-treated condition and may be driven in as received without further re-heating or refrigeration.

5056 Rivets

(e) 5056 rivets are one-quarter hardened during manufacture, and should not be heat-treated. This rivet is commonly used in magnesium structure.

Material Designations

20 For cross-reference between current and former material designations refer to Figure 3.

Current Designation	Former Designation
2117	A17S
2017	17S
5056	56S
2024	24S
1100	2S
7075	75S
2014	14S

Figure 3 Revised Material Designations

Rivet Number Code

21 For rivet numbering code, see Figure 4.

Application of Standard Rivet Types

22 For applications of standard rivet types, see Figure 5.

Substitutions of Bolts for Rivets

23 Use AN-3 series bolts, or AN502, AN525 or NAS220 series screws to replace standard solid shank rivets only when the proper rivets or riveting equipment is not available. Use bolts or screws of the same size as the replaced rivet, ensuring that a close fit is obtained.

Replacement Precautions

24 In replacing monel rivets, do not use cadmium plated bolts where subject to temperatures over 233°C (450°F), or zinc plated bolts where subject to 371°C (700°F) or above.

EXAMPLE: MS20426AD5-12

MS 20426 AD 5 - 12

- MS — Military Standard.
- 20426 — Rivet Type:
  - 20426 = Solid rivet 100° CSK Head, (Al. & Al.Aly only).
  - 20427 = Solid rivet 100° CSK Head Steel, (CRES, Monel & Copper).
  - 20470 = Solid rivet Universal Head, (Al. & Al.Alys only).
  - 20613 = Solid rivet Universal Head, (CRES).
  - 20615 = Solid rivet Universal Head, (Copper & Monel).
- AD — Material Code: (Replaces first dash number)
  - 'AD' = 2117 Al.Aly.
  - 'D' = 2017 Al.Aly.
  - 'DD' = 2024 Al.Aly.
  - 'B' = 5056 Al.Aly.
  - 'A' = 1100 Al.Aly.
  - 'M' = Monel
  - 'F' = FS302 or FS304 Nickel-Copper Aly.
  - 'C' = Copper
- 5 — Diameter in 1/32 inch. (5 x 1/32 = 5/32 inch)
- Alternate Material Code (replaces second dash number)
  - 'C' = Carbon Steel Cad Plated (MS20427 only)
  - 'CU' = Copper
  - 'MP' = Monel, Cad Plated
  - 'P' = Carbon Steel, Cad Plated (MS20613 only)
  - 'C' = CRES, Passivated (MS20613 only)
- 12 — Length in 1/16 inch (12 x 1/16 = 3/4 inch)

Figure 4 Standard Rivet Numbering Code

Identification	Dimpled ⊙	Raised Teat ⊙	Raised Double Dash ⊜	Raised Cross ⊕	Plain ○	Triangle △	Plain ○
Rivet Material	Al. Alloy 2117-T3	Al. Alloy 2017-T31	Al. Alloy 2024-T31	Al. Alloy 5056	Al. 1100	Mild Steel Cad-Plated	Monel
Universal Hd.	MS20470AD	MS20470D	MS20470DD	MS20470B	MS20470A	MS20613P	MS20615M
Flush Head	MS20426AD	MS20426D	MS20426DD	MS20426B	MS20427A	MS20427C	MS20427M
Max. Temp. for Strength	200° F	200° F	200° F	200° F		550° F	1000° F
Sizes	1/16 to 3/8 incl.	1/16 to 3/8 incl.	1/16 to 3/8 incl.	1/16 to 3/8 incl.	1/16 to 3/8 incl.	1/16 to 3/8 incl.	1/16 to 1/4 incl.
Soft Material	Acceptable		Prohibited	Undesirable	Preferred	Prohibited	
Al. Alloy to Al. Alloy	Preferred			Prohibited	(1)	Prohibited	
Al. Alloy to Cad-Plated Steel	(2)			Prohibited		Preferred	Prohibited
Al. Alloy to Corr-Res Stl.							
Al. Alloy to Titanium							
Cad-Plated Steel to Cad-Plated Steel	Permissible but Undesirable					(3)	
Cad-Plated Steel to Corr-Res Stl.							
Cad-Plated Steel to Titanium							
Corr-Res Steel to Corr-Res Stl. Steel	Prohibited			Prohibited			Preferred
Corr-Res Steel to Titanium							
Titanium to Titanium							
Mgnsm. Aly. to Mgnsm. Aly.	Prohibited			Preferred	Prohibited		
Mgnsm. Aly. to Cad. Plated Steel							
Mgnsm. Aly. to Al. Aly.							

Note: (1) May be used for welding, where extra softness is required, or for plugging holes.
(2) May be used for weight saving or strength.
(3) Not recommended for structural applications.

Figure 5 Applications of Standard Rivet Types

Colouring of Rivets

25 The practice of colour coding rivets has been abandoned with these exceptions:-

(a) DuPont rivets are colour coded for grip length, (refer to Figure 42).

(b) 5056 blind rivets (for magnesium) are frequently coloured orange.

(c) 5056 solid rivets are sometimes coloured red or orange.

LAYING OUT RIVET PATTERN

26 Wherever possible, rivet edge distance, rivet spacing and distance between rows should be the same as that of the original installation. Where this is not possible, follow the detailed instructions in EO 05-1-3/24. For protruding head rivets, minimum edge distance is twice hole diameter, minimum spacing of rivets is four times hole diameter. Twice the diameter is satisfactory for standard edge distance for spacing and edge distance of flush rivets. (See 'A' on Figure 6.)

27 When riveting external seams, especially in the thinner gauge materials, exercise care to maintain the above mentioned distances. Values larger than standard may result in the formation of water traps caused by the tendency of the sheet to lift along its edge when riveted. (See 'B' on Figure 6.) When this occurs, serious corrosion inevitably follows. This is especially true of seaplanes which are in contact with salt water.

28 Provide a minimum of 1/32 inch between the edge of non-flush rivet heads and bend radius tangent points. Otherwise maintain the normal edge distances (See 'C' on Figure 6.)

29 If watertight, fuel tight or flotation-tight joints are required see Figure 7 as a guide for maximum spacing of rivets.

BALANCING SHEAR AND BEARING STRENGTHS

30 The diameter and number of the rivets used in a joint should be such that the total shear strength of the rivets is approximately equal to the bearing, or crushing, strength of the material being riveted. The shear strength

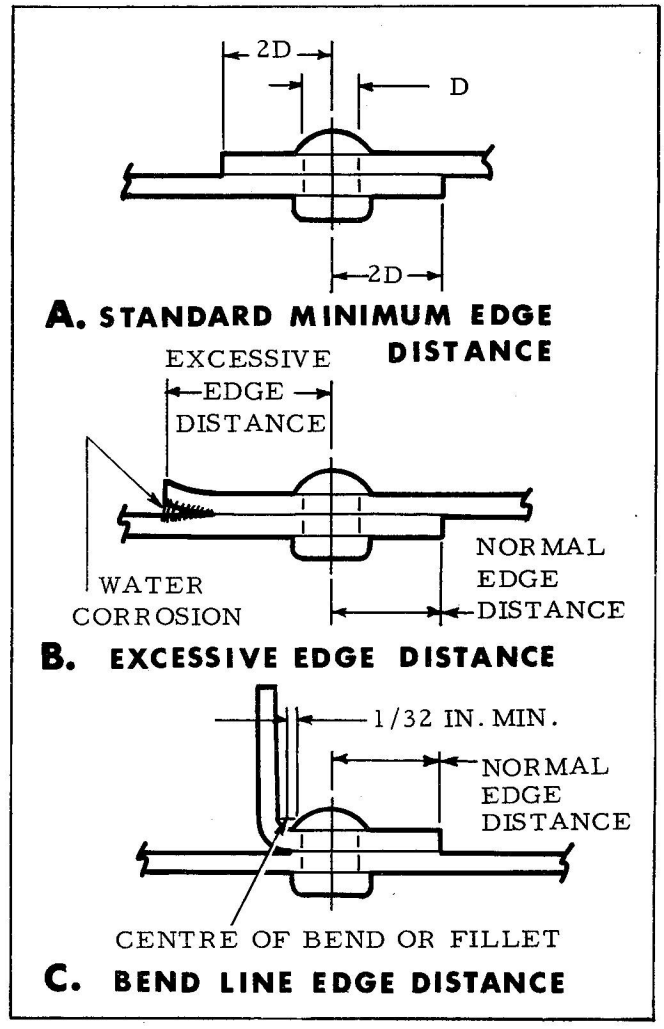


Figure 6 Edge Distances

of a rivet if found by multiplying its cross-sectional area in square inches by the shear value in pounds per square inch of the rivet material. The bearing strength of the material equals the rivet diameter times the allowable bearing stress in pounds per square inch of the material multiplied by the thickness of the material. Thus the shear strength of a rivet varies directly with the square of its diameter and may be increased rapidly by increasing the size of rivet, whereas the bearing strength of the material, if its thickness is unchanged, varies directly with the rivet diameter and may be increased rapidly by using a greater number of rivets. This would usually be accomplished by additional rows of rivets rather than additional rivets in the same row, in order not to reduce bearing strength of the sheet.

31 Therefore, by varying the diameter and number of rivets, the shear strength of the rivets may be made approximately equal to the

Thinnest Material	Watertight 2 Rows				Fueltight 2 Rows				Flotation Single Row			
	Rivet Diameters				Rivet Diameters				Rivet Diameters			
	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	3/32	1/8	5/32	3/16
.0159	1/2				7/16				9/16	5/8	11/16	3/4
.020	1/2				7/16				9/16	5/8	11/16	3/4
.025	1/2	5/8			7/16	9/16			9/16	11/16	3/4	13/16
.028	1/2	5/8			7/61	9/16			5/8	11/16	3/4	13/16
.032	1/2	5/8			7/16	9/16			5/8	11/16	3/4	7/8
.036	1/2	5/8			7/16	9/16			5/8	3/4	13/16	7/8
.040	1/2	5/8	3/4		7/16	9/16			11/16	3/4	13/16	15/16
.045		5/8	3/4			9/16	11/16			3/4	7/8	15/16
.051		5/8	3/4			9/16	11/16			13/16	15/16	1
.057		5/8	3/4			9/16	11/16			13/16	15/16	1-1/16
.064		5/8	3/4	1		9/16	11/16			7/8	1	1-1/8
.072			3/4	1			11/16				1-1/16	1-3/16
.080			3/4	1			11/16				1-1/8	1-1/4
.090			3/4	1			11/16				1-3/16	1-3/8
.102			3/4	1			11/16					1-7/16
.114			3/4	1			11/16					1-1/2
.128			3/4	1			11/16	15/16				1-9/16
.144			3/4	1			11/16	15/16				
.162				1				15/16				
.182				1				15/16				
.250				1				15/16				

Figure 7 Rivet Spacing for Fluid Tight Joints

bearing strength of the material. In calculating the shear strength of a rivet, the number of planes on which a rivet tends to shear must be considered, because the shear strength increases directly in relation to the number of planes or thicknesses.

DRILLING

32 Drill holes with either a light power drill or a hand drill. The normal straight shank twist drill is most commonly used. Refer to Figure 8 for the size of drill for the corresponding rivet.

Rivet Diameter	Drill Size	Drill Diameter
1/16	No. 51	.0670
3/32	No. 40	.0980
1/8	No. 30	.1285
5/32	No. 21	.1590
3/16	No. 11	.1910
7/32	No. 1	.2280
1/4	F	.2570
5/16	P	.3230
3/8	W	.3860

Figure 8 Rivet Drill Sizes

33 To transfer holes from one drilled part to another, superimpose the one on the other, using the drilled component as a pattern, drill through. For very thin material scribe the hole location from the drilled part onto the part to be drilled. Spot the holes with a centre punch on the bench and drill. In areas involving complete new sections, either drill from the skin inward into the stringer or drill from the stringer outward. In either method, first drill .098 inch pilot holes in the member nearest the operation. Locate and attach the second member to the first by C clamps or spring fasteners (Cleco) through the holes, size drill through both members, separate the sheets and remove burrs from holes.

34 Flimsy members, such as light stringers requiring drilling from skin surfaces are often marked along their length with a rivet line in pencil. Place the skin, predrilled with pilot holes, over the stringer and flex the latter to bring the pencil line onto the skin holes centre line. Use an occasional Cleco fastener to hold the stringer in position. Drilling the skin from the stringer may often prove more convenient, but, because of the flexibility of the customary stringer, the resulting rivet line in the skin may prove somewhat irregular.

Drilling Practices

35 Observe the following practices in drilling for rivets:

(a) Centre punch all rivet locations. The centre punch mark must be large enough to prevent the drill from slipping out of position, yet it must not dent the surface of the material. Placing a bucking bar behind the metal during punching will help to prevent denting.

(b) Make sure drill is of the correct size and that it is sharp, with the drill points ground according to standard practice, (included angle of 118°; clearance angle of 12° to 15°).

(c) Place the drill in the centre punch mark. When using a power drill, give the chuck a few turns before starting the motor.

(d) While drilling, always hold the drill at right angles to the work.

(e) Avoid excessive pressure. Let the drill bit do the cutting.

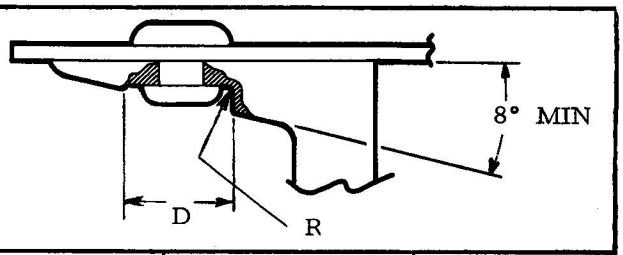
(f) Never push the drill through the stock.

(g) Remove all burrs with a burring tool.

(h) Clean away all drill swarf.

SPOTFACING

36 The work surface nearest to the original manufactured head of the rivet must be flat and normal to the rivet hole. Machining is not required upon this surface except for removing fillets or for angularity in excess of 8°. Where spotfacing is required to remove excessive angularity, the spotface diameters shown in Figure 9 must be used.



Rivet Dia.	Diameter 'D'	Radius 'R'
3/32	3/8	.031
1/8	7/16	.031
5/32	1/2	.031
3/16	9/16	.062
1/4	11/16	.062

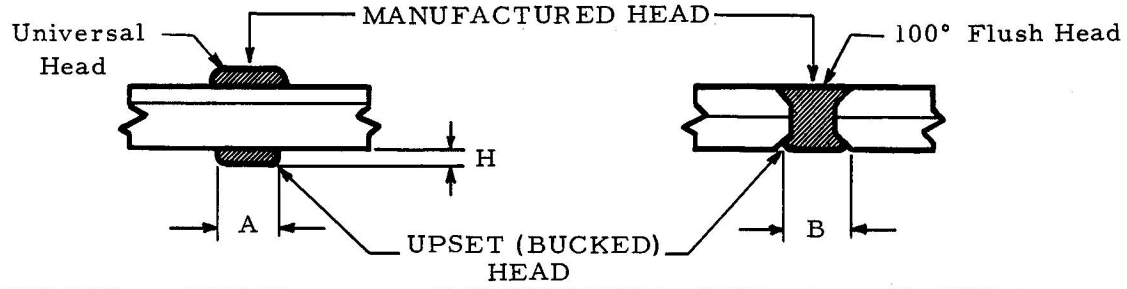
Figure 9 Spotfacing Dimensions

RIVET HEADS AND TOOL SHAPES

37 The heads of aluminum alloy solid shank rivets have been standardized to two types; 100° flush head (MS20426) and universal head, (MS20470), (see Figure 10). The correct tool shape for MS20426 rivets, both rivet set and bucking bar, is flat. With MS20470 rivets, the rivet set is concaved to suit head form; bucking bar is flat. MS20613 and MS20615 (round head, steel, monel and copper) are to be driven only with sets formed to fit the rivet head. For the dimensions and applications of typical bucking bars see Figure 11. Dimensions of the upset heads of rivets are given in Figure 10.

INSPECTION OF RIVETING

38 The following limitations govern the acceptability of both manufactured and upset rivet heads (see Figure 12):-



Rivet Size	A Diameter		B Diameter	H Height	
	Min.	Max.	Min.	Min.	Max.
3/32	0.140	0.157	0.154	0.031	0.063
1/8	0.187	0.208	0.206	0.042	0.083
5/32	0.234	0.260	0.257	0.052	0.104
3/16	0.281	0.312	0.309	0.062	0.125
7/32	0.328	0.365	0.361	0.073	0.146
1/4	0.375	0.417	0.413	0.083	0.167

NOTE

Where rivets joint plastic parts and the minimum acceptable upset will prevent cracking, dimensions approaching A min. and H max. values are recommended.

Maximum values represent desirable upper limits and are for reference only.

Figure 10 Upset Head Dimensions

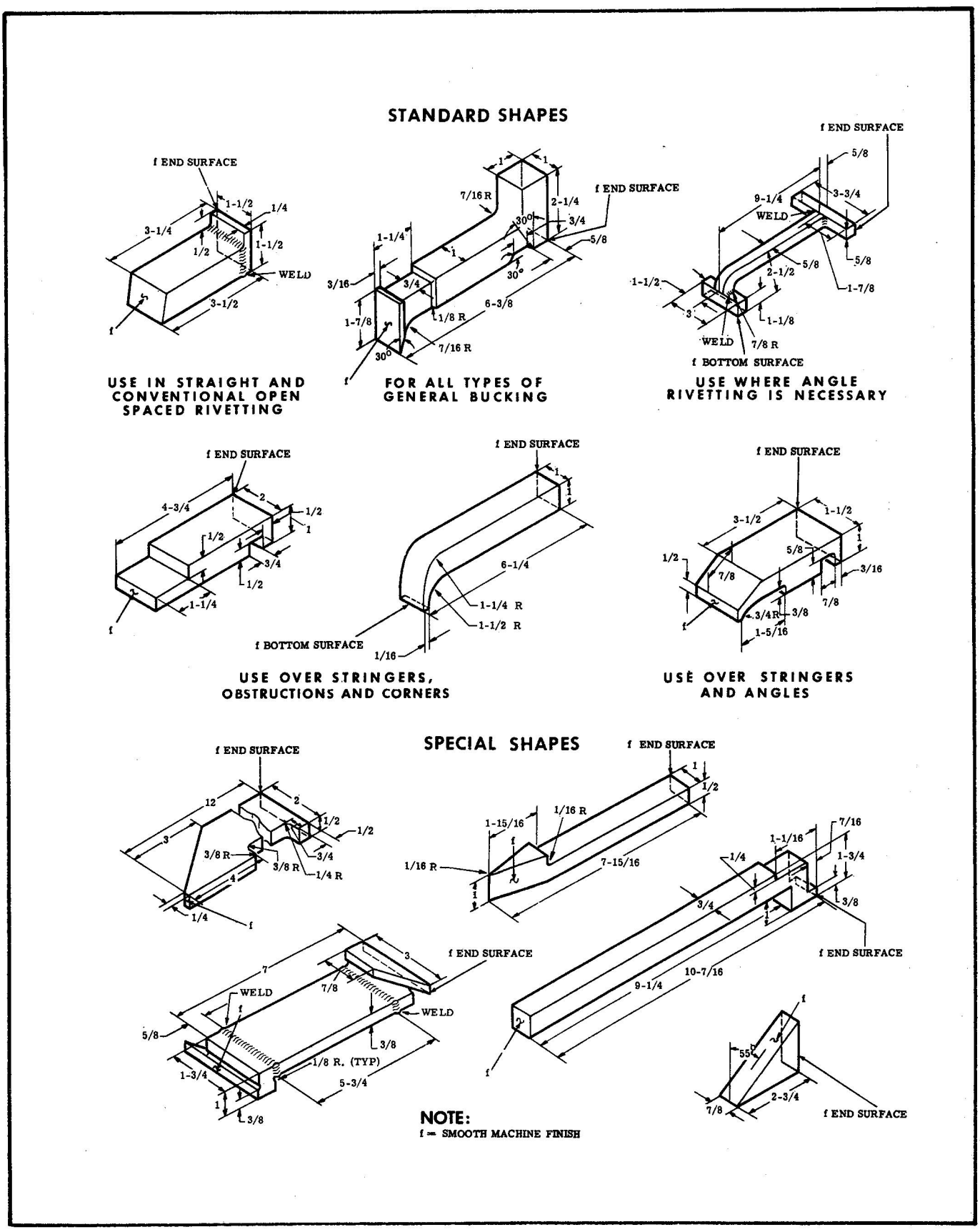


Figure 11 Bucking Bars

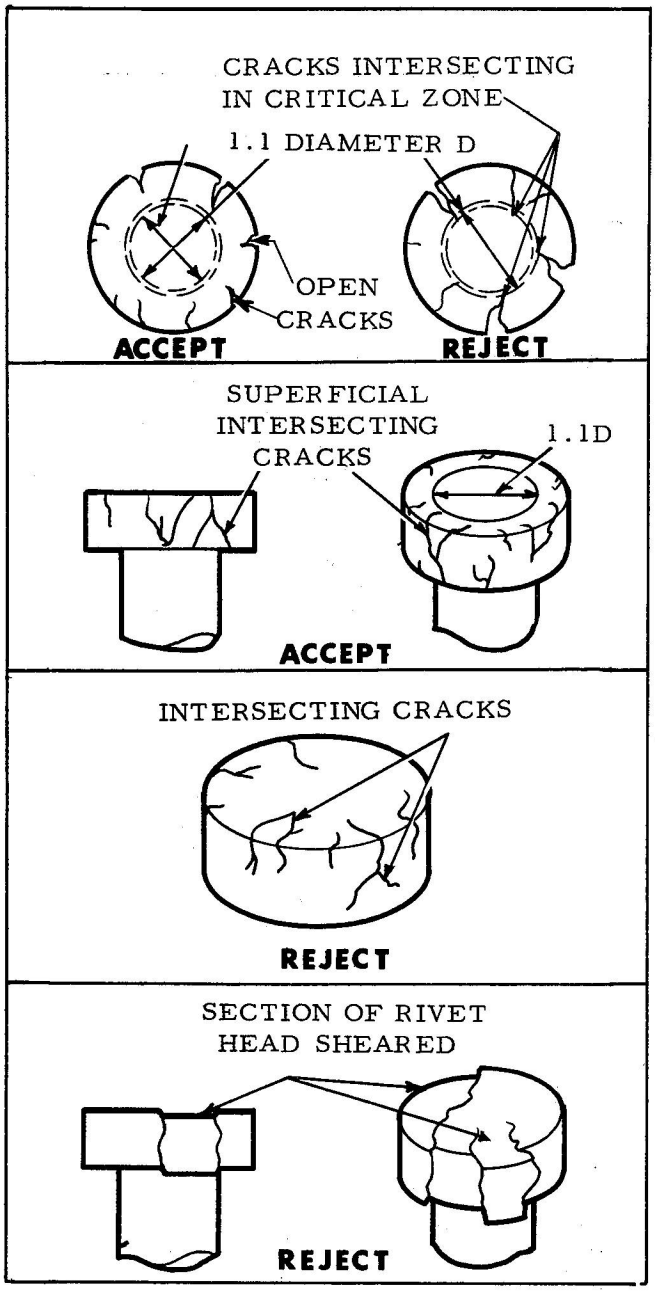


Figure 12 Inspection of Rivet Heads

(a) To be acceptable, the rivet head must have a minimum crack-free surface diameter equal to 1.1 times the rivet shank diameter.

(b) Superficial intersecting cracks on the side of the head or outside the critical surface diameter of 1.1 shank diameter are acceptable. A superficial crack is defined as one having a shallow penetration not extending into the critical areas (1.1D) of the driven head of a rivet.

(c) Rivets are not acceptable if cracks (other than superifical) intersect in the head, producing a potential cause for a portion of the head to chip off.

(d) Rivets are not acceptable if a section of the rivet is sheared.

FLUSH RIVETING

GENERAL

39 Flush riveting is achieved by radius dimpling, coin dimpling, countersinking, or by a combination of either coin or radius dimpling with countersinking. Radius dimpling is accomplished by stationary or portable squeezers using suitable size dies, or by using the rivet to be driven as the male die. Coin dimpling, see Figure 13, is done on portable or stationary squeezers, using dies subject to high ram pressures. These dies form the dimple and then swage the metal into a nearly perfect seal for the rivet. Unlike the radius dimple, the included angles of nesting coin dimples do not vary. Coin dimpling is the preferred method. On harder types of metal, heat is used on the dies to form the metal without cracking. This is called hot coin dimpling. Dimpling of metal-to-metal bonded parts and of extruded material to any alloy temper or thickness is prohibited.

RADIUS DIMPLING

40 Dimpling dies for light work may be set

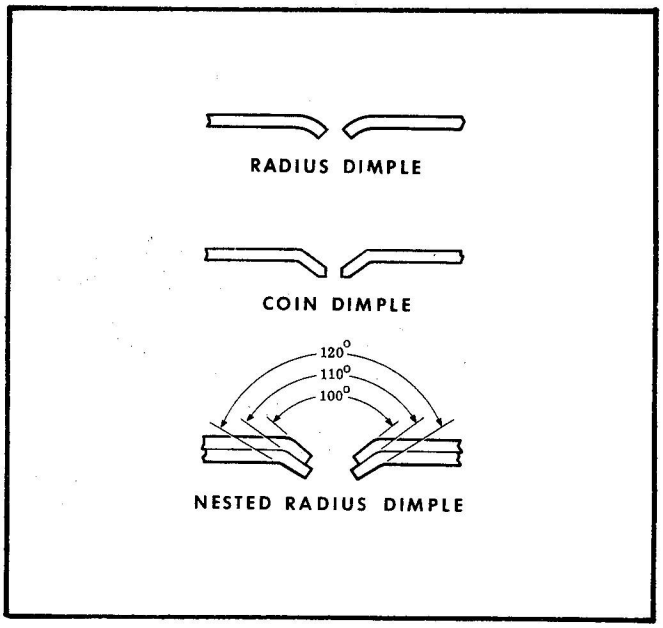


Figure 13 Dimples

up in portable pneumatic or hand squeezers, as shown at 'A' on Figure 14. For repair work the dies can be held by hand as in 'B'. If dies are used with a squeezer, they must be adjusted accurately to the thickness of the sheet being dimpled. For sheet thickness for predimpling, see Figure 15.

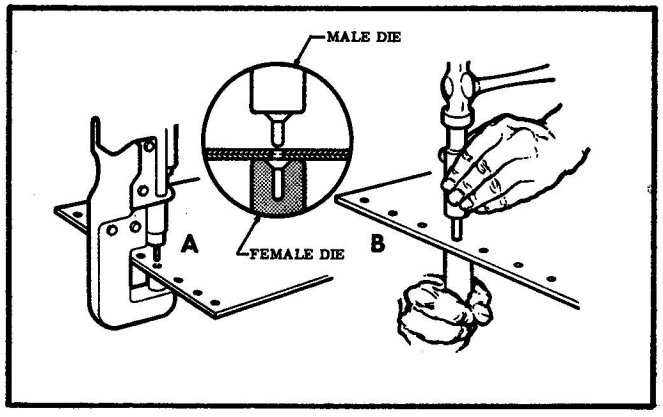


Figure 14 Radius Dimpling

Diameter of Rivet	Thickness of Outer Sheet		*Max. Thickness of Middle Sheet	Thickness of Inner Sheet	
	Min.	Max.		Min.	Max.
3/32	.020	.064	.064	.016	.064
1/8	.020	.081	.081	.020	.081
5/32	.020	.081	.081	.025	.081
3/16	.020	.081	.081	.032	.081
1/4	.020	.093	.093	.051	.093

*Dimensions omitted when only two sheets are used.

Figure 15 Sheet Thicknesses for Predimpling

RADIUS DIMPLING WITH RIVET (DRAW DIMPLING)

41 Dimpling with the rivet is a method of flush riveting in which the rivet is drawn into the materials, thereby forming its own countersink. The rivet may be drawn by squeezing, using a flat dolly in one member of the squeezer and a dimpling die, or a draw-set, having an angle of 115° in the other member. The flat dollies are then used to upset the rivet.

42 Where squeezers cannot be used because of inaccessibility, the dimpling and riveting may be with pneumatic hammers, a draw set, and suitable bucking bars. For dimensions of typical bucking bars, see Figure 11. To dimple the material, insert the rivet, refer to Figure 16, in the drilled hole and place a swivel draw set over the shank of the rivet on the inside of the structure. Use the draw set in a hammer, usually of 4X size, which is adjusted to give a hard blow. Hold a bucking bar against the head of the rivet, and, with a short burst draw the rivet flush with the skin and too hard a blow will damage the skin by dimpling it too deeply. Ensure that blows are properly timed. If the burst is timed too short or too long, it has the same effect as either too light or too heavy a blow.

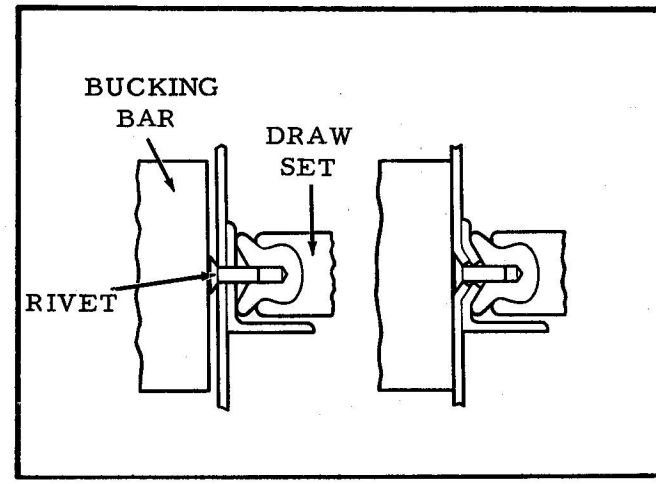


Figure 16 Draw Dimpling

43 A number of rivets may be inserted and the dimpling done before they are upset. Since the draw set is countersunk 115°, the metal is forced in toward the shank of the rivet and holds it in place. The rivets are then upset in the usual manner by bucking from the inside and hammering from the outside. Alternating the hammering action from inside to outside in the dimpling and riveting operations prevents bucking and keeps the outer skin smooth and taut.

Limitations of Dimpling with Rivets

44 Limits for dimpling with the rivet, are given for the total thickness of the sheets, the thickness of the outer skin, and the thickness of the inner sheet, see Figure 17. If three parts are being riveted together, the thickness of the middle sheet is governed by the thickness of the outer and inner sheets.

Diameter of Rivet	Total Thickness of Sheet	Max. Thickness of Outer Sheet	Thickness of Inner Sheet	
			Min.	Max.
3/32	.073	.036	.025	.036
1/8	.093	.051	.032	.051
5/32	.101	.064	.040	.064

Note: Total thickness of outer and inner sheets must not exceed values given in the second column.

Figure 17 Sheet Thicknesses for Dimpling with Rivet

COIN DIMPLING

45 For operation of dimpling machines, refer to EO 70-30GA-2. For spacing, gauge limits and tool operating temperatures, see Figures 18 and 19.

Testing Dimples

46 Prior to dimpling, make a test specimen, see Figure 20, as follows:

(a) The specimen should be of the same material, heat-treat and thickness as the skin to be dimpled. A suitable size is 1 inch by 8 inches.

(b) Drill at least six holes along the centre line. Dimple the holes.

Material or Group of Materials	Temperature - °F		
	Both Tools Unheated	Hot (1)	
		2 Heated Tools	1 Heated Tool
Aluminum Alloy 2014-T6, 2024-T (all heat treated tempers) and 7075-T6	Prohibited (3)	525° (±25°)	550° (±25°)
Corrosion Resistant Steel (2)	Room Temperature	525° (±25°)	550° (±25°)
Titanium. Burr Both Sides Prior to Dimpling	Prohibited	700° (±25°)	
Other Aluminum Alloys	Room Temperature	Not Required	Not Required

NOTE

(1) When hot dimpling, use the two heated tools method unless the application necessitates the one heated tool method. Allow 30 minutes for the tools to heat up, if not provided with an automatic temperature control.

(2) Dimple corrosion resistant steel at room temperature, if the dimples are found satisfactory, If not, one of the heated tool methods must be used. Dimple characteristics must be the same as that required for aluminum alloys. In some cases it may be necessary to pass a sizing drill through the dimpled hole to eliminate burrs. Burring of holes before dimpling should not be done.

(3) Dimple 2024-T (all heat treated tempers) hot as specified in the table or cold at room temperature.

Figure 18 Coin Dimpling Temperatures

Rivet Dia.	Min. Edge Distance For Dimpled Joints	Spacing for Dimpled Joints		Min. Thickness For Machine C'Sink	Min. Thickness For Machine Sub C'Sink
		Minimum	Maximum		
3/32	1/4	7/16	1-1/2	.040	.050
1/8	5/16	9/16	1-1/2	.050	.063
5/32	3/8	23/32	1-1/2	.063	.071
3/16	7/16	27/32	1-1/2	.071	.080
7/32	1/2	1	1-1/2	.080	.090
1/4	9/16	1-1/8	1-1/2	.100	.112

NOTE

Minimum edge distance for joints other than dimpled joints is 2 x hole diameter.

Minimum spacing for joints other than dimpled joints is 4 x hole diameter.

Thickness For Dimpling

Rivet Dia.	Minimum				Maximum							
			Titanium			Stationary Squeezer				Portable Squeezer		
						Titanium		C.R.Steel			C.R.Steel	
	Al. Alloy	Milled Al. Alloy Clad On Top	Pure AMS 4900 4901	Alloy AMS 4908	Al. Alloy	Pure AMS 4900 4901	Alloy AMS 4908	Anld	1/2H	Al. Alloy	Anld	1/2H
3/32	.020	.020	.016	.025	.051	.063	.056	.050	.050	.051	.050	.050
1/8	.020	.025	.016	.025	.064	.063	.063	.063	.063	.064	.063	.050
5/32	.025	.032	.016	.025	.072	.100	.063	.080	.063	.064	.063	.036
3/16	.032	.040	.016	.025	.091	.100	.100	.080	.063	.051	.050	.032
7/32	.032	.040	.016	.025	.091	.100	.100	.080	.063	.051	.050	.032
1/4	.040		.025	.025	.102	.063	.063	.063	.050	.102	.063	.050

Figure 19 Spacing and Gauge Limits for Coin Dimpling

(c) Bend the specimen across the dimples as shown and inspect for acceptability, see Figure 21.

47 Drive flush rivets by the same methods and in the same manner as rivets with universal heads. To avoid cracking the dimple of the inner sheet, align the dimpled rivet holes before the rivet is driven and draw the sheets tightly together. Do not upset rivet shank too flat, see Figure 10, Diameter 'A'. If rivet holes are out of alignment, the rivets will be clinched and will crack the dimple of the inner sheet, especially if the material is thin. To ensure that the sheets are drawn tightly together so that the rivet cannot upset between the sheets and so crack the inner dimple, use a draw buck as shown in Figure 22. Place the draw buck over

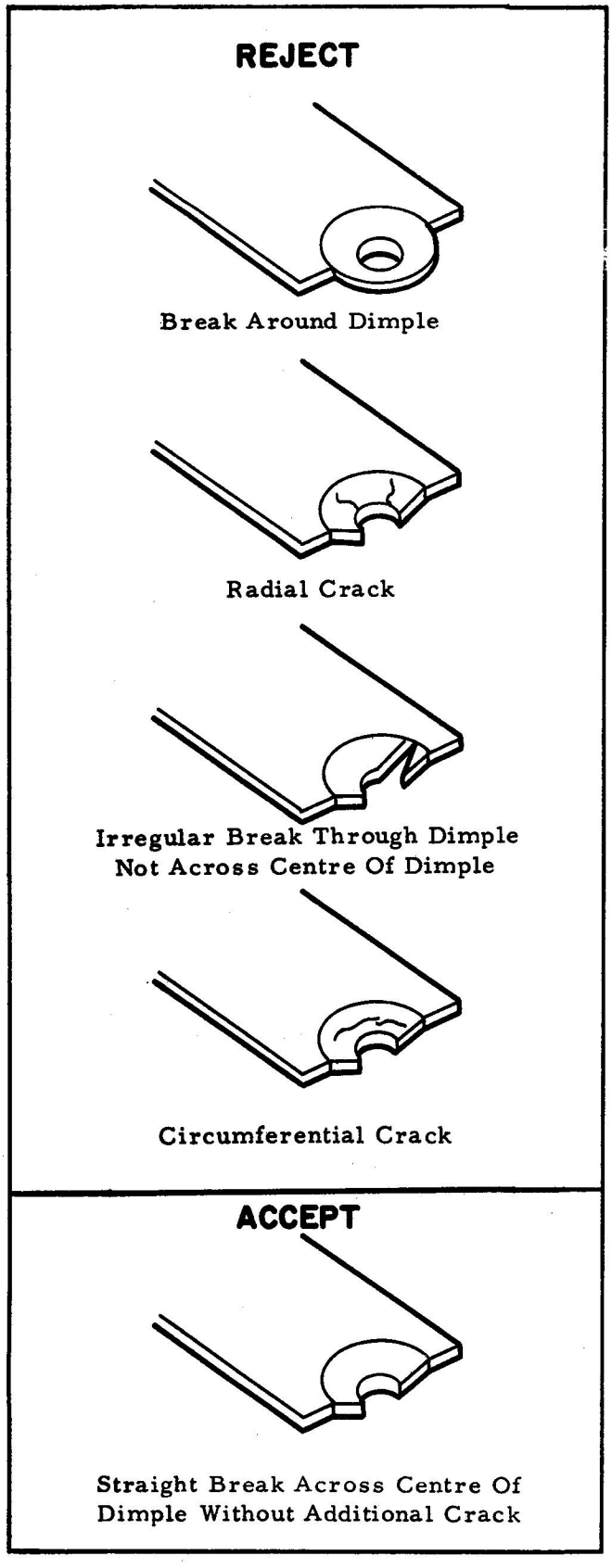


Figure 21 Acceptability of Dimples on Bend Test

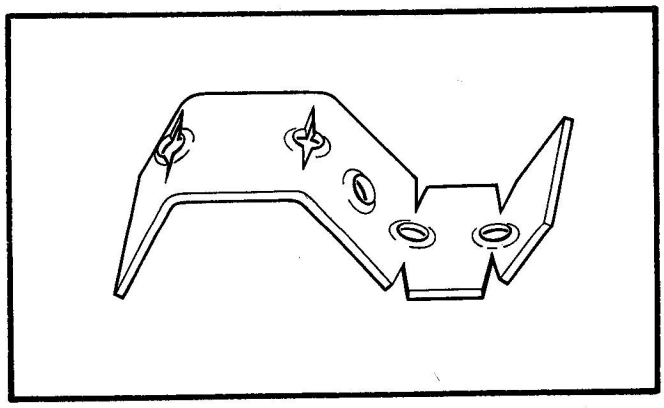


Figure 20 Bend Test Specimen

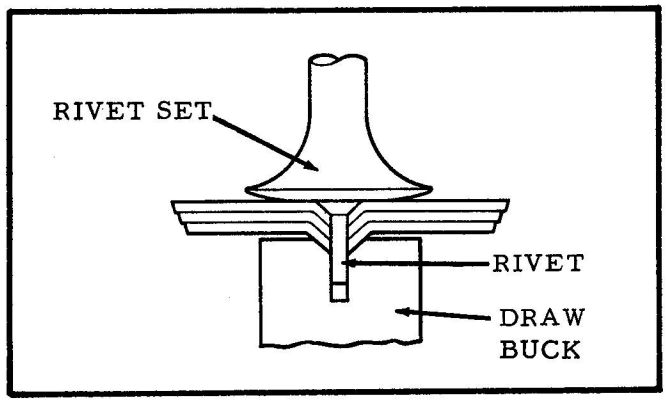


Figure 22 Draw Bucking of Rivets

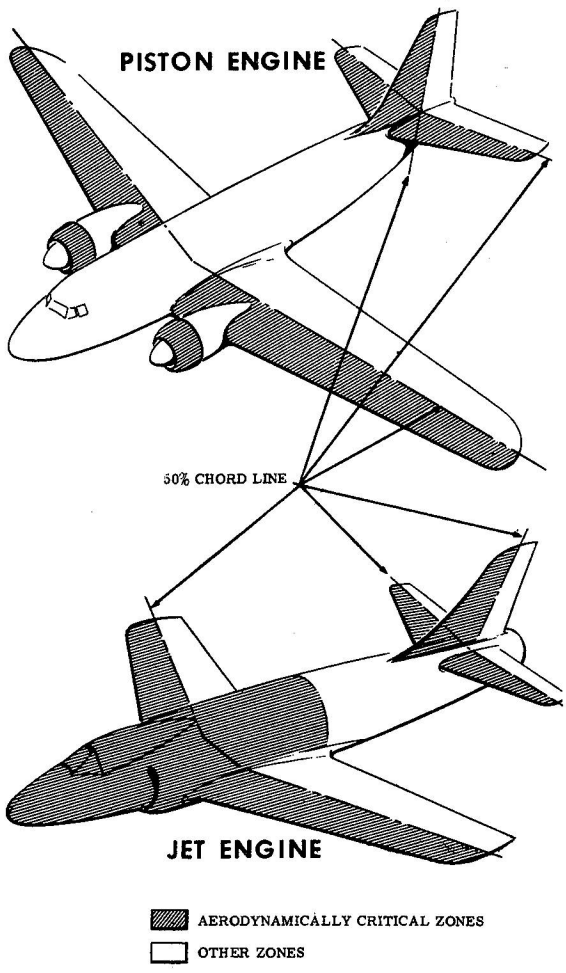
the shank of the rivet and, with a few blows of the hammer and rivet set, draw the sheets tightly together.

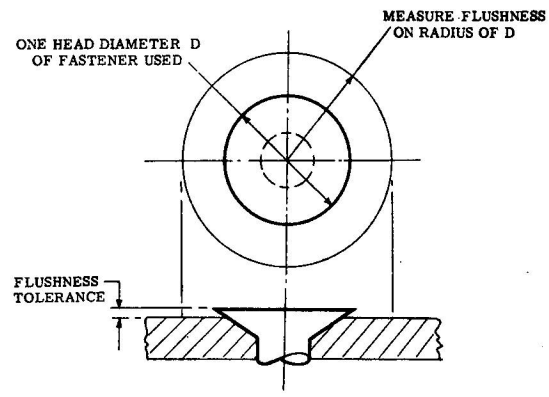
CUT COUNTERSINKING

48 For cut countersinking, predrill the rivet holes to rivet size and then countersink. The countersink pilot size must correspond to the drilled hole size. Keep the cutter sharp to avoid chatter and vibration which would result in improper seating of the rivet head. Countersinks must be capable of .001 inch adjustments.

RIVET MILLING

49 Rivet heads must be flush within the tolerances shown in Figure 23. This can be accomplished with a micro-shaver which will mill a rivet head on a flat or a convex surface but not on a concave surface. Place the tool directly over the rivet head and apply pressure evenly on a flat surface. When used on a convex surface, place the tool on the chordline of the curve and rock in order to mill the rivet of the rounded contour. Take care not to touch the sheet with the cutter.





Type of Aircraft	Surface	Flushness Tolerances			
		Critical Zones		Non-Critical Zones	
		C'Sunk Joints	Dimpled Joints	C'Sunk Joints	Dimpled Joints
Jet Propelled	Contoured	+.002 -.000	+.002 -.004	+.010 -.000	+.010 -.004
Flat		+.002 -.000	+.002 -.002		
Propeller Driven	Flat & Contoured	+.005 -.000	+.005 -.004		

Figure 23 Flushness Tolerances and Applicability

NOTE

When rivet heads are shaved, the head diameter must not be reduced by more than 5%.

Flushness Tolerance of Countersunk Rivets

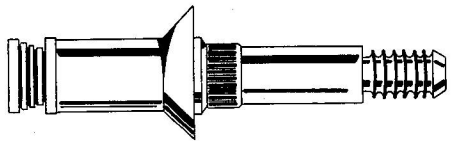
50 To determine flushness tolerance of countersunk rivets, see Figure 23.

BLIND RIVETS

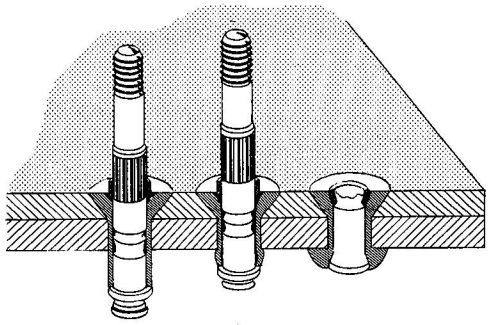
GENERAL

51 Blind rivets are designed for use in double surface structure where access to both sides of the work is not possible.

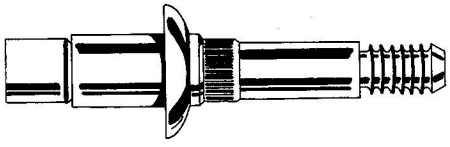
52 Use blind rivets to replace solid rivets only when the layout of the repair makes it



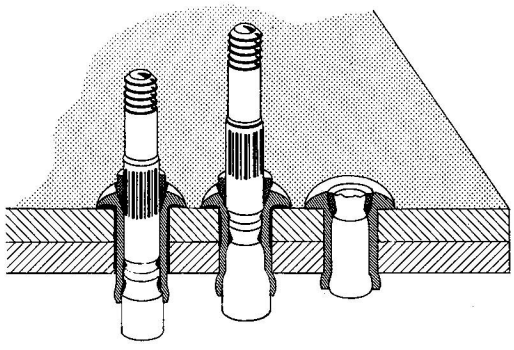
SELF-PLUGGING BLIND RIVET
with mechanical lock on stem. (bulb type)



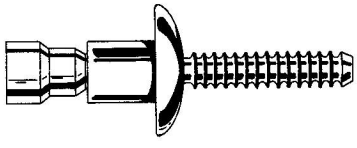
A



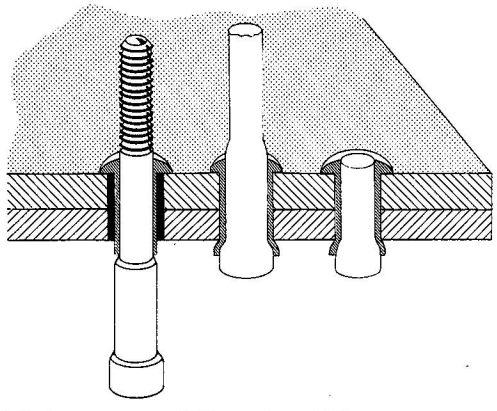
SELF-PLUGGING BLIND RIVET
with mechanical lock on stem. (standard type)
(NAS1398 and NAS1399)



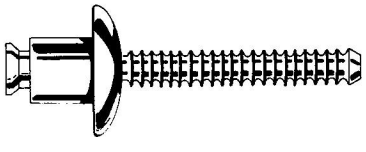
B



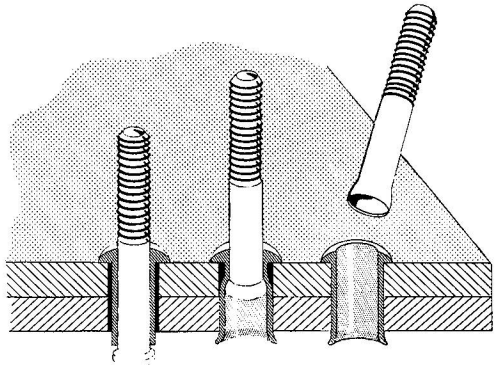
Standard SELF-PLUGGING RIVET
(friction locking - MS20600 & MS20601 type)



C



PULL-THROUGH HOLLOW BLIND RIVET



D

Figure 24 Typical Pull-Stem Blind Rivets

impossible to buck solid rivets. Plan the close-out to permit the largest proportion of rivets to be solid.

CAUTION

Do not use blind rivets on control surface hinge brackets, wing attachment fittings, landing gear fittings, fixed tail surface attachment fittings, nor other similar heavily stressed locations.

TYPES

53 Blind rivets may be chemically expanded (explosive rivets) or mechanically expanded by means of a separate or integral core which is pulled into or through the hollow rivet (pull-stem type) or driven into the rivet (drive-pin) from the manufactured head size.

54 For structural modifications, maintenance and repairs within the RCAF, blind rivets have been standardized generally to the pull-stem, mechanically expanded, self-plugging types (MS20600 and 20601). The pull-through hollow type may be used where there is insufficient clearance to allow installation of the self-plugging type. Typical pull-stem blind rivets are illustrated in Figure 24.

55 Explosive rivets (MS20602 and 20603) are not generally used due to the hazards of storing and handling.

HEAD STYLES

56 Head styles of the blind rivets are also standardized to two types: Universal Head (corresponding to MS20470 style in solid rivets) and 100° Countersunk (Flush) Heads (corresponding to solid MS20426 rivets).

PULL-STEM BLIND RIVETS

Pull-Through Blind Rivet

57 The pull-through blind rivet consists of a hollow rivet on a hardened steel stem. On installation, the rivet is securely held in place, while the stem is withdrawn.

58 The head on the end of the stem first forms a head on the blind end of the rivet, forcing the sheets together. As the head then progresses through the hollow rivet, it expands the rivet shank to provide a force fit in the hole. The stem is completely withdrawn leaving a hollow, tubular-type rivet. (See 'D' on Figure 24.

Self-Plugging (MS20600 and MS20601) Rivets

59 The self-plugging rivet is similar to the pull-through rivet in construction. Its difference in application and installation consists in the fact that the longer head on the stem, having formed a blind head on the rivet, is not pulled completely through the rivet, but is drawn into it, expanding it, and is left in the rivet as a plug, forming a solid-type rivet fastening. (See 'C' on Figure 24.)

Mechanical Lock-Stem (Self-Plugging) Rivets (NAS1398 and 1399)

60 These are self-plugging rivets having a locking collar on the stem which, on installation of the rivet, is forced between the stem and the inside circumference of the rivet to provide a positive means of locking the plug in place. (See 'B' on Figure 24.)

61 Figures 25 and 26 illustrate the identification of MS20600, MS20601, NAS1398 and NAS1399 rivets by diameter, grip range and head style.

NOTE

Do not confuse the length of the rivet shank with the grip length.

62 Rivets must be allowed adequate clearance on the blind side. See Figure 27. If clearance is insufficient for self-plugging rivets, hollow pull-through type may be used.

Cherry Blind Rivets

63 Blind rivets of Cherry manufacture are as follows:-

(a) Cherry Rivet - These are standard pull-through rivets, or self-plugging rivets with friction-locking stems.

(b) Cherrylock Rivets - Self-plugging rivets in which the stem is positively locked into the rivet on installation. These include Cherrylock rivets designed to form a pronounced bulb of the upset head. (See 'A' on Figure 24.)

EXAMPLE: MS20600AD6W10

MS 20600 AD 6 W 10

- 10 — Max. Grip in 1/16 inch (up to 7/8 inch); Grip Range = 1/16 inch.
- W — Stem Type (W = Serrated) (K = Knob) (obsolete)
- 6 — Diameter in 1/32 inch (available in 1/8, 5/32, 3/16 and 1/4 inch diameter).
- AD — Material (Available in AD, B, M and P). See Standard Rivet Code.
- 20600 — Rivet and head style (20600 = Self plugging Universal Head) (20601 = Self plugging 100° CSK Head)

Figure 25 Identification of MS20600 & MS20601 (Self-Plugging) Blind Rivets

NAS 1398 B 4 - 4

- 4 — Max. Grip in 1/16 inch (up to 7/8 inch) (Grip range = 1/16 inch)
- 4 — Diameter in 1/32 inch. (Available in 1/8, 5/32, 3/16 and 1/4 inch)
- B — Material 'B' = 5056 Al. Aly; 'D' = 2017 Al. Aly; 'M' = Monel; 'C' = CRES. Add: 'W' for Cad plate, 'S' for Silver plate
- 1398 — Rivet Type and Head Style: 1398 = Mech. Lockstem - Protruding Head; 1399 = Mech. Lockstem - 100° CSK (Flush) Head.

Figure 26 Identification of NAS1398 & 1399 (Mechanically-Locked Stem) Blind Rivets

Grip	Clearance C (Min.)
1/32 to 5/64	9/16
5/64 to 9/64	5/8
9/64 to 13/64	3/4
13/64 to 17/64	7/8
17/64 to 21/64	1

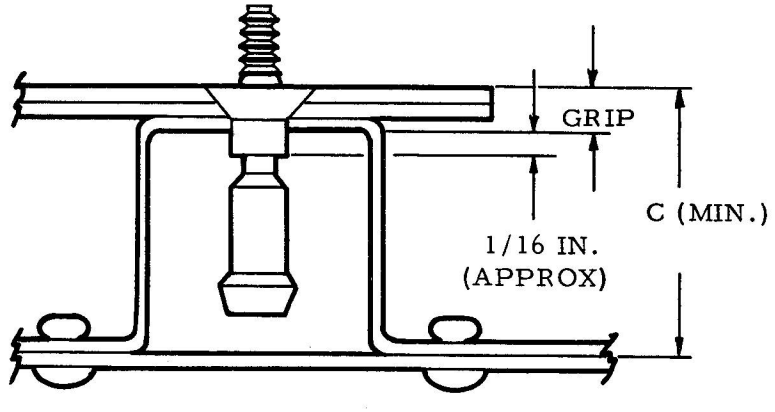


Figure 27 Blind Rivet Stem Clearance

64 Cherry blind rivets are available with the serrated ('W'-type) stem or the earlier knob ('K'-type) stem, and in Universal or Flush (100° Countersunk) head styles.

65 For identification of Types of Cherry Blind Rivets refer to Figure 28.

Huck Blind Rivets

66 The Huck range of Blind rivets is generally similar to the Cherry rivet and Cherrylock rivets. For the identification of Huck Type Blind Rivets refer to Figure 29.

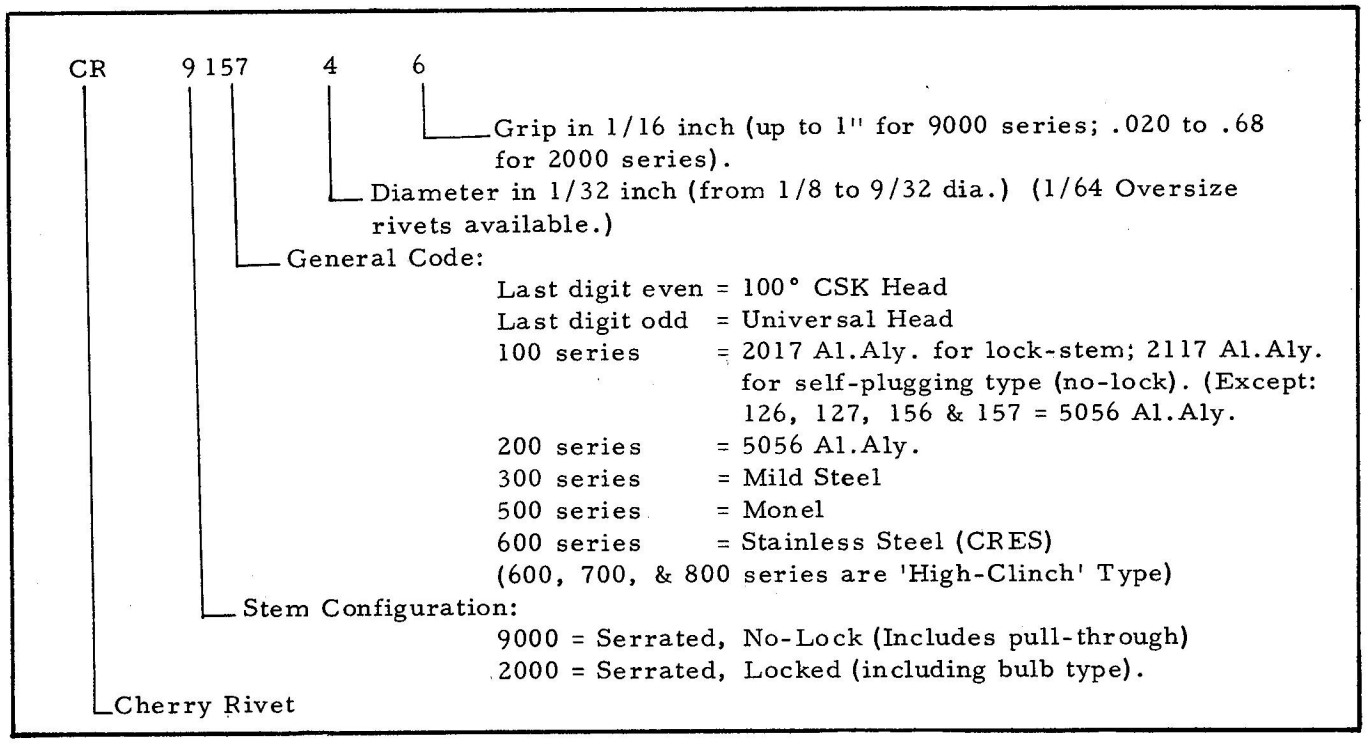


Figure 28 Identification of Cherry Blind Rivets

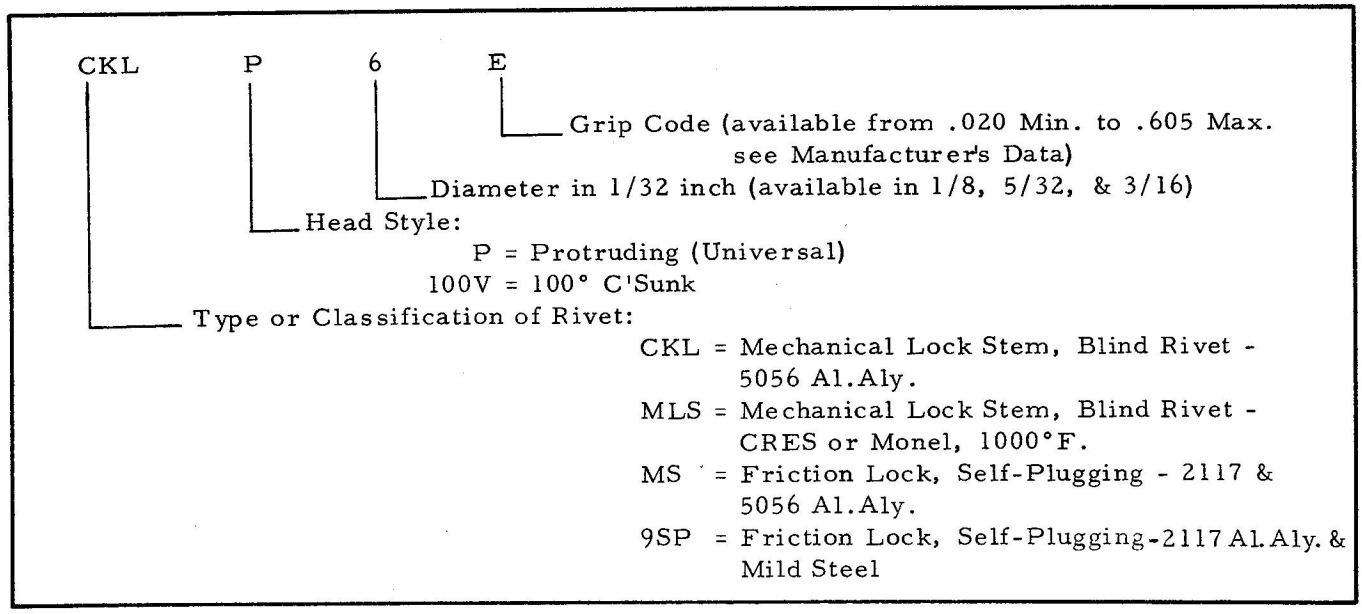


Figure 29 Identification of Huck Blind Rivets

Oversize Blind Rivets

67 Oversize blind rivets are available in nominal sizes of 1/8, 5/32, 3/16, 1/4, 5/16, and 3/8 inch.

Rivet Storage

68 Store rivets in the boxes in which they are received from the manufacturers or in moisture-proof containers, properly labelled, giving all the information that appears on the manufacturer's boxes. Do not remove protective film from the rivets. The lubricant is necessary for proper stem installation and shank expansion. Protect rivets from dirt or grit. Use oldest rivets in stock first.

Drilling and Countersinking

69 Use standard drilling and countersinking procedures as for solid shank rivets. If parts have not been prepunched, pilot drill, if necessary, to properly locate holes. For final hole sizes, see Figure 30. Minimum sheet thicknesses for Countersinking are shown in Figure 31.

RIVET DIA.	DRILL	HOLE SIZE LIMITS
3/32"	#40	.097 to .101
1/8"	#30	.128 to .132
1/8" O.S.	#29	.137 to .141
5/32" O.S.	#16	.177 to .181
3/16"	#10	.192 to .196
3/16" O.S.	#5	.206 to .210
7/32"	#2	.220 to .225
1/4"	F	.256 to .261
1/4" O.S.	I	.271 to .276
9/32"	L	.289 to .295
9/32" Monel	M	.294 to .300
5/16" O.S.	11/32	.342 to .348
3/8" O.S.	13/32	.404 to .411

Figure 30 Blind Rivet Drill Sizes

Rivet Diameter	Thickness
1/8	.040
5/32	.050
3/16	.063

Figure 31 Minimum Sheet Thickness for Countersinking

Dimpling

70 Holes to be dimpled should be pilot drilled and redrilled to size. Ensure that the dimpling punch pilot is of such a diameter that the hole size, after dimpling, is within limits. Typical hole size gauges for this purpose are shown in Figure 32. Holes which are beyond the maximum limit should be redrilled to take an oversize rivet. (See Figure 30.)

Riveting

71 Pull-stem blind rivets are installed with a gun (see Figure 33) in which a chuck grips the serrations (or knob) on the stem and pulls it through or into the rivet while simultaneously bearing hard on the head of the rivet. For lock-stem rivets, an additional anvil in the nose of the gun advances automatically to drive the locking collar home after the blind head is formed.

72 Different sizes of rivet diameter require different chuck jaws and anvils. Different head types will require only different outer anvils provided that the rivet diameters are the same.

73 For the description of riveting guns and their attachments for use on Cherry rivets, refer to EO 70-IC-2.

74 Tools and Nose Assemblies for installation of Huck Blind Rivets are listed in Figure 34.

75 Adjust operating air pressure as follows: (Line pressure should be between 90 and 110 psi.)

(a) For 1/8 inch dia. rivet, set pressure to 31 pounds.

(b) For 5/32 inch dia. rivet, set pressure to 47 pounds.

(c) For 3/16 inch dia. rivet, set pressure to 67 pounds.

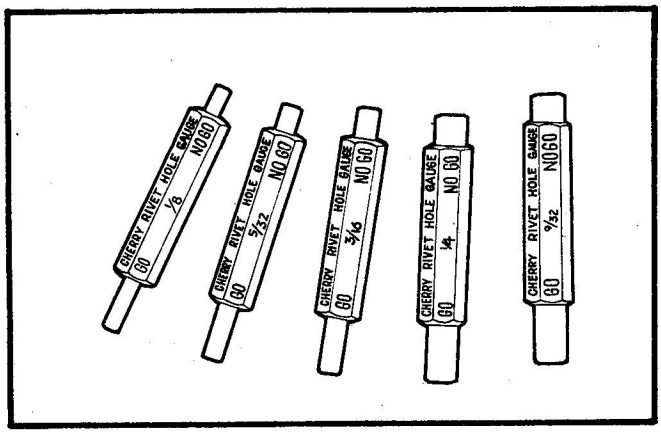


Figure 32 Typical Hole Size Gauges

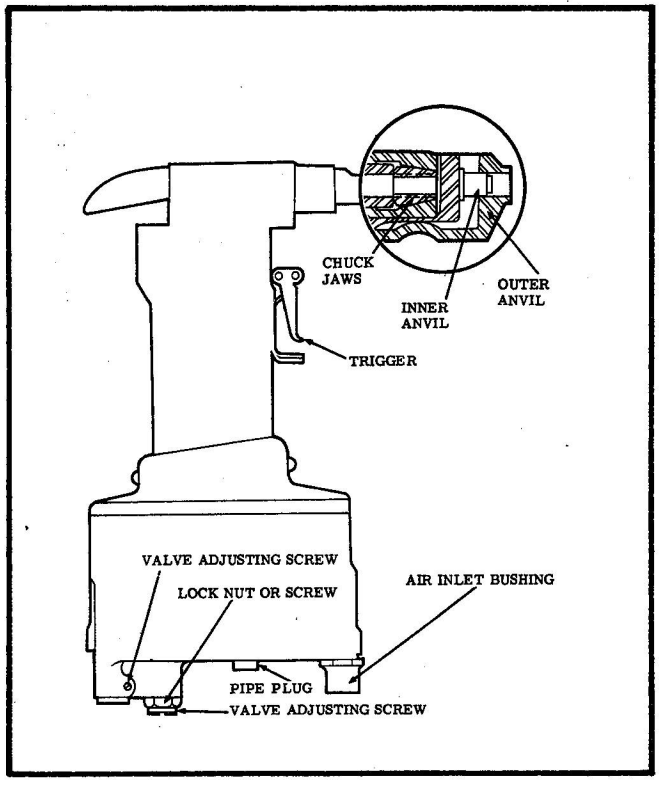


Figure 33 Typical Blind Rivet Gun

76 To ensure rapid driving of the rivet with minimum effort, proceed as follows:-

(a) Hold the head of the gun steady and at right angles to the work, with sufficient pressure to hold the head of the rivet firmly in place. Do not use great pressure unless necessary to bring together the parts to be riveted.

(b) Squeeze the trigger of the gun, hold until rivet pin breaks and release trigger.

NOTE

Do not drive a further rivet until the gun has been latched by the return action.

Inspection of Riveting

77 Before trimming the fractured stem of expanded rivets (if flush fracturing rivets are not used), and whether the blind end of the rivet is visible or not, inspect installed rivets from manufactured head side as follows:-

(a) All protruding head rivets:- Head tilt shall not exceed the maximum shown in Figure 35.

(b) Self-Plugging Rivets:- Check that a minimum of 1/32 inch of the enlarged stem is visible above the manufactured head of Standard Self-Plugging Rivets (see Figure 36). For Mechanical Lock-Stem, Self-Plugging Type, check that the locking collar is driven home flush with the top surface of the rivet head. If flush fracturing type is used, the stem should be sheared relatively flat and flush with the surface of the rivet head (see Figure 24), otherwise, the length of the enlarged stem visible above the head shall be 1/16 to 5/32 inch. If the enlarged portion of the stem protrudes less than the permissible minimum, the hole is too small or the rivet is too short and should be replaced. For rivets in clusters covering the same grip length the stems should be a reasonably uniform height above the work surface.

78 Trim the fractured stem of expanded rivets if flush fracturing rivets are not used. Flat ground nippers must be used as shown in Figure 37. Do not use chisel or curved nippers. Do not tap or hit heads of expanded rivets, as this will cause them to loosen.

79 If the blind end is visible after expansion, inspect for proper head formation (which must be tulip-shaped) for the position of the stem end in relation to the end of the rivet sleeve as shown in Figure 38.

80 Perform a stem push-out test on trimmed rivets by applying a force of 10 pounds on the stem, using a stem inspection gauge (Cherry Part 352B1 or equivalent). This should preferably be done several hours after the installation. If the stem can be pushed out or is

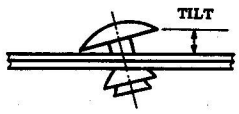
		INSTALLATION TOOLS																	
FASTENER	Dia.	115	116	120	136	194	200	285	287	350	352	353 354	356	357	359	393	394	504	505
CKL (P)	4				99-560		78975			78975									
	5				99-561		78976			78976									
	6				99-562		78977			78977									
CKL (100V)	4				99-560		78972			78972									
	5				99-561		78973			78973									
	6				99-562		78974			78974									
OCKL (P)	6						99-307			99-307									
OCKL (100V)	4						99-71			99-71									
	5						99-72			99-72									
	6						99-73			99-73									
MLSP	4						99-453												
	5						99-454												
	6						99-455												
MLS100	4						99-457			99-457									
	5						99-458												
	6						99-459												
BLIND BOLT (P & 100)	5						99-600												
	6						99-589												
	8	99-591	99-662					99-591	99-591			99-591						99-662	99-662[3]
	10		99-663						99-598									99-663	99-663[3]
	12		99-599															99-599	99-599[3]
PT 9SP MS	4			120B		99A-1	79663				79663		79663	79663	99A-1	99A-1	99A-1		
	5			120C[2]		99A-2	79664				79664		79664	79664	99A-2	99A-2	[2]99A-2		
	6					99A-3	79665				79665		79665	79665	99A-3	99A-3			
	8	87559				99-4	79626	87559	87559		79626	87559	79626	79626	99-4				

Nose Assembly Not Available
Tool Not Recommended

1. CKL (100V) and/or MLS100 Nose Assemblies may be used by removing Inner Anvils. 2. PT and MS Only.
3. Requires Use of 102460 Adapter.

Figure 34 Tools and Nose Assemblies for Installation of Blind Rivets

loose, either the rivet is too long or the hole is too large. Remove the rivet and replace either by the next size larger, or the next size shorter rivet length.



Rivet Size	Maximum Tilt
1/8	0.004
5/32	0.006
3/16	0.008

Figure 35 Permissible Tilting of Rivet Heads

Removal

81 Remove pull-stem blind rivets as follows:

(a) Drill out locking collar (if fitted) and drive out the rivet stem, using a tapered steel drift pin not over 3/32 inch in diameter at the small end. (Pry out any remaining locking collar, using the drift pin.)

(b) Using a drill one size smaller than that listed in Figure 30 for the nominal diameter of the rivet, drill almost through the rivet head.

(c) Break off the head, using the drift pin as a pry.

(d) Drive out the remainder of the rivet.

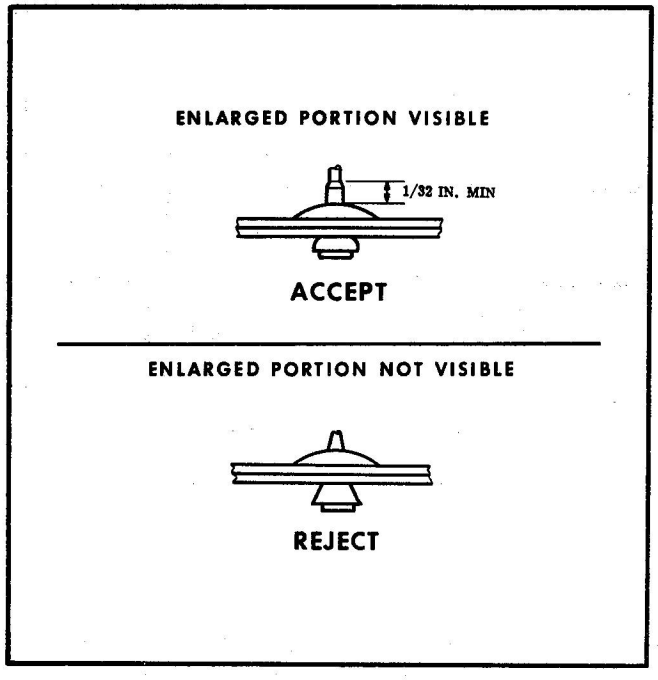


Figure 36 Measurement of Protrusion of Pull-Stem

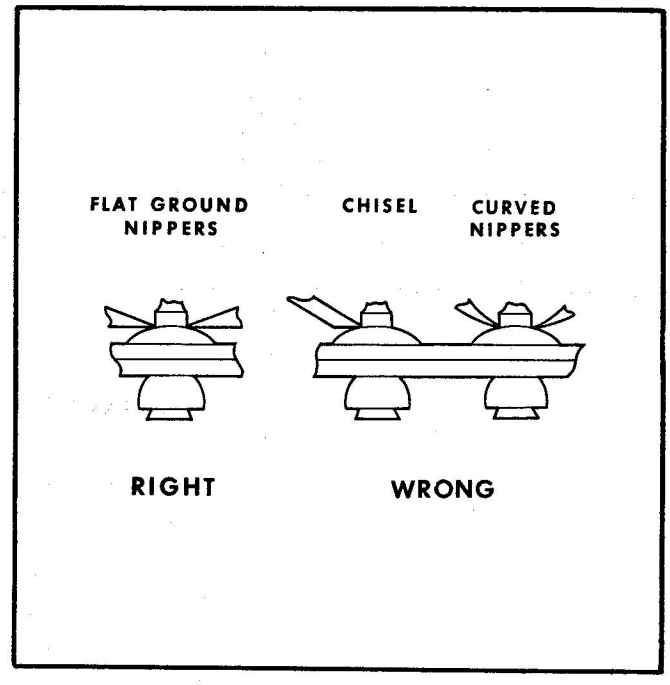


Figure 37 Trimming Stems of Standard Self-Plugging Rivets

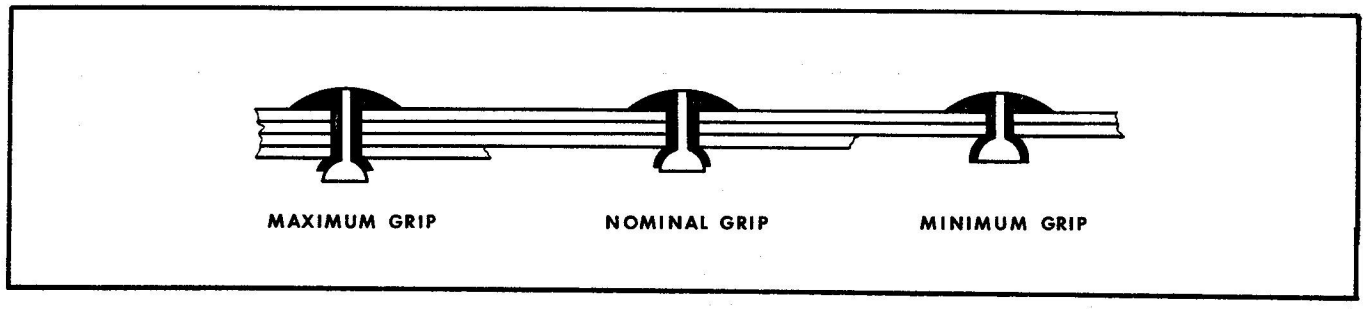


Figure 38 Blind End Formation of Self-Plugging Rivets

DRIVE-PIN RIVETS

General

82 These rivets are expanded by driving a hardened steel pin into the core of the hollow rivet. The blind head may be formed by splaying out the cross-split end of the rivet (MS24661 and MS24662 type - see Figure 39) or expanding it further to form a bulbed head (Deutsch Type - see Figure 40).

83 The structure being riveted must be able to withstand both the initial insertion of the rivet and the subsequent driving in of the pin. (See Figure 40 for minimum thickness of bucking member.)

Rivet Selection

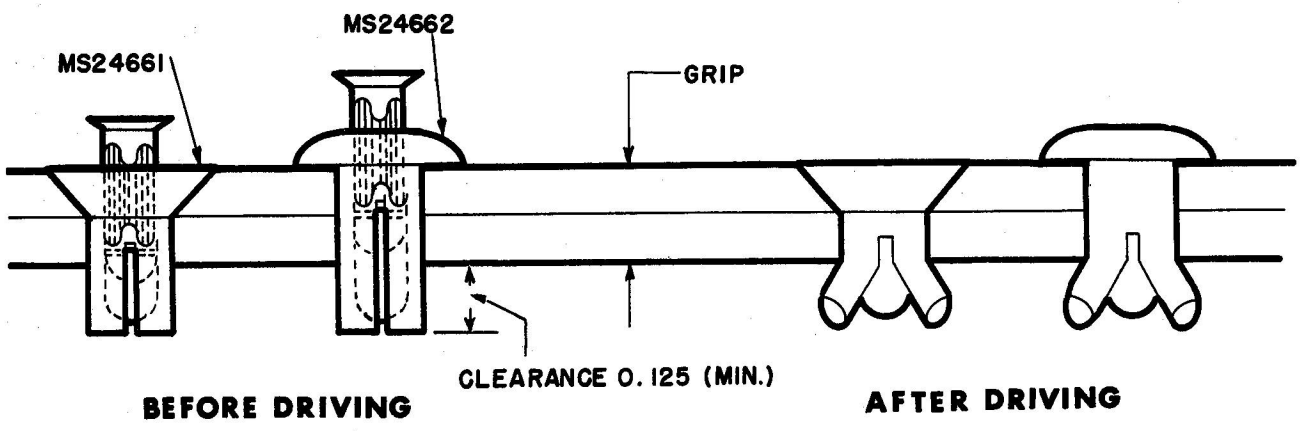
84 Examples of Part Number Identification of MS type drive-pin rivets are given in Figure 39, and of Deutsch type in Figure 40.

Installation

85 Drive-pin rivets are installed with a conventional rivet gun and a set having hollow clearance for the central pin. If space permits, a hammer will suffice to expand the rivet and form the upset head by driving in the steel pin.

CAUTION

Do not drive drive-pin rivets into tight



Dash No. (See Note 1)	Dia. +.003 -.001	Nominal Grip (Range = Nom ± 1/64)
1 to 26	0.125	1/32 to 13/32 in increments of 1/32 (See Note 2).
27 to 64	.156	1/16 to 5/8 in increments of 1/32 (See Note 2).
65 to 102	.187	
103 to 140	.250	

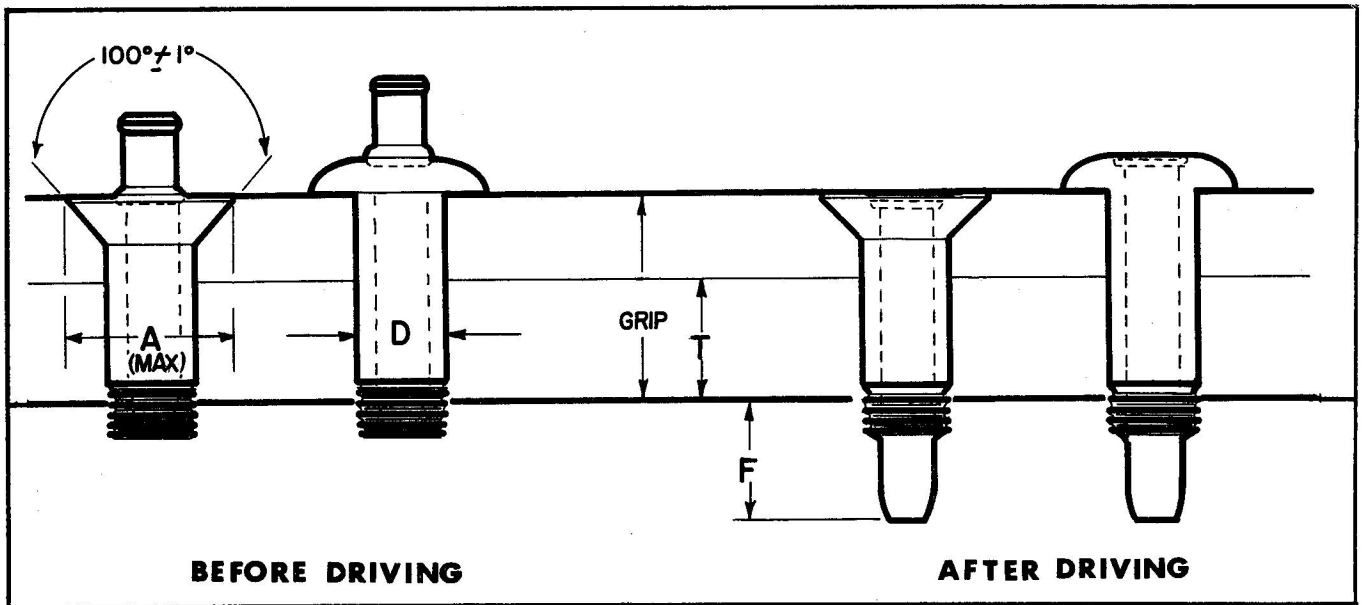
Note 1: Odd dash numbers indicate Aluminum; even numbers indicate Carbon Steel.

Note 2: Take next highest EVEN dash number to calculate grip size of ODD dash number.

EXAMPLE: MS 24661-29

- 24661 = CSK Head
- 24662 = Universal Head
- Aluminum rivet, 0.156 dia.
- Grip range 5/64 to 7/64

Figure 39 Drive-Pin Rivets Type MS24661 and MS24662



Dash No	Dia. D	A (Max)	T (Min)	F (Max)	Hole Preparation	
					Pre-drill	Size Drill
06	3/16	.3047	.125	5/32	No.16(.117)	No.11(.191)
08	1/4	.3988	.188	7/32	A(.234)	G (.261)
10	5/16	.4787	.250	15/64	M(.295)	O (.316)
12	3/8	.5062	.375	17/64	T(.358)	W (.386)

Sample Deutsch Part No:- 6950-DO6-10

6950 - D - 06 - 10

- 10 — Nom. grip in 1/16 inch ; Range = Nom±1/32 inch. (Available -3 to -22)
- 06 — Diameter in 1/32 inch.
- D — Material (D = Dural) (S = Stainless Steel)
- 6950 — Rivet Type and Head Style: 6950 = Flush Head, 6951 = Protruding Head

Figure 40 Deutsch Drive-Pin Rivets

holes by hammering the pin. Use hollow drift which will clear the head of the pin. Installed rivets must not be milled or shaved to meet flushness requirements.

86 After the pin has been seated in the recess, smooth out the locking lip section with a rotary or rolling action of the driving tool.

Removal

87 Remove drive-pin rivets as follows:-

(a) With suitable drill, drill out pin and tap sleeve.

(b) Extract rivet by means of a screw-in puller or a screw, with a nut and spacers.

CHEMICALLY EXPANDED (EXPLOSIVE) RIVETS

NOTE

Explosive rivets are not generally used in the RCAF due to the hazards in storing and handling. The information contained here is to be used only when specific instructions and tools are issued for a special project.

General

88 Explosive blind rivets (MS20602, MS20603 Type A, and DuPont P56S series) contain an explosive charge packed into a concentric cavity in the rivet shank. The blind end of the rivet is sealed with a plug. See Figure 41.

89 On installation, heat is applied to the rivet head to ignite the explosive charge. The resultant expansion swells the rivet in the hole and also forms a head at the blind end. The plug in the Type 'A' rivet is retained. The clearance required by the obsolete open-ended explosive rivet (Type 'B') to protect material facing the blind end from corrosion, is not therefore required when using the Type 'A' rivet which is also comparatively noiseless and has better detonation with no flash.

90 These rivets have a strength in shear and tension of approximately 85% of the standard 2017-T rivet.

Storage

91 Store explosive rivets in the boxes in which they are received from the manufacturer or in moisture proof containers, properly labelled, giving all the information that appears on the manufacturer's box. Observe the following precautions:

(a) Storage rooms must be cool and dry.

(b) Do not store nor place explosive rivets, even for a short time, near hot equipment, such as radiators, furnaces, etc.

(c) Do not remove the protective film on the rivets. The film is necessary for proper heating, firing and expanding of the rivet.

Safety Precautions

92 Observe the following safety precautions when using explosive rivets:

(a) Do not expand explosive rivets in the presence of any explosive vapours or fluid, such as gasoline, paints, thinners, alcohol, etc. If such vapours are present, consult engineering authority for the method of dispersing them before proceeding.

(b) Explosive rivets must not be fired when any part of the body of the operator or others is in a direct line with the plug end of the rivet.

(c) Return unused rivets to stores. Do not keep them in a tool box. Destroy discarded rivets.

(d) Before changing a heating or riveting iron tip, make sure that the iron is disconnected from the electrical supply and the tip cooled off with water or compressed air.

Types and Sizes

93 For the identification of Explosive rivets refer to Figure 41. Rivets are colour coded according to diameter and grip length as shown in Figure 42.

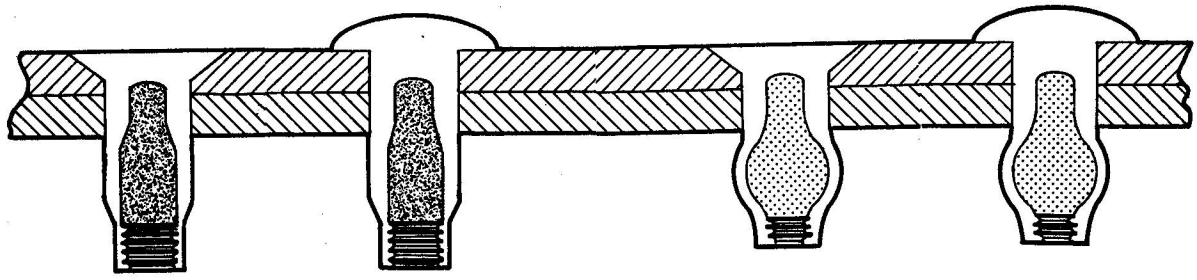
Drilling

94 Pre-drill holes, dimple if required, and re-drill to size. Drill sizes are given in Figure 43.

Riveting Tools

95 Any soldering iron with a tip which can be machined to the dimensions shown in Figure 44 and capable of exploding the rivet within 2 to 6 seconds is suitable. Allow approximately 20 minutes for iron to heat up if necessary. For continuous riveting, an air-cooled electrically-heated iron is recommended. Figure 44 illustrates the shape of iron tip for Protruding and Flush Head rivets, and the Part and Code Number of tip for a DuPont No. 6 air-cooled riveting iron. (This iron requires a transformer and shop air line and does not require a heating up period.)

96 Rework or replace tips as soon as the contour becomes worn, distorted or splayed out. (DuPont replaceable tips are not suitable for rework.)



BEFORE EXPANSION **AFTER EXPANSION**

TYPICAL MILITARY DESIGNATION

MS 20602 B 4 P 32

- 32 — Max.grip in 1/100 inch (32 = .325 inch) (Available range: .025 to .485 inch in increments of .020 inch)
- P — P = 'A'-Type (Plugged end. Open end obsolete)
- 4 — Diameter in 1/32 inch. Available in 1/8, 5/32 & 3/16 inch Dia.
- B — Material: 'B' = 5056 Al.Aly. 'D' = 2017 Al.Aly.
- 20602 — Rivet Type and Head Style: '20602' = Universal Head '20603' = 100° CSK Head

TYPICAL COMMERCIAL DESIGNATION

P 56S 204 A 16

- 16 — Grip Length in 1/100 inch (.05 to .485 inch, in .04 inch increments)
- A — Head Style: 'A' = Universal Head (Modified Brazier) '100' = 100° Countersunk
- 204 — Shank Diameter in 1/1000 inch (204 = 204/1000 Dia.)
- 56S — Rivet Material: 'DR' = 2017 Al.Aly.(Use in Al.Aly. & Steel '56S' = 5056 Al.Aly.(Use in Al.Aly., Magnesium Aly, & Steel) 'N' = Nickel.(Use in Copper & Brass, Monel or Inconel, Steel & Stainless Steel.)
- P — Rivet Type: P = Plugged or 'Blast-Free' Rivet (Type 'A') No Prefix = Open or Regular - (Type 'B') (Obsolete)

Figure 41 Identification of Explosive Rivets

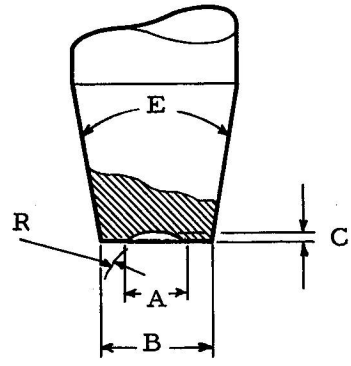
2017 RIVETS					
Grip Length	Dash No.	1/8 Dia.	5/32 Dia. Length	3/16 Dia. Length	Colour Identification
.025-.045	4	.272			Yellow
.045-.065	6	.292	.357		Black
.066-.105	8	.332	.377	.440	Red
.106-.105	10	.332	.377	.460	Blue
.106-.125	12	.352	.417	.480	Brown
.126-.145	14	.372	.437	.500	Yellow
.146-.165	16	.392	.457	.520	Black
.166-.185	18	.412	.477	.540	Red
.186-.205	20	.432	.497	.560	Blue
.206-.225	22	.452	.517	.580	Brown
.226-.245	24	.472	.537	.600	Yellow
.246-.245	24	.472	.537	.620	Black
.266-.285	28	.512	.577	.640	Red
.286-.305	30	.532	.597	.660	Blue
.306-.325	32	.552	.617	.680	Brown
.326-.345	34			.700	Yellow
.346-.365	36			.720	Black
.366-.385	38			.740	Red
.386-.405	40			.710	Blue
.406-.425	42			.610	Brown
.426-.445	44			.630	Yellow
.446-.465	46			.650	Black
.466-.485	48			.670	Red

5056 RIVETS					
Grip Length	Dash No.	1/8 Dia.	5/8 Dia. Length	3/16 Dia. Length	Colour Identification
.005-.045	4	.272			Yellow
.046-.085	8	.312			Red
.086-.125	12	.352			Brown
.126-.165	16	.392			Black
.166-.205	20	.432			Blue
.206-.245	24	.472			Yellow
.246-.285	28	.512			Red
.286-.325	32	.552			Brown
.326-.365	36				Black
.025-.085	8		.377		Red
.086-.145	14		.437		Yellow
.146-.205	20		.497		Blue
.206-.265	26		.557		Black
.266-.325	32		.617		Brown
.326-.385	38				Red
.025-.105	10			.460	Blue
.086-.165	16			.520	Black
.166-.245	24			.600	Yellow
.246-.325	32			.680	Brown
.326-.405	40			.760	Blue
.406-.485	48				Red

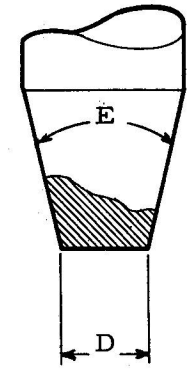
Figure 42 Grip, Length and Colour Identification of Explosive Rivets

Rivet Diameter	1/8	5/32	3/16
Pilot Hole Diameter	0.129 (No.30)	0.159 (No.21)	0.191 (No.11)
Final Hole Diameter	0.135-0.139 (No.29)	0.172-0.176 (No.17)	0.203-0.207 (No.6)

Figure 43 Hole Sizes for Explosive Rivets



TIP FOR PROTRUDING HEAD RIVET



TIP FOR FLUSH HEAD RIVET

Tip Dimensions						
	Protruding Head					Flush Head
Rivet Dia.	A Dia.	B Dia.	C Depth	R Rad.	E Angle	D Dia.
1/8	.170	.220	.020	.181	See Note	.134
5/32	.210	.260	.025	.226		.171
3/16	.250	.300	.030	.272		.202

No.6 DuPont Riveting Iron Tips						
	Protruding Rivets			Flush Head Rivets		
Tip	1/8	5/32	3/16	1/8	5/32	3/16
Code No.	6-B-4	6-B-5	6-B-6	6-C-4	6-C-5	6-C-6
Part No.	5562	5563	5564	5565	5566	5567

NOTE

The angle E is normally 45° for straight head tips, but this angle may be altered as desired and the tips offset as required, providing that the other dimensions shown are maintained.

Figure 44 Riveting Iron Tip Dimensions

Riveting

NOTE

Explosive rivets have no ability to draw together the parts to be riveted. Use skin fasteners at less than six inch spacing to hold parts together.

97 Fit a rivet of the proper grip length into the prepared hole. If the rivet does not go in easily, do not tap or force, but clean the hole with the final hole size drill. Should the rivet still not go in the hole easily, discard it.

98 For satisfactory riveting, check that iron tip is snug fitting on the rivet head and is free from dirt and oxide. Clean tips frequently with fine wire wool.

99 Centre the tip of the iron on the rivet head so that it is not in contact with the surrounding material (see Figure 45). Hold the iron at right angles to the surface of the work, and apply sufficient pressure to seat the rivet head.

100 Remove iron immediately rivet has exploded.

101 Rivets should explode in 2 to 6 seconds, 2 seconds being the optimum. Discard any rivet which fails to explode within 6 seconds.

WARNING

Do not leave rejected or defective rivets on the work bench or shop floor. All such rivets should be collected in a box and periodically transferred to a wire basket and destroyed.

102 Rivets will not normally explode before two seconds unless the tip of the iron is too hot. (Regulate temperature of the DuPont No. 6 iron by means of the high/low switch and air pressure valve on the transformer.)

103 Do not tap or hit heads of installed rivets as this will loosen them.

Inspection of Riveting

104 Maximum permissible head tilt and gap are as specified for pull-stem blind rivets. If blind end is visible after installation, check that the head is correctly barrel-shaped (see Figure 41) and is free from splitting.

STRUCTURAL FASTENERS

LOCKBOLTS

105 The lockbolt is a high strength fastener used on aircraft primary and secondary structures. It consists of a pin with a serrated shank onto which a collar is swaged on installation. It is a permanent, shakeproof type of fastener which may be used in shear or tension. Three basic types of Lockbolt are available; the pull-type, the stump and the blind lockbolt. Holes for the two former types are permitted a slight interference fit, while the blind type require a small clearance. Typical lockbolts are shown in Figure 46.

106 Although not a blind fastener, the pull-type lockbolt does not require bucking. Installation is by means of a gun which pulls on the pin of the lockbolt, while simultaneously swaging the locking collar into the locking grooves of the pin. Continued pressure automatically breaks the pin at breakneck groove. (See 'A' on Figure 46.)

Stump Lockbolts

107 These are used primarily where there is insufficient clearance for the effective installation of the pull-type lockbolt, but are otherwise similar in application. Installation is by

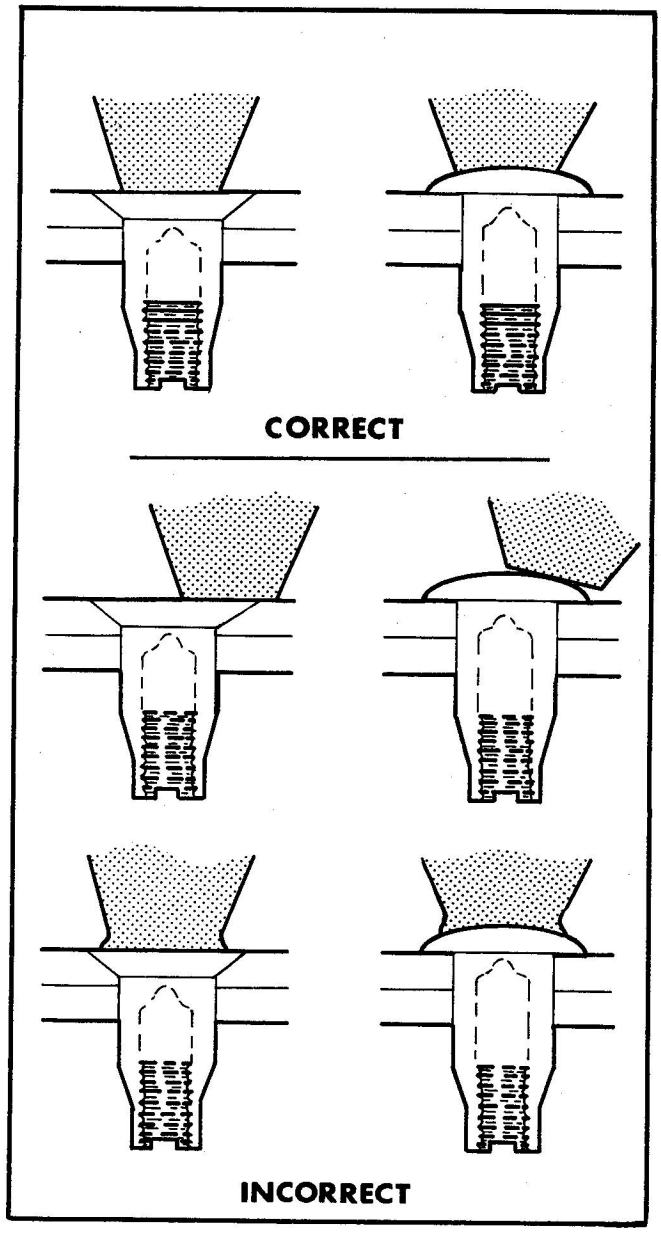
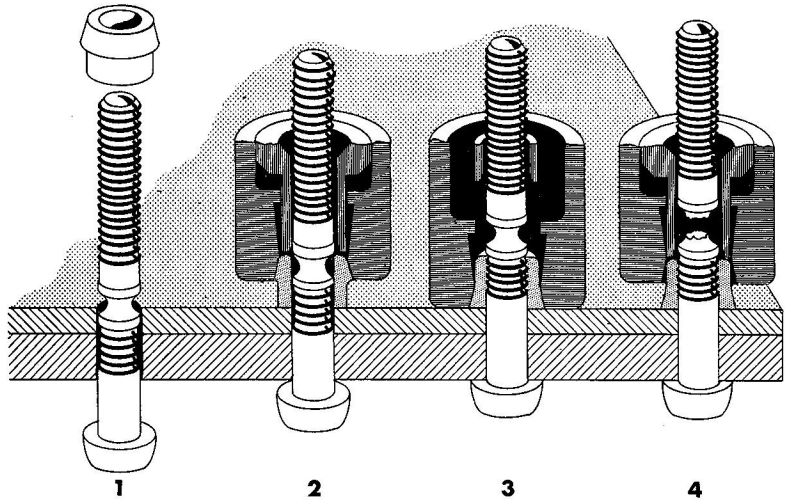


Figure 45 Correct Application of Explosive Rivet Tools

A

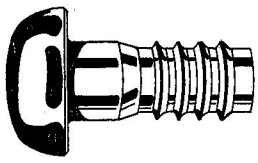
PULL-TYPE LOCKBOLT

1. Insert collar over lockbolt pin.
2. Tool pulls pin into position and draws sheets together.
3. Tool swages collar.
4. Pin breaks at groove.

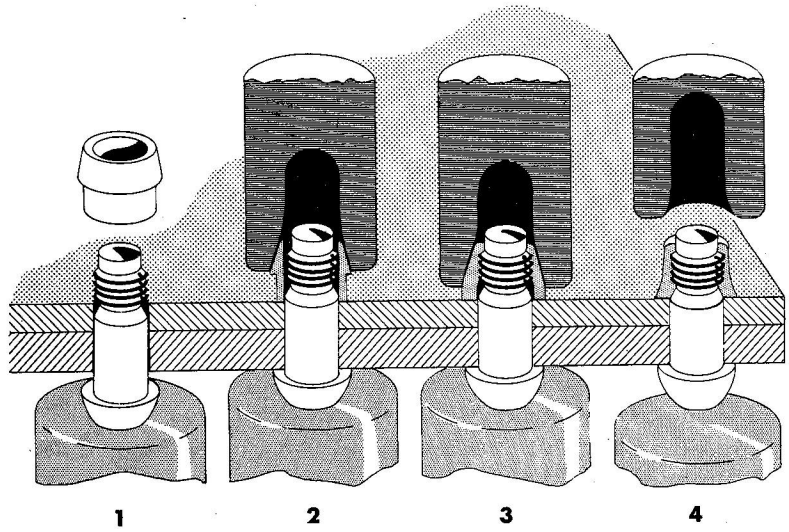


B

STUMP LOCKBOLT

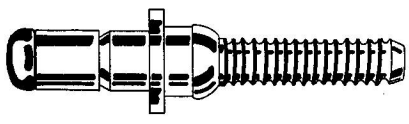


1. Stump inserted, collar fitted.
2. Pressure of tool and bucking bar forces sheets together.
3. Continued pressure swages collar.
4. Installation complete.

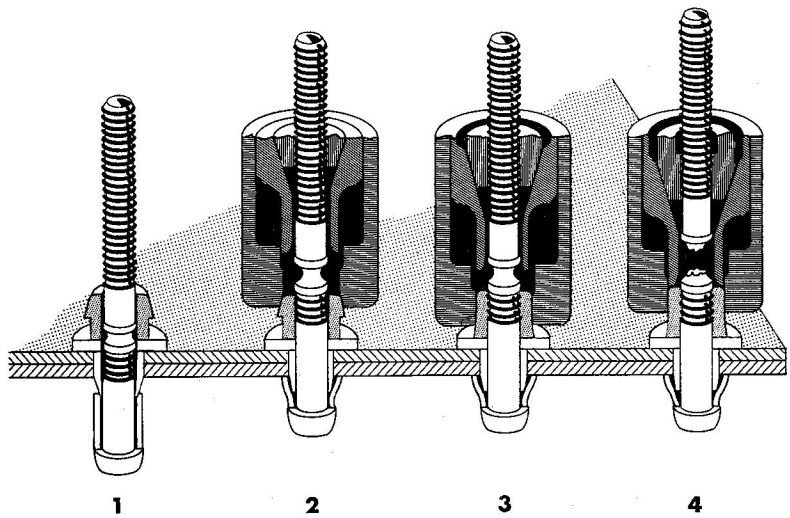


C

BLIND LOCKBOLT



1. Lockbolt inserted from open side.
2. Gun pulls on pin, draws sheets together and forms blind head.
3. Continued pressure of tool swages collar.
4. Further pressure breaks pin at groove.



1234

Figure 46 Typical Lockbolts

means of conventional rivet gun, using a special tool (see 'B' on Figure 46) for swaging the collar.

Blind Lockbolts

108 The blind lockbolt is installed by means of the rivet pull gun. A head is first formed on the blind side as the pin is drawn into the hollow rivet. Further pressure swages the locking collar into the locking grooves in the pin in the same manner as the lockbolts. Still further pressure, as with the pull-type lockbolt, cause the pin to shear at the breakneck groove provided (see 'C' on Figure 46).

Titanium Lockbolts

109 A range of Titanium Lockbolts, having a tensile strength of 160,000 to 180,000 psi., for tension and shear applications, are available in both pull-type and stump-type with standard Protruding and 100° Countersunk head forms. These are tabulated by basic NAS part numbers in Figure 47. Grip range is designated by adding a dash number representing maximum grip in 1/16 inch.

Huck and Cherry Lockbolts

110 For the code identification of Huck and Cherry Lockbolts and Collars refer to Figure 48. The grip ranges corresponding to the grip dash numbers in the identification code are listed in Figure 49.

Shear and Tensile Strengths

111 For ultimate single shear and tensile strengths refer to Figure 51.

NOTE

When suitable lockbolts or installation tools are not available, use AN-3 series bolts or AN502, AN525 or NAS220 series screws of same size as the fastener being replaced. Ensure that close fit is obtained.

Drilling

112 Hole sizes for Lockbolts vary with the Type of Lockbolt used, class of fit required, and accessibility of the location.

Countersinking and Dimpling

113 For dimpling table refer to EO 05-1-3/6.

Angular or Curved Surfaces

114 The blind head or the collar and washer of blind lockbolts can be formed against a surface not exceeding 7° from perpendicular with the axis of the hole, or on curved surfaces with a minimum radius of curvature of three times the pin diameter. The pin head should be installed on a surface normal to the pin axis.

115 For spotface diameters to provide clearance for the pull gun where spotfacing is required, see Figure 50.

Installation Tools

116 For recommended tools for the installation of different types and sizes of lockbolts, see Figures 52 and 53.

	Rivet Diameter	Pull Type		Stump Type		Collar Part No.
		Prot. Hd.	100° CSK Hd.	Prot. Hd.	100° CSK Hd.	
Tension Type	3/16	NAS2006	NAS2106	NAS2206	NAS2306	NAS1080-6
	1/4	NAS2008	NAS2108	NAS2208	NAS2308	NAS1080-8
	5/16	NAS2010	NAS2110	NAS2210	NAS2310	NAS1080-10
Shear Type	3/16	NAS2406	NAS2506	NAS2606	NAS2706	NAS1080-C6
	1/4	NAS2408	NAS2508	NAS2608	NAS2708	NAS1080-C8
	5/16	NAS2410	NAS2510	NAS2610	NAS2710	NAS1080-C10
	3/8	NAS2412	NAS2512	NAS2612	NAS2712	NAS1080-C12

Figure 47 Titanium Lockbolt Part Numbers

Bolt and Stump Designation:-

2L P EU - 6 - 6

- 6 (last): Grip in 1/16 inch. (Available up to 2" grip.)
- 6 (first): Diameter in 1/32 inch. (Available 1/8, 5/32, 3/16, 1/4, 5/16, & 3/8 inch.)
- EU: Material Code: 'E' = 7075 Al.Aly.
  'EU' = A 286 Stainless Steel.
  'P' = Titanium
  'T' = Alloy Steel
- P: Head Style: 'P' = Protruding Head
  '509' = 100° CSK Head (Tension Type)
  '100' = 100° CSK Head (Shear Type)
- 2L: Prefix: '2L' = Tension Type Lockbolt
  '2LS' = Tension Type Stump
  '2AL' = Shear Type Lockbolt
  'SLS' = Shear Type Stump
  'S3L' = Shear Type Lockbolt
  'S3S' = Shear Type Stump 109,000 KSI
  'BL' = Blind Lockbolt

R3001 = Tension Type Lockbolt, Protruding Head
R3002 = Tension Type Lockbolt, 509 Type CSK Head

Collar Designation:-

6LC C 8

- 8: Diameter in 1/32 inch.
- C: Collar Material: 'C' = 2024-T4 Al.Aly. (with heat-treated pins only)
  'F' = 6061-T67 Al.Aly. (with 7075 Al.Aly. pins)
  'R' = Mild Steel (with heat-treated steel pins for high temperature applications)
  'M' = Monel
- 6LC: Collar Type: LC for SL and SLS
  6LC for SAL and SLS
  6DC for S3L and S3S

Figure 48 Huck and Cherry Lockbolts.

Grip Number	Grip Range	
	Min.	Max.
1	.031	.094
3	.094	.156
3	.156	.219
4	.219	.281
5	.281	.344
6	.344	.406
7	.406	.469
8	.469	.531
9	.531	.594
10	.594	.656
11	.656	.719
12	.718	.781
13	.781	.844
14	.843	.906
15	.906	.969
16	.968	1.031
17	1.031	1.094
18	1.094	1.156
19	1.156	1.219
20	1.219	1.281
21	1.281	1.344
22	1.343	1.406
23	1.406	1.469
24	1.469	1.531
25	1.531	1.594
26	1.594	1.656
27	1.656	1.718
28	1.718	1.781
29	1.781	1.844
30	1.844	1.906
31	1.906	1.968
32	1.968	2.031
33	2.031	2.094

1. Applicable to tension type lockbolt, Blind Lockbolts (BL series), and Blind Bolts (B series) only. (Grip varies ± .001 between these types of fasteners.)

2. Rivets of additional grip ranges also available.

Figure 49 Grip Range and Dash Numbers of Huck & Cherry Lockbolts

117 Install Lockbolts as follows (refer to Figure 46):-

NOTE

Do not degrease pins or collars before installation. The gun must be in full return position before insertion on the next pin to be driven.

(a) Pull-Type Lockbolts:

(i) Insert the locking collar over the lockbolt pin tail extending through the hole.

(ii) Apply the gun to the collar, press the trigger and hold until the pin breaks at the breakneck groove.

(b) Use conventional rivet guns for the installation of Stump-Type lockbolts. Refer to Figure 53 for the correct tool for swaging the collar.

(c) Install Blind Lockbolts with the rivet pull gun, using the applicable nose assemblies listed in Figure 53.

Inspection of Lockbolt Swaging

118 Normally, visual inspection of pin length and swaging of the collar is adequate. Figure 54 depicts the appearance of collars in various stages of swaging.

119 If verification is required (e.g. on tension type bolts) gauges are available for determining more precisely the degree of swaging, and the length of protruding pin. Such gauges are illustrated in Figure 55, together with a list of the appropriate gauge for given type and diameter of lockbolt. For details of the use of the gauges refer to Figure 56.

120 Dimensions for the inspection of swaging by measurement are given in Figure 57 for lockbolts and Figure 58 for stumps.

Removal of Lockbolts

121 Two methods of removing Lockbolts, Lockbolt Stumps or Blind Lockbolts are illustrated in Figure 59.

Pin Dia.	Spotface Dia.	Fillet R.
3/16	.812	.062
1/4	.812	.062
5/16	1.125	.062
3/8	1.125	.062

Figure 50 Spotface Diameters for Lockbolts

Lockbolt Pin Material	Heat Treated Alloy Steel		7075-T6		
Lockbolt Collar Material	2024-T4		6061-T67		
	Loading (Pounds)				
Diameter	Single Shear	Tension Type Tension	(Shear Type) (S) Tension	Single Shear	(Tension Type) Tension
1/8	1150		450		
5/32	1805 "S"		750		
5/32	1995	1100	750	960	740
3/16	2620	2210	1105	1260	1195
1/4	4650	4080	2040	2185	2200
5/16	7300	6500	3250	3450	3500
3/8	10,500	10,000	5050	4970	5455
1/2	18,534	15,500			
Oversize shank type available in 3/16, 1/4, 5/16 and 3/8 diameter. Blind oversize fasteners available in Al. Alloy and Alloy Steel (Diameter 1/4, 5/16 and 3/8). Shear strength is slightly higher than those given above; tension is slightly lower.					

Figure 51 Ultimate Allowable Single Shear and Tensile Strengths of Lockbolts

Tools	Aircraft Lockbolts	Lockbolt Stumps	Blind Lockbolts
3/16	CP 352 or CP 353	CP 3X for Al. Stumps CP 5X for Steel Stumps	
1/4	CP 352 Al. Alloy only	CP 5X for Al. Stumps	CP 352-L-6 Nose Assy
	CP 353 Al. Alloy and Al. Steel	CP 7X for Steel Stumps	CP 353-L-6 Nose Assy
5/16	CP 353	CP 7X for Al. Stumps CP 40 Boyer for Steel Stumps	
3/8	CP 353	CP 50 Boyer	

Figure 52 Chicago Pneumatic Air Hammer Tools for Lockbolt Installation

FASTENER	Dia.	INSTALLATION TOOLS 115	116	117	194	200	285	287	352	353	354	356	357	504	505	609	610 613	611 612	614
AL	5			117-5	99-259[2]	99-626			99-626			99-626	99-626[2]			99-540		99-148	
ACT	6			117-6	99-260[2]	99-608			99-608			99-608				99-541	99-395	99-156	
R3007	8	99-609		117-8		99-634[2]	99-609	99-609	99-634[2]	99-609	99-609					99-216[2]	99-126	99-165	
R3008	10	99-622	99-664				99-622	99-622		99-622	99-622			99-664	99-664[3]			99-135	
	12	99-613	99-651				99-613	99-613		99-669	99-669			99-651	99-651[3]			99-145	99-410
2L	5			117-5	99-259[2]	99-626			99-626			99-626	99-626[2]			99-540		99-148	
R3001	6			117-6	99-260[2]	99-608			99-608[2]			99-608				99-541	99-395	99-156	
R3002	8	99-609		117-8			99-609	99-609	99-634[2]	99-609	99-609						99-126	99-165	
R3014	10	99-622	99-664				99-622	99-622		99-668	99-668			99-664	99-664[3]			99-135	
	12	99-613	99-651					99-613						99-651	99-651[3]			99-145[2]	99-410
	16													99-656	99-656[3]				
S3L	4					99-614			99-614			99-614	99-614						
	5					99-620			99-620			99-620							
	6					99-608			99-608			99-608							
	8	99-609					99-609	99-609		99-609	99-609								
	10							99-622											
	12		99-659											99-659	99-659[3]				
SAL	6					99-608			99-608			99-608				99-541	99-395	99-156	
R3104	8	99-609					99-609	99-609		99-609	99-609					99-216	99-126	99-165	
R3105	10	99-622	99-664				99-622	99-622		99-622	99-622			99-664	99-664[3]			99-135	
	12	99-613	99-651				99-613	99-613		99-613	99-613			99-651	99-651[3]			99-145	99-410
10L	6					99-671			99-671								99-593		
	8						99-672	99-672			99-672						99-594		
	10						99-673	99-673										99-584	
	12							99-674						99-623					99-585
BL	8					99-666			99-666			999-66				99-84	99-395	99-156	
	10	99-667					99-667	99-667		99-667	99-667						99-126	99-165	
3BL	12	99-668	99-664				99-668	99-668						99-664	99-664			99-433	
OS/OSR	8	99-495			99-278	99-86	99-495	99-495	99-86	99-495	99-495	99-66	99-86				99-241	99-271	
	10	99-335					99-335	99-335		99-335	99-335							99-281	
	12	79585					79585	79585		79585	79585							99-291	
DR/DRW	8	99-608[1]			99-260[2]	99-666			99-666			999-66	99-666[2]			99-84	99-395	99-156	

Nose Assembly Not Available
Tool Not Recommended

1. Requires Use of 102463 Adapter. 2. Tool Capacity Limited to Aluminum Fasteners. 3. Requires Use of 102460 Adapter

Figure 53 Tools and Nose Assemblies for Installation of Lockbolts

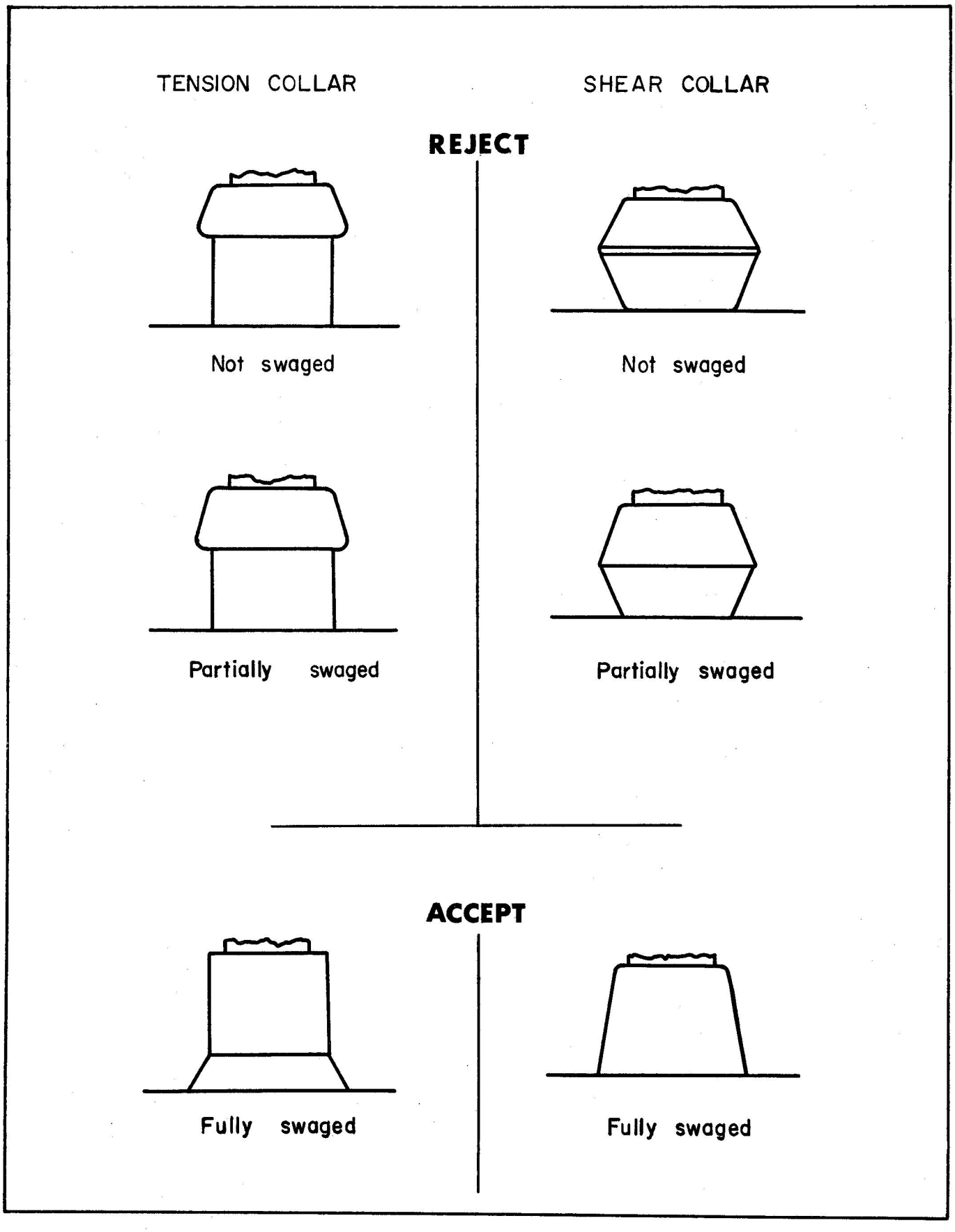
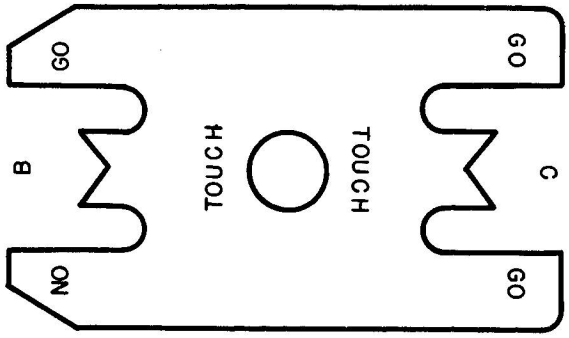
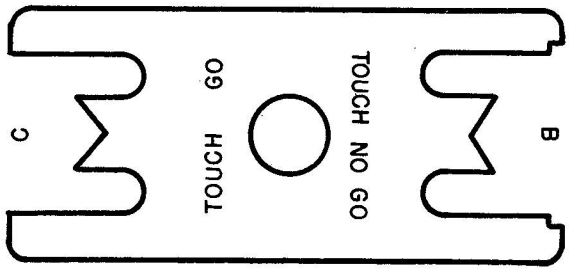


Figure 54 Visual Inspection of Lockbolt Swaging



H-76 SHEAR GAUGE



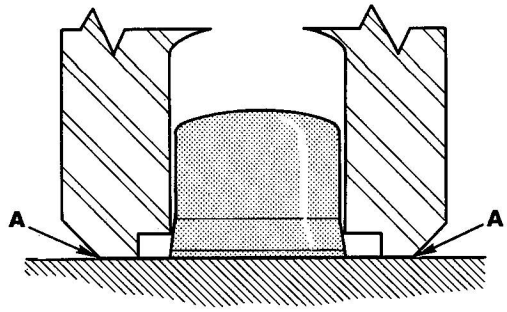
H-85 TENSION GAUGE

GAUGE NO.	LOCKBOLT SERIES	DIAMETER
HG 85-2	ALPP, R3001, R3007, ACT509, ALP426, R3002, R3008, R3014, R3020, 2L200	1/4
HG 85-3	ALPP, ACT509, ALP426	5/16
HG 85-4	ALPP, ACT509, ALP426	3/8
HG 85-5	R1028, R1029, R3007, R3008	5/16
HG 85-6	R1028, R1029, R3007, R3008	3/8
HG 85-7	2PL, ALPP, ALP426, 2L426	5/32
HG 85-8	R3001, R3002, OALP, R3014, R3020	5/16
HG 85-9	R3001, R3002, OALP, R3014, R3020	3/8
HG 85-10	ALPP, R3001, R3007, ACT509, ALP426 R3002, R3008, R3014, R3020, 2L200	3/16
HG 76-1	SALP, SAL100, R3104, R3105, R3106	3/16
HG 76-2	SALP, SAL100, R3104, R3105, R3106	1/4
HG 76-3	SALP, SAL100, R3104, R3105, R3106	5/16
HG 76-4	SALP, SAL100, R3104, R3105, R3106	3/8

NOTE

Inspection of Blind Lockbolt: use L-6 G24 Inspection gauge for BL-8 bolts, and L-8 for BL-10 bolts.

Figure 55 Gauges for Inspection of Lockbolt Swaging

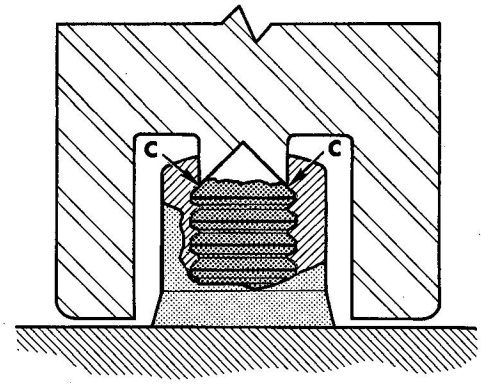


I. CHECK SWAGE (TENSION TYPE)

(a) Center gauge on collar (notch toward collar) or draw gauge across collar.

(b) If gauge touches sheet at A, collar is sufficiently swaged - ACCEPT.

(c) If gauge does not touch sheet at A, collar is not sufficiently swaged - REJECT.

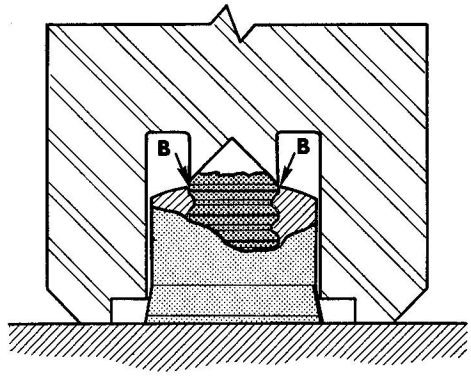


III. CHECK FOR MAXIMUM GRIP (TENSION AND SHEAR TYPES)

(a) Reverse gauge and centre on collar.

(b) If points C touch pin, installation is driven under maximum grip - ACCEPT.

(c) If points C do not touch pin, installation is driven over maximum grip. REJECT and replace with next longer pin.

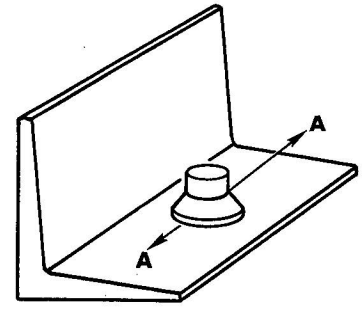


II. CHECK PIN FOR MINIMUM GRIP (TENSION AND SHEAR TYPES)

(a) Center gauge on collar (notch toward collar).

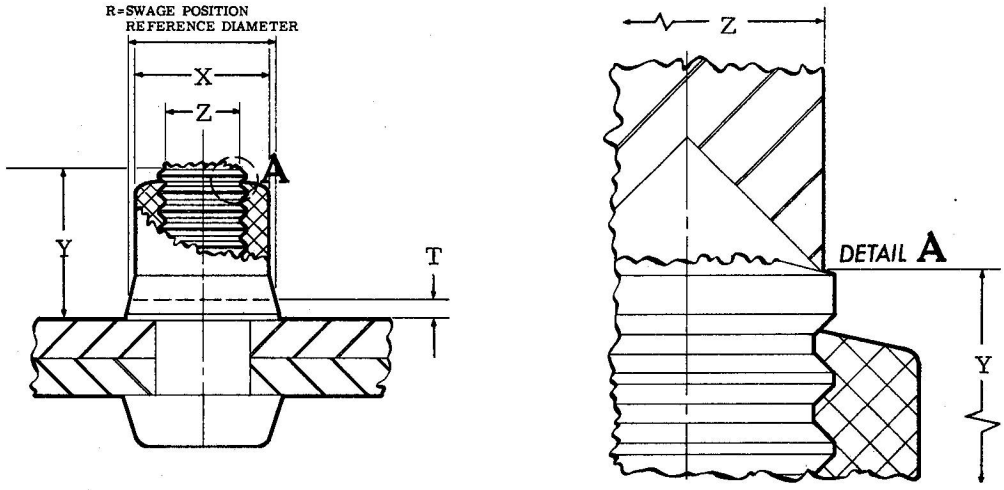
(b) If points B do not touch pin, installation is driven over minimum grip - ACCEPT.

(c) If points B touch pin, installation is under minimum grip. REJECT and replace with next shorter pin.



IV. WHEN COLLAR IS INSTALLED AGAINST SLOPE INSPECT IN PLANE A - A.

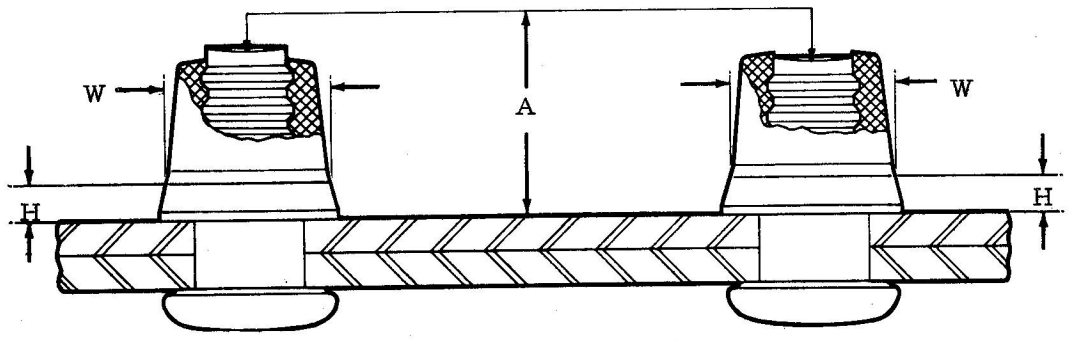
Figure 56 Use of Lockbolt Swaging Gauges



Lock bolt Dia.	X	Y	Z Ref.	R	T			Assured Ultimate Tensile Load (Min.)	
					Min.	Max.	When Y is	Pin Material	
3/16	.2812	.240(±.050)	.165	.304	.013	.039	.190 to .225	Alloy Steel	2,210
						.059	.226 to .291	7075 Al. Aly.	1,375
1/4	.3672	.337(±.059)	.225	.401	.011	.039	.278 to .310	Alloy Steel	4,080
						.046	.311 to .396	7075 Al. Aly.	2,535
5/16	.4545	.389(±.060)	.269	.487	.044	.084	.339 to .358	7075 Al. Aly.	4.025
						.094	.359 to .459		
3/8	.5525	.480(±.069)	.340	.063	.017	.063	.411 to .444	7075 Al. Aly.	6,275
						.083	.455 to .459		
5/16	.4572	.365(±.056)	.269	.487	.044	.137		Alloy Steel	4,225
						.185		Alloy Steel	3,250
3/8	.5572	.460(±.060)	.340	.590	.042	.125		Alloy Steel	5,050

1. Inspect for completeness of swage (T dimension) first.
2. If T falls between its minimum and the lesser of the two maximums shown, the driven lockbolt is acceptable for the range of Y tabulated in column Y.
3. If T falls between the two maximums shown, the driven lockbolt is acceptable only if the Y dimension falls within the specified range shown following the larger of the maximum allowable T dimensions.
4. If T is less than the minimum tabulated, pin motion after the beginning of collar swage is indicated, and the driven lockbolt should be rejected unless direct inspection establishes the fact that both pin head and collar are in intimate contact with the work.
5. Under any conditions, pin position must be such that Y falls within the limits tabulated under column Y.

Figure 57 Inspection Dimensions for Lockbolts



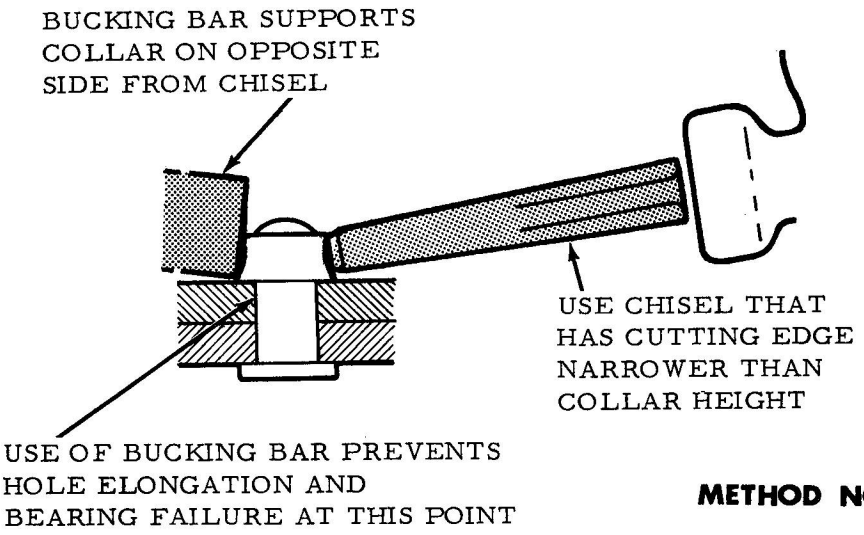
Diameter	Pin Material	A	W	H Maximum
3/16	Steel	.255 (±.043)	.298	.0595
	7075 Al.Aly.	.280 (±.043)		.0685
1/4	Steel	.330 (±.047)	.395	.0805
	7075 Al.Aly.	.353 (±.047)		.0745
5/16	Steel	.414 (±.031)	.487	.1075
	7075 Al.Aly.	.439 (±.041)	.500	.0655
3/8	Steel	.514 (±.031)	.590	.1575
	7075 Al.Aly.	.539 (±.044)		.1205

Figure 58 Inspection Dimensions for Lockbolt Stumps

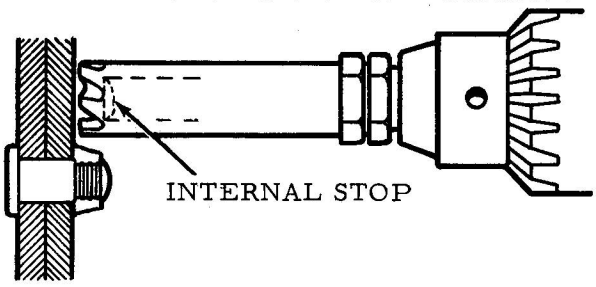
BLIND BOLTS

122 The blind bolt (Huck 'B' series) is a structural fastener similar in principle to the stem-lock type of self-plugging blind rivet.

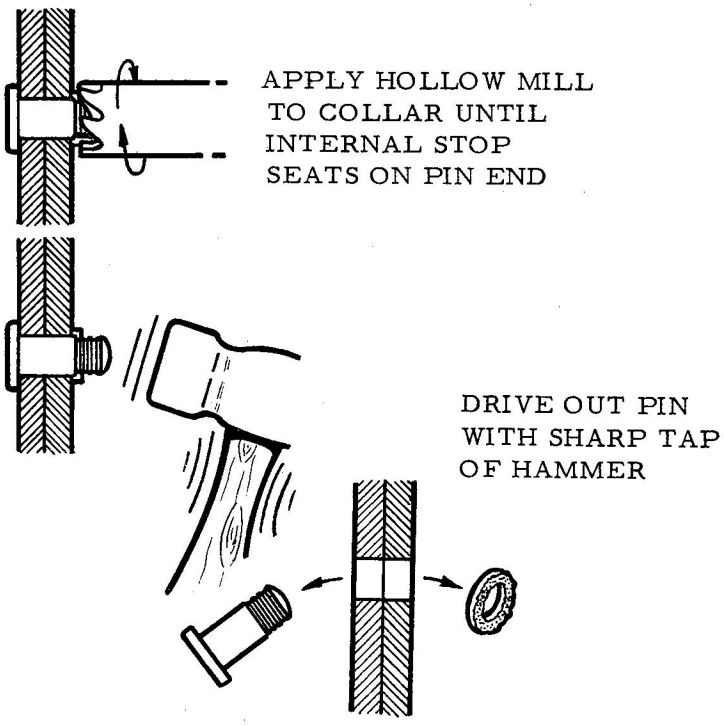
123 The application of Blind Bolts is similar to those of Blind Lockbolts. Installation is by means of a pull rivet gun. The stem is locked by a locking collar forced into the locking groove in the stem.



METHOD NO. 1



ADJUST INTERNAL STOP OF HOLLOW MILL TO PIN HEIGHT (JUST SHORT OF WORK SURFACE) AND INSERT HOLLOW MILL INTO DRILL MOTOR.



METHOD NO. 2

Figure 59 Lockbolt Removal

HI-SHEAR RIVETS

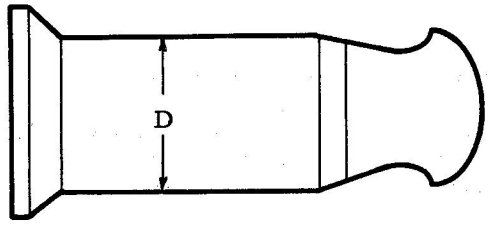
NOTE

Unless authorized in specific aircraft EOs, Hi-Shear rivets are not to be installed in the field but should be replaced with similar-sized AN bolts. Where spotfacing is required, approval must be obtained from the engineering authority. For the replacement of flush Hi-Shear rivets refer to EO 05-1-3/24.

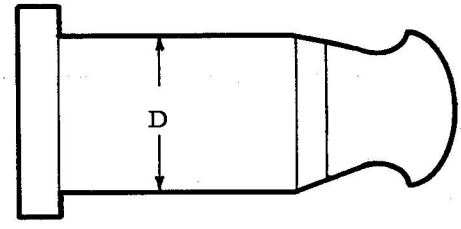
General

124 Hi-Shear rivets are close-tolerance fasteners used primarily for shear loads and permanent attachment only. The rivets are installed with riveting equipment requiring accessibility from both sides but are unlike ordinary rivets in other respects. The Hi-Shear rivet consists of two parts; a cadmium-plated alloy steel pin, heat treated to a tensile strength of 160,000 to 180,000 pounds per square inch, with a head on one end, and a groove at the other, and an aluminum alloy retaining collar. Only the collar is upset during installation, being forced into the groove on the pin by axial pressure from a special tool which simultaneously gives the collar its conical shape and trims and ejects the excess collar material.

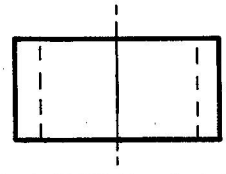
125 As the pin does not swell during assembly, continuous support is not needed. Thus, hollow sections which are sufficiently rigid to withstand the axial pressure of the collar-upsetting operation may be successfully riveted.



NAS 1055
100° CSK Head (Al.Aly.)



NAS 1054
Flat Head (Al.Aly.)



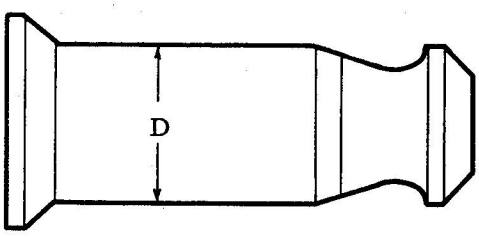
Collar — NAS 179 (Al.Aly. 2117-T4) or NAS 528 (Al.Aly. 2024-T4)

First Dash No.	4	5	6	8	10	12
Nominal Diameter	1/8	5/32	3/16	1/4	5/16	3/8
Diameter 'D'	.1240 .1215	.1560 .1535	.1895 .1870	.2495 .2470	.3120 .3095	.3745 .3720

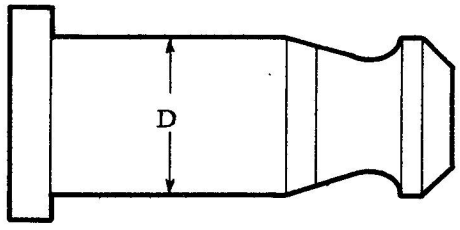
EXAMPLE: NAS 1055 - 8 - 8

- 8 (last): Maximum grip in 1/16 inch (Range = 1/16 inch) Available in grip capacity up to 4 inches.
- 8 (middle): Nom. Diameter in 1/32 inch. (See Table)
- NAS 1055: Rivet Type: 1054 = Flat Head; 1055 = 100° CSK

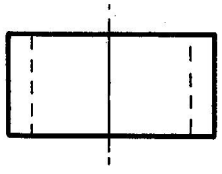
Figure 60 Hi-Shear Close-Tolerance Rivets - Types and Part Numbers



NAS 1906 - 1916
100° CSK Head



NAS 1806 - 1816
Flat Head



Collar — NAS 179 (Al.Aly. 2117-T4) or NAS 528 (Al.Aly. 2024-T4)

Part No.	Nom.Dia.	D	Collar Part No.
NAS 1806	3/16	0.1895	NAS 528
NAS 1906		0.1890	
NAS 1808	1/4	0.2495	
NAS 1908		0.2490	
NAS 1810	5/16	0.3120	
NAS 1910		0.3115	
NAS 1812	3/8	0.3745	
NAS 1912		0.3740	
NAS 1814	7/16	0.4370	NAS 179
NAS 1914		0.4365	
NAS 1816	1/2	0.4995	
NAS 1916		0.4990	

Dash number of rivet indicates Max.Grip in 1/16 inch .
Dash number of collar indicates nominal bore diameter (same as nominal diameter of mating rivet) in 1/32 inch .

Figure 61 Titanium Hi-Shear Rivets - Types and Part Numbers

Titanium Hi-Shear Rivets

126 A series of interference fit, precision Hi-Shear rivets is available in Titanium alloy, with standard flat head or 100° Countersunk head. The available range or nominal diameters is shown in Figure 61.

Part Number Identification

127 The first dash number indicates nominal diameter in 1/32 inch, the second dash number indicates maximum grip in 1/16 inch. The collar dash number is the same as the pin dash number for a given nominal diameter. Collars are one length only for each diameter. See Figures 60 and 61.

Rivet Selection

128 For selection and grip length, determine the proper length rivet by the rivet part number or by trial. In determining the length by trial, the straight portion of the shank should be flush or extend up to 1/16 inch from the work, see Figure 62. Use a washer only if correct length pin is not available.

Dimpling or Countersinking

129 For limitations on dimpling and countersinking, see Figures 63, 64 and 65.

Spotfacing

130 Collars may be formed against an angular surface not more than 7° from perpendicular with the axis of the hole, and a curved surface of radius not less than three times the pin diameter, without requiring spotfacing (see Figure 66). The manufactured head should be seated on a surface normal to the axis of the hole.

Tool Clearances

131 Minimum clearance for driving Hi-Shear rivets are shown in Figure 67.

Installation

CAUTION

Do not rework the ends or internal surfaces of Hi-Shear rivet sets.

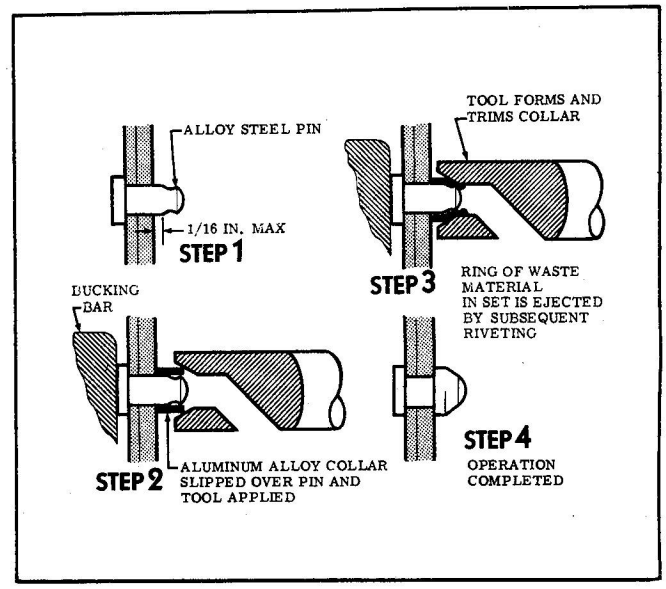


Figure 62 Hi-Shear Riveting

Hi-Shear Rivet Size	Countersink	Sub-Countersink
3/16	.063	.071
1/4	.071	.080
5/16	.080	.090
3/8	.090	
7/16		
1/2		

Figure 63 Minimum Material Thickness for Countersinking for Hi-Shear Rivets

		Thickness		
		Milled	Titanium	
Hi-Shear Rivet Size	Aluminum Alloy	Al. Alloy Clad on Top	Pure AMS 4900 4901	Alloy AMS 4908
3/16	.020	.032	.016	.025
1/4	.025	.040	.016	.025
5/16	.032	.050		

Figure 64 Minimum Material Thickness for Dimpling for Hi-Shear Rivets

Hi-Shear Rivet Size	Aluminum Alloy	Stationary Squeezer				Portable Squeezer		
		Corrosion Resistant Steel		Titanium		Corrosion Resistant Steel		
		Annealed	1/2 Hard	Pure AMS4900 AMS4901	Alloy AMS4908	Aluminum Alloy	Annealed	1/2 Hard
3/16	.081	.080	.080	.063	.063	.064	.050	.032
1/4	.091	.063	.050	.063	.063			
5/16	.091	.050	.050					

Figure 65 Maximum Material Thickness for Dimpling for Hi-Shear Rivets

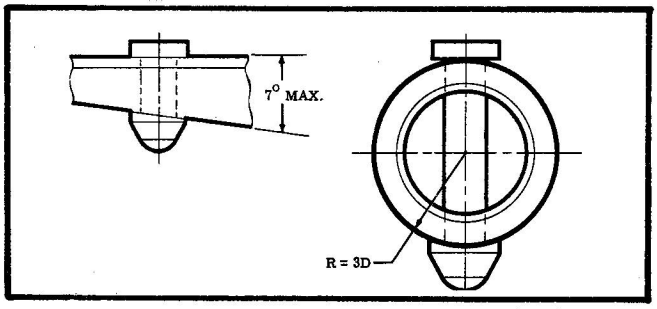


Figure 66 Limitations of Angular or Curved Surfaces

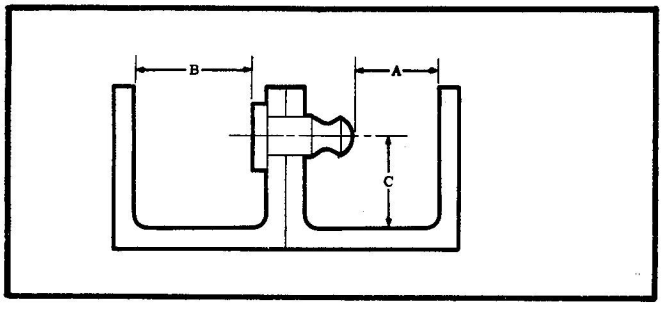


Figure 67 Clearances Required for Driving Hi-Shear Rivets

132 Hi-Shear rivet collars in the condition received automatically supply the internal lubrication to the rivet sets as they are driven. See Figure 62.

133 Where the retention of pins and collars during installation is difficult, use sealing compound to hold them in place. Ensure that the area where the compound is to be applied is free from all chips and dirt.

Riveting Inspection

134 Refer to Figure 68 for acceptable limits of swaging the collar.

INTERNAL-THREADED BLIND FASTENERS (JO-BOLTS)

Description

135 This type of fastener consists of an internally threaded, tubular rivet (the nut), threaded core with a head on the blind side (the screw) and a sleeve between the head of the screw and the tapered end of the nut.

136 On installation, (see Figure 69) the nut is held stationary, while the screw is driven (from the open side) into the nut. The head of the screw forces the sleeve over the tapered end of the nut, forming the blind head which pulls the sheets together. The protruding end of the screw is snapped off by the installation tool after the screw is fully driven.

CAUTION

Do not use in locations where bolt or nut portions, in event of looseness, could fall or be drawn into engine intake.

Rivet Types

137 Three head styles are available for internal-threaded fasteners:-

(a) Protruding (Hexagonal) Head.
(b) 100° Countersunk (Flush) Head.
(c) 100° Countersunk (Millable) Head.

138 The protruding head configuration is available in either general purpose type maximum temperature 450°F (NAS1669), high temperature (1200°F) types, (NAS1671), or

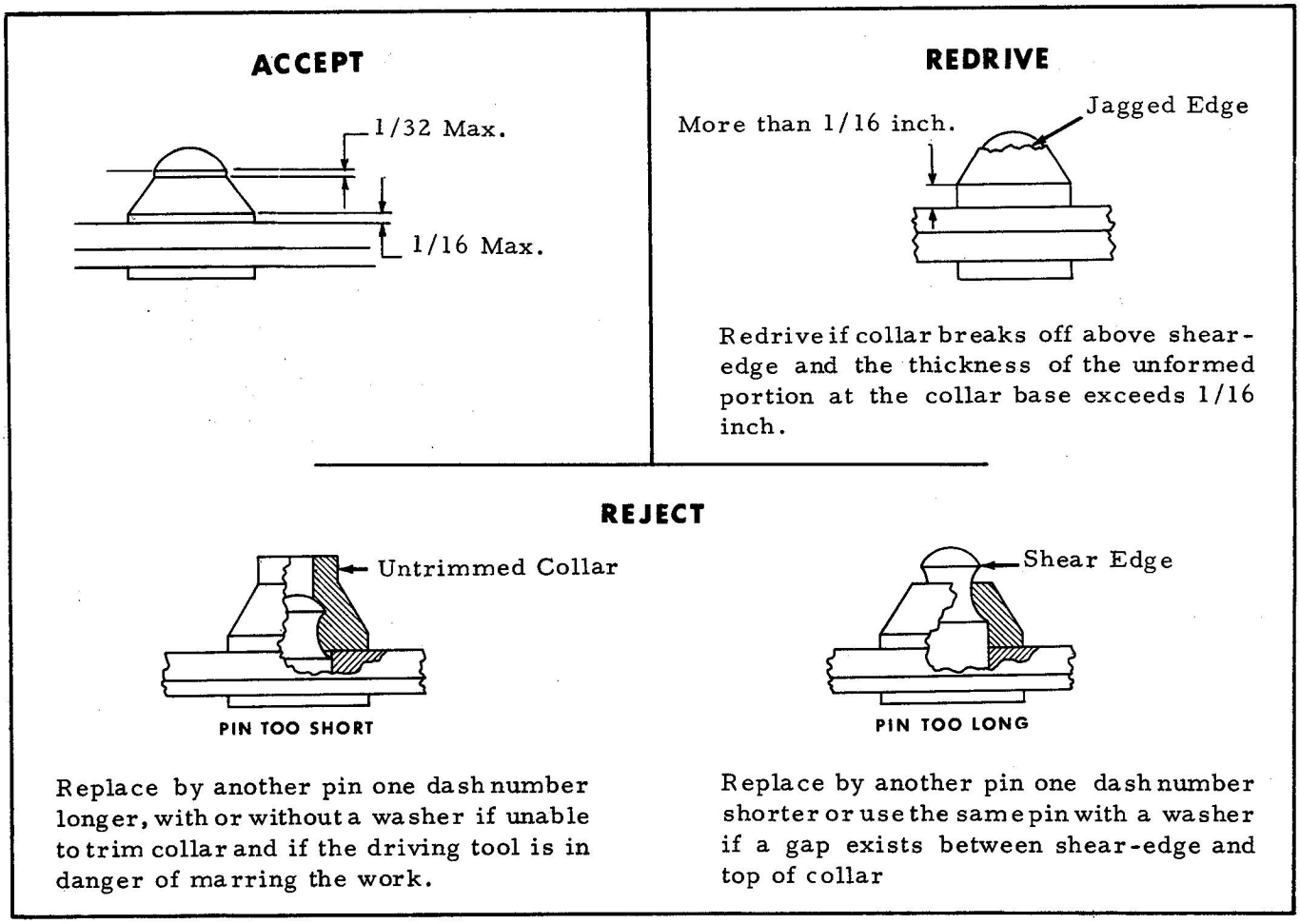


Figure 68 Acceptable Limits of Hi-Shear Rivet Swaging

light weight Al. Alloy types (NAS1673). The 100° Countersunk (Flush) head configuration is available in general purpose or high temperature types (NAS1670 and 1672 respectively). The 100° Countersunk (Millable) head configuration (NAS1674) is available in the light weight (Al. Alloy) only, and is limited to a maximum temperature of 250°F.

139 The nut, screw, and sleeve, for high-temperature applications, are heat-resistant steel. General purpose and light-weight fasteners have nuts of Alloy Steel and Alum. Alloy respectively, with screws of Alloy Steel and sleeves of Corrosion Resistant Steel.

Rivet Selection

140 Refer to Figure 69 for details of coding for type, size and grip range of internal-threaded blind fasteners.

141 For minimum allowable strengths, tensile and shear, see Figure 70.

Drilling and Countersinking

142 A pilot hole should be drilled, the plates dimpled or countersunk if applicable and the hole redrilled and reamed to suit fastener size (see Figure 71). Drill sizes for oversize fasteners are listed in Figure 72.

143 The limitations for spotfacing angular and curved surfaces are similar to those given for Hi-Shear rivets.

Installation

144 The use of a power screw driver (Ingersol Rand part OAINS-3, or equivalent) is recommended for the installation of internal-threaded blind fasteners. Alternatively, a hand ratchet driver (part H.T) may be used. A range of adapters and nose assemblies is available to adapt these tools to fasteners of various sizes and head configurations (see Figure 73).

145 For procedure, refer to Figure 74.

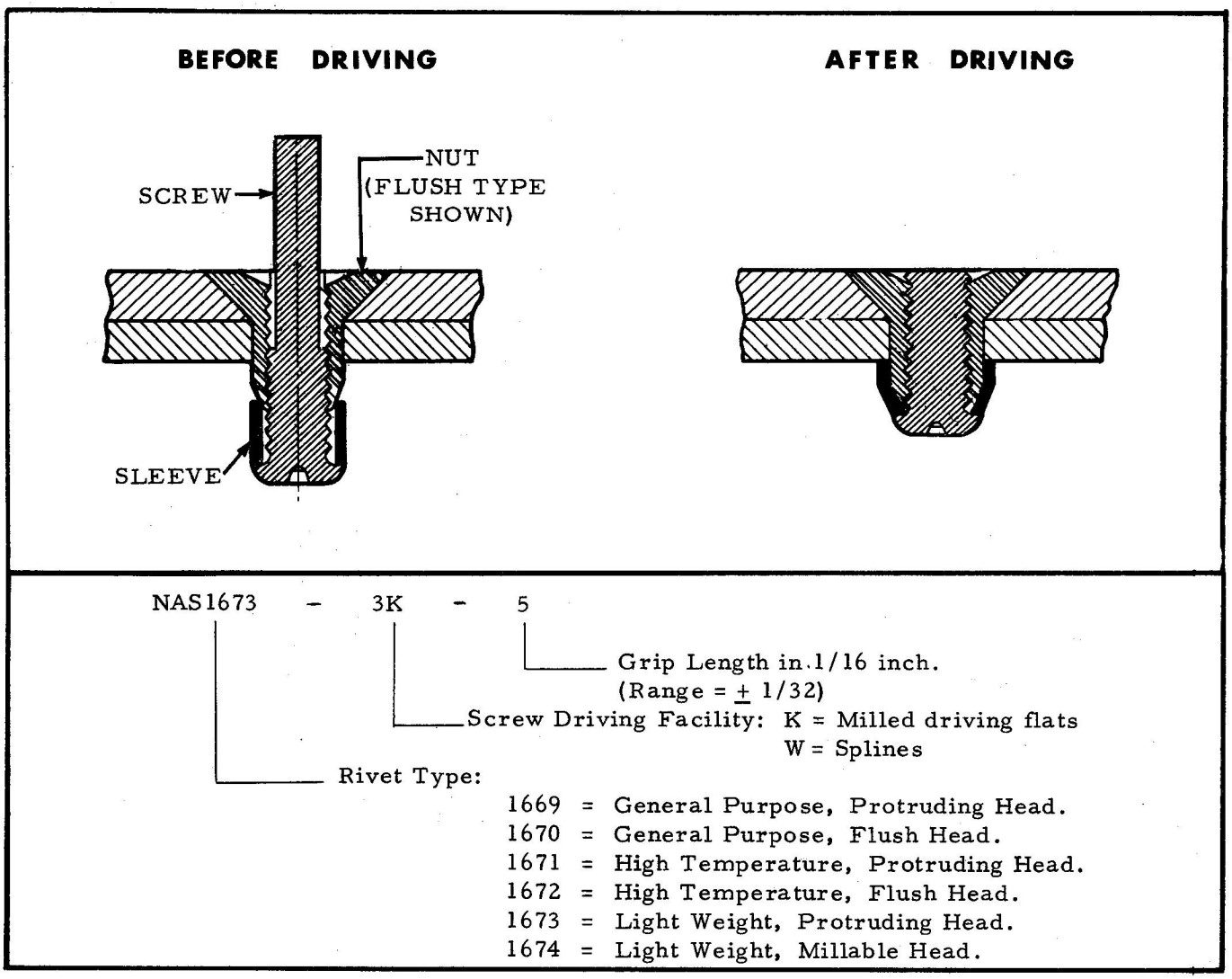


Figure 69 Internal-Threaded Blind Fasteners (Jo-Bolts)

	Double Shear Strength (Min.) Pounds			Tensile Strength (Min.) Pounds		
Fastener Size	General Purpose	High Temperature	Light Weight	General Purpose	High Temperature	Light Weight
08	3355	2700	1920	900	820	750
3	5240	4530	3100	1400	1400	950
4	9000	7200	5300	2100	2100	1500
5	12000	10350		3600	3600	
6	19500	15750		5600	5600	

Figure 70 Shear and Tensile Strengths of Internal-Threaded Blind Fasteners

Fastener Size	Nominal Diameter	Finished Hole Size ±.003-.000	Countersink Diameter	
			Millable Head	Flush Head
08	.164	.165	.270 to .280	.331 to .336
3	.200	.199	.325 to .335	.375 to .390
4	.260	.260	.450 to .460	.495 to .510
5	.312	.312		.623 to .638
6	.375	.375		.750 to .765

Figure 71 Drilling and Countersinking for Internal-Threaded Blind Fasteners

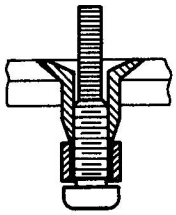
Nom. Size	Pre-drill	Finished Hole Size +.002 -.000	Countersink Dia. at 100°	
			Millable Head	Flush Head
-08	No. 20 (.161)	.180	.279 to .269	.336 to .331
-3	No. 7 (.201)	.215	.335 to .325	.390 to .375
-4	G (.261)	.276	.460 to .450	.510 to .495
-5	N (.302)	.327		.638 to .623
-6	U (.368)	.390		.765 to .750

Figure 72 Drill Sizes for Oversize Internal-Threaded Blind Fasteners

Nom. Dia.	Power Tool Adapter Ass'y	Hand Tool Adapter Ass'y	Nose Adapter	Wrench Adapter for Power Tool	Wrench Adapter for Hand Tools
#8	NSEM-164F NSEM-164FAPA NSEM-164P	NSHA-F164 NSHA-FAPA164 NSHA-P164	NS-F164 NS-PAFA-164 NS-P164	NS-164	NS-D-164
#10	NSEM-200F NSEM-200FAPA NSEM-200P	NSHA-F200 NSHA-FAPA200 NSHA-P200	NS-200 NS-PAFA200 NS-P200	NS-200	NS-D-200
1/4	NSEM-260F NSEM-260FAPA NSEM-260P	NSHA-F260 NSHA-FAPA260 NSHA-P260	NS-F260 NS-PAFA260 NS-P260	NS-260	NS-D-260
5/16	NSEM-312F NSEM-312P	NSHA-F312 NSHA-P312	NS-F312 NS-P312	NS-312	NS-D-312
3/8	NSEM-375F NSEM-375P	NSHA-F-312 NSHA-P-375	NS-F375 NS-P375	NS-375	NS-D-375

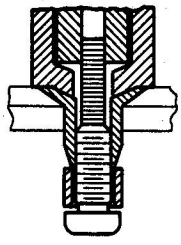
Figure 73 Nose Assemblies & Adapters for Installation of Internal-Threaded Blind Fasteners

STEP 1



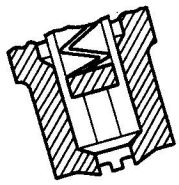
Fastener assembly of proper grip length is inserted in hole drilled through members to be joined. It can be pushed through the properly prepared hole with ease prior to driving.

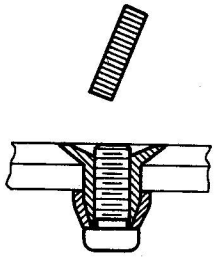
STEP 2



Nose adapter of pneumatic power tool (or special hand wrench) now engages nut as well as slabbed portion of bolt shank. Alternative method in overhead work: engage nut and slabbed shank in nose adapter first, and insert fastener in hole by upward pressure with the tool.

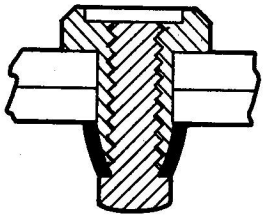
STEP 3





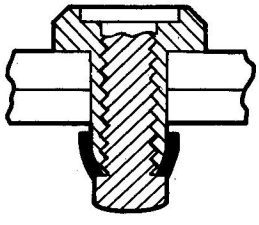
Power is turned on. Bolt is wrenched while nut is held. Sleeve, compressed between bolt head and conical end of nut, is drawn over the taper. Sleeve is expanded, forms a head that grips the mating surface of the member being joined. Positive sheet clamp-up is simultaneously effected. Power tool snaps off and ejects slabbed portion of bolt shank as soon as the fastener is fully driven, leaving the nut flush with the surface of the work when employing the flush head type.

Figure 74 Installation of Internal-Threaded Blind Fasteners

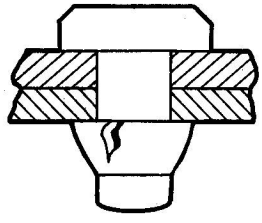


Properly Formed Blind Head

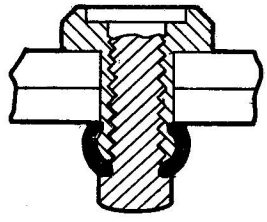
ACCEPTABLE



Sleeve Not Pulled Up To Material



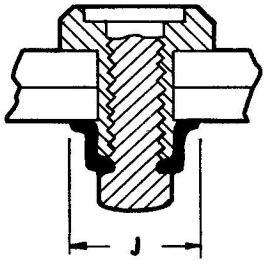
Split Sleeve



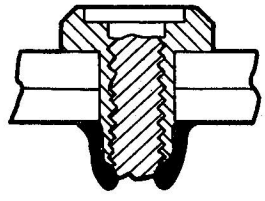
Buckled Sleeve

NOT ACCEPTABLE

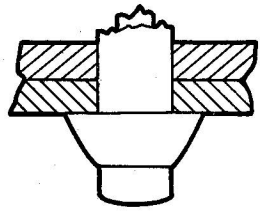
Fastener Size	J Max.
08	.244
3	.300
4	.384
5	.427
6	.516



Flared Sleeve (Not Acceptable Beyond Limits Shown in Table)



Screw Head Failure



Nut Head Failure

Figure 75 Visual Inspection of Installed Internal-Threaded Blind Fasteners

Inspection of Riveting

146 Where visual examination of the blind head is possible, refer to Figure 75 for illustrations of unacceptable conditions compared with a correctly formed head.

147 For determination of adequate formation of blind head by measurement from the open side, refer to Figure 76.

Removal

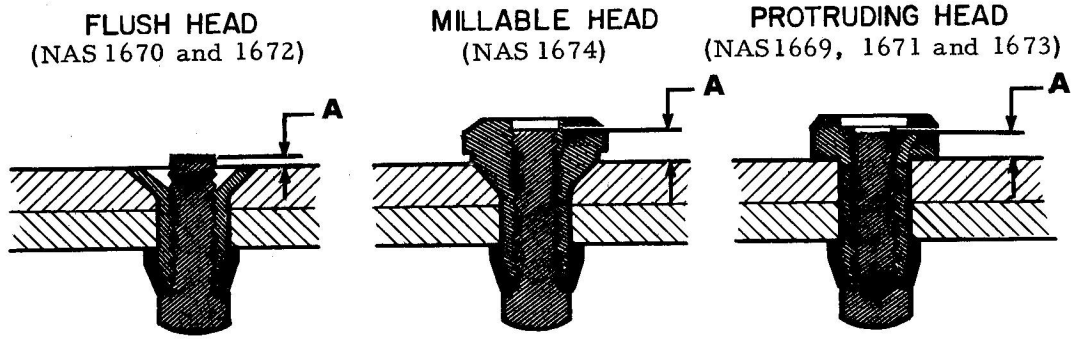
148 The procedure for removing Internal-Threaded Blind Rivets is detailed on Figure 77.

GENERAL PURPOSE FASTENERS

BLIND RIVET NUTS (NAS1329 & NAS1330)

General

148 These are internally-threaded, counterbored tubular rivets which can be blind-headed. They are available in flat head (NAS1329) and 100° Countersunk head (NAS1330) keyed or unkeyed, with open or closed ends. Whenever possible, the keyed type rivet nut is to be employed in preference to the unkeyed type. For types and part number designation see Figure 78.



Measured from top of head of nut.

Measured from skin surface

Measured from skin surface

Fastener Size	Torque Values Inch Lbs.	Dimension 'A' (See Note)					
		General Purpose		High Temperature		Light Weight	
		Flush	Prot.	Flush	Prot.	Millable	Prot.
08	4	+.020 -.068	+.000 +.088	+.082 -.006	+.000 +.088	+.000 +.088	+.000 +.088
3	6	+.015 -.073	+.010 +.098	+.072 -.016	+.015 +.103	+.010 +.098	+.015 +.103
4	10	+.010 -.078	+.047 +.135	+.072 -.026	+.032 +.130	+.010 +.098	+.047 +.135
5	20	+.010 -.083	+.043 +.146	+.072 -.031	+.027 +.130		
6	30	+.010 -.093	+.049 +.152	+.072 -.031	+.027 +.130		

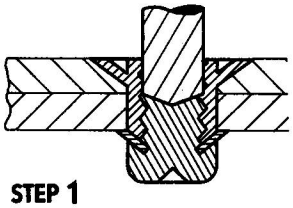
NOTE: Plus (+) A dimension indicates screw end projection above the plane of reference.
Minus (-) A dimension indicates screw end recess below the plane of reference.

Figure 76 Dimensional Check of Installed Internal-Threaded Blind Fasteners

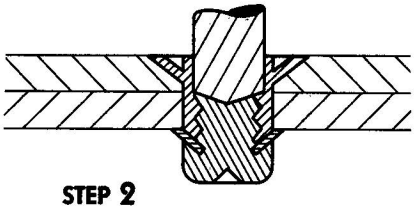
1	Fastener Size	-08	-3	-4	-5	-6
2	Drill Size	No.42 (.094)	No.35 (.110)	No.24 (.152)	No.17 (.173)	No.5 (.206)
3	Drill Size	No.23 (.154)	No.12 (.189)	D (.246)	M (.295)	23/64(.359)

NOTE: Drill speed not to exceed 500 r.p.m.

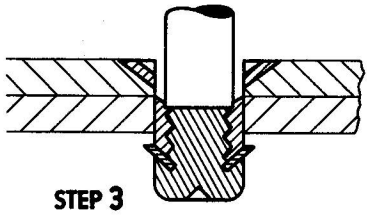
A. FASTENER CLAMPED UP BUT OUT OF GRIP RANGE



Select drill in accordance with Column 3, drill to depth of pilot hole.

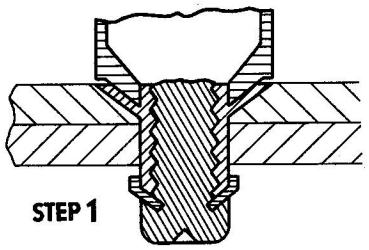


Select drill in accordance with Column 2, drill to below head-shank juncture.

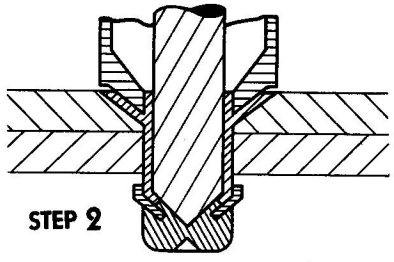


With hammer and nominal size punch, sever head and drive out shank and blind head.

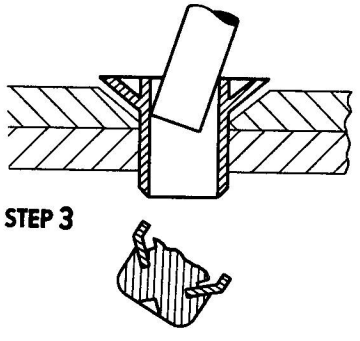
B. FASTENER TOO LONG BUT NOT CLAMPED UP



Prevent nut from turning by engaging driving tool nose adapter. Hold nose adapter with hand tool handle or vise grip pliers.

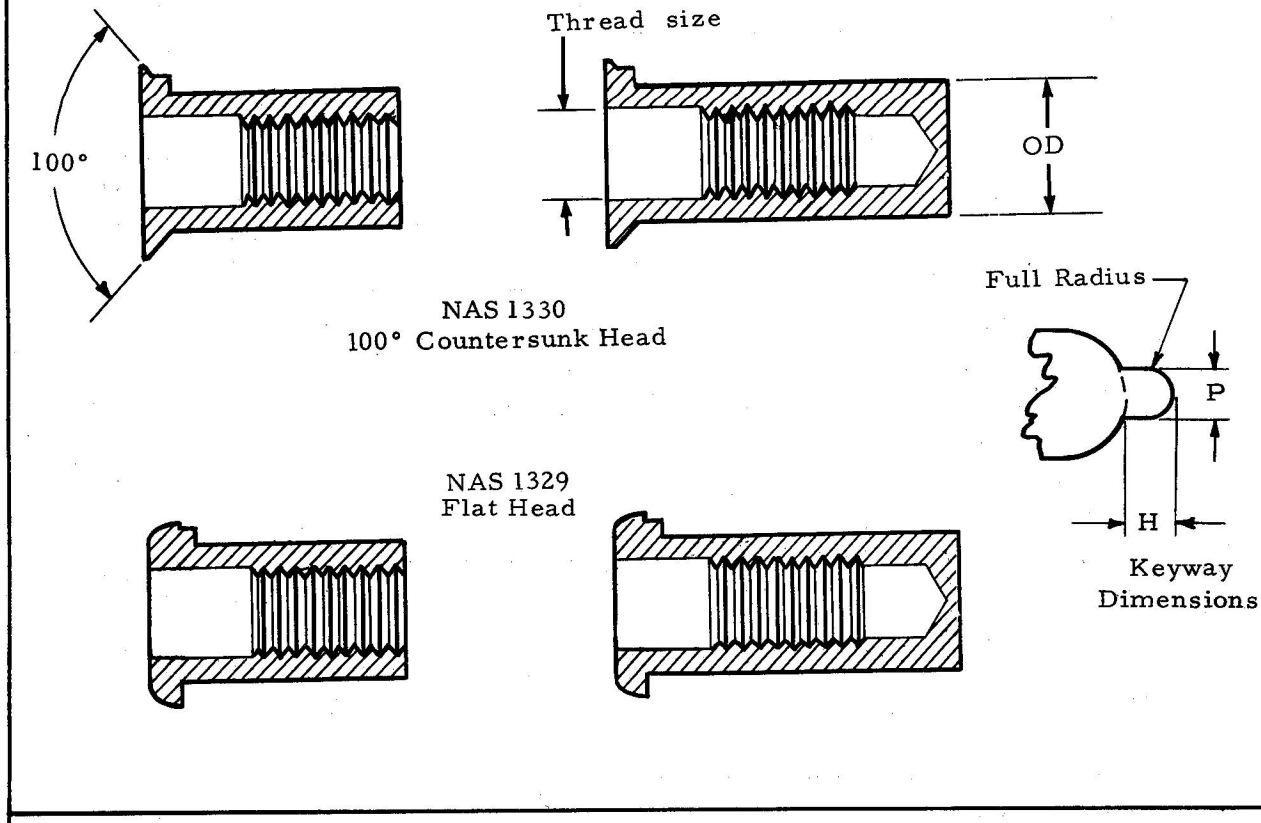


Select drill in accordance with Column 2, drill through shank, severing bolthead.



Pick nut out of hole with punch.

Figure 77 Removal of Internal-Threaded Blind Fasteners



NAS 1329 A 3 K 130

- 130 — Max. grip in .001 inch. (Range = .050 inch)
- K — Type of End: 'K' = Keyed Open End; 'B' = Keyless Closed End; 'KB' = Keyed Closed End; 'No Symbol' = Keyless Open End
- 3 — Internal Thread: '3' = 10 - 32 UNF
- A — Material: 'A' = Aluminum Alloy; 'S' = Steel; 'C' = Corrosion Resistant Steel
- NAS 1329 — Blind Rivet Nut & Head Style '1329' = Flat Head; '1330' = Countersunk Head

Thread Code	Grip Ranges	
	NAS 1329	NAS 1330
-04	-60, -85, -110, -135, -160.	-81, -106, -131, -156, -181.
-06	-75, -120, -160, -200, -240.	-106, -161, -201, -241, -281.
-08	-75, -120, -160, -200, -240.	-106, -161, -201, -241, -281.
-3	-80, -130, -180, -230, -280.	-116, -166, -216, -266, -316.
-4	-80, -140, -200, -260, -320.	-151, -211, -271, -331, -391.
-5	-125, -200, -275, -350.	-181, -256, -331, -406.
-6	-115, -200, -285, -370.	-211, -296, -381, -466.
-8	-145, -265, -385, -505.	-276, -396, -516, -636.

Figure 78 Blind Rivet Nuts

			Drill & Countersink Dims.			Keyway Dimensions	
Thread Size	Coding	Nominal O.D.	Lead Drill	Finish Drill Recomm.	C'Sink Dia.	P +.003 -.000	H
#4-40	04	.155	29 (.136)	5/32 (.156)	.263	.062	.046 to .048
#6-32	06	.189	19 (.166)	12 (.189)	.323	.062	.056 to .058
#8-32	08	.221	8 (.199)	2 (.221)	.355	.062	.056 to .058
#10-32	-3	.250	1 (.228)	1/4 (.250)	.391	.062	.056 to .058
1/4-28	-4	.332	N (.302)	Q (.332)	.529	.062	.097 to .102
5/16-24	-5	.413	3/8 (.375)	Z (.413)	.656	.128	.110 to .115
3/8-24	37	.490	15/32 (.469)	1/2 (.500)	.770	.128	
1/2-20	50	.640	19/32 (.594)	41/64 (.641)	.990	.159	.135 to .140

Figure 79 Drill Sizes for Blind Rivet Nuts

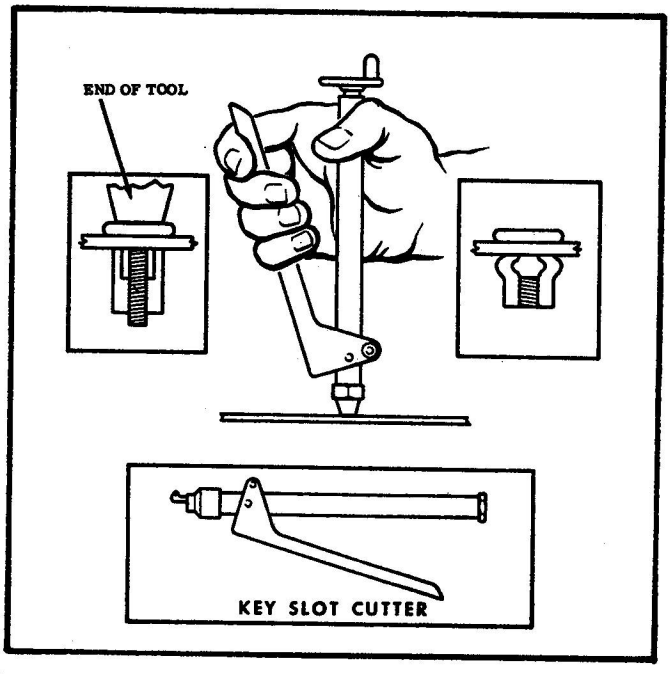


Figure 80 Installation of Blind Rivet Nuts

149 Clearance on the blind side must be sufficient to allow the manufactured head to seat correctly on (or into) the material to be riveted. The closed end type will require up to 50% more clearance than the open end type.

Drilling and Countersinking

150 Drill and countersink sizes together with the keyway dimensions for blind rivet nuts are given in Figure 79.

151 A special tool is available (see Figure 80) for cutting the keyway in the sheet.

Installation

152 Both pneumatic and hand operated tools are used for installation of rivet nuts. Similar tools are available for straight heading and also for heading performed at angles of 45° and 90° to the head of the rivet nut. When using the hand tool, hand thread the rivet nut on the mandrel until the head rests against the anvil of the heading tool. It is important that the mandrel (screw) be at a 90° angle to the surface of the sheet at all times. Unless both of these points are observed, the rivet nut will be easily bent or broken. After threading the rivet nut on the mandrel, position it in the work and upset by slowly drawing the handles together until solid resistance is felt. Excessive pressure (such as two-handed operation) beyond this point is unnecessary and may strip the threads.