AP101A-1401-1

(Superseding AP1464B, Vol. 1, Part 2, Sect. 4, Chap. 8 and Sect. 6, Chap. 10)

RIVETING PROCESSES USED ON AIRCRAFT, IDENTIFICATION OF RIVETS AND JO-BOLTS

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

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Chapter 1

RIVETING PROCESSES USED ON AIRCRAFT

CONTENTS

Introduction

1 This chapter describes briefly the processes used in aircraft riveting. Reference should be made to Chapter 2 of this publication for information on the identification and coding of aircraft rivets. In addition to the riveting processes, this chapter gives suggestions on the choise of use of tools,

and includes an outline of the methods which may be employed to minimise and distribute creep in sheet riveting.

2 This chapter refers in general to the use of rivets, materials and tools manufactured to imperial measurements. To enable the general information to be applied to items manufactured to metric measurements, the following conversion tables are included at the end of this chapter:-

Table 13 - Standard wire gauge to inches and millimetres

Table 14 - Twist drill sizes

Table 15 - Fractions of an inch to decimals of an inch and millimetres

General

3 In the construction of metal airframe structure, the majority of permanent joints are made with either rivets or bolts. To securely attach faying surfaces together, rivets are cheaper to use, are lighter and more rapidly fastened than nuts and bolts but, as in the case of power-operated machine riveting, more extensive equipment is usually required to effect the permanent joints.

4 The trend of using bolts instead of rivets to secure permanent joints is, while being used as an alternative to rivets in repair work when necessary, mainly employed in bolting together skin plating and other highly stressed structures such as main plane spar root ends and attachment points, undercarriage main retraction sections and built-up sections in engine bays.

5 The extensive use of rivets has enabled the manufacturers to standardize rivet design to ensure that, for a given type of metal airframe structure, the required type and size of rivet is readily available for assembly work. Rivets are always supplied to the operator with one head already formed and the shank bare to permit insertion into the rivet hole, the opposite end being formed into a head by manual or mechanical tools.

6 The types of rivets to be used in repair work will vary with the nature of the repair, but they will always be specified in the appropriate repair scheme, either in this publication or in the relevant aircraft Vol. 6.

RIVET MATERIALS

7 Rivets are made in a variety of materials, the most common of which are the aluminium alloys, but steel, tungum, monel, nickel alloy, and copper are also used.

8 Duralumin to BS.L37 is extensively used for solid rivets because of its strength when it becomes age hardened, but such rivets cannot be used until they have been solution treated; the rivet heads are liable to fracture if the rivets are used in the untreated condition. The heat treatment procedure for rivets in BS.L37 material is to heat them uniformly in a salt bath or muffle furnace to a temperature of 495 ± 5 deg.C; then quench in water at a temperature not exceeding 40 deg.C. Once the rivets have been solution treated, they must be used within two hours at most, but preferably within one hour; the earlier the rivets are used, the more easily are they placed. The ageing of normalized rivets can be suppressed by refrigeration as shown in Table 1, but the procedure to ensure that they have not age hardened needs careful control. Failures have occurred in service because rivets have been used accidentally in the annealed condition in which they are delivered.

TABLE 1 REFRIGERATION OF NORMALIZED RIVETS

Temperature (deg.C)	Maximum storage (hr)
0 to -5	45
-15 to -20	150

9 Aluminium alloy rivets to BS.L58 (formerly DTD.303) do not require heat treatment, but they are not as strong as duralumin rivets and are subject to electrolytic corrosion under certain conditions, especially on external surfaces which are left unpainted, or if used in material other than magnesium alloy.

▶10 Rivets made of aluminium alloy to BS.L86 are almost as strong as duralumin rivets and do not require heat treatment. BS.L86 is the metal most commonly used for rivets in aluminium alloy structures, but it is not suitable for use with magnesium alloy as, even when barium chromate jointing compound is used, there is a danger of inter-metallic corrosion; for magnesium alloy components, the risk of corrosion is considerably decreased if rivets made of aluminium alloy to BS.L58 are used, (see para. 12 CAUTION). ◀

Aluminium and aluminium alloy

11 A list of the aluminium and aluminium alloy solid rivets classified under their materials is given in Table 2.

Interchangeability

12 In instances where aluminium alloy rivets BS.L58 are not available, ▶aluminium alloy rivets to BS.L86 or duralumin rivets to BS.L37 may be used ◀ in lieu; but if rivets to BS.L37 are used, even as substitutes for rivets of a lower quality, they must be heat treated.

CAUTION ...

▶ Aluminium alloy rivets to BS.L86 or duralumin rivets to BS.L37 must not be used for the riveting of magnesium-rich materials, as there is a danger of inter-metallic corrosion. ◀

Mild steel and miscellaneous

13 A list of the mild steel and miscellaneous solid rivets classified under their materials is given in Table 3.

RELATIVE STRENGTH OF VARIOUS RIVETS

14 Solid rivets have the greatest strength and are therefore preferable, but they can only be used for repair work where there is access to both sides of the structure undergoing repair. Where only one side of the structure is accessible, hollow rivets, which are of an approved type but are of less strength than solid rivets, should be fitted if authorized in the relevant aircraft Vol. 6. If hollow rivets are not authorized, a suitable access

TABLE 2 DETAILS OF ALUMINIUM AND ALUMINIUM ALLOY SOLID RIVETS

Material of rivet	Material spec.	Minimum tensile strength		Ident colour	Ident marking on hd or tail of rivet	AS drg No.	Heat treatment required
		ton f/in^2	h bar				
Aluminium	BS.L36	7	11	Black	Dimple or letter 'A'	155-snap head 160-90° csk.hd. 160-120° csk.hd.	None
Aluminium alloy (MG.5)	BS.L58 (DTD 303)	16	25	Green	Letter 'X'	157-snap head 159-mushroom head 162-90° csk.hd. 165-120° csk.hd.	None
▶ Aluminium alloy	BS.L 86	17	26	Violet	Letter 'S'	2227-snap head 2228-mushroom head 2229-90° csk.hd. 2230-120° csk.hd.	None ◀
Duralumin	BS.L37	25	39	None	Letter 'D'	156-snap head 158-mushroom head 161-90° csk.hd. 164-120° csk.hd.	AP1464B Vol.2 Lft.3W

hole must be made in the structure to enable the required type of rivet to be fitted. The hole must be positioned so that access is available for its repair after the completion of the riveting operations.

TABLE 3 DETAILS OF MILD STEEL AND MISCELLANEOUS SOLID RIVETS

Material of rivet	Material spec.	Minimum tensile strength		Finish	AS No.	Heat treatment
		ton f/in^2	h bar			
Mild steel	BS.1109	20	31	Cadmium plated	455-snap head 460-90° csk.hd. 463-120° csk.hd.	None
Monel	DTD 204A	35	54	Cadmium plated	457-snap head 462-90° csk.hd. 465-120° csk.hd.	None
Tungum	DTD 367	28	43	None	458-snap head 466-90° csk.hd. 468-120° csk.hd.	None
Copper	-	14	22	None	459-snap head 467-90° csk.hd. 469-flat head	None

15 In the repair of secondary and tertiary structures, alternative rivets to those called for in the repair schemes given in the relevant aircraft Vol.6, may be used at the discretion of the Senior Engineering Officer. They must never be used however, in the repair of primary structure, unless authorized in the Vol. 6 or by the manufacturer's stress department.

16 The strengths of the rivets vary according to their size, type of head and the material from which they are made. Given equality in size and material, snap-head rivets are the strongest. The next strongest are those with a mushroom head; they have good holding down properties and are generally used on external skinning where a flush surface is not essential. Countersunk-head rivets, although weaker than the snap and mushroom-head rivets, are used extensively to achieve the required flush external jointing and finish vitally important to aerodynamic cleanliness and aircraft performance.

17 Normally, 100 or 120 deg. countersunk-head rivets are used in production and repair work in light-gauge skinning. The 90 deg. type of head is used for improved flush finish in heavier gauge materials. Rivets with a 60 deg. countersunk-head are occasionally used in very heavy gauge material where a dead-smooth surface is necessary.

18 The relative strength of the various types of rivet head is very difficult to assess, because so much depends on the thickness of the sheet being riveted. If the sheet thickness is less than a quarter of the nominal diameter of the

rivet, for example, an $\frac{1}{8}$ in diameter rivet in 22 s.w.g. sheet, then a good rivet head is important; if, however, the sheet is thicker than $\frac{1}{4}$D (where D is the nominal diameter of the rivet), the size and shape of the rivet head are relatively unimportant.

19 When the sheet thickness is less than $\frac{1}{4}$D a snap-head rivet is about 6 per cent stronger in shear and tension than a mushroom-head rivet, while a standard countersunk-head rivet is about 15 to 20 per cent weaker than a mushroom-head, though this is partly due to the sheet being cut away to form the countersink.

RIVET SIZES FOR SHEET GAUGES

20 The diameter of rivets used in aircraft construction and repair are determined by the constructor's design staff from the relative strengths of the rivets and the metal to be joined, the required length of the rivets being governed by the thickness of the structure to be riveted. The approximate relationships between rivet size and sheet gauge are as shown in Table 4. Although it is sometimes necessary to fit rivets of $\frac{3}{8}$ in diameter, the range of rivet sizes reference in AP 1086 does not usually exceed $\frac{1}{4}$ in diameter. Where special large-diameter rivets are required for replacing similar rivets in repair work, they will be referenced in the relevant aircraft Vol. 6 together with information on the tools required for fitting them, according to the type of repair in hand.

TABLE 4 RIVET SIZE FOR VARIOUS SHEET GAUGE THICKNESS

SWG	Minimum size rivet dia (in)
22	3/32
20	1/8
18	5/32
16	3/16
14	7/32
12	1/4
10	5/16

Rivet lengths

21 The length of any rivet required for repair work is governed not only by its diameter and the gauge of the metal surfaces to be joined, but also by the amount of shank required to form the second head. The last factor is called the allowance and is the length of shank, protruding through the metal surface, which is to be formed into the head and is always calculated as so many times D, where D equals the diameter of the rivet. If a rivet is too long, it must be cut off and filed square to leave the correct allowance as shown in Table 5.

Note ...

Before selecting the type and length of rivet required for repair work, the thickness of the metal surfaces to be joined, plus the allowance on the rivet shank, should always be accurately calculated to obviate the necessity for shortening the length of rivet. When the calculation indicates that the length of a rivet is within the range given in AP 1086, Sect. 28Q, it may be fitted in the rivet holes and closed without filing or cutting the shank to the correct length.

TABLE 5 RIVET ALLOWANCES ON SHANK LENGTH

Type of head to be formed	Rivet material	Allowance (in inches)	Remarks
Snap	Low tensile steel	1.6D	-
Snap	Light alloy	1.7D	Larger allowance due to greater clearance
Flat, reaction	Light alloy		Refer to para. 26 et seq.
Counter-sunk	All materials	0.6 to 0.75 D	-
Tubular	All materials	0.5D	0.75 D if the head is to be 'spun'

RIVETING PROCESSES

General

22 The following paragraphs outline the various methods of riveting used on aircraft. Broadly speaking, riveting processes fall into two classes of work: first, where the components are accessible to the operators from both sides, and second, where the components are accessible from one side only. Such methods as the ordinary snap and dolly riveting, reaction riveting, and squeeze riveting fall into the first class, while the various blind riveting processes and plug riveting come under the second class.

Marking out

23 Except for outlines, which may be marked with scribers, all marking out on all alloys used for the repair of airframes is done with a graphite pencil. However, since graphite can cause galvanic corrosion, all traces of pencil line are to be removed when the repair is completed.

24 If it is necessary to delineate a defect such as a crack, where the marking has to remain for more than a few hours, a grease pencil of any colour except black (as this might contain carbon) is to be used.

Drilling

Method

25 When drilling through an assembly, the operator is liable to pitch

forward when the drill breaks through; this can be prevented if the drill is enclosed within a spring-loaded shield (fig. 1) which leaves only a short length of drill projecting and absorbs the shock. The shield saves drills and drilling time as the operator can push harder with safety; further time is saved when a drill template is used, as the holes in the template are countersunk and the end of the shield can be tapered to fit, so that drill insertion is simplified.

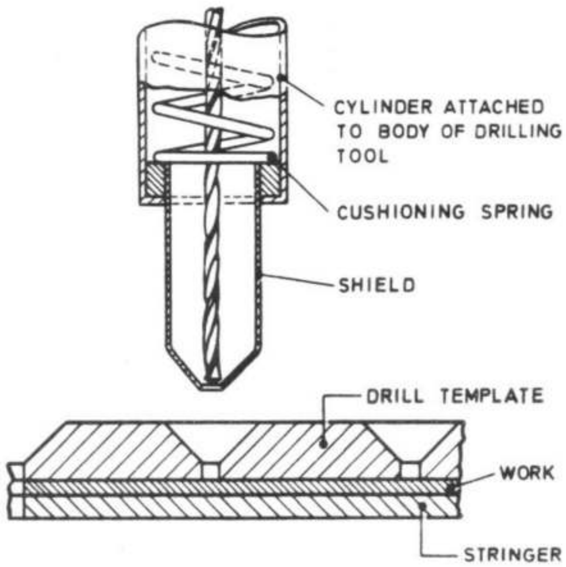

Fig. 1 Rapid drilling attachment

Drill sizes

26 If a drill template is not used, the positions of the holes are to be marked with a centre punch. The punch mark must be large enough to prevent drill slip yet not so deep that the surrounding sheet is distorted. All burrs must be removed and all swarf brushed from the sheet after the drilling operation is completed. In cases where it is not possible to remove burrs due to dismantling difficulties, it is important to ensure good clamp-up during the drilling operation. This mav be achieved by using service bolts, gripping pins or clamps as close to the side of the hole as possible. Any gap between plates will result in burrs.

27 Generally, rivet holes are drilled 0.08 to 0.13 mm (0.003 to 0.005 in) oversize. Reference is to be made to Table 6 for the average recommended drill sizes which can be used with all types of rivets, but there are many variations; for example, in pressure sealing, the sizes must be very much more carefully controlled, and on thin sheet which is drilled prior to dimpling, the holes are drilled undersize, that is, a 5/64 in drill is used for a 5/32 in rivet, a 3.00 mm drill for an 1/8 in rivet, and a 3.90 mm drill for a 5/32 in rivet.

Notes ...

(1) Table 6 gives only the average recommended drill sizes, and does not provide a definite ruling. For example, while Chobert rivets can be fitted satisfactorily in holes drilled in accordance with this table, they are more frequently fitted in holes made by a dead size drill, for

example, an $\frac{1}{8}$ in drill is used for an $\frac{1}{8}$ in dia rivet.

(2) If the correct size of drill as given in the table is not available, the next smaller size should be used.

28 If pilot holes are to be drilled, the recommended drill sizes to be used are given in Table 6.

TABLE 6 RECOMMENDED DRILL SIZES FOR RIVET HOLES AND PILOT HOLES

Rivet diameter (in)	Drill size	
	Pilot hole	Rivet hole
1/16	1.40 mm	1.70 mm
3/32	1.80 mm	2.50 mm
7/64 (pop rivet)	-	2.85 mm
1/8	2.50 mm	3.30 mm
5/32	2.50 mm	4.00 mm
3/16	3.30 mm	4.90 mm
0.2 (pop rivet)	-	5.20 mm
1/4	3.30 mm	6.50 mm
5/16	3.30 mm	8.00 mm
3/8	3.30 mm	9.80 mm

Note ...

When close-tolerance rivets are to be used in repair schemes, very careful drilling and reaming is necessary to ensure that the rivet holes do not exceed the tolerance specified in the relevant aircraft Vol. 6.

Reaming requirements

29 Reaming is required when installing some types of fastener, for example, close tolerance and over-size rivets, Hi-shear pins, Jo-bolts, etc., and also when specified in the aircraft Vol. 6. These reamers are usually special-to-type and are not available as standard equipment.

Countersinking

30 Holes for countersunk-head rivets must be either cut-countersunk or dimpled to receive the rivet head, according to the thickness of the metal sheet and the diameter of the rivet. The method which is generally used in each case is indicated in Table 7, although where the method given in a relevant aircraft Vol. 6 repair scheme is at variance with that shown in the Table, the method specified in the repair scheme must be effected.

Cut

31 Cut-countersinking is the process whereby a cone is machined in the sheet metal to fit the countersink on the rivet head; it is used on the leading edges of mainplane and wherever else a perfect flush finish is required. The process must not be employed on sheet of 22 s.w.g. or less, and may only be used on sheet of 20 and 18 s.w.g. where there is no

possibility of stress concentration or vibration; in these instances, the sheet should be dimpled or mushroom-head rivets should be used.

TABLE 7 APPLICATION OF CUT-COUNTERSINKING OR DIMPLING METHODS

Sheet metal gauge	Rivet diameter (in inches)				
	3/32	1/8	5/32	3/16	1/4
24 s.w.g. and thinner	D	D	D	D	-
22 s.w.g.	D	D	D	D	D
20 s.w.g.	D	D	D	D	D
18 s.w.g.	C	C	D	D	D
16 s.w.g. and thicker	C	C	C	C	C

Note ...
C = Cut-countersunk D = Dimple

32 Cut-countersinking does not distort the sheet and gives a smooth finish provided that the rivet heads are uniform and that the countersinking is correct. A stop should be used on the drill to ensure that the countersink is of the correct depth; the stop should not be large enough to conceal the point of the drill from the operator when it has been so inserted into the pilot hole, and should be prevented from rotating on the sheet. The drill should be fixed in the chuck of the machine to provide a countersink that fits the head of a rivet taken from the batch to be used; the heads of rivets vary more from batch to batch than within any one batch.

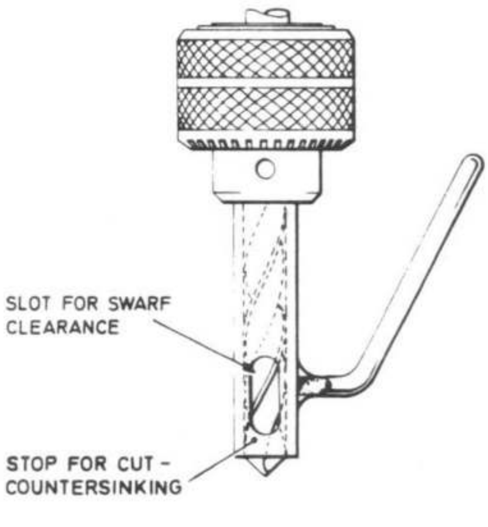

Fig. 2 Countersinking tool

33 A simple type of stop for cut-countersinking is shown in fig. 2; it consists of a short length of tube with a welded handle to prevent it from rotating. Fig. 3 shows a combined drill and countersink with a stop which does not conceal the point of the drill.

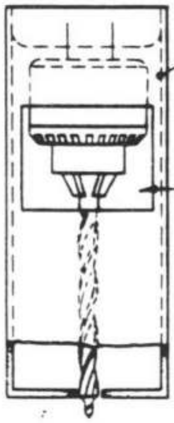

Fig. 3 Combined drill and countersinking tool

34 Cut-countersinking can be accurately carried out using the approved cut-countersinking tool sets. The Ref. No. 1C/6456 set contains an adjustable holder and eight cutters; four for 90 deg. countersinks and four 120 deg. countersinks. The Ref. No. 1C/7436 set contains an adjustable holder and four cutters for 100 deg. countersinks. The Ref. No. 1C/7575 set contains an adjustable holder and four cutters for 60 deg. countersinks. Each set covers hole sizes 3/32, 1/8, 5/32 and 5/16 in diameters. Twist drills ground to the correct angle may be used in non-critical areas, if the tool sets are not available. In all cases it is essential to ensure that the correct depth of countersink is achieved. Knife edges due to countersinking too deeply on thin skins, must be avoided.

Dimple

35 Sheet metal of less than 18 s.w.g. is usually dimpled to form the countersinks. A common method is to squeeze the rivet head into the sheet, the underside of which is supported by a cupped die which has a diameter slightly greater than that of the rivet head and is centred on the rivet shank. After a burst from a pneumatic hammer, the die is replaced by a flat reaction block (para. 48) and the rivet is set.

36 On 22 s.w.g. sheet metal it is possible to obtain a flush finish without the use of a die, if hammering is started just before the reaction block is applied. Neither of these dimpling methods, however, produces as flat a finish as countersinking.

37 A better finish than that produced by the above methods can be obtained if an accurately formed punch is used in the riveting dolly. The punch should have a deeper taper than the rivet head (for example, about 115 deg. for a 120 deg. countersunk head) to compensate for the resilience of the sheet. The die should be relatively heavy and should have a cup formed in it of the same taper as that of the punch.

38 If the part to which the sheet is to be riveted is comparatively thick, it may be countersunk and the sheet dimpled into it. Where the necessary equipment is available, the sheet may be removed after the drilling operation and a press used for dimpling.

39 Dimpling of sheet metal may be effected by hand tools referenced as:- Tools, dimpling,male Ref. No. 1C/7027 and female 1C/7028 and 7029. These tools will form dimples for 120 deg. countersunk 3/32 in dia. rivets, but are not suitable for all materials or locations. Hot dimpling, spin dimpling and squeeze dimpling tools are provisioned for special applications. These machines, designed for light or heavy duties, are pneumatically operated and are supplied under the appropriate aircraft Section 26 reference number, together with the referenced list of components comprising the machines and accessories. Where applicable, all reference numbers and full operating instructions are given in the relevant aircraft Vol. 6.

Note ...

No provision is made in the R.A.F. AP 1086 for the spin dimpling machines or squeeze dimpling tools to be obtained as a general issue.

40 Hot dimpling is now considered to be the most efficient process and is superseding other forms of machine dimpling. This process employs two heated dies under pressure. 90, 100 and 120 deg. dimples can be formed in a wide range of materials without risk of cracks.

Rivet sets

41 Fig. 4 shows a rivet set for a countersunk-head rivet. It should be noted that the hammer dolly has a slightly crowned face, while the surface of the reaction block is flat.

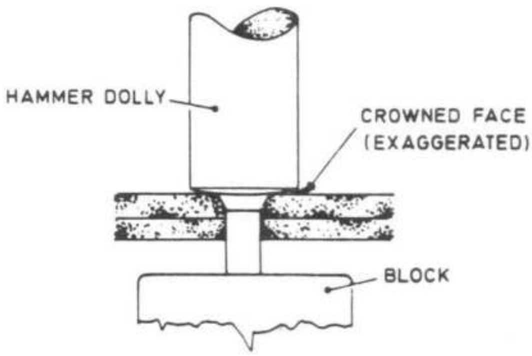

Fig. 4 Rivet set for countersunk-head rivets

42 The snap for a mushroom-head or a snap-head rivet should have a slightly larger radius than the head, and the rim should be clear of the sheet (fig. 5).

43 It is recommended that snaps should not be used for the driven heads, even in squeeze riveting, unless they are necessary to centre the tool, and if they are so used, they must be shallow. The surfaces of all tools must be

kept clean and smooth.

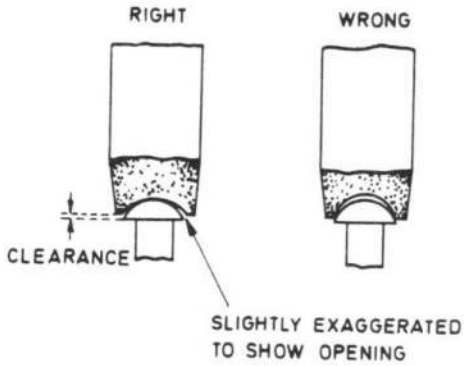

Fig. 5 Rivet set for snap-head rivets

Riveting technique for solid rivets

44 Solid rivets may be fitted either manually with suitable snaps and dollies, or mechanically with approved riveting tools which may be hand or power operated (AP 1464B, Vol. 1, Sect. 2 and Sect. 4).

45 When manual riveting is employed in repair work, a simple process may be used for structure that can be riveted on the bench, wherein the rivet is inserted with the pre-formed head on the undersurface of the metal to be joined (fig. 6) and the tail protruding through the top surface; the pre-formed head is then supported by a suitable dolly or block and the tail shaped to the required form by a hammer and snap, or by the hammer only, as appropriate.

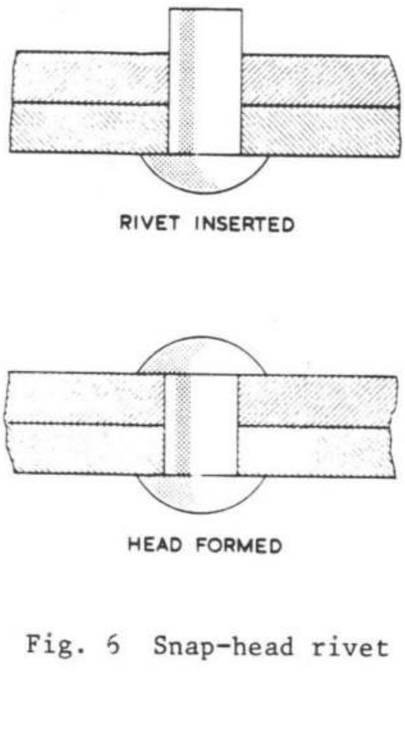

Fig. 6 Snap-head rivet

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to AP 101A-1401-1

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46 Fig. 4, illustrates a rivet set for a countersunk-head rivet. It should be noted that the hammer dolly has a slightly crowned face, whereas the surface of the reaction block is flat. The snap for a mushroom-head or a snap-head rivet must have a slightly larger radius than the rivet head and the rim must be clear of the sheet (fig. 5).

47 It is recommended that snaps should not be used for the driven heads, even in squeeze riveting, unless they are necessary to centre the tool and if they are so used, they must be shallow. The surfaces of all tools must be kept clean and smooth.

Reaction riveting

48 Reaction riveting is widely used for the setting of solid rivets and for skinning, that is, for the attachment of sheet metal to frames. Two operators are required, one equipped with a drilling tool and one with a reaction block or dolly. A vibrating pneumatic hammer, which may give anything from 15 to 65 blows per second, is the driving tool most widely used, especially for skin riveting. The block is of flat surfaced metal, and should be as light as possible in order to minimise fatigue; a block weighing 136g (0.3 lb) is usually sufficient for an $\frac{1}{8}$ in rivet. The surface of the block should be kept clean and smooth.

49 Each rivet is inserted from the outside, and the hammer is applied to the pre-formed head, a crowned or cupped dolly being used as required, and the block is held by the second operator against the rivet tail. The impact of the hammer drives the preformed head of the rivet against the skin, which, being springy, is driven against the parts nearer the rivet tail, while the rivet shank is swelled from the tail backwards by the reaction of the block.

50 The closing caused by reaction riveting eliminates the need for the drawing-up operation commonly used with hand riveting.

51 The surface of the block must be flat, so that the driven head may swell without restraint and form a squash or cheese head. The advantages of this type of head are, firstly, that the length of the rivet is not critical secondly, that there is no danger of the dolly pressing against and deforming the skin, and thirdly, that, for the same diameter, a squash head is stronger than a snap head. Examples of reaction blocks, shaped to reach into most types of structure are shown in fig. 7.

52 Fig. 8 shows a rivet in a cut-countersunk hole. Detail A shows the squash head insufficiently formed; the head diameter is only fractionally greater than the original shank diameter, but the sheets have been drawn together and the hole fairly well filled. Detail B shows a similar rivet swelled approximately 36 per cent; a diameter of 1.1/3D is the lower limit considered acceptable for the driven head, while $1\frac{1}{2}$D is the normal requirement (where D is the nominal diameter of the shank). Ideally, the thickness of the driven head should be $\frac{1}{2}$D (Detail C) although there is no loss of strength until the thickness is less than 2/5D. The protruding length of shank required to form a driven head $1\frac{1}{2}$D in diameter and $\frac{1}{2}$D thick is about 1.1/10D, plus a little more to allow for the swelling of the rivet shank in the hole. A more precise indication of the rivet length necessary to form a head of the correct dimensions is given in the graphs of fig. 9, which gives examples of the effect of hole size and plate thickness on the formed head dimensions. Reference should also be made to fig. 10, detail A.

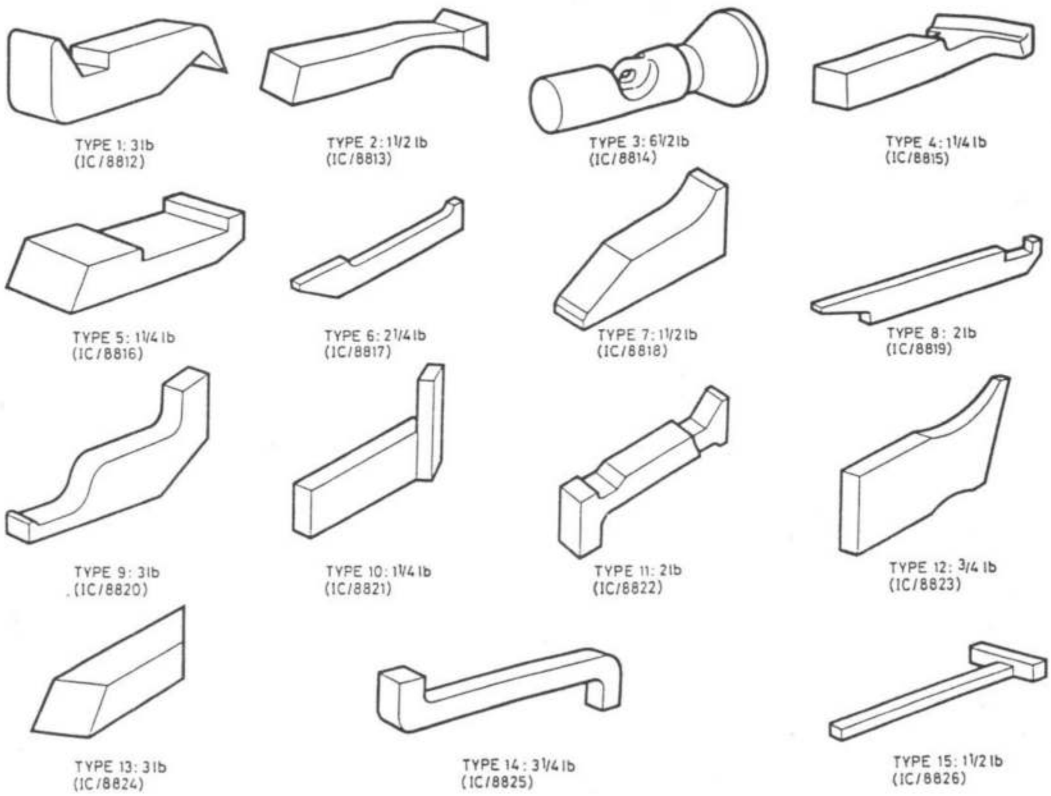
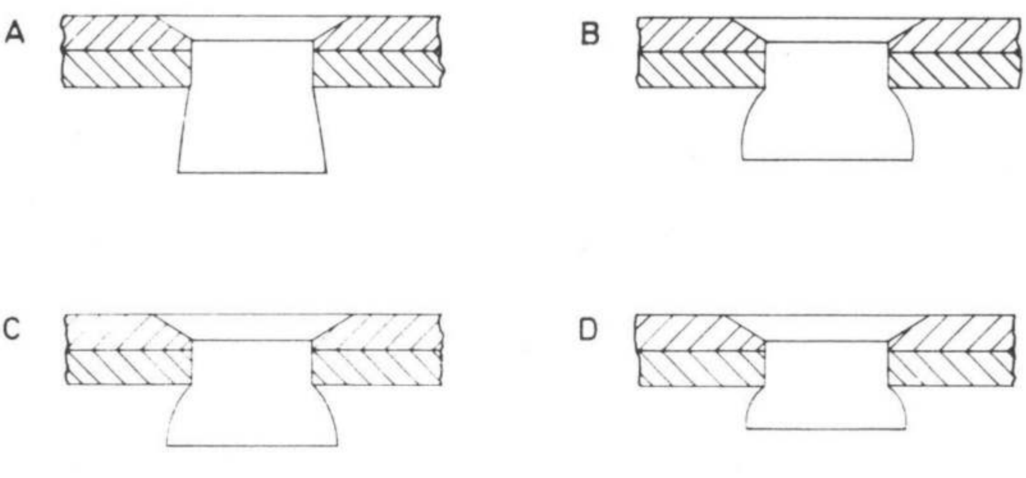


Fig. 7 Examples of reaction riveting blocks



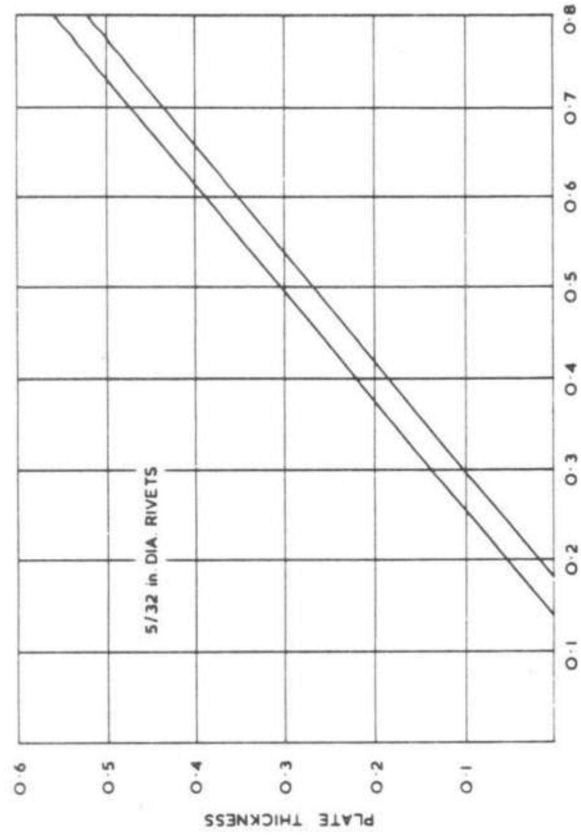
A Reaction rivet insufficiently hammered. Driven head is swelled by about 20 per cent.

B Reaction rivet just sufficiently hammered. Driven head is swelled about 36 per cent.

C Driven head is swelled by about 50 per cent, i.e. the thickness of the driven head is about half the shank diameter. These are the dimensions usually called for.

D Reaction rivet in hole that has crept and been redrilled oversize The hole is filled but the head does not bed well.

Fig. 8 Reaction rivets



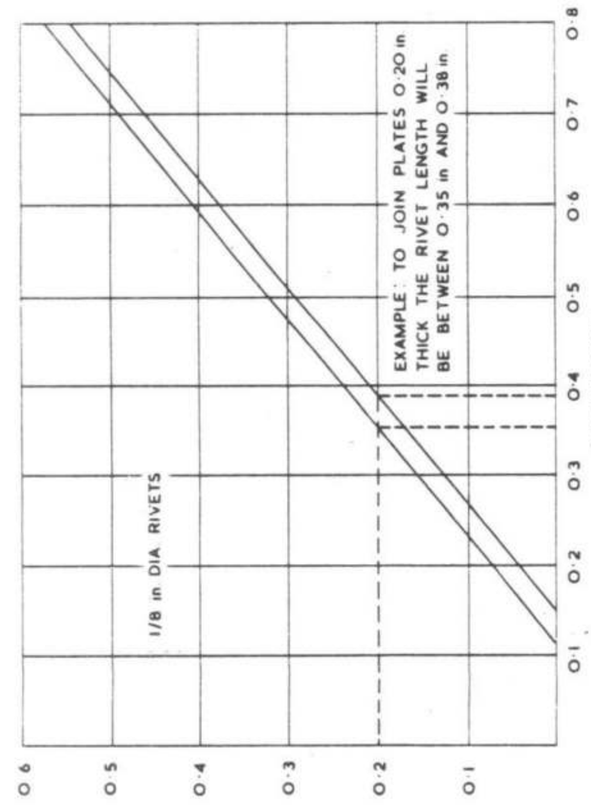
NOTE 1 Drill sizes for use with these graphs are as follows:

1/8 in dia rivet — 3·30 mm drill

5/32 in dia rivet — 4·10 mm drill

3/16 in dia rivet — 4·90 mm drill

NOTE 2 Rivets cut to the lengths shown by the graphs will produce widths across the formed head of between 1·33 and 1·5 x rivet diameter, for a formed head thickness of 0·5 x rivet diameter. 1·33 x rivet diameter is to be used for joining stress corrosion prone materials.



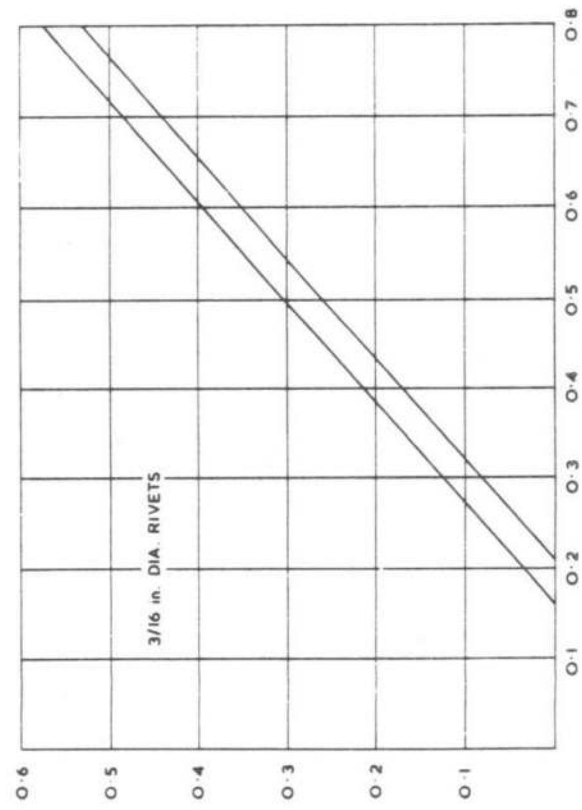
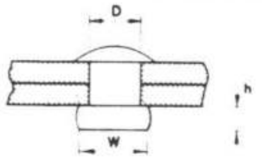


Fig. 9 Shank length calculation graphs for reaction riveting

Rivet Dia (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Width min W max	0·125 to 0·14	0·167 to 0·187	0·208 to 0·234	0·25 to 0·28	0·29 to 0·33	0·33 to 0·38
Thickness h	0·046	0·062	0·078	0·94	0·109	0·125

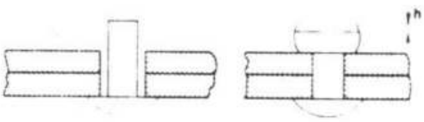


Note - Minimum width W corresponds to 1·33 D
Maximum width W corresponds to 1·5 D
Thickness corresponds to 0·5 D

Formed reaction head dimensions

ITEM 1

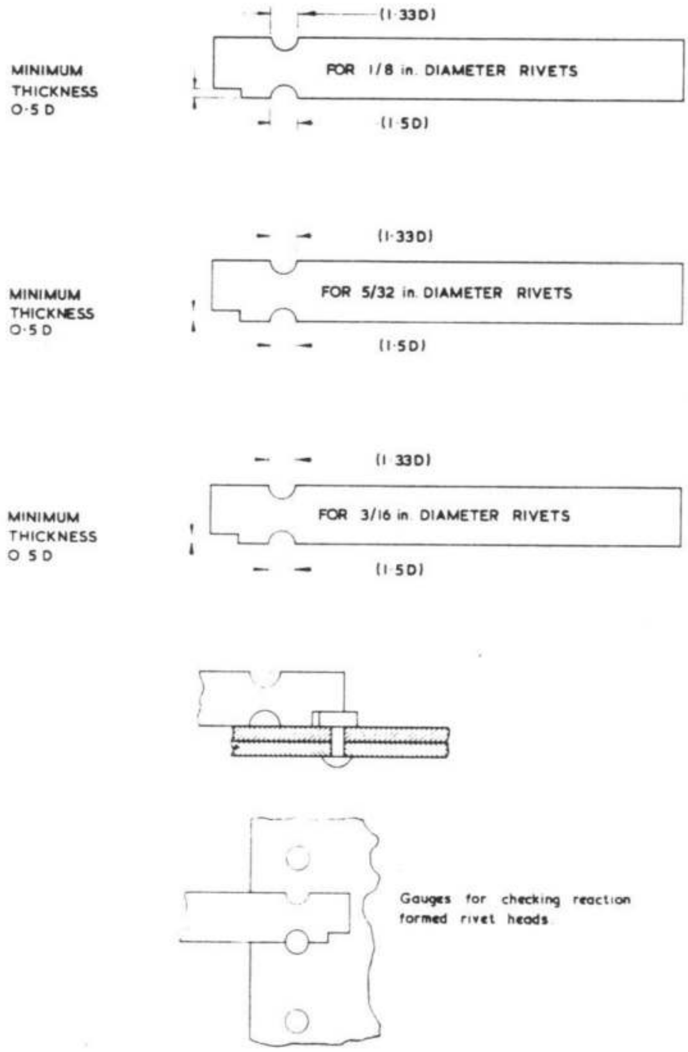
Rivet Dia. (in.)	Reduction in formed head thickness (h) for one 16 SWG plate	Drill size (mm)
1/8	0·006 in	3·30
5/32	0·005 in	4·10
3/16	0·002 in	4·90



Reduction in formed head due to rivet expansion in hole

ITEM 2

DETAIL A



DETAIL B

Fig. 10 Reaction rivet head dimensions

53 Allowance has been made on the graphs for shank expansion due to hole clearance using the drill sizes quoted in Table 6. To assist in obtaining the correct diameter of formed head, a GO/NO GO gauge may be manufactured to the dimensions given in fig. 10, detail B.

54 Overpanning of the formed or driven head can be detrimental to the surrounding metal. Excessive hammering and swelling of the rivet shank can initiate cracks around the hole. This is particularly serious in the case of aluminium/zinc alloys such as DTD 683 and 687. It is therefore preferable that the lower limit of 1.33D width across the formed head is not exceeded on these materials, as cracks can rapidly spread and lead to failure of the joint.

55 Properly controlled reaction riveting stretches the riveted parts only very slightly, because, as the hammering continues, the head swells, presents a larger area, and diminishes the pressure which might tend to swell the

shank excessively. If, however, stretching does not occur, there is always the danger of creep when thin sheets are riveted to frames and stringers, because the thin sheets are slightly wavy and are straightened when riveted to stiff straight parts, so that the holes in the sheets tend to creep past those in the stiffer parts.

Procedure

56 The sequence of operations for manually fitting solid rivets is as follows:-

56.1 Mark out the positions of the rivets on the metal to be joined, ensuring that the correct landing, pitch and distance between rows are used (para. 58 and 59), centre punch and drill the rivet holes with the correct sized drill to ensure the required clearance. The holes should be reamed if the relevant Vol. 6 calls for this operation.

56.2 Dismantle the drilled metal surfaces and remove all burrs and swarf around the holes.

56.3 Assemble the job again and secure with suitable service bolts or clamps in every fourth hole.

56.4 If countersunk rivets are to be fitted, dimple or cut-countersink the metal surface as required. The holes should be reamed and again deburred if this operation is called for in the relevant Vol. 6.

56.5 Insert rivets of the correct length (para. 21).

56.6 Close the rivet by the reaction process described in para. 47 et seq.

Note ...

The judicious use of masking tape over the manufactured head will often prevent marking of the skin surface or ringing in the case of protruding head rivets.

56.7 Using the correct snap, form the head of each rivet to the required shape.

Riveting faults

57 Before commencing any type of riveting job, the operator should, whenever possible, make a dummy run by fitting rivets in holes drilled in some spare pieces of metal and forming the appropriate heads on them to check his ability to produce well-set, satisfactory rivets or correct any fault riveting. The main causes of faulty riveting are as follows:-

57.1 Excessive or insufficient shank allowance.

57.2 Rivet holes not drilled straight or drilled to the wrong size.

57.3 Rivet holes out of line on separate surfaces.

57.4 Surfaces of metal not drawn-up close together, possibly due to burrs around drill holes.

57.5 Wrong size of dolly or snap used, thus damaging the metal surface or forming a bad rivet head.

57.6 Rivets not filling rivet holes correctly.

57.7 Rivet head not central with the shank.

57.8 Formed reaction head overdriven.

Riveted joints

58 When riveting together two or more sheets of metal during any repair work, the correct rivet spacing and pattern must always be observed. The rivets must not be too close to each other, otherwise the excessive number of rivet holes will weaken the metal sheet; they must not be too far apart or there will not be sufficient of them to take the loads imposed upon the structure which they are securing and, also, the joint will not be effectively sealed against the weather or the ingress of liquid. Rivets must never be fitted too close to the edge of the metal sheeting as this would allow them to tear through the metal under load.

59 These factors must be taken into consideration when planning any rivet spacing and pattern for repair work involving single, double or treble rows of chain or staggered riveting. For practical purposes, the minimum distances necessary to cover the considerations given in para. 58 are as follows (where the symbol D denotes the diameter of the rivets):-

59.1 The basic minimum permissible distance between any two rivet centres is 4D. Therefore:-

59.2 The minimum pitch is 4D.

59.3 The minimum distance between rows of chain rivets is 4D.

59.4 The minimum distance between staggered rows of rivets is governed by the basic minimum of 4D between any rivets, allied to the actual pitch used.

Note ...

When the pitch in the individual rows of rivets is itself at the minimum of 4D, the minimum distance between rows of staggered rivets is 3.5D. As the pitch increases, so the minimum distance between the rows decreases, therefore the expression:-

$$\sqrt{16D^2 - \left(\frac{\text{pitch}}{2}\right)^2}$$

should be used to calculate the required distance between rows.

59.5 The minimum distance between rivet centres and the edge of the metal sheet (the landing) is 2D for 18 gauge and thicker material and $2\frac{1}{2}$D for all material thinner than 18 gauge.

<u>Riveting hammers</u>

60 The high-speed riveting hammers run at about 3600 blows per minute, and are lighter and less fatiguing to the operator than the slow and harder hitting hammers. In addition, there is less danger that they will stretch the sheet.

61 Single-shot pneumatic hammers close a rivet with one or two heavy blows instead of a burst of light blows, but they are heavier than the fast-running hammers and require a heavier block. Single-shot hammers are more suitable for driving long rivets in heavy parts than for skin riveting, because they will compress a longer rivet throughout its length.

Distribution of creep

62 Creep is bound to occur when thin sheets are riveted to large assemblies, and, as it is quicker to re-drill a complete run of holes than to re-drill as required, all holes should be pilot drilled and then opened out; the sheet must be pressed hard against its mating component during this operation to exclude swarf. If sheet grippers are required, gripping pins should be used. The following pins are available for their corresponding hole diameters:-

Gripping pin	Hole diameter
Ref. No. 1B/1208008	3/32 in
Ref. No. 1B/1208010	1/8 in
Ref. No. 1B/1208011	5/32 in

63 Much of the skill required for the satisfactory riveting of sheet metal to framework, lies in minimising creep and in distributing it evenly. Local slackness may be obviated if the sheet is pre-stretched slightly before it is assembled.

64 The procedure used in the application and riveting of the sheet varies greatly, according to the type and size of the structure; a typical method of riveting the sheet to the fuselage is described in the following paragraph. It is assumed that the frames, but not the stringers, have the holes for fixing already drilled, that the frames are set up in a jig, and that the stringers and other frame members are already riveted in position.

65 The sheet is then applied as follows:-

65.1 The skin sheets are fixed to the frame by gripping pins fitted through holes especially drilled, the sheets being trimmed to the exact size required.

65.2 The sheets are drilled through the pre-drilled holes in the frames; the sheets must be held back against the frames to prevent swarf from collecting between them.

65.3 Drill templates are fitted, and the sheets and the stringers are drilled with a drill of the nominal size of the rivets.

65.4 With the skin sheets lying flat on the stringers, occasional holes about a foot apart are re-drilled with a drill about 0.003-0.005 in larger than the nominal rivet diameter; rivets are then inserted and formed in these occasional holes.

65.5 The holes between the occasional rivets are re-drilled with the oversize drill and the rivets are inserted and formed. It is usual to rivet one sheet at a time, and not to open out the holes in the next sheet until immediately before riveting.

66 Creep must be scrupulously limited after the re-drilling operation. If necessary, the short lengths between the occasional rivets may be further sub-divided by occasional rivets. The amount of creep that occurs is not usually more than about 0.009 in but holes as much as 0.015 in oversize (due to re-drilling after creep) may be necessary.

67 Inspection for oversize holes is difficult, and is usually based on the fact that the larger the hole the more rivet metal is required to fill it

and the less metal is left to form the head. If the rivet heads are relatively small at the end of a row, it may be necessary to have them removed and replaced by oversize rivets.

Note ...

Where countersunk-head rivets are used on a stressed component, the only way of ensuring that a rivet is fitted tightly is for the countersunk head to be 0.001-0.0015 in proud of the surrounding surface after the rivet has been fitted; the rivet head must not be below the surface of the skin.

68 Another method of disturbing creep uniformly is to insert all the rivets in a row before the riveting operation is commenced; a strip of paper should be pasted over the rivet heads to keep them in place, but jointing compound may be used to serve the same purpose. The occasional rivet method is preferable, but this alternative is useful for long runs.

69 The quilted appearance usual on a metal-skinned structure is due partly to the fact that thin sheets are fixed locally before they are straightened by being close-riveted to the stiff frame members; if a complete sheet is tensioned it lies more smoothly. One method of tensioning a sheet is to apply a pull to each corner until it is riveted, but no attempt should be made to tension a sheet that is not flat or nearly flat; tension should not be applied to a curved sheet because it tends to draw the skin straight from stringer to stringer between frames. Tensioning the sheets will not eliminate local buckles, which are usually due to uneven joints between frame members, or to an accumulation of creep in one locality.

Fitting and removing rivets

Solid rivets - removing

70 When the removal of existing rivets is necessary, great care must be taken to avoid damage to the surrounding material, particularly if this is thin metal sheeting. If there is insufficient support for the rivets during the removal operations, or if a pre-formed head has to be chipped off with a cold chisel and the hammer blows are too heavy, the metal structure may be distorted, the rivet holes elongated or incipient cracks caused. Such cracks, although at first imperceptible, may spread under load and vibration thus weakening the structure.

71 The removal of solid rivets should be effected in the following sequence of operations:-

71.1 On snap, dome or mushroom-head rivets, file a flat on the pre-formed heads.

Note ...

It is preferable to work on a pre-formed head as this is more symmetrical about the rivet shank than a formed head.

71.2 Mark the centre of the heads with a centre-punch.

71.3 Using a drill of the same nominal diameter as the rivet shanks (fig. 11), carefully drill out the heads to a depth slightly more than the thickness of the centre-punched heads.

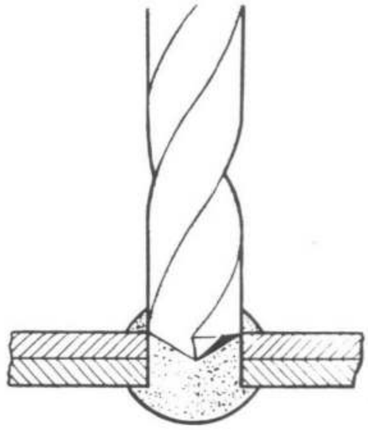


Fig. 11 Drilling out head of rivet

71.4 If the rivet heads are not removed by the drilling operation, have the opposite end of the rivets supported with a suitable dolly and cut off the drilled heads with a small, sharp cold chisel, the cut being made in the direction of the line of rivets (not across it). Care is to be taken to avoid damage to surrounding material.

71.5 Support the structure locally to prevent buckling of the sheets or fittings and eject the rivets with a parallel pin punch slightly smaller than the diameter of the rivet shank.

Plug rivets - fitting (fig. 12)

72 The procedure for fitting plug rivets, which necessitates the use of a power hammer, is as follows:-

72.1 Drill suitable-sized holes to the required depth in the solid member.

72.2 With the appropriate taps, tap the holes to leave a coarse thread similar to that of an Acme thread.

72.3 If countersunk rivets are to be fitted, countersink the holes in the solid member to the same angle as that of the rivet heads and either dimple or cut-countersink the metal sheet according to its thickness (see Table 7).

72.4 Cut the rivets to the required lengths, which must include the allowance for the shank expansion.

72.5 Drive the rivets into the threaded rivet holes with a pneumatic hammer so that each rivet tail strikes the bottom of its hole and the shank swells until the threads are filled and the rivet is secured.

Plug rivets - removing

73 To remove a plug rivet, a chiselled slot should be made in the rivet head and the rivet screwed out with a suitable screwdriver. As an alternative to this method, a small hole may be drilled in the centre of the rivet head, the tang of a file or a square punch inserted and the rivet screwed out.

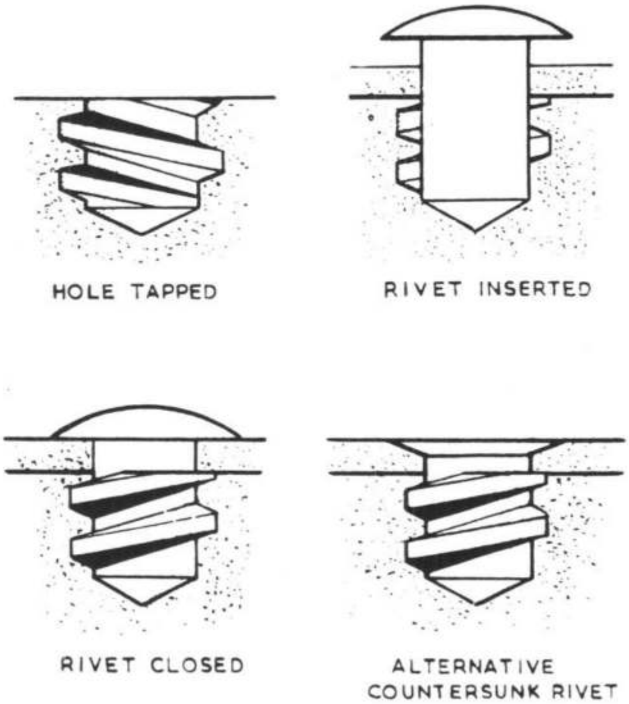


Fig. 12 Plug riveting

Hollow rivets - removing

74 Hollow rivets should be drilled out in the same way as solid rivets (para. 70); it is recommended, however, that a hand drill should be used with the minimum of pressure, as the high speed of a power-driven drill used with considerable pressure is liable to spin the rivet in the work.

Hi-shear pins - fitting

75 The complete closing sequence is illustrated in fig. 13. Normally the collars are driven with standard riveting guns or squeezers fitted with a Hi-shear set, but pins up to 3/16 in diameter can be set with a hand tool, hammer and re-action block. The set is unusual in having a hollow centre with a discharge port through which severed portions of the trimmed collar are ejected. As the collar is swaged into the pin groove, the pin trimming edge severs that portion of collar which remains above the trimming edge and there is no upsetting of the pin itself as in normal riveting.

76 Hi-shear pins are produced to close tolerances and should be fitted to drill-reamered and de-burred holes in accordance with current procedure or as directed in the relevant airframe Vol. 6. When a pin is inserted it should be checked for correct length before driving. After ensuring that the mating faces of the materials to be pinned are in close contact with each other, check the pin length in the hole for 'maximum grip' (fig. 14); the pin groove edge should be just clear of the face of the work. Next, check for 'minimum grip', apply the collar over the end of the pin and ensure that the pin trimming edge does not show above the collar; if it does, a shorter pin must be used. If a shorter pin is not obtainable, then a washer, reamed to the correct hole size, may be employed to adjust the thickness of material being

pinned but this method should not be used as a normal practice.

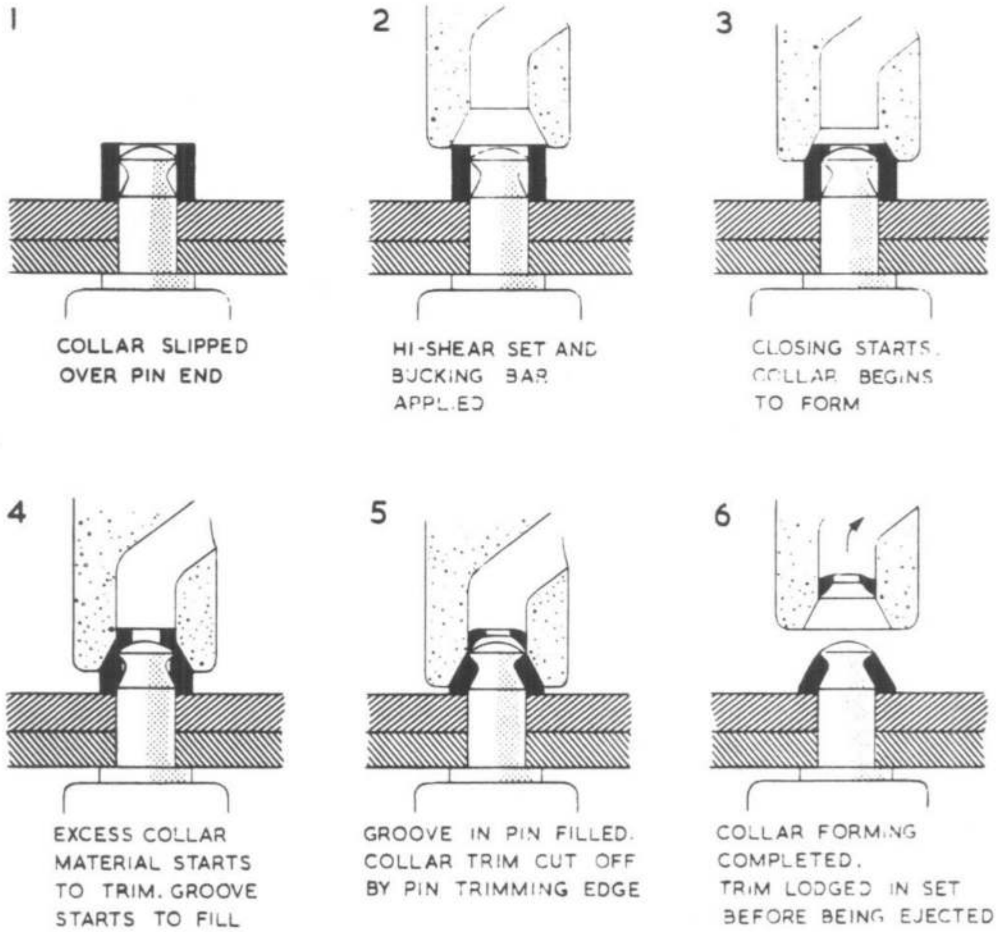


Fig. 13 Hi-shear collar forming sequence

77 When a gun is used to set Hi-shear pins it should be sufficiently powerful to drive the collars rapidly. Long,weak bursts on the gun tend to work-harden a collar and make it more difficult to drive. An air pressure of at least 6.12 bar (90 lbf/in^2) is required to ensure rapid driving. The pin head should always be backed by a heavy reaction block so that the full force of the gun is applied to the collar and is not dissipated in vibrating the structure. For reaction setting a straight trimming set is inserted in a reaction block which is then applied to the collar and a flush set in the gun is held up to the head of the Hi-shear pin. It is possible to close the collars of pins up to 3/16 in diameter by using a hand set, but above this size of pin a power tool must be used to do the work effectively. Faults and methods of correction; when setting Hi-shear pins, are illustrated in fig. 15. When approved for Service use details of Hi-shear tools will be found in the relevant aircraft Vol. 6.

Hi-shear pins - removing

78 There are four methods suitable for the removal of Hi-shear pins and these are illustrated in fig. 16. Whichever removal method is adopted the

aim should be to retain the original hole size without damaging the structure. If the pin can also be removed without damage and shows no signs of stress it may be used again with a new collar; in this respect it is similar to a bolt but does not suffer elongation due to overtightening.

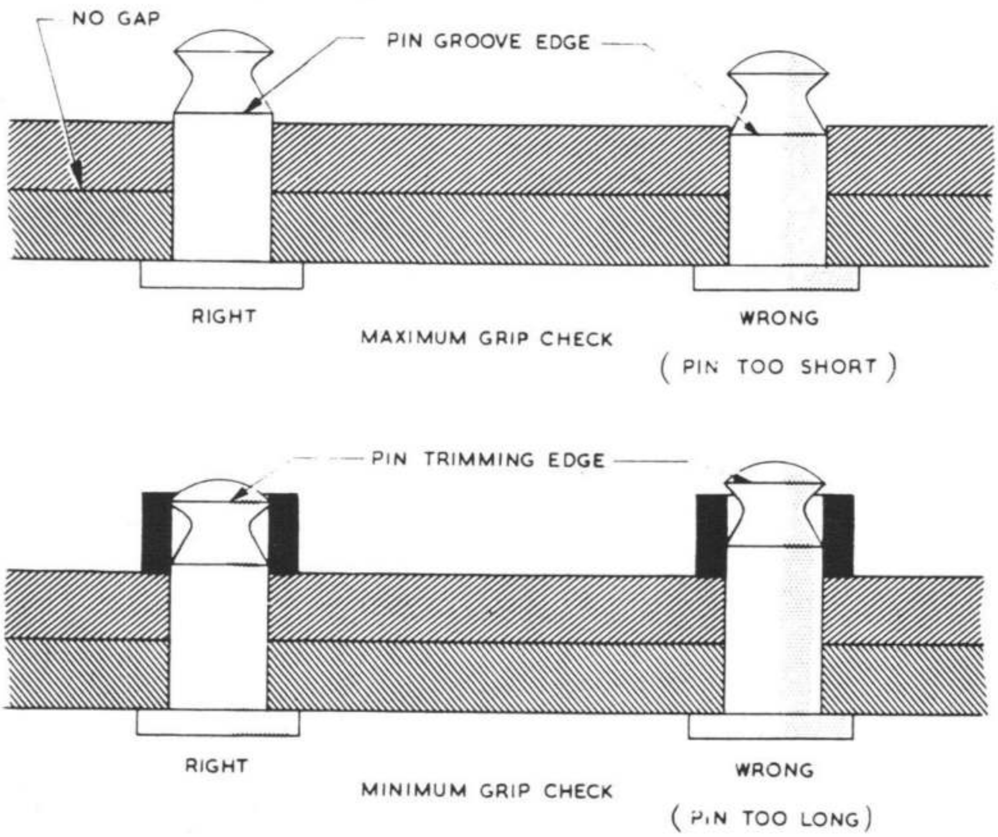


Fig. 14 Hi-shear grip checks

Tucker pop rivets - fitting

CAUTION ...

(1) When using break-head pop rivets care must be taken to drive out the rivet mandrel heads and remove them from the structure after completion of the riveting operation.

(2) Where there is any possibility of loose mandrel heads entering parts of the structure where there are moving parts, electrical installations, or where they may be drawn by suction effect into turbine engine compressors, either directly or through clearance holes, the break-stem type of rivet should preferably be used.

(3) When using break-stem type rivets precautions must be taken to ensure that the captive portion of the mandrel does not become loose due to vibration. An acceptable method of ensuring this is to dip the rivet in a cold-setting adhesive before insertion.

79 Drill sizes are listed in Table 8. The angle of countersink for standard pop rivets is 120 deg. but certain sizes of monel rivet have a 100 deg.

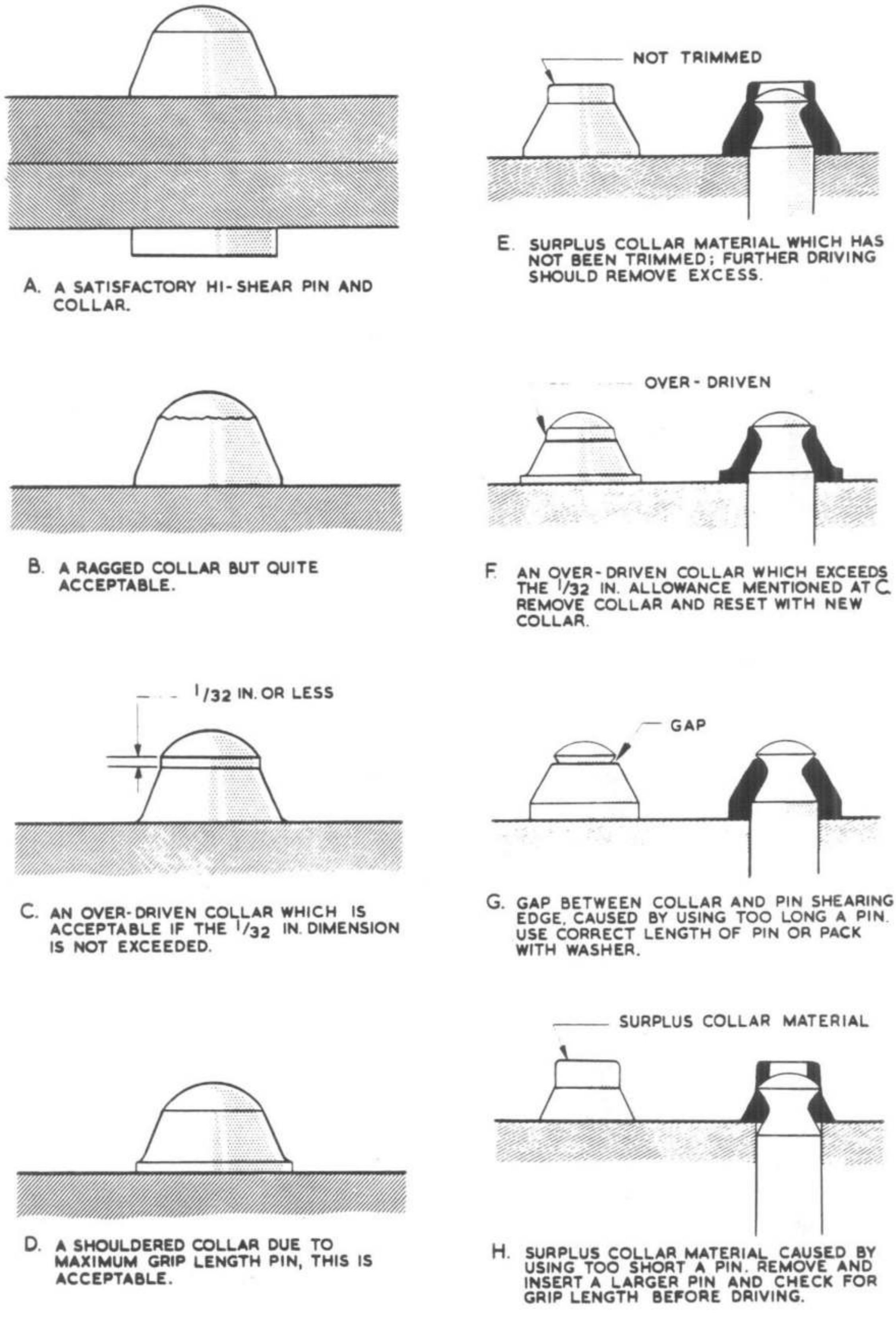


Fig. 15 Hi-shear pin setting faults

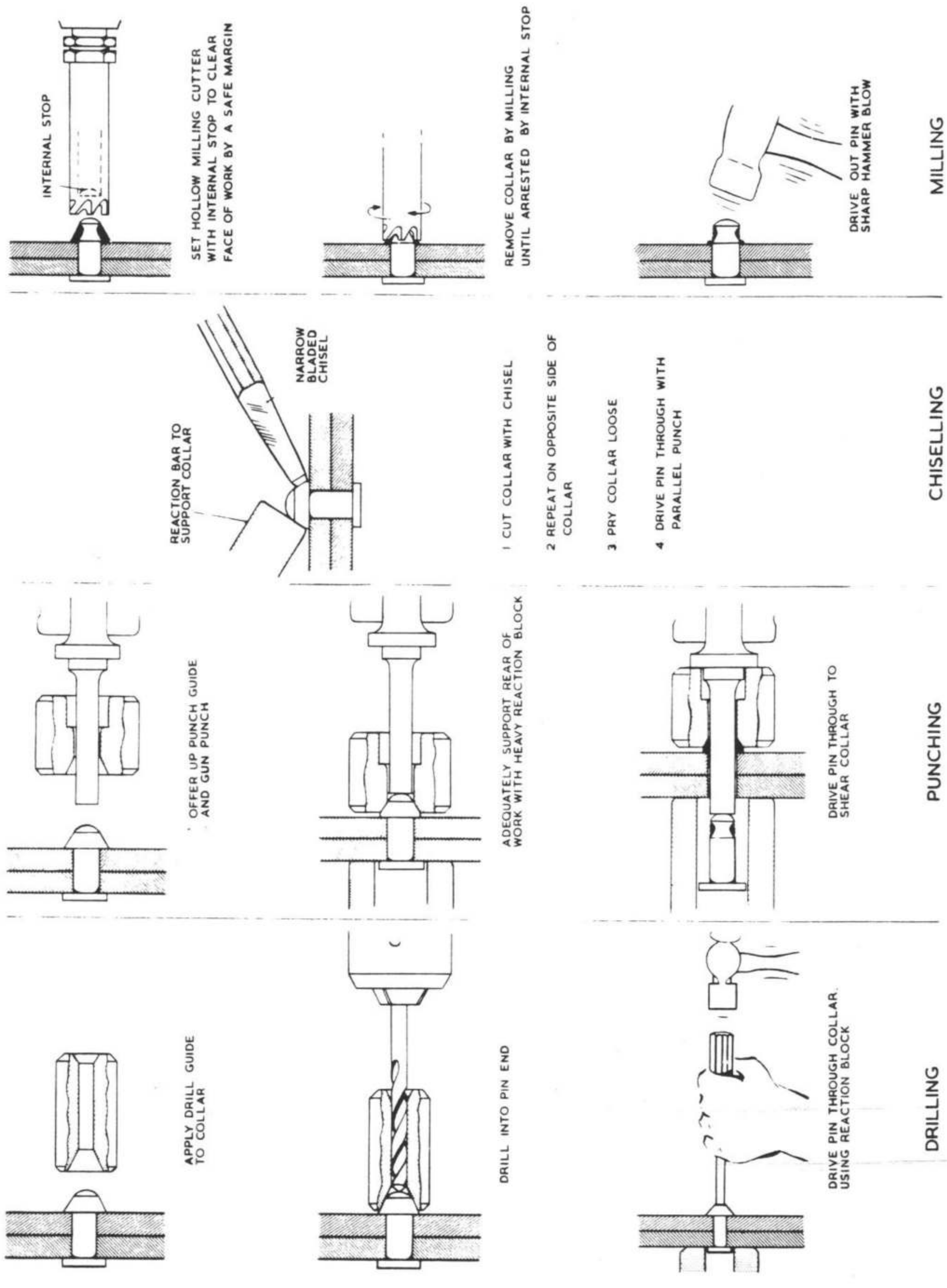


Fig. 16 Hi-shear pin removal

countersunk head. De-burring of rivet holes should conform to the radii indication in fig. 21, Chap. 2.

TABLE 8 DRILL SIZE FOR POP RIVETS

Rivet diameter (in)	Drill reference	Drill diameter (in)
3/32	41	0.096
7/64	33	0.113
1/8	30	0.128
5/32	20	0.161
3/16	11	0.191
7/32	2	0.221
1/4	F	0.257

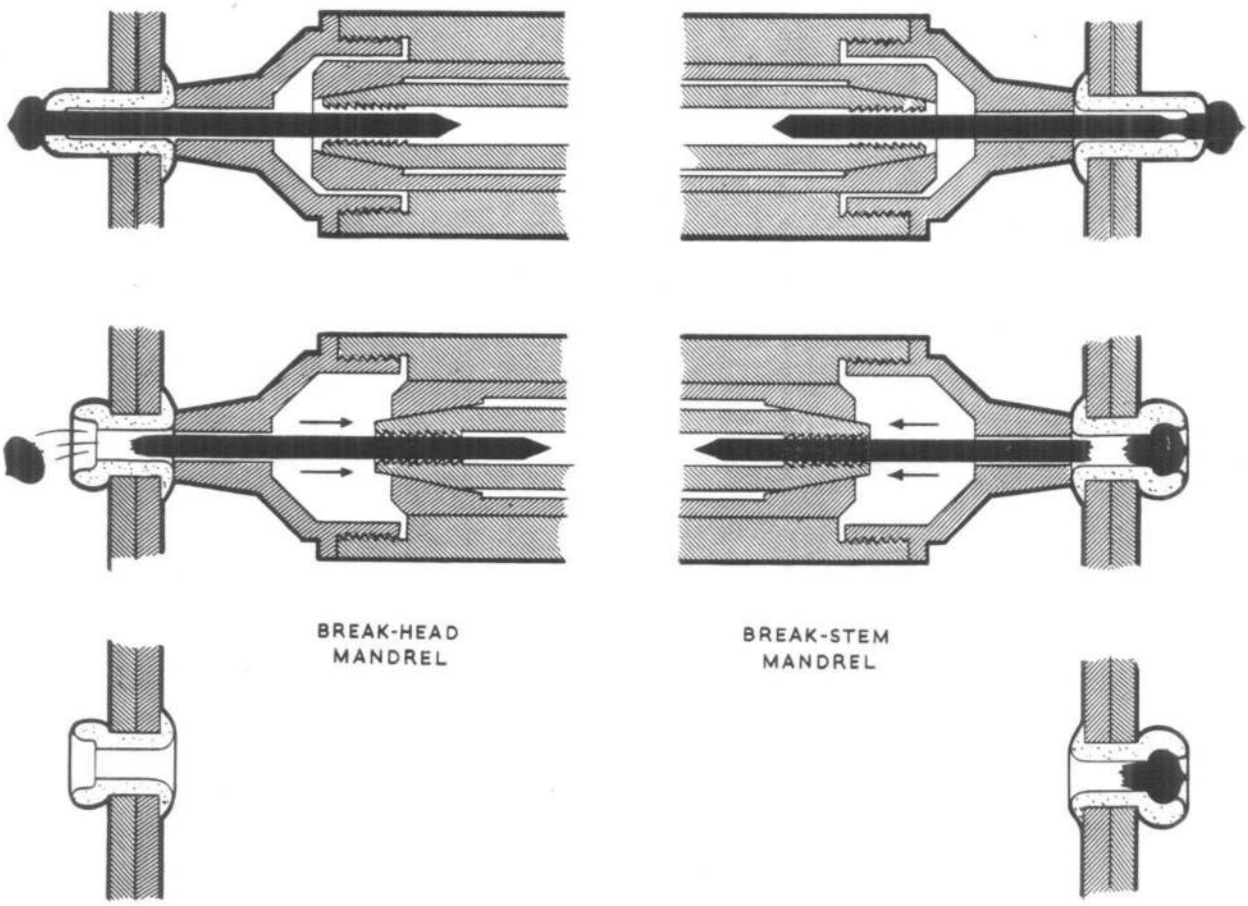


Fig.17 Tucker pop rivet development

80 The stages of pop riveting are illustrated in fig.17. As the mandrel tail is withdrawn by the riveting tool, the material being joined is drawn tightly together and, at a pre-determined tension, the mandrel fractures.

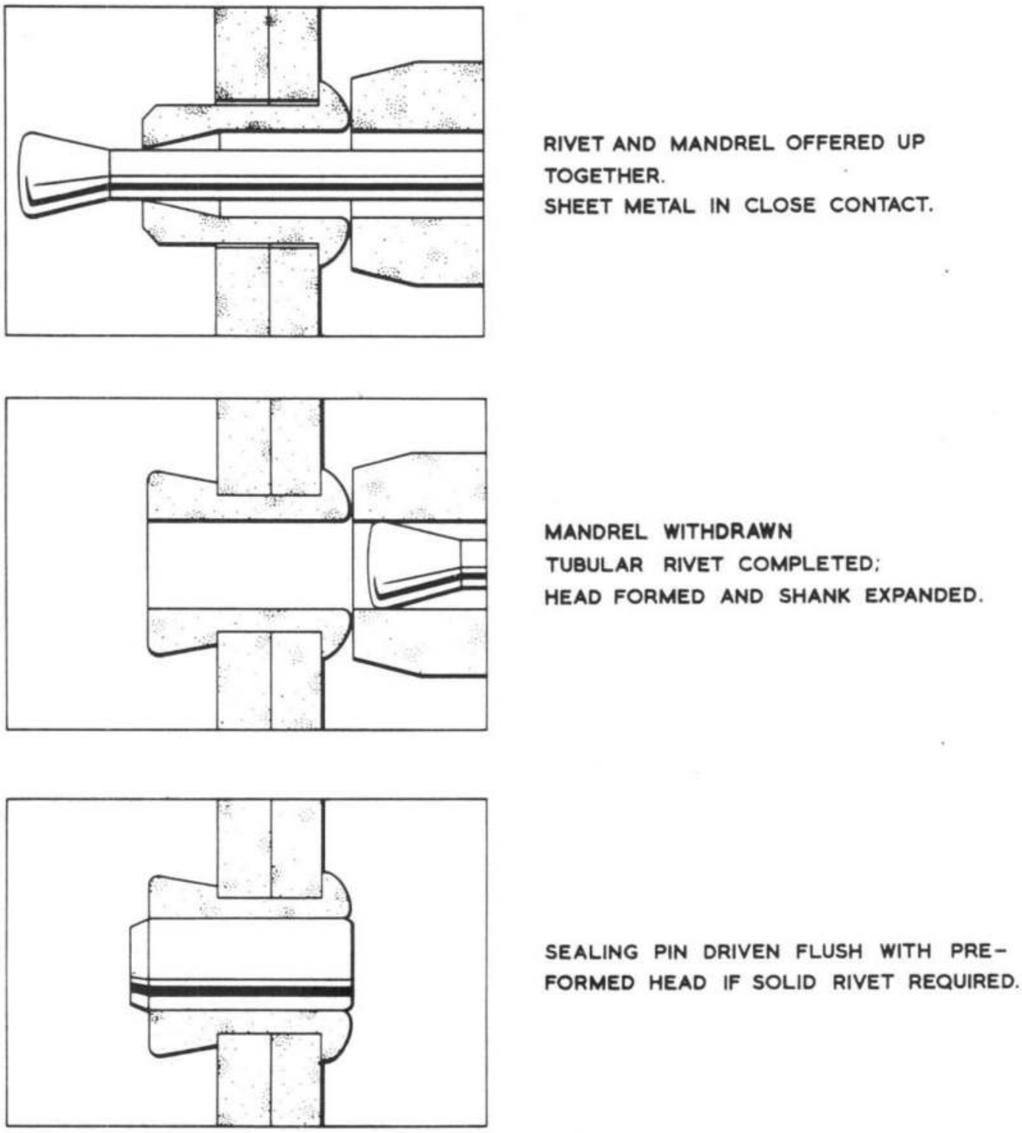


Fig.18 Setting Chobert rivets

With break-head mandrels the head is normally ejected; with break-stem mandrels the correct retention of the mandrel head by the rivet is dependent upon sufficient projection of the rivet through the assembled material; for this reason it is essential to select the correct length of rivet for the job in hand.

Tucker pop rivets - removing

81 Removal of Tucker pop rivets is simplified by the drill-centring action of tubular rivets. It is necessary to remove all rivet stubs and swarf before closing off an area on re-assembly, this is particularly important as the mandrel heads and the rivets are of dissimilar metals.

Chobert rivets - fitting

82 As a Chobert rivet is set with a steel mandrel attached to the riveting tool it is possible to thread a number of rivets on the mandrel to permit a continuous feed. The action of the riveting gun automatically moves the

rivets forward to the mandrel head ready for placing, this permits a very high rate of work as compared with other processes where the rivets have individual mandrels. Repetition riveting tools which are pneumatically or hydro-pneumatically operated are described in AP 1464B Vol.1, Pt.2, Sect.2, Chap.7. Automatic hand-operated riveting tools which are provisioned for setting rivets up to 3/16 in dia., are described in Sect.2, Chap.2 of the same publication.

83 The action of a riveting mandrel is shown in fig.18. When the rivet and mandrel are inserted into the rivet hole and held firmly in position, the tool is operated to retract the mandrel, which transforms the tapered bore of the rivet to a uniform bore; by this action the rivet tail is expanded to form a head and the rivet shank is expanded to fill the rivet hole. As the contraction of the rivet length is very slight it is essential to pull the metal sheets into close contact with sheet grippers or service bolts before riveting starts, failure to do so may result in local distortion of the skin.

84 Sealing pins are manufactured to an interference fit and, when required, are tapped in to produce a flush finish with the rivet heads.

Note ...

Steel sealing pins must not be used with aluminium alloy rivets and vice versa.

85 By reference to Table 9 the appropriate rivet length for the thickness to be riveted can be ascertained. The correct hole size for the rivet diameter is given in Table 10. As Chobert rivets are manufactured to close tolerances it is important that the correct drill is used. The expansion allowance for a steel rivet is less than that allowed for an aluminium alloy rivet. If a rivet hole is drilled oversize the rivet expansion will be insufficient to fill the rivet hole and increased shear loads will be carried by adjacent rivets. If a rivet hole is drilled undersize, the mandrel head may fracture owing to the increased tension which is necessary to broach out the rivet. Alternatively, when riveting thin gauges of sheet metal there will be a tendency to distort the skin. After drilling, the holes should be deburred as standard practice but reference should be made to the relevant aircraft TOPIC-6 to ensure that the correct deburring technique is used. Present-day practice on pressurized aircraft indicates a trend towards radius deburring, which reduces local stress at the rivet neck, as opposed to chamfer deburring.

TABLE 9 RIVET LENGTH IN RELATION TO MATERIAL THICKNESS FOR CHOBERT RIVETS

Joint thickness (in)	Rivet length* (in)
Up to 0.062	1/8 or 5/32
0.062 - 0.125	3/16 or 7/32
0.125 - 0.187	1/4 or 9/32
0.187 - 0.250	5/16 or 11/32
0.250 - 0.312	3/8 or 13/32
0.312 - 0.375	7/16 or 15/32
0.375 - 0.437	1/2 or 17/32

TABLE 9 RIVET LENGTH IN RELATION TO MATERIAL THICKNESS FOR CHOBERT RIVETS (continued)

Joint thickness (in)	Rivet length* (in)
0.437 - 0.500	19/32
0.500 - 0.562	21/32
0.562 - 0.625	23/32
0.625 - 0.687	25/32

Note ...

*The rivet length is measured overall for countersunk-head rivets and measured from under the head for snap-head rivets.

Chobert rivets - removing

86 The self-centring action of tubular rivets when drilling rivet heads makes the operation relatively simple. If sealing pins have been used they may be punched part-way through to permit centralized drilling. Whenever possible the remote face of the work should be supported before rivet pins or rivet shanks are punched through. All rivet fragments and sealing pins must be removed from the structure before the area is sealed off by completion of the repair.

Avdel rivets - fitting (fig. 19)

87 Avdel riveters are described in AP 1464B, Vol.1, Part 2, Sect.2, Chap.8. When a rivet is to be placed, the riveter is loaded and applied to the work, ▶and pulls the stem into the rivet; this tulips the rivet tail and expands the shank, thus filling the hole in the work and gripping the stem; the stem ◀ fractures at a predetermined load leaving its head and part of its stem in the rivet.

▶88 The projecting end of the stem in the rivet should be nipped off close to◀ the rivet head and, if a very clean surface finish is required, milled flush ▶with the rivet head or the sheeting, as applicable. Avdel rivets are cold headed or machined from bar to accurate limits corresponding to those ◀ required for close tolerance solid rivets, thus the work preparation and the riveting operations must be done with the same care and accuracy as for Chobert riveting (para. 82).

▶89 Aluminium alloy Avdel rivets are supplied in grip lengths to suit sheet thicknesses up to 0.516 in. Stainless steel Avdel rivets suit sheet thicknesses up to 0.250 in. Any given rivet can be used with sheet material ◀ of a certain range of thickness, and this range is referred to as the grip range; the sheet thickness measurement of a dimpled hole must include the depth of the dimple (C in fig.20). When the space behind the sheets is limited, the amount of mandrel protrusion (A and B in fig.20) must be considered; the mandrel protrusion for each diameter of rivet is given in Table 11.

TABLE 10 DRILL AND MANDREL SIZE IN RELATION TO RIVET DIAMETER FOR CHOBERT RIVETS

Rivet dia. (in)		Rivet types	Recommended hole size	Mandrel head dia. (in)
Nominal	Actual			
3/32	0.0955-0.0935 0.096 -0.094	All steel All Al. alloy	0.098 -0.1005	0.0725
1/8	0.127 -0.125	All types	0.1285-0.1315	0.088
5/32	0.158 -0.156	All types	0.161 -0.164	0.107
3/16	0.190 -0.188 0.188 -0.186	All steel All Al. Alloy	0.1935-0.1965	0.132
1/4	0.249 -0.247 0.247 -0.245	All steel All Al. Alloy	0.250 -0.253	0.184

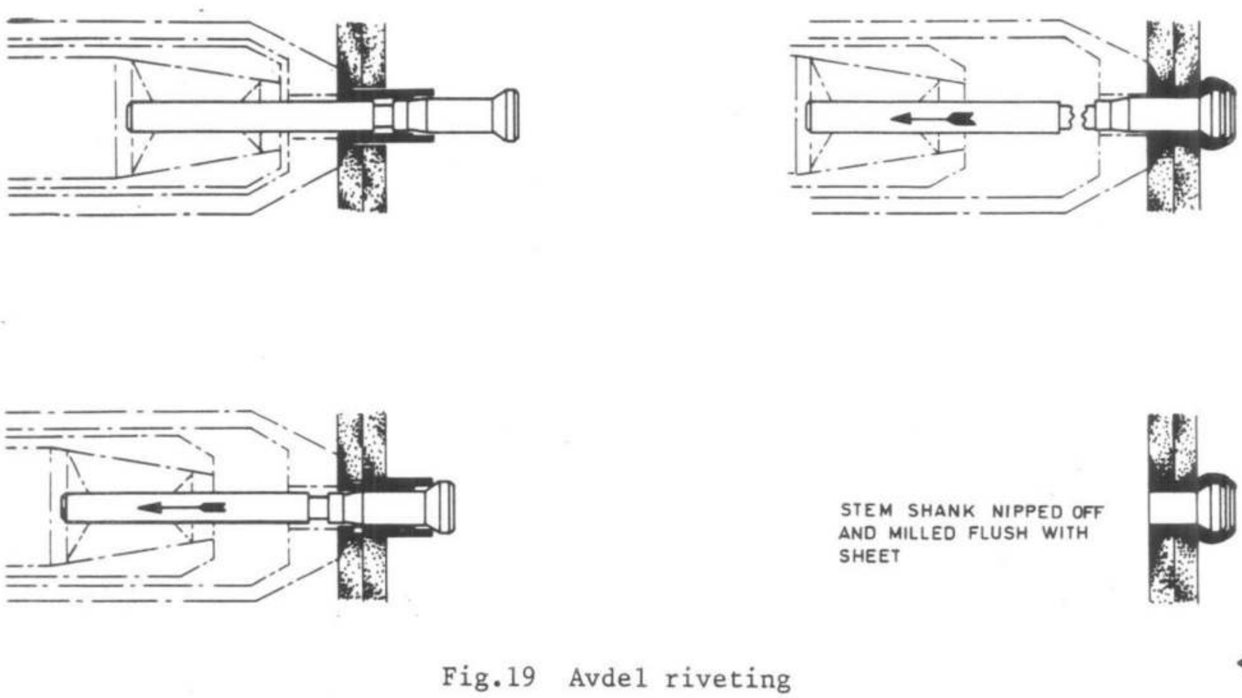


Fig.19 Avdel riveting

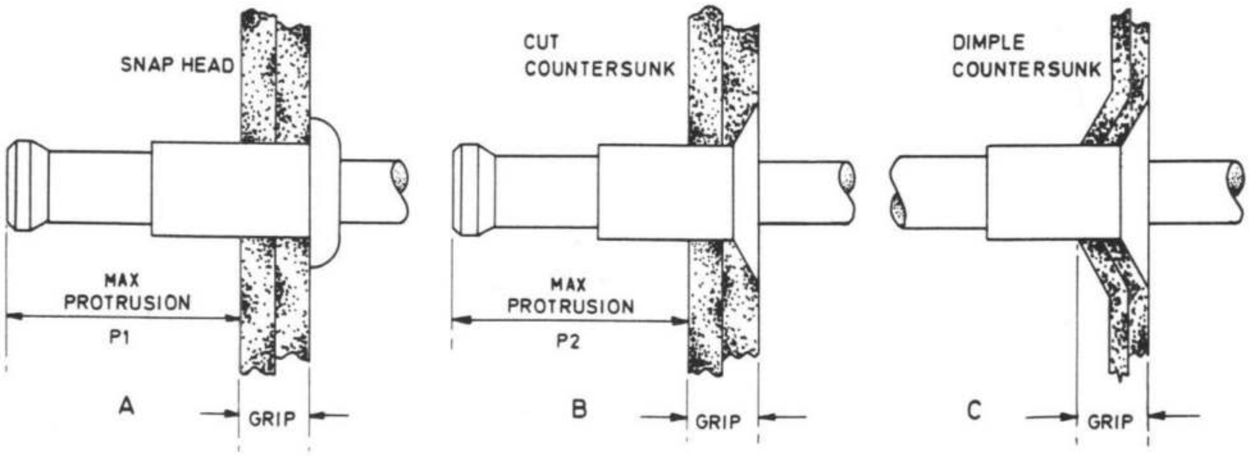


Fig.20 Avdel (Al. alloy) rivet grip and stem protrusion

TABLE 11 GRIP RANGES, DIAMETER AND LENGTH CODING OF RIVETS, AND STEM PROTRUSION FOR SNAP-HEAD (P1) AND COUNTERSUNK-HEAD (P2) AVDEL RIVETS; ALUMINIUM ALLOY

Grip range (in)	1/8 in dia rivets			5/32 in dia rivets			3/16 in dia rivets		
	Code	P1(in) AGS 2065/	P2(in) AGS 2066/	Code	P1(in) AGS 2065/	P2(in) AGS 2066/	Code	P1(in) AGS 2065/	P2(in) AGS 2066/
*0.020-0.078) †0.044-0.078)	405	0.37	0.35	506	0.41	0.39	607	0.44	0.42
0.047-0.141	407	0.46	0.40	508	0.50	0.44	609	0.54	0.48
0.109-0.203	409	0.52	0.46	510	0.63	0.50	611	0.66	0.53
0.172-0.266	411	0.65	0.52	512	0.63	0.63	613	0.66	0.66
0.234-0.328	413	0.65	0.65	514	0.75	0.62	615	0.78	0.65
0.297-0.391	415	0.76	0.64	516	0.75	0.74	617	0.78	0.77
0.359-0.453				518	0.86	0.73	619	0.90	0.77
0.422-0.516				520	0.87	0.87	621	0.90	0.90

* Snap-head † Countersunk-head

Imex blind rivets - fitting (fig.21)

90 The setting of Imex rivets can be performed using standard pop riveting tools with the addition of a special nose piece and, in certain instances, special jaws. Further information on the availability of these items will be issued later. The recommended riveting thicknesses are shown in Table 12.

▶ TABLE 11A GRIP RANGES, DIAMETER AND LENGTH CODING OF RIVETS, AND STEM PROTRUSION FOR SNAP-HEAD (P1) AND COUNTERSUNK-HEAD (P2) AVDEL RIVETS: STAINLESS STEEL

Grip range (in)	1/8 in dia rivets			5/32 in dia rivets			3/16 in dia rivets		
	Code	P1(in) AGS 3920 3922	P2(in) AGS 3921 3923	Code	P1(in) AGS 3920 3922	P2(in) AGS 3921 3923	Code	P1(in) AGS 3920 3922	P2(in) AGS 3921 3923
*0.031-0.062	405	0.53	-						
0.062-0.125	407	0.60	0.56	508	0.62	0.55	609	0.67	0.57
0.125-0.187	409	0.66	0.60	510	0.68	0.62	611	0.73	0.67
0.187-0.250	411	0.73	0.67	512	0.74	0.68	613	0.80	0.73

* Snap-head only

CONTINUED ON PAGE 35

◀

special jaws. Further information on the availability of these items will be issued later. The recommended riveting thicknesses are shown in Table 12.

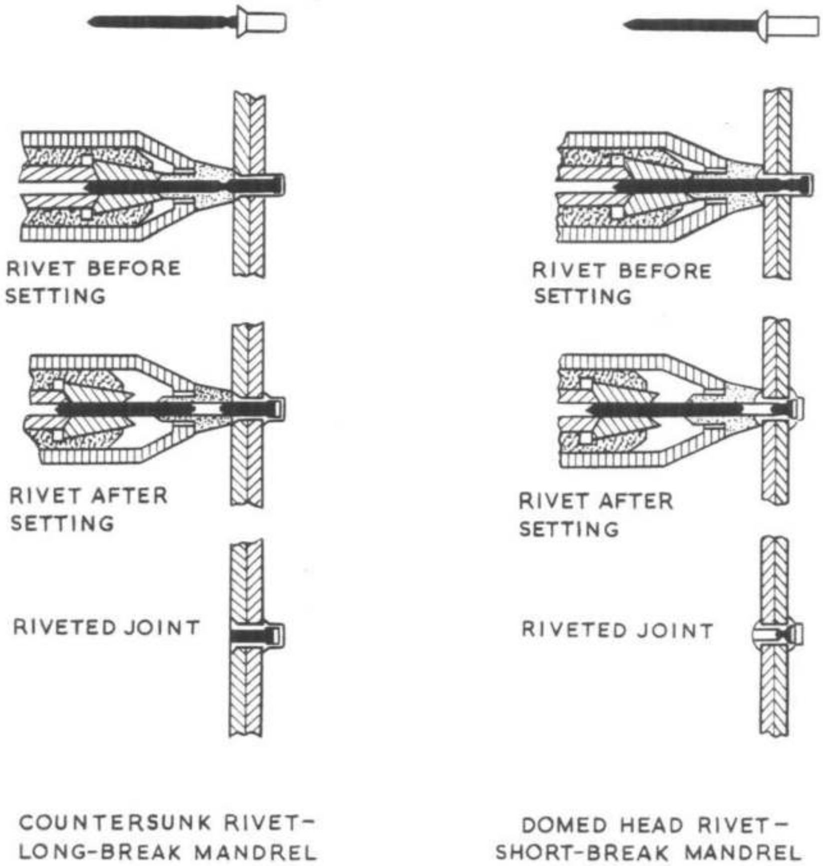


Fig. 21 Setting Imex rivets

91 The recommended drill sizes for 1/8, 5/32 and 3/16 in dia. rivets are 0.128, 0.161 and 0.191 in respectively.

Cherrylock rivets - fitting

92 The installation of the cherrylock and bulbed cherrylock rivet is similar to conventional riveting using an appropriate pulling head.

93 A pictorial representation of the riveting procedure is given in fig. 22 for both the cherrylock and bulbed cherrylock rivets.

Rivet removal tools

Drill guide

94 To prevent drill wander when removing rivet heads, the drill guide shown in fig. 23 has been designed as a simple tool which can be manufactured locally. The belled end should be concentric with the main bore and to achieve this the guide should be spun in a lathe to the correct form. The bellings should also permit the tool to fit snugly around the rivet head, otherwise the purpose of the tool is lost and it would be less effective than centre-punching before drilling. The material used will depend upon the anticipated life of the tool, light-alloy tube is adequate for the removal of a few rivet heads but case-hardened steel tubing is preferable for extended use. On application it is essential to hold the drill at right-angles to the face of the work to avoid canting the drill centring tube.

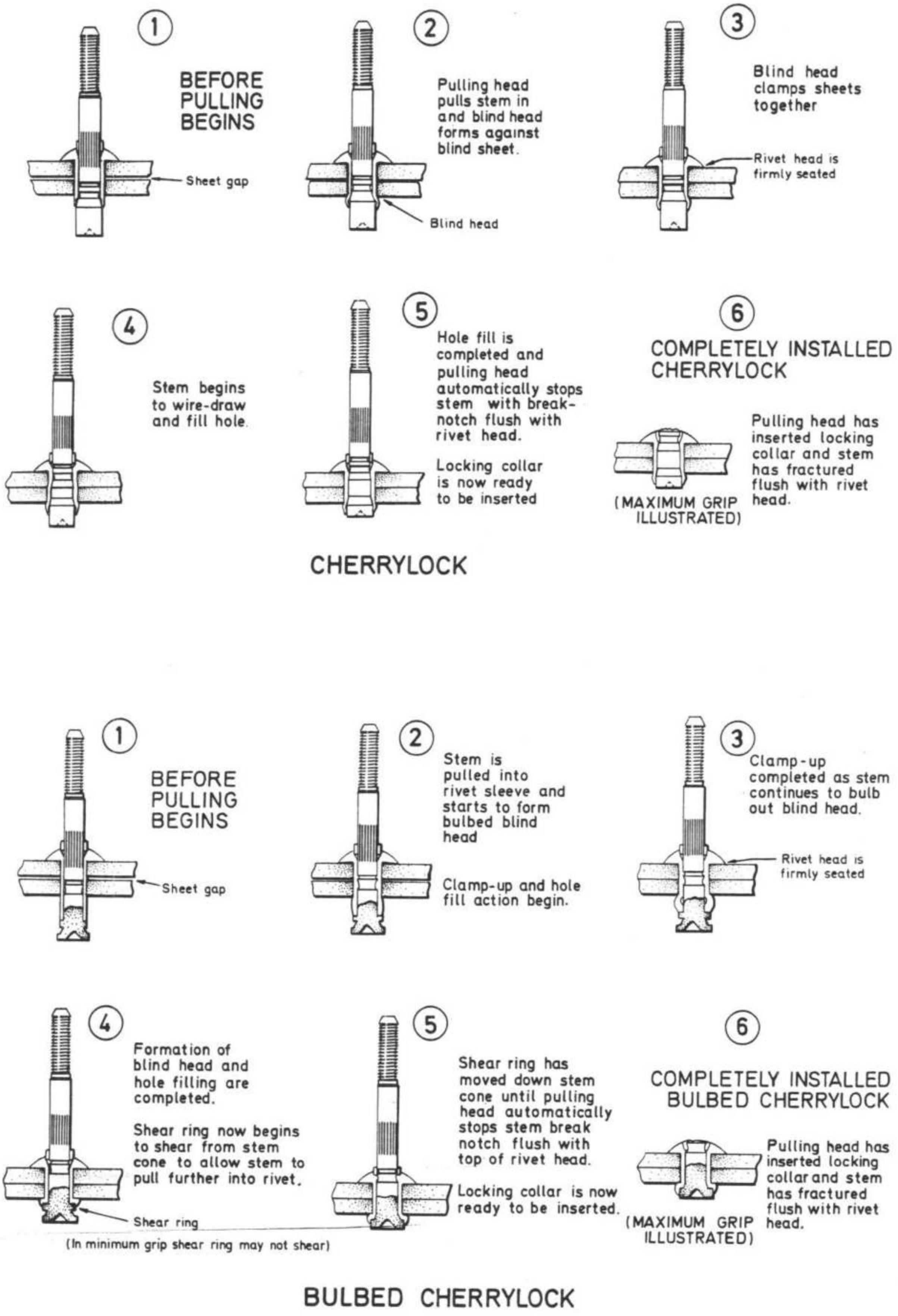


Fig. 22 Cherrylock riveting procedure

TABLE 12 RECOMMENDED RIVETING THICKNESS FOR IMEX RIVETS

Thickness of material (in)	Rivet diameter 1/8 in	5/32 in	3/16in
0.375			
0.343			612
0.312			612
0.281	410	510	
0.250	410	510	
0.218			68
0.187			68
0.156	46	56	
0.125	46	56	
0.093	44	54	64
0.062	44	54	64
0.031	42		
	Rivet code numbers		

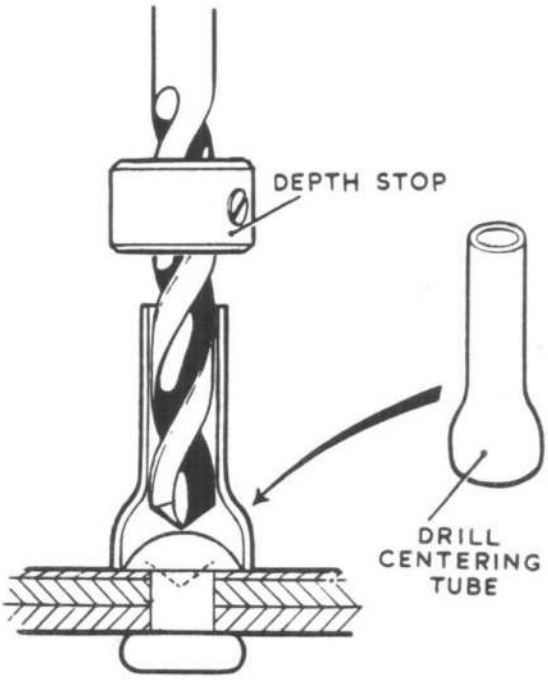


Fig. 23 Rivet removal

Drill depth stop

95 A drill depth stop is desirable whenever a drill centring tube is used; it should be set in such a manner that after drilling the head, the rivet can be removed with a light chisel blow on the side of the rivet head, followed by removing the shank with a parallel pin punch.

96 It may appear to be much quicker to centre-pop rivet heads and drill to a depth estimated by the experience of the operator; this method gives no accurate control of the depth drilled and can easily result in damage to the sheet metal. Using a depth stop and drill centring tube ensures that the sheet metal cannot be penetrated as the face of the sheet is used as a datum when setting the drill stop.

Rivet collector box

97 To avoid the danger of loose rivet shanks remaining in the structure after repair work has been completed, a collector box is recommended; this can take the form of a reaction block bored to permit the passage of a rivet head as it is punched out and counter-bored from the back to hold thirty or forty such rivets. The back of the block can be capped with a lid or a swing plate. Accessibility will determine whether or not the entry passage of the block should be concentric with the block or offset. The face of the block should be relieved to avoid interference with local rivet heads. Under no circumstances should loose rivets or swarf be allowed to remain within sealed compartments; apart from the danger of physical obstruction (e.g. blockage of drainage holes, interference with moving parts), corrosion due to electrolytic action is liable to occur and in the latter instance, swarf, which is metal in the raw state, can be more harmful than a loose rivet which has had a protective treatment applied.

Rivet hole location jig

98 The location of existing rivet holes may need to be transferred to a new repair skin which overlaps the existing holes. If it is not possible to drill through from the holes which already exist, then a location jig must be improvised; such a jig is illustrated in fig. 24. Although the dimensions will be decided by the particular application, 16 s.w.g. mild steel strip, case-hardened locally at the pilot hole will normally provide a satisfactory drill guide. The locating pin should be tapered and radiused to permit easy location and it must be smoothly finished at both ends to avoid scratching any protective treatment. The packing piece should be equal to the maximum gauge of material on which the tool may be used.

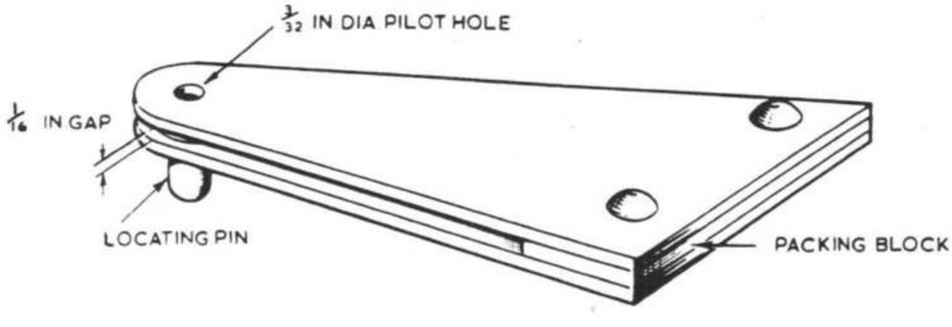


Fig. 24 Location jig

Oversize rivet holes

99 If any rivet hole is found to be enlarged, as indicated by a loose rivet, or shows signs of cracks around the edges, or a hole is enlarged during the drilling-out operations on any rivets for repair purposes, the repair information given in the relevant aircraft Vol. 6 usually contains approved authorization for the hole to be enlarged up to 1/32 in more than its original diameter and also for a correspondingly larger rivet to be fitted as a replacement. When enlarging existing rivet holes, they must be carefully reamed to the required size, which must ensure that all cracks are entirely removed from the edges of the holes. Usually rivet holes can be enlarged once only, but if there is sufficient landing and thickness of material for the larger rivet, however, a second enlargement is possible.

Squeeze riveting

100 Squeeze riveting is a method of setting solid rivets which is used chiefly in aircraft construction for such operations as the riveting of spar web plates to spar booms, stiffeners to webs, or at other locations where the work lends itself to complete jigging. The process applies a steady pressure to the rivet and will swell even the longest rivets throughout their length; the parts must be clamped together before full pressure is developed, because if any gap exists between the parts, the rivet shank may be extruded into it and prevent the parts from being drawn together.

101 The drive head of the rivet is usually contained in a snap or cup, but this allows a very high compressive stress to be developed in the shank and causes the metal round the hole to be stretched excessively unless the load is limited. A flat head instead of a snap is recommended for the driven head unless the snap is required to centre the head on the rivet, but in such instances, the snap should not contact the part being riveted.

102 On thin sheets of low tensile, it is not unusual for squeeze rivets to stretch the hole by as much as 20 per cent; there is no advantage in so much expansion of the rivet shank and it would cause distortion in many assemblies. In small parts, the rivet shank may be permitted to swell the hole by about 10-15 per cent of the shank diameter, but in parts which have rows of rivets, the percentage must be much less, as the cumulative stretching effect causes serious distortion. It is important that very long rivets should be close fits in their holes, as otherwise, when driven, they will bend instead of compressing uniformly.

103 Most squeeze riveting machines are operated by compressed air, either directly or through the medium of a hydraulic intensifier. Various types of machine are used, ranging from hand tools such as the scissors and yoke type, to pedestal-mounted machines such as the BIF and FMA squeeze riveting machines used by aircraft constructors.

104 Another type of squeeze riveting machine is the De Bergue. De Bergue riveting was originally adopted for the manufacture of the structural components of all-metal air-frames, but it is now used chiefly for the construction of aircraft fuel and oil tanks where thin sheets have to be jointed together to form the shell and baffles.

105 The riveting process is similar for all these machines. The holes for the rivets are pre-drilled, except for the fully-automatic FMA machine, which drills the hole immediately before inserting the rivet. A rivet is inserted into the hole and placed between the punch and anvil on the riveting

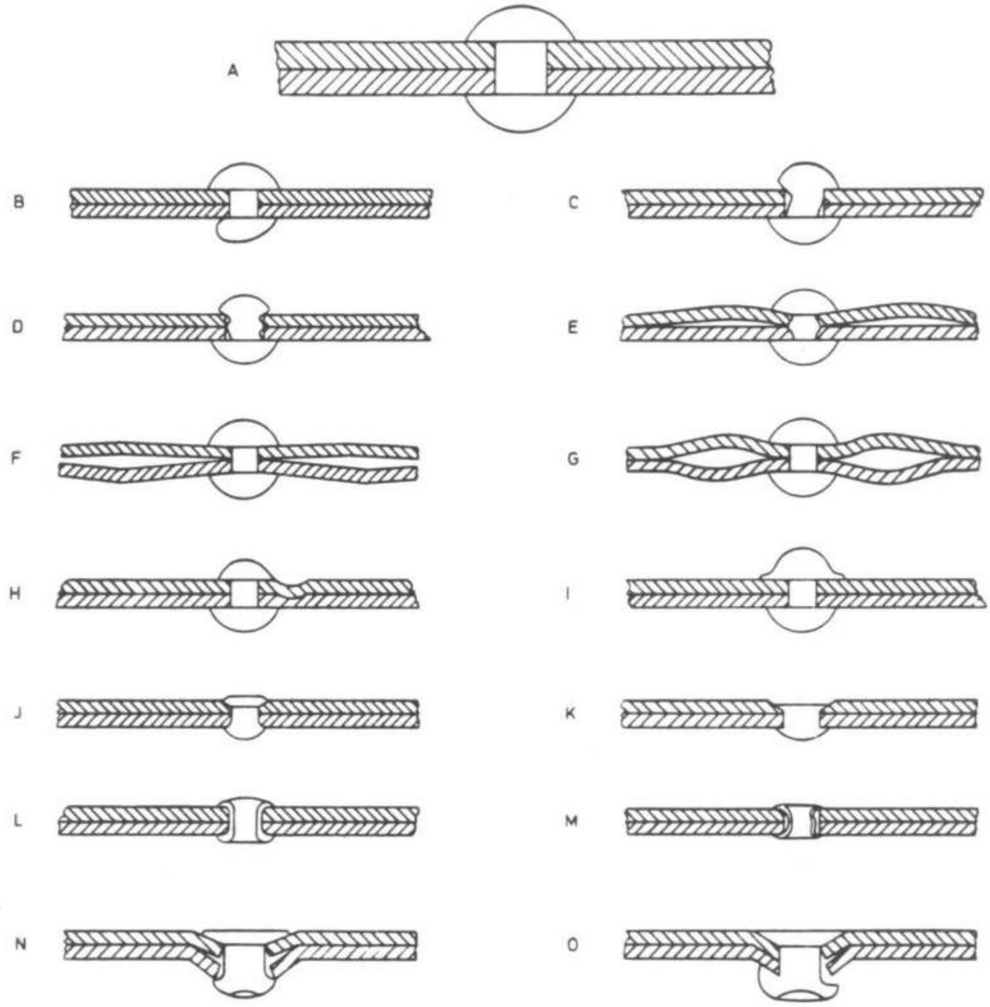
machine. The anvil is usually cup-shaped to centre the rivet tail, and has a rim which meets the under surface of the work; the work is supported by this rim while the punch forces the rivet head into the work and dimples it and, simultaneously, the anvil forms the driven head on the rivet tail.

Inspection of riveting

106 Some typical riveting faults are illustrated in fig. 25. Slackness of a rivet is indicated by the cracking of the paintwork over it and, if oil is present, by oil stains on the paintwork; the cracked paint and the oil stain combine to make the defect appear more serious than it really is. Proof-loading tests should be made on the mandrels of placed Avdel rivets with an Avdel pin tester.

TABLE 13 CONVERSION TABLE - s.w.g. TO INCHES AND MILLIMETERS

Gauge	Inches	mm
7/0	0.5000	12.700
6/0	0.4640	11.786
5/0	0.4320	10.972
4/0	0.4000	10.160
3/0	0.3720	9.449
2/0	0.3480	8.839
0	0.3240	9.230
1	0.3000	7.620
2	0.2760	7.010
3	0.2520	6.401
4	0.2320	5.893
5	0.2120	5.385
6	0.1920	4.877
7	0.1760	4.470
8	0.1600	4.064
9	0.1440	3.658
10	0.1280	3.251
11	0.1160	2.946
12	0.1040	2.642
13	0.0920	2.337
14	0.0800	2.032
15	0.0720	1.829
16	0.0640	1.626
17	0.0560	1.422
18	0.0480	1.219
19	0.0400	1.016
20	0.0360	0.914
21	0.0320	0.813
22	0.0280	0.711
23	0.0240	0.610
24	0.0220	0.559
25	0.0200	0.508
26	0.0180	0.457
27	0.0164	0.417
28	0.0148	0.376
29	0.0136	0.345
30	0.0124	0.315
31	0.0116	0.295
32	0.0180	0.274
33	0.0100	0.254
34	0.0092	0.234
35	0.0084	0.213
36	0.0076	0.193
37	0.0068	0.173
38	0.0060	0.152
39	0.0052	0.132
40	0.0048	0.122
41	0.0044	0.112
42	0.0040	0.102
43	0.0036	0.091
44	0.0032	0.081
45	0.0028	0.071
46	0.0024	0.061
47	0.0020	0.051
48	0.0016	0.041
49	0.0012	0.030
50	0.0010	0.025



A Properly driven rivet

B Rivet driven correctly, dolly head at slant

C Rivet driven at slant

D Weak head and leakage, hole too large

E Rivet not pulled tight, clinches between plates

F Rivet tight, plates bulged because of poor fit

G Overdriven rivet, rivet body and plates clinched too much

H Rivet struck incorrectly, damaged plate

I Rivet too long, damaged rivet, too may blows

J Countersink too shallow, weak joint, not flush unless filed

K Countersink too deep, plates not held up, leakage

L Tubular rivet too short, weak head

M Hole too large, tubular rivet buckled. Weak joint

N Semi-tubular rivet not properly closed, incorrect pressure, machine settings, or rivet size

O Semi-tubular rivet driven at slant or elongated hole

Fig. 25 Typical faults in riveted joints

TABLE 14 TWIST DRILL SIZES

Old drill gauge and letter size		British Standard (international) series		
OLD SIZE	Decimal equivalent	NEW SIZE		Decimal equivalent
	in	mm	in	in
80	0.0135	0.35		0.0138
79	0.0145	0.38		0.0150
78	0.0160	0.40		0.0157
77	0.0180	0.45		0.0177
76	0.0200	0.50		0.0197
75	0.0210	0.52		0.0205
74	0.0225	0.58		0.0228
73	0.0240	0.60		0.0236
72	0.0250	0.65		0.0256
71	0.0260	0.65		0.0256
70	0.0280	0.70		0.0276
69	0.0292	0.75		0.0295
68	0.0310		1/32	0.0312
67	0.0320	0.82		0.0323
66	0.0330	0.85		0.0334
65	0.0350	0.90		0.0354
64	0.0360	0.92		0.0362
63	0.0370	0.95		0.0374
62	0.0380	0.98		0.0386
61	0.0390	1.00		0.0394
60	0.0400	1.00		0.0394
59	0.0410	1.05		0.0413
58	0.0420	1.05		0.0413
57	0.0430	1.10		0.0433
56	0.0465		3/64	0.0469
55	0.0520	1.30		0.0512
54	0.0550	1.40		0.0551
53	0.0595	1.50		0.0591
52	0.0635	1.60		0.0630
51	0.0670	1.70		0.0669
50	0.0700	1.80		0.0709
49	0.0730	1.85		0.0728
48	0.0760	1.95		0.0768
47	0.0785	2.00		0.0787
46	0.0810	2.05		0.0807

TABLE 14 TWIST DRILL SIZES (continued)

Old drill gauge and letter size		British Standard (international) series		
OLD SIZE	Decimal equivalent	NEW SIZE		Decimal equivalent
	in	mm	in	in
45	0.0820	2.10		0.0827
44	0.0860	2.20		0.0866
43	0.0890	2.25		0.0886
42	0.0935		3/32	0.0938
41	0.0960	2.45		0.0965
40	0.0980	2.50		0.0984
39	0.0995	2.55		0.1004
38	0.1015	2.60		0.1024
37	0.1040	2.65		0.1043
36	0.1065	2.70		0.1063
35	0.1100	2.80		0.1102
34	0.1110	2.80		0.1102
33	0.1130	2.85		0.1122
32	0.1160	2.95		0.1161
31	0.1200	3.00		0.1181
30	0.1285	3.30		0.1299
29	0.1360	3.50		0.1378
28	0.1405		9/64	0.1406
27	0.1440	3.70		0.1457
26	0.1470	3.70		0.1457
25	0.1495	3.80		0.1496
24	0.1520	3.90		0.1535
23	0.1540	3.90		0.1535
22	0.1570	4.00		0.1575
21	0.1590	4.00		0.1575
20	0.1610	4.10		0.1614
19	0.1660	4.20		0.1654
18	0.1695	4.30		0.1693
17	0.1730	4.40		0.1732
16	0.1770	4.50		0.1772
15	0.1800	4.60		0.1811
14	0.1820	4.60		0.1811
13	0.1850	4.70		0.1850
12	0.1890	4.80		0.1890
11	0.1910	4.90		0.1929
10	0.1935	4.90		0.1929
9	0.1960	5.00		0.1968
8	0.1990	5.10		0.2008
7	0.2010	5.10		0.2008
6	0.2040	5.20		0.2047

TABLE 14 TWIST DRILL SIZES (continued)

Old drill gauge and letter size		British Standard (international) series		
OLD SIZE	Decimal equivalent	OLD SIZE		Decimal equivalent
	in	mm	in	in
5	0.2055	5.20		0.2047
4	0.2090	5.30		0.2087
3	0.2130	5.40		0.2126
2	0.2210	5.60		0.2205
1	0.2280	5.80		0.2283
A	0.2340		15/64	0.2344
B	0.2380	6.00		0.2362
C	0.2420	6.10		0.2402
D	0.2460	6.20		0.2441
E	0.2500		1/4	0.2500
F	0.2570	6.50		0.2559
G	0.2610	6.60		0.2598
H	0.2660		17/64	0.2656
I	0.2720	6.90		0.2717
J	0.2770	7.00		0.2756
K	0.2810		9/32	0.2812
L	0.2900	7.40		0.2913
M	0.2950	7.50		0.2953
N	0.3020	7.70		0.3031
O	0.3160	8.00		0.3150
P	0.3230	8.20		0.3228
Q	0.3320	8.40		0.3307
R	0.3390	8.60		0.3386
S	0.3480	8.80		0.3465
T	0.3580	9.10		0.3583
U	0.3680	9.30		0.3661
V	0.3770		3/8	0.3750
W	0.3860	9.80		0.3858
X	0.3970	10.10		0.3976
Y	0.4040	10.30		0.4055
Z	0.4130	10.50		0.4134

TABLE 15 FRACTIONS OF AN INCH TO DECIMALS OF AN INCH AND TO MILLIMETRES

Inch		Millimetre
1/64	0.015 625	0.396 875
1/32	0.031 250	0.793 750
3/64	0.046 875	1.190 625
1/16	0.062 500	1.587 500
5/64	0.078 125	1.984 375
3/32	0.093 750	2.381 250
7/64	0.109 375	2.778 125
1/8	0.125 000	3.175 000
9/64	0.140 625	3.571 875
5/32	0.156 250	3.968 750
11/64	0.171 875	4.365 625
3/16	0.186 500	4.762 500
13/64	0.203 125	5.159 375
7/32	0.218 750	5.556 250
15/64	0.234 375	5.953 125
1/4	0.250 000	6.350 000
17/64	0.265 625	6.746 875
9/32	0.281 250	7.143 750
19/64	0.296 875	7.540 625
5/16	0.312 500	7.937 500
21/64	0.328 125	8.334 375
11/32	0.343 750	8.731 250
23/64	0.359 375	9.128 125
3/8	0.375 000	9.525 000
25/64	0.390 625	9.921 875
13/32	0.406.250	10.318 750
27/64	0.421 875	10.715 625
7/16	0.437 500	11.112 500
29/64	0.453 125	11.509 375
15/32	0.468 750	11.906 250
31/64	0.484 375	12.303 125
1/2	0.500 000	12.700 000
33/64	0.515 625	13.096 875

Inch		Millimetre
17/32	0.531 250	13.493 750
35/64	0.546 875	13.890 625
9/16	0.562 500	14.287 500
37/64	0.578 125	14.684 375
19/32	0.593 750	15.081 250
39/64	0.609 375	15.478 125
5/8	0.625 000	15.875 000
41/64	0.640 625	16.271 875
21/32	0.646 250	16.668 750
43/64	0.671 875	17.065 625
11/16	0.687 500	17.462 500
45/64	0.703 125	17.859 375
23/32	0.718 750	18.256 250
47/64	0.734 375	18.653 125
3/4	0.750 000	19.050 000
49/64	0.765 625	19.446 875
25/32	0.781 250	19.843 750
51/64	0.796 875	20.240 625
13/16	0.812 500	20.637 500
53/64	0.828 125	21.034 375
27/32	0.843 750	21.431 250
55/64	0.859 375	21.828 125
7/8	0.875 000	22.225 000
57/64	0.890 625	22.621 875
29/32	0.906 250	23.018 750
59/64	0.921 875	23.415 625
15/16	0.937 500	23.812 500
61/64	0.953 125	24.209 375
31/32	0.968 750	24.606 250
63/64	0.984 375	25.003 125
1	1.000 000	25.400 000

Note ... All values in this table are exact.

Chapter 2

IDENTIFICATION OF RIVETS

CONTENTS

Para

Introduction

1 This chapter describes the methods of visual identification and the code systems employed for rivets used on aircraft; information concerning the riveting processes involved is given in Chapter 1. Some types of rivet are used only by the aircraft constructors and are not provided for the repair of aircraft by Service personnel; an example of this is the LAR semi-tubular rivet, a brief description of which is included in this chapter for identification purposes.

TYPES OF RIVETS

2 Rivets are supplied in various types, sizes and materials, to suit different requirements. Those used in the construction and repair of metal aircraft structures may be divided into three classes as follows:-

2.1 Solid rivets.

2.2 Blind rivets.

2.3 Tubular rivets.

3 Solid rivets are manufactured to drawings issued by the SBAC (Society of British Aerospace Companies), but are likely to be superseded by drawings issued by the BSI (British Standards Institution). Light alloy rivets are dyed to conform with a pre-determined colour scheme laid down for certain materials and/or are marked with letters or symbols on either their heads or tails; rivets made from other materials are either cadmium plated or self-colour, but bear no standard markings.

4 Blind rivets are manufactured to AGS (Aircraft General Standards) drawings and include the Tucker and Chobert types, which are widely used due to the ease and speed with which they can be placed. Both types utilize the colour identification only and both types are hollow, but Chobert rivets may be plugged, after fitment, to ensure water-tightness and/or to increase their strength. A restriction on the use of Tucker rivets is given in para. 33.

The proprietary Avdel self-sealing rivet is also used for blind riveting.

5 Tubular rivets, which are also made to AGS drawings, are used chiefly on hollow or tubular members where the use of solid rivets is impracticable, or where there is more likelihood of the sheet metal tearing than of the rivet breaking under stress. Distance pieces should be fitted between the inner surfaces of the metal sheets, in line with the rivet holes, to prevent the structure being crushed or distorted when closing the rivets. The colour code used is the same as for solid rivets. In addition to the conventional tubular rivets, there are split-tubular rivets which are made from sheet material to AGS drawings, and semi-tubular (LAR or TST) rivets which are of proprietary manufacture; the identification colours for split-tubular rivets, and for semi-tubular rivets in aluminium alloy, are the same as for the conventional type, but any semi-tubular rivets in aluminium alloy to BS.L36 are natural or self-colour.

IDENTIFICATION OF RIVETS

6 The identification of various types of rivets used in the construction and repair of aircraft structures is achieved by observing the clues existing on the rivets themselves, which will show the shank diameter, rivet length, type of head, material from which the rivets are made, the types of rivets being inspected, e.g. solid, tubular or hollow pop type, and the colour stain on the rivets.

7 The information obtained from the visual check of the rivets should then be applied to the code systems employed for aircraft rivets under the AS (Aircraft Standards), BS (British Standards) and AGS (Aircraft General Standards) specifications and drawings, which will enable the required rivets to be demanded by the correct Sect. 28Q reference number AP 1086. Examples of the application of identification code systems are given in para. 15 et seq.

ANGLES OF COUNTERSUNK-HEAD RIVETS

90 and 120 deg heads

8 90 and 120 deg countersunk-head rivets are referenced in AP 1086, Sect. 28Q to meet the repair requirements of existing aircraft which have these rivets fitted by the manufacturer. They are made to approved AS and AGS specification drawings which are revised periodically, thus allowing AS drawings to be superseded by, or adsorbed into, the BS range, if appropriate. When this occurs, the alteration to the drawing number is recorded and the publication amended accordingly.

100 deg head

9 A range of 100 deg precision-head countersunk rivets has been designed with manufacturing tolerances, on head and shank dimensions, which are more accurate than those of the normal rivet (e.g. AS 162) but less accurate than those of the existing close-tolerance rivets in the AS series. These are now referenced in AP 1086, Sect. 28Q. Rivets to the new design, issued to BS and SBAC specifications, conform with a tripartite agreement between the Air Forces of America, Britain and Canada for future use in aircraft. Within the terms of this agreement, provision is also made for a 60 deg. rivet to be used, if required, for special applications. The existing stocks of 90 and 120 deg countersunk rivets will be maintained to meet the construction and repair requirements of existing types of Service aircraft.

SOLID RIVETS

GENERAL

10 Solid rivets used for the construction and repair of metal aircraft structures are manufactured from a number of specified metals and are provided in several different types of head formation as shown in fig. 1. The rivets are made to BS (British Standards) and SBAC (Society of British Aerospace Companies) specification drawings, the SBAC drawings forming part of the AS (Air Standards) series, and the BS drawings part of the SP (Standard Parts) series.

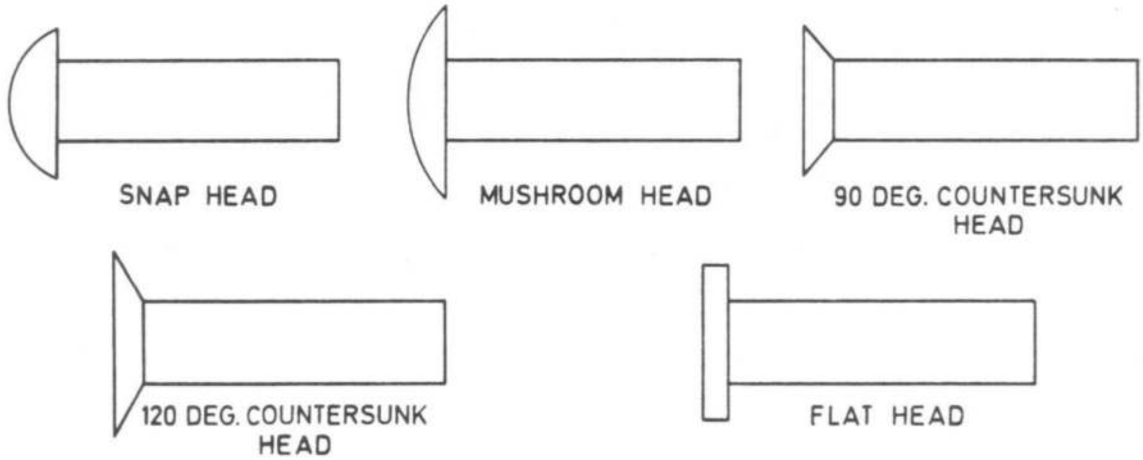


Fig. 1 Solid rivets : examples of head formation

11 The Tables contained in this Chapter indicate the type, material, diameter and length of the rivets usually required for repair work. The majority of the rivets are referenced in AP 1086, Sect. 28Q, but some of those listed in the revised range of rivets introduced by SDM(A) I.S.192 to meet future aircraft requirements, may not yet be referenced. If any of these rivets are required for specific repairs before the vocabulary has been amended, demands should be submitted as Section 28Q/NIV, quoting the appropriate BS or SBAC code numbers to identify them.

IDENTIFICATION OF SOLID RIVETS

12 The identification code for any solid rivet consists of the AS drawing number (SBAC Series) or the SP drawing number (BS Series) which denotes the type of rivet and the material from which it is made, followed by a part number; the first figure (or, for rivets greater than 9/32 in diameter, the first two figures) of the part number will indicate the diameter of the rivet expressed in thirty-seconds of an inch and the last two figures will denote the length of the rivet in sixteenths of an inch. Thus in the AS range, 'AS 155/824' is a snap-head rivet made of aluminium to BS. L36, with anodized finish, $\frac{1}{4}$ in diameter and $1\frac{1}{2}$ in long; 'AS 2229/-1010' is a 90 deg. ▶ countersunk-head rivet made of aluminium alloy to BS. L86, 5/16 in diameter ◀

and ⅝ in long; 'AS 465/404' is a 120 deg. countersunk-head rivet made of monel metal to DTD 204, ⅛ in diameter and ¼ in long: 'AS 158/815' is a mushroom-head rivet made of aluminium alloy to BS. L37, ¼ in diameter and 15/16 in long and 'AS 455/1248' is a snap-head rivet made of mild steel to BS. 1109, ⅜ in diameter and 3 in long.

13 In the SP range the code number 'SP. 69/410' will identify the rivet as a 100 deg. countersunk precision-head rivet made of aluminium alloy to BS.4 L37, ⅛ in diameter and ⅝ in long, while 'SP. 76/1214' is a snap-head rivet made of mild steel to BS. 1109, ⅜ in diameter and ⅞ in long.

14 The identification code system used for all close tolerance rivets is similar to that used to identify normal solid rivets in the AS series, but introduces additional, intermediate lengths (see para. 17).

Note ...

The length of a snap, mushroom or flat-head rivet is measured from the tail of the shank to below the head, but the length of a countersunk-head rivet is measured from the tail of the shank to the upper face of the head.

Identification colours and marks

15 The materials from which light-alloy, solid rivets are made is identified by the colour in which the rivets have been dyed and also by the marks made on their heads or tails. Only three colours are used, namely, black to identify rivets of all range sizes made from BS. L36, green for L58 and ▶ violet for L86. Material to BS. 4L37 is not coloured but left plain. ◀

16 Mild steel rivets to BS. 1109 are cadmium-plated and those of the high chromium-copper alloys to DTD 204 or 10 (monel metal) are plain, unplated or cadmium-coated, the coating giving the rivets a greyish appearance.

17 The number or letter marks on the heads or tails of rivets are an added means of identity; the complete range of both AS and SP rivet markings are given in Tables 1 and 2. Identification data relating to the various types of solid rivets are shown in fig. 2 to 14; their associated part identification numbers are given in Tables 3 to 14.

18 Apart from the AS numbers, the identification code system used for solid rivets made of mild steel, monel, tungum and copper, is the same as that for solid rivets made of aluminium and aluminium alloy materials, but the rivets themselves bear no identification colouring or identification marking. Tungum and copper solid rivets bear no protective finish but can be identified by their natural colours; mild steel and monel solid rivets are cadmium coated, but the mild steel rivets are strongly magnetic and so can be readily distinguished from the monel ones which are only slightly magnetic. Every care should,however, be taken to keep the rivets in their packets or to provide some other means of identification once they have been removed from their packets; a small tray or box, clearly labelled, might be useful in this respect.

Close tolerance rivets

19 Close tolerance rivets are made of duralumin to BS.L37 and aluminium ▶ alloy to BS.L86; the duralumin rivets are self colour and the aluminium alloy ◀ rivets are anodized and dyed violet, but neither bears any other identification

TABLE 1 IDENTIFICATION OF SOLID RIVETS TO SBAC SPECIFICATIONS

AS No.	Material specification	Material	Head formation	Colour or finish	Mark on rivet head or tail
155	BS.L36	Aluminium	Snap	Black	A
156	BS.L37	Aluminium alloy	Snap	Natural	D
157	BS.L58	Aluminium alloy (Mag.5)	Snap	Green	X
158	BS.L37	Aluminium alloy	Mushroom	Natural	D
159	BS.L58	Aluminium alloy (Mag.5)	Mushroom	Green	X
160	BS.L36	Aluminium	90 deg. csk.	Black	A
161	BS.L37	Aluminium alloy	90 deg. csk.	Natural	D
162	BS.L58	Aluminium alloy (Mag.5)	90 deg. csk.	Green	X
163	BS.L36	Aluminium	120 deg. csk.	Black	A
164	BS.L37	Aluminium alloy	120 deg. csk.	Natural	D
165	BS.L58	Aluminium alloy (Mag.5)	120 deg. csk.	Green	X
455	BS.1109	Mild steel	Snap	Cadmium plating	-
457	DTD.204	High Ni.Cu. alloy (Monel metal)	Snap	Natural	-
458		Tungum	Snap	Natural	-
459		Copper	Snap	Natural	-
460	BS.1109	Mild steel	90 deg. csk.	Cadmium plating	-
462	DTD.204	High Ni.Cu. alloy (Monel metal)	90 deg. csk.	Natural	-
463	BS.1109	Mild steel	120 deg. csk.	Cadmium coating	-
465	DTD.204	High Ni.Cu.alloy (Monel metal)	120 deg. csk.	Natural	-

TABLE 1 IDENTIFICATION OF SOLID RIVETS TO SBAC SPECIFICATIONS (continued)

AS No.	Material specification	Material	Head formation	Colour or finish	Mark on rivet head or tail
466		Tungum	90 deg. csk.	Natural	-
467		Copper	90 deg. csk	Natural	-
468		Tungum	120 deg. csk.	Natural	-
469		Copper	Flat	Natural	-
2227	BS.L86	Aluminium alloy	Snap	Violet	S
2228	BS.L86	Aluminium alloy	Mushroom	Violet	S
2229	BS.L86	Aluminium alloy	90 deg. csk.	Violet	S
2230	BS.L86	Aluminium alloy	120 deg. csk.	Violet	S
2918	BS.L37	Aluminium alloy	90 deg. csk. (close tolerance)	Natural	D
2919	BS.L37	Aluminium alloy	120 deg. csk. (close tolerance)	Natural	D
3362	BS.L86	Aluminium alloy	90 deg. csk. (close tolerance)	Violet	S
3363	BS.L86	Aluminium alloy	120 deg. csk. (close tolerance)	Violet	S
4694	DTD.204	High Ni. Cu.alloy (Monel metal)	Snap	Cadmium plating	-
4695	DTD.204	High Ni. Cu.alloy (Monel metal)	90 deg. csk.	Cadmium plating	-
4696	DTD.204	High Ni. Cu.alloy (Monel metal)	120 deg. csk.	Cadmium plating	-

TABLE 2 IDENTIFICATION OF SOLID RIVETS TO BS SPECIFICATIONS

SP No.	Material specification	Material	Head formation	Colour or finish	Mark on rivet head or tail
68	BS.L36	Aluminium	100 deg.csk.	Black	-
69	BS.4L 37*	Aluminium alloy	100 deg.csk.	Natural	7
70	BS.L58	Aluminium alloy (Mag.5)	100 deg.csk.	Green	8
71	BS.L86	Aluminium alloy	100 deg.csk.	Violet	0
76	BS.1109	Mild steel	Snap	Cadmium plating	-
77	BS.L36	Aluminium	Snap	Black	1
78	BS.4L37	Aluminium alloy	Snap	Natural	7
79	BS.L58	Aluminium alloy (Mag.5)	Snap	Green	8
80	BS.L86	Aluminium alloy	Snap	Violet	0
81	DTD.204	High Ni.Cu. alloy (Monel metal)	Snap	Natural	M
82	DTD.204	High Ni.Cu. alloy (Monel metal)	Snap	Cadmium plating	M
83	BS.4L37*	Aluminium alloy	Mushroom	Natural	7
84	BS.L58	Aluminium alloy (Mag.5)	Mushroom	Green	8
85	BS.L86	Aluminium alloy	Mushroom	Violet	0
86	BS.1109	Mild steel	100 deg.csk.	Cadmium plating	-
87	DTD.204	High Ni.Cu.alloy	100 deg.csk.	Natural	M
88	DTD.204	High Ni.Cu.alloy	100 deg.csk	Cadmium plating	M

*Note ...

A departure from the accepted convention of not quoting the issue prefix of a standard is necessary in the starred items. This is occasioned by the identification markings, given in Table 2, differing from those applied to rivets manufactured in accordance with AS drawings (Table 1). This is of particular importance in relation to rivets made from L37 material in view of the revision of British Standard 3L37 to change from the 'L1' to the 'L64' type of composition. Because of that change, the use of 4L37 material is specifically required by these rivet standards given in the Tables contained in fig. 8 to 14 inclusive

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
160	BS.L36	Aluminium	Black	A	6
161	BS.4L37	Aluminium alloy	Natural	D	5
162	BS.L58	Aluminium alloy (Mag.5)	Green	X	5
460	BS.1109	Mild steel	Cad. pl.	-	4
462	DTD.204	High Ni-Cu alloy (Monel metal)	Natural	-	5
467	-	Copper	Natural	-	6
2229	BS.L86	Aluminium alloy	Violet	S	5
4695	DTD.204	High Ni-Cu alloy (Monel metal)	Cad. pl.	-	5

Dimensions

Nominal size of rivet (in)	Head dia. A (in)	Head depth B (in)	Shank dia. D (in)
1/16	0.115	0.029	0.062
3/32	0.170	0.041	0.094
1/8	0.225	0.053	0.125
5/32	0.279	0.065	0.156
3/16	0.334	0.077	0.187
7/32	0.387	0.091	0.219
1/4	0.444	0.103	0.250
5/16	0.555	0.128	0.312
3/8	0.666	0.156	0.375

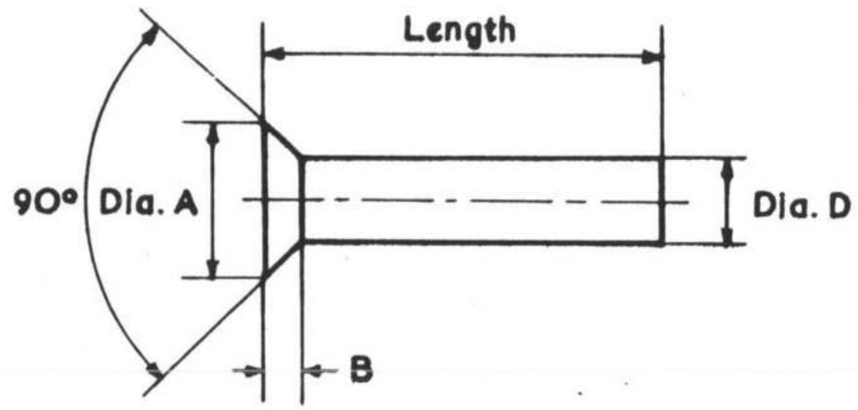


Fig. 2 90 deg. countersunk-head rivets (AS series)

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
163	BS.L36	Aluminium	Black	A	6
164	BS.L37	Aluminium alloy	Plain	D	5
165	BS.L58	Aluminium alloy (Mag.5)	Green	X	5
463	BS.1109	Mild steel	Cad. pl.	-	5
465	DTD.204	High Ni-Cu alloy (Monel metal)	Plain	-	5
2230	BS.L86	Aluminium alloy	Violet	S	5
4696	DTD.204	High Ni-Cu alloy (Monel metal)	Cad. pl.	None	5

Dimensions

Nominal size of rivet (in)	Head dia. A (in)	Head depth B (in)	Shank dia. D (in)
1/16	0.131	0.027	0.062
3/32	0.193	0.036	0.094
1/8	0.256	0.045	0.125
5/32	0.318	0.056	0.156
3/16	0.381	0.064	0.187
7/32	0.443	0.078	0.219
1/4	0.506	0.088	0.250
5/16	0.633	0.107	0.281
3/8	0.760	0.130	0.312

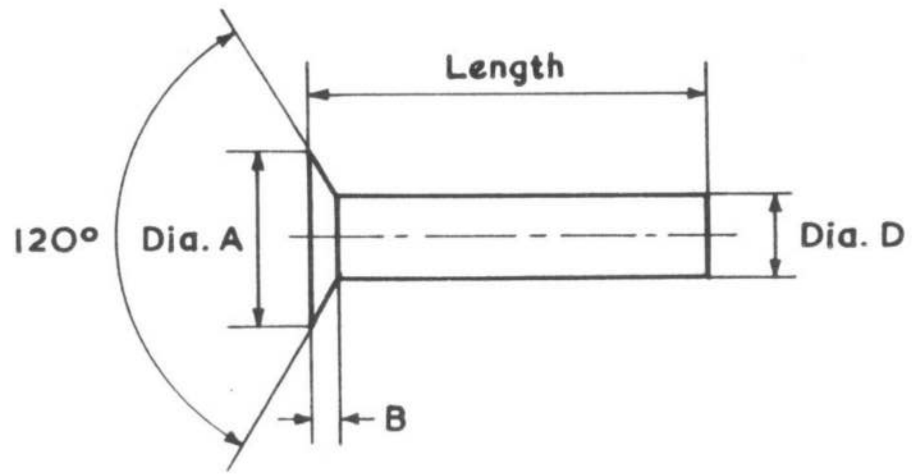


Fig. 3 120 deg. countersunk-head rivets (AS series)

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
158	BS.4L37	Aluminium alloy	Plain	D	5
159	BS.L58	Aluminium alloy (Mag.5)	Green	X	5
2228	BS.L86	Aluminium alloy	Violet	S	5

Dimensions

Nominal size of rivet (in)	Head depth B (in)	Head dia. C (in)	Shank dia. D (in)	Head rad. R (in)
1/16	0.025	0.140	0.062	0.110
3/32	0.038	0.210	0.094	0.170
1/8	0.050	0.280	0.125	0.220
5/32	0.063	0.350	0.156	0.270
3/16	0.075	0.420	0.187	0.330
7/32	0.088	0.490	0.219	0.390
1/4	0.100	0.560	0.250	0.440
5/16	0.125	0.700	0.312	0.550
3/8	0.150	0.840	0.375	0.660

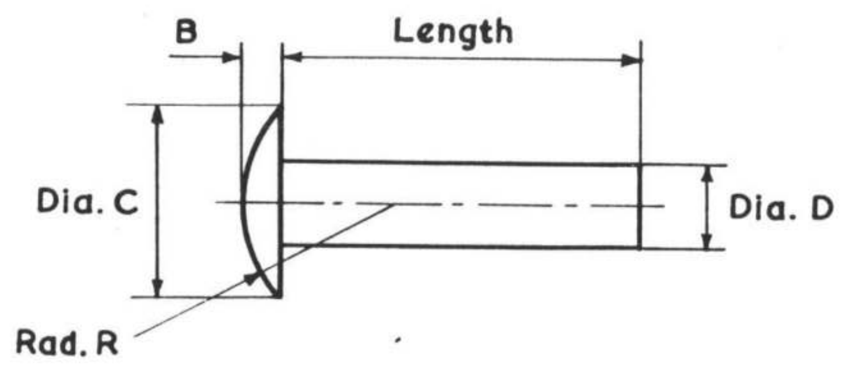


Fig. 4 Mushroom-head rivets (AS series)

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
155	BS.L36	Aluminium	Black	A	3
156	BS.4L37	Aluminium alloy	Plain	D	4
157	BS.L58	Aluminium alloy (Mag.5)	Green	X	4
455	BS.1109	Mild steel	Cad.pl.	-	4
457	DTD.204	High Ni-Cu alloy (Monel metal)	Plain	-	4
459	-	Copper	Natural	-	6
2227	BS.L86	Aluminium alloy	Violet	S	4

Dimensions

Nominal size of rivet (in)	Head depth A (in)	Head dia. B (in)	Shank dia. D (in)	Head rad. R (in)
1/16	0.040	0.110	0.062	0.060
3/32	0.060	0.160	0.094	0.090
1/8	0.080	0.220	0.125	0.120
5/32	0.090	0.270	0.156	0.150
3/16	0.110	0.330	0.186	0.180
7/32	0.130	0.380	0.218	0.210
1/4	0.150	0.440	0.250	0.240
9/32	0.170	0.490	0.281	0.260
5/16	0.190	0.550	0.312	0.290
11/32	0.210	0.600	0.344	0.320
3/8	0.230	0.660	0.375	0.350

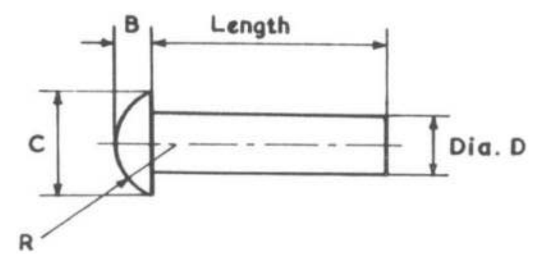
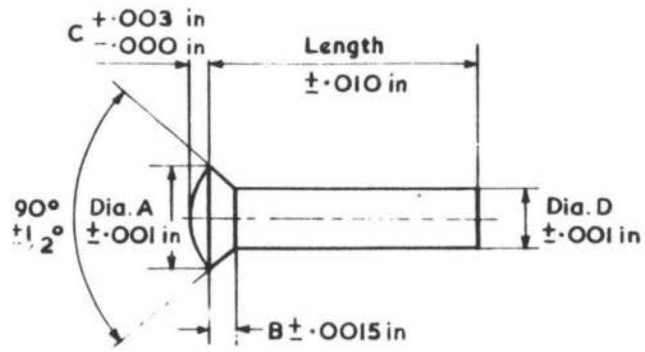


Fig. 5 Snap-head rivets (AS series)

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
2918	BS.L37	Aluminium alloy	Plain	7	7
3362	BS.L86	Aluminium alloy	Violet	9 or 0	7



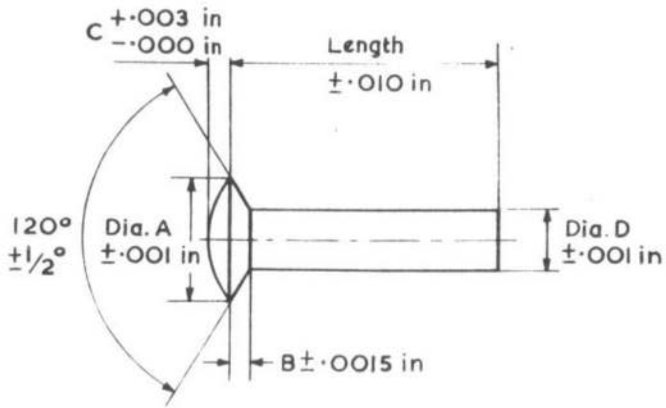
Dimensions

Nominal size of rivet (in)	Head diameter A (in)	Depth B (in)	Depth C (in)	Shank diameter D (in)
3/32	0.157	0.035	0.003	0.094
1/8	0.212	0.046	0.003	0.125
5/32	0.267	0.058	0.003	0.156
3/16	0.322	0.070	0.004	0.187
7/32	0.377	0.082	0.004	0.219
1/4	0.432	0.094	0.005	0.250
9/32	0.487	0.106	0.005	0.281
5/16	0.542	0.118	0.006	0.312

Fig. 6 90 deg. countersunk-head, close tolerance rivets (AS series)

Identification data

AS No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
2919	BS.L37	Aluminium alloy	Plain	7	7
3363	BS.L86	Aluminium alloy	Violet	9 or 0	7



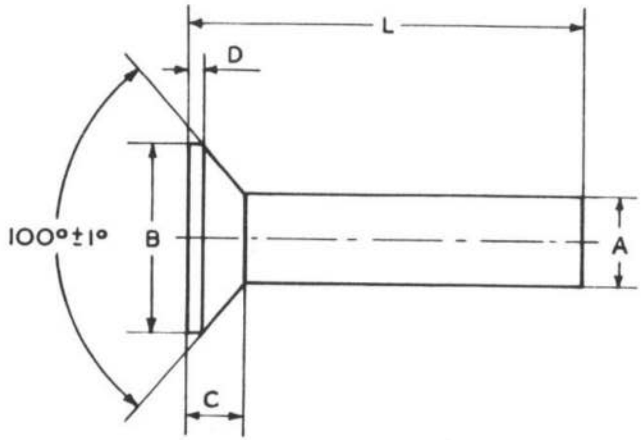
Dimensions

Nominal size of rivet (in)	Head diameter A (in)	Depth B (in)	Depth C (in)	Shank diameter D (in)
3/32	0.177	0.027	0.003	0.094
1/8	0.239	0.036	0.003	0.125
5/32	0.302	0.045	0.003	0.156
3/16	0.364	0.054	0.004	0.187
7/32	0.426	0.063	0.004	0.219
1/4	0.489	0.072	0.005	0.250
9/32	0.552	0.081	0.005	0.281
5/16	0.614	0.090	0.006	0.312

Fig. 7 120 deg. countersunk-head, close tolerance rivets (AS series)

Identification data

SP No.	Material Spec.	Material	Colour	Mark on tail or head of rivet	Table Ref.
68	BS.L36	Aluminium	Black	–	8
69	BS.4L37	Aluminium alloy	Plain	7	8
70	BS.L58	Aluminium alloy (Mag. 5)	Green	8	8
71	BSL86	Aluminium alloy	Violet	9	8



Dimensions

Nominal size of rivet (in)	Shank diameter A (in) max.	Shank diameter A (in) min.	Head diameter B (in) Absolute min.	Depth of head C (in)	Depth of land D (in)
1/16 (0.062)	0.065	0.061	0.104	0.022	0.006
3/32 (0.094)	0.097	0.093	0.164	0.036	0.008
1/8 (0.125)	0.128	0.124	0.208	0.042	0.009
5/32 (0.156)	0.159	0.155	0.267	0.055	0.010
3/16 (0.187)	0.190	0.186	0.329	0.070	0.012
1/4 (0.250)	0.253	0.249	0.445	0.095	0.015
5/16 (0.312)	0.315	0.311	0.526	0.106	0.018
3/8 (0.375)	0.378	0.374	0.650	0.134	0.020

Fig. 8 100 deg. countersunk precision-head, aluminium and aluminium alloy rivets (SP series)

Note . . .

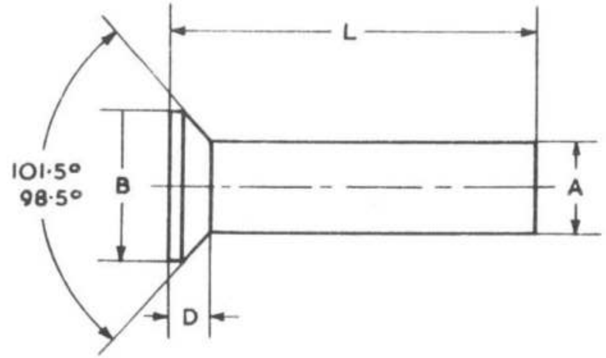
(1) These rivets have precision heads in addition to shank tolerances which lie between those applicable to AS and SP normal and AS close-tolerance rivets, the function of the precision head being that of providing added strength and improved flushness by ensuring a better fit.

(2) The tolerances on the precision head angle, diameter and depth are all closer than those of non-precision head rivets such as those covered by SP.87 and 88. As an example, the overall tolerance on the head diameter of a 1/8 in rivet is 0.007 in in the SP.68 to 71 range and 0.012 in the SP.87 and 88 range.

(3) The maximum and minimum head diameters are controlled in the specification, but only the minimum actual values are quoted.

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
87	DTD.204	High Ni-Cu alloy	Plain	M	9
88	DTD.204	High Ni-Cu alloy	Cad.pl.	M	9



Dimensions

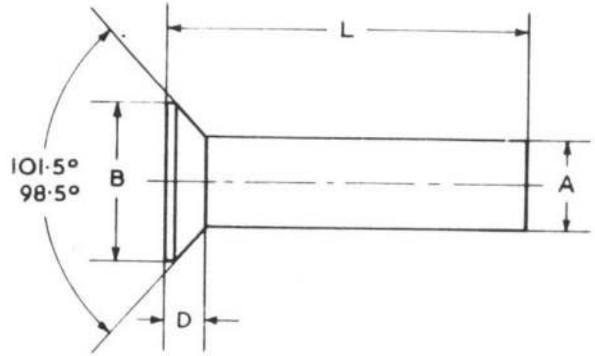
Nominal size of rivet (in)	Shank diameter A (in)		Head diameter B (in) Absolute min.	Depth of head D (in)
	max.	min.		
1/16 (0.062)	0.065	0.059	0.111	0.032
3/32 (0.094)	0.097	0.091	0.162	0.041
1/8 (0.125)	0.128	0.122	0.204	0.048
5/32 (0.156)	0.160	0.154	0.262	0.061
3/16 (0.187)	0.191	0.185	0.323	0.078
7/32 (0.219)	0.223	0.215	0.381	0.091
1/4 (0.250)	0.254	0.246	0.439	0.103
5/16 (0.312)	0.316	0.306	0.515	0.115
3/8 (0.375)	0.379	0.367	0.637	0.143

Note . . .
The maximum and minimum rivet head diameters are controlled in the specification but only the minimum actual values are given.

Fig. 9 100 deg. countersunk-head, high nickel-copper alloy rivets (SP series)

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
86	BS 1109	Mild steel	Cad.pl.	-	10



Dimensions

Nominal size of rivet (in)	Shank diameter (A) in		Head diameter B (in) Absolute min.	Depth of head D (in)
	max.	min.		
1/16 (0.062)	0.065	0.059	0.111	0.032
3/32 (0.094)	0.097	0.091	0.162	0.041
1/8 (0.125)	0.128	0.122	0.204	0.048
5/32 (0.156)	0.160	0.154	0.262	0.061
3/16 (0.187)	0.191	0.185	0.323	0.078
7/32 (0.219)	0.223	0.215	0.381	0.091
1/4 (0.250)	0.254	0.246	0.439	0.103
5/16 (0.312)	0.316	0.306	0.515	0.115
3/8 (0.375)	0.379	0.367	0.637	0.143

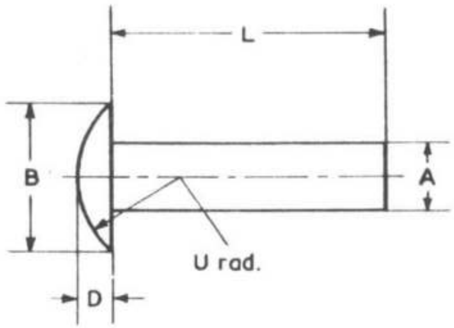
Note . . .
The maximum and minimum head diameters are controlled in the specification, but only the minimum actual values are given.

Fig. 10 100 deg. countersunk-head mild steel rivets (SP series)

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
83	BS.4L37	Aluminium alloy	Plain	7	11
84	BS.*L58	Aluminium alloy (Mag.5)	Green	8	11
85	BS.*L 86	Aluminium alloy	Violet	0	11

* Latest issue



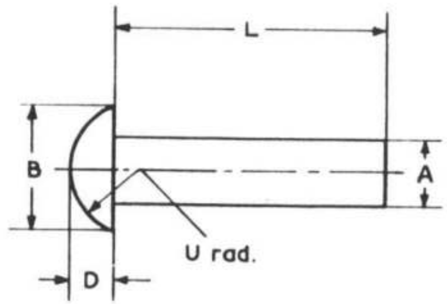
Dimensions

Nominal size of rivet (in)	Shank diameter A (in)		Head diameter B (in)		Head depth D (in)		Head radius U (in)
	max.	min.	max.	min.	max.	min.	
1/16 (0.062)	0.065	0.061	0.130	0.117	0.027	0.023	0.090
3/32 (0.094)	0.097	0.093	0.197	0.178	0.041	0.035	0.136
1/8 (0.125)	0.128	0.124	0.263	0.237	0.054	0.046	0.181
5/32 (0.156)	0.160	0.155	0.325	0.299	0.066	0.058	0.226
3/16 (0.187)	0.191	0.186	0.389	0.359	0.080	0.070	0.271
7/32 (0.219)	0.223	0.218	0.453	0.423	0.093	0.083	0.317
1/4 (0.250)	0.254	0.249	0.517	0.483	0.106	0.094	0.363
5/16 (0.312)	0.316	0.311	0.645	0.603	0.132	0.118	0.452
3/8 (0.375)	0.379	0.374	0.773	0.727	0.158	0.142	0.543

Fig. 11 Mushroom-head aluminium alloy rivets (SP series)

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
76	BS.1109	Mild steel	Cad.pl.	-	12



Dimensions

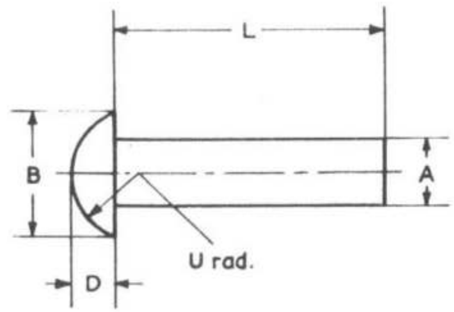
Nominal size of rivet (in)	Shank diameter A (in)		Head diameter B (in)		Head depth D (in)		Head radius U (in)
	max.	min.	max.	min.	max.	min.	
1/16 (0.062)	0.065	0.059	0.114	0.103	0.039	0.035	0.058
3/32 (0.094)	0.097	0.091	0.170	0.157	0.059	0.053	0.088
1/8 (0.125)	0.128	0.122	0.227	0.210	0.079	0.071	0.117
5/32 (0.156)	0.160	0.154	0.282	0.263	0.098	0.090	0.146
3/16 (0.187)	0.191	0.185	0.338	0.317	0.117	0.107	0.175
7/32 (0.219)	0.223	0.215	0.394	0.371	0.136	0.126	0.206
1/4 (0.250)	0.254	0.246	0.450	0.425	0.156	0.144	0.234
5/16 (0.312)	0.316	0.306	0.562	0.531	0.194	0.180	0.292
3/8 (0.375)	0.379	0.367	0.673	0.638	0.233	0.217	0.352

Fig. 12 Snap-head mild steel rivets (SP series)

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
77	BS.*L36	Aluminium	Black	1	13
78	BS.4L37	Aluminium alloy	Plain	7	13
79	BS.*L58	Aluminium alloy (Mag.5)	Green	8	13
80	BS.*L58	Aluminium alloy	Violet	9	13

* Latest issue



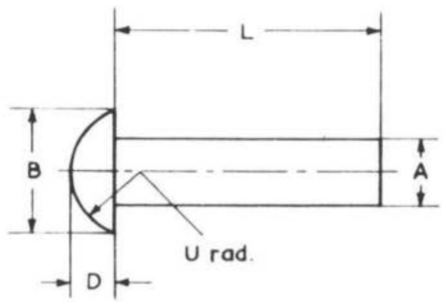
Dimensions

Nominal size of rivet (in)	Shank diameter A (in)		Head diameter B (in)		Head depth D (in)		Head radius U (in)
	max.	min.	max.	min.	max.	min.	
1/16 (0.062)	0.065	0.061	0.114	0.103	0.039	0.035	0.058
3/32 (0.094)	0.097	0.093	0.170	0.157	0.059	0.053	0.088
1/8 (0.125)	0.128	0.124	0.227	0.210	0.079	0.071	0.117
5/32 (0.156)	0.160	0.155	0.282	0.263	0.098	0.090	0.146
3/16 (0.187)	0.191	0.186	0.338	0.317	0.117	0.107	0.175
7/32 (0.219)	0.223	0.218	0.394	0.371	0.136	0.126	0.206
1/4 (0.250)	0.254	0.249	0.450	0.425	0.156	0.144	0.234
5/16 (0.312)	0.316	0.311	0.562	0.531	0.194	0.180	0.292
3/8 (0.375)	0.379	0.374	0.673	0.638	0.233	0.217	0.352

Fig. 13 Snap-head aluminium and aluminium alloy rivets (SP series)

Identification data

SP No.	Material specification	Material	Colour	Mark on tail or head of rivet	Table Ref.
81	DTD.204	High Ni-Cu alloy	Plain	M	14
82	DTD.204	High Ni-Cu alloy	Cad.pl.	M	14



Dimensions

Nominal size of rivet (in)	Shank diameter A (in)		Head diameter B (in)		Head depth D (in)		Head radius U (in)
	max.	min.	max.	min.	max.	min.	
1/16 (0.062)	0.065	0.059	0.114	0.103	0.039	0.035	0.058
3/32 (0.094)	0.097	0.091	0.170	0.157	0.059	0.053	0.088
1/8 (0.125)	0.128	0.122	0.227	0.210	0.079	0.071	0.117
5/32 (0.156)	0.160	0.154	0.282	0.263	0.098	0.090	0.146
3/16 (0.187)	0.191	0.185	0.338	0.317	0.117	0.107	0.175
7/32 (0.219)	0.223	0.215	0.394	0.371	0.136	0.126	0.206
1/4 (0.250)	0.254	0.246	0.450	0.425	0.156	0.144	0.234
5/16 (0.312)	0.316	0.306	0.562	0.531	0.194	0.180	0.292
3/8 (0.375)	0.379	0.367	0.673	0.638	0.233	0.217	0.352

Fig. 14 Snap-head high nickel-copper alloy rivets (SP series)

TABLE 3 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.5

Rivet diameter D (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS										
1/8	202										
3/16	203	303	403								
1/4	204	304	404	504	604						
5/16	205	305	405	505	605	705	805				
3/8	206	306	406	506	606	706	806	906	1006		
7/16	207	307	407	507	607	707	807	907	1007	1107	1207
1/2	208	308	408	508	608	708	808	908	1008	1108	1208
9/16	209	309	409	509	609	709	809	909	1009	1109	1209
5/8	210	310	410	510	610	710	810	910	1010	1110	1210
11/16	211	311	411	511	611	711	811	911	1011	1111	1211
3/4	212	312	412	512	612	712	812	912	1012	1112	1212
13/16	213	313	413	513	613	713	813	913	1013	1113	1213
7/8	214	314	414	514	614	714	814	914	1014	1114	1214
15/16	215	315	415	515	615	715	815	915	1015	1115	1215
1	216	316	416	516	616	716	816	916	1016	1116	1216
1.1/8		318	418	518	618	718	818	918	1018	1118	1218
1.1/4		320	420	520	620	720	820	920	1020	1120	1220
1.3/8		322	422	522	622	722	822	922	1022	1122	1222
1.1/2		324	424	524	624	724	824	924	1024	1124	1224
1.3/4			428			728	828	928	1028	1128	1228
2							832	932	1032	1132	1232

Note . . .
The last two figures of the code numbers denote the rivet length in $^1/_{16}$ in and the remaining figure or figures denote the diameter in $^1/_{32}$ in
EXAMPLES: *A snap head rivet in BS.L36 material $^1/_8$ in diameter and $^3/_4$ in long is AS.155/412 and a similar rivet $^3/_8$ in diameter and 2 in long is AS.155/1232.*

TABLE 4 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG. 2 AND 5

(Numbers outside heavy lines are for AS 156 rivets only. For AS 157 and 2227 rivets only.)

Rivet diameter D (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202								
3/16	203	303	403	503					
1/4	204	304	404	504	604				
5/16	205	305	405	505	605	705			
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807		
1/2	208	308	408	508	608	708	808	1008	
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
11/16	211	311	411	511	611	711	811	1011	1211
3/4	212	312	412	512	612	712	812	1012	1212
13/16	213	313	413	513	613	713	813	1013	1213
7/8	214	314	414	514	614	714	814	1014	1214
15/16	215	315	415	515	615	715	815	1015	1215
1	216	316	416	516	616	716	816	1016	1216
1.1/8		318	418	518	618	718	818	1018	1218
1.1/4		320	420	520	620	720	820	1020	1220
1.3/8		322	422	522	622	722	822	1022	1222
1.1/4		324	424	524	624	724	824	1024	1224
1.3/4		328	428		628	728	828	1028	1228
2					632		832	1032	1232

Note . . .
The last two figures of the code numbers indicate the length of the rivet in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in
EXAMPLES:– A snap head rivet in BS.L58 material 1/8 in diameter and 5/8 in long is AS.157/410 and a similar rivet 5/16 in diameter and 1 1/4 in long is AS.157/1020.

TABLE 5 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG. 2, 3 AND 4

Rivet diameter D (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202								
3/16	203	303	403						
1/4	204	304	404	504	604				
5/16	205	305	405	505	605				
3/8	206	306	406	506	606				
7/16	207	307	407	507	607	707			
1/2	208	308	408	508	608	708	808		
9/16	209	309	409	509	609	709	809		
5/8	210	310	410	510	610	710	810	1010	
11/16	211	311	411	511	611	711	811	1011	
3/4	212	312	412	512	612	712	812	1012	1212
13/16	213	313	413	513	613	713	813	1013	1213
7/8	214	314	414	514	614	714	814	1014	1214
15/16	215	315	415	515	615	715	815	1015	1215
1	216	316	416	516	616	716	816	1016	1216
1.1/8		318	418	518	618	718	818	1018	1218
1.1/4		320	420	520	620	720	820	1020	1220
1.3/8		322	422	522	622	722	822	1022	1222
1.1/2		324	424	524	624	724	824	1024	1224
1.3/4	For AS 158, 159, 161, 162, 164, 165, 457, 462, 2228, 2229, 2230 & 4695 rivets only					728	828	1028	1228
2							832	1032	1232

Numbers outside the heavy lines are for AS 161 rivets only.

Note . . .

The last two figures of the code numbers indicate the rivet length in $\frac{1}{16}$ in and the remaining figure or figures denote the diameter in $\frac{1}{32}$ in

EXAMPLES:– A 90 deg countersunk head rivet in BS.L58 material $\frac{1}{8}$ in diameter and $\frac{7}{8}$ in long is AS.162/414 and a similar rivet in BS.69 material $\frac{7}{32}$ in diameter and $1\frac{3}{4}$ in long is AS.2229/728.

TABLE 6 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG. 2, 3 and 5

Rivet diameter D (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202							Numbers above the heavy lines are for AS 459 rivets only	
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807		
1/2	208	308	408	508	608	708	808		
9/16	209	309	409	509	609	709	809		
5/8	210	310	410	510	610	710	810		
11/16	211	311	411	511	611	711	811		
3/4	212	312	412	512	612	712	812		
13/16	213	313	413	513	613	713	813		
7/8	214	314	414	514	614	714	814		
15/16	215	315	415	515	615	715	815		
1	216	316	416	516	616	716	816		
1.1/8		318	418	518	618	718	818		
1.1/4		320	420	520	620	720	820		
1.3/8		322	422	522	622	722	822		
1.1/2		324	424	524	624	724	824		
1.3/4						728	828		
2							832		

Note . . .
The last two figures of the code numbers indicate the length of the rivet in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in
EXAMPLE:– A 120 deg countersunk head rivet in BS.L36 material 5/32 in diameter and 7/8 in long is AS.163/514.

TABLE 7 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG. 6 AND 7

Rivet diameter D (in)	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16
Rivet length L (in)	PART IDENTIFICATION NUMBERS							
3/16	303							
1/4	304	404	504	604	704	804	904	1004
9/32	304.5	404.5	504.5	604.5	704.5	804.5	904.5	1004.5
5/16	305	405	505	605	705	805	905	1005
11/32	305.5	405.5	505.5	605.5	705.5	805.5	905.5	1005.5
3/8	306	406	506	606	706	806	906	1006
13/32	306.5	406.5	506.5	606.5	706.5	806.5	906.5	1006.5
7/16	307	407	507	607	707	807	907	1007
15/32	307.5	407.5	507.5	607.5	707.5	807.5	907.5	1007.5
1/2	308	408	508	608	708	808	908	1008
17/32	308.5	408.5	508.5	608.5	708.5	808.5	908.5	1008.5
9/16	309	409	509	609	709	809	909	1009
19/32	309.5	409.5	509.5	609.5	709.5	809.5	909.5	1009.5
5/8	310	410	510	610	710	810	910	1010
21/32	310.5	410.5	510.5	610.5	710.5	810.5	910.5	1010.5
11/16	311	411	511	611	711	811	911	1011
23/32	311.5	411.5	511.5	611.5	711.5	811.5	911.5	1011.5
3/4	312	412	512	612	712	812	912	1012
25/32	312.5	412.5	512.5	612.5	712.5	812.5	912.5	1012.5
13/16	313	413	513	613	713	813	913	1013
27/32	313.5	413.5	513.5	613.5	713.5	813.5	913.5	1013.5
7/8	314	414	514	614	714	814	914	1014
29/32	314.5	414.5	514.5	614.5	714.5	814.5	914.5	1014.5
15/16	315	415	515	615	715	815	915	1015
31/32	315.5	415.5	515.5	615.5	715.5	815.5	915.5	1015.5
1	316	416	516	616	716	816	916	1016
1.1/32	316.5	416.5	516.5	616.5	716.5	816.5	916.5	1016.5
1.1/16	317	417	517	617	717	817	917	1017
1.3/32	317.5	417.5	517.5	617.5	717.5	817.5	917.5	1017.5
1.1/8	318	418	518	618	718	818	918	1018

Note . . .

(1) The decimal .5 value after the standard code numbers indicates length of 1/32 in greater than that denoted by the code number it follows.

(2) The last two figures of the standard code numbers indicate the rivet length in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in

EXAMPLES:– A 90 deg countersunk head rivet in BS.4L37 material 1/8 in diameter and 5/8 in long is AS.2918/410 and a 120 deg countersunk head rivet in BS.L69 material 5/16 in diameter and 25/32 in long is AS.3363/1012.5.

TABLE 8 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.8

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Rivet length L (in) ± 0.010	PART IDENTIFICATION NUMBERS							
1/8	202	302						
3/16	203	303	403					
1/4	204	304	404	504				
5/16	205	305	405	505	605			
3/8	206	306	406	506	606	806		
7/16	207	307	407	507	607	807	1007	
1/2	208	308	408	508	608	808	1008	1208
9/16	209	309	409	509	609	809	1009	1209
5/8	210	310	410	510	610	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*811	*1011	*1211
3/4	*212	312	412	512	612	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*813	*1013	*1213
7/8	*214	314	414	514	614	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*815	*1015	*1215
1	*216	316	416	516	616	816	1016	1216
1.1/8		*318	418	518	618	818	1018	1218
1.1/4		*320	420	520	620	820	1020	1220
1.3/8		*322	422	522	622	822	1022	1222
1.1/2		*324	424	524	624	824	1024	1224
1.3/4			428	528	628	828	1028	1228
2				532	632	832	1032	1232
2.1/2					640	840	1040	1240
3					648	848	1048	1248

Note . . .

*(1) Asterisks indicate 'Non-preferred sizes' and may not be listed in **AP1086**, Sect. 28Q (Book 12).*

(2) The last two figures of the code numbers denote the length in 1/16 in the remaining figure or figures denoting the diameter in 1/32 in e.g. a rivet in 4L37 material of 1/8 in diameter and 5/8 in long is SP.69/410.

TABLE 9 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG. 9

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202								
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807	1007	
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including $^3/_{16}$ in is ±0.010 in and that for rivets of $^7/_{32}$ in diameter and larger is ±0.015 in

(2) Asterisk indicate 'Non-preferred sizes' and may not be listed in AP.1086, Sect. 28Q (Book 12).

(3) The last two figures of the code numbers denote the rivet length in $^1/_{16}$ in and the remaining figure or figures denote the rivet diameter in $^1/_{32}$ in

EXAMPLE:– A rivet in DTD.204 material, cadmium plated of $^1/_8$ in diameter and $^3/_4$ in long is SP.88/412.

TABLE 10 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.10

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202	302							
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807		
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including 3/16 in is ±0.010 in and that for rivets of 7/32 in. diameter and larger is ±0.015 in.
(2) Asterisk indicate 'Non-preferred sizes' and may not be listed in AP.1086, Sect. 28Q (Book 12).
(3) The last two figures of the code numbers denote the length of rivet in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in
EXAMPLE:– A rivet in BS.1109 material 1/8 in diameter and 5/8 in length is SP.86/410.

TABLE 11 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.11

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202	302							
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807	1007	
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including $^3/_{16}$ in is ±0.010 in and that for rivets of $^7/_{32}$ in diameter and larger is ±0.015 in

(2) Asterisk indicate 'Non-preferred sizes' and may not be listed in AP.1086, Sect. 28Q (Book 12).

(3) The last two figures of the code numbers denote the rivet length in $^1/_{16}$ in and the remaining figure or figures denote the diameter in $^1/_{32}$ in
EXAMPLE: A rivet in L58 material $^1/_8$ in diameter and $^5/_8$ in long is SP.84/410.

TABLE 12 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.12

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202	302							
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807	1007	
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including 3/16 in is ±0.010 in and that for rivets of 7/32 in diameter and larger is ±0.015 in

(2) Asterisk indicate 'Non-preferred sizes' and may not be listed in AP.1086, Sect. 28Q (Book 12).

(3) The last two figures of the code numbers denote the rivet length in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in
EXAMPLE:– A rivet in BS.1109 material 1/8 in diameter and 5/8 in long is SP.76/410.

TABLE 13 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.13

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202	302							
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807	1007	
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including 3/16 in is ±0.010 in and that for rivets of 7/32 in diameter and larger is ±0.015 in

(2) Asterisk indicate 'Non-preferred sizes' and may not be listed in AP.1086, Sect. 28Q (Book 12).

(3) The last two figures of the code numbers denote the rivet length in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in
EXAMPLE:– A rivet in L69 material 1/8 in diameter and 5/8 in long is SP.80/410.

TABLE 14 SIZE RANGE FOR RIVETS AS SPECIFIED IN FIG.14

Rivet diameter A (in)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Rivet length L (in)	PART IDENTIFICATION NUMBERS								
1/8	202	302							
3/16	203	303	403						
1/4	204	304	404	504					
5/16	205	305	405	505	605				
3/8	206	306	406	506	606	706	806		
7/16	207	307	407	507	607	707	807	1007	
1/2	208	308	408	508	608	708	808	1008	1208
9/16	209	309	409	509	609	709	809	1009	1209
5/8	210	310	410	510	610	710	810	1010	1210
*11/16	*211	*311	*411	*511	*611	*711	*811	*1011	*1211
3/4	*212	312	412	512	612	712	812	1012	1212
*13/16	*213	*313	*413	*513	*613	*713	*813	*1013	*1213
7/8	*214	314	414	514	614	714	814	1014	1214
*15/16	*215	*315	*415	*515	*615	*715	*815	*1015	*1215
1	*216	316	416	516	616	716	816	1016	1216
1.1/8		*318	418	518	618	718	818	1018	1218
1.1/4		*320	420	520	620	720	820	1020	1220
1.3/8		*322	422	522	622	722	822	1022	1222
1.1/2		*324	424	524	624	724	824	1024	1224
1.3/4			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
2.1/2					640	740	840	1040	1240
3					648	748	848	1048	1248

Note . . .

(1) The tolerance in length for rivets of diameters up to and including 3/16 in is ±0.010 in and that for rivets of 7/32 in diameter and larger is ±0.015 in

(2) Asterisk indicate non-preferred sizes and may not be listed in AP.1086, Sect. 28Q (Book 12).

(3) The last two figures of the code numbers denote the rivet length in 1/16 in and the remaining figure or figures denote the diameter in 1/32 in

EXAMPLE:– A cadmium plated rivet in DTD.204 material 1/8 in diameter and 5/8 in long is SP.82/410.

marking. The diameter of the heads and shanks of the rivets are controlled within ± 0.001 in, while their lengths are controlled to within ± 0.01 in. The rivets are included in the AS series, and are made with two types of countersunk-head, thus:-

'AS.2918' - 90 deg. csk. head rivet in BS.L37

'AS.2919' - 120 deg. csk. head rivet in BS.L37

'AS.3362' - 90 deg. csk. head rivet in BS.L 86

'AS.3363' - 120 deg. csk. head rivet in BS.L86

20 The code system utilized for close tolerance rivets is the same as that for solid rivets in the AS series as described in para. 12, but the lengths of close tolerance rivets increase by increments of 1/32 in, the intermediate lengths being indicated by the addition of the decimal figure '.5' to the end of the part number; thus, '306' is a rivet 3/32 in dia. and ⅜ in long while '306.5' is a rivet of the same diameter but 13/32 in long. Examples of the code system are as follows:-

'AS.2918/313' is a duralumin, close tolerance rivet, with a 90 deg. csk. head, 3/32 in dia. and 13/16 in long

'AS.2919/815.5' is a duralumin, close tolerance rivet, with a 120 deg. csk. head, ¼ in dia., and 31/32 in long

HI-SHEAR RIVETS (fig. 15)

Introduction

21 Hi-shear pins are used to effect a saving in weight while retaining the full shear strength of an equivalent size bolt. When setting Hi-shear pins there is also a considerable reduction in time as opposed to fitting split-pinned bolts. Access is required for both sides of the structure.

22 For repair purposes it is often considered expedient to replace Hi-shear pins with conventional bolts; reference must be made to the relevant aircraft Vol.6 for information on this subject. If bolts are to be used in place of pins, it is important that the plain shank of the bolt is sufficient to pass through the complete assembly, leaving the threads clear of the hole.

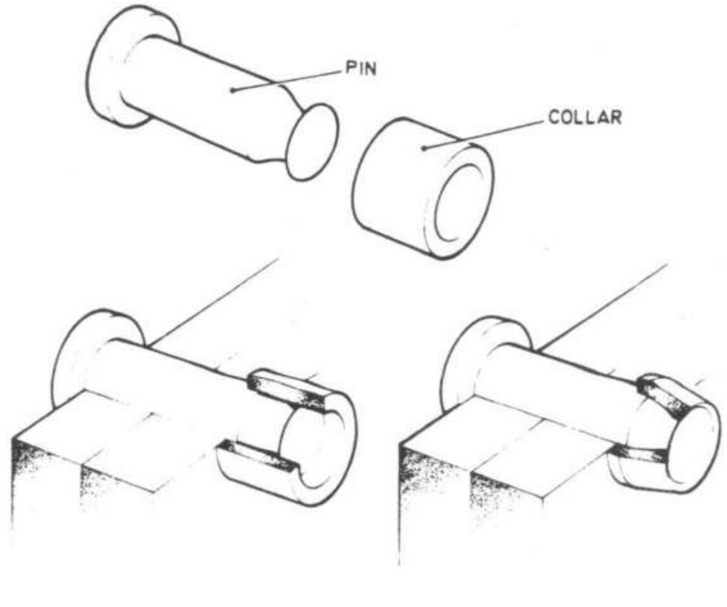


Fig. 15 Hi-shear rivet

Description

23 The Hi-shear assembly consists of two components; a pin with a close-tolerance shank, necked at the tail end, and a straight collar. The pin may be made of alloy steel, stainless steel, aluminium alloy, monel or litanium alloy. The collar is usually of anodised aluminium alloy (to BS.L86) but mild steel and annealed monel metal are also employed. In production, the collars are impregnated with a special lubricant to ensure satisfactory closing; chromate paint should not be used during installation as it interferes with the forming operation.

24 The use of a steel pin ensures a greater shear strength (across the pin axis) and tensile strength (along the pin axis) than with the soft material rivets and can be used in place of nuts and bolts for some applications.

25 The Hi-shear rivet can be used to join structures of any thickness but with thin structures the criterion of failure will be the strength of the structure in contact with the Hi-shear pin. If a thin structure is over-loaded around the area of the rivet, the hole with either tear or elongate.

Pins

26 A range of Hi-shear pins are available with flat and countersunk-heads and in various diameters and lengths to suit a wide range of materials to be riveted. Pin lengths (fig. 16) for rivets of 3/16 in diameter and above are supplied in 1/16 in increments and for diameters below 3/16 in in 1/32 in increments.

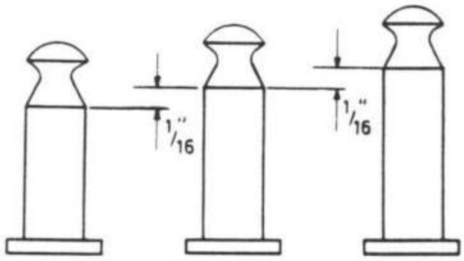


Fig. 16 Pin lengths (Hi-shear)

27 As the pin lengths are graduated in 1/16 in or 1/32 in increments, depending on diameter, the material thickness can vary 1/16 in or 1/32 in respectively without changing pin lengths. Adjustment for variations of material thickness in between the pin lengths is made automatically by trimming the collar to the required length while the rivet is driven as shown in fig. 17.

Collars

28 Collars are available in only one length for each diameter of pin, any excess length being trimmed automatically during riveting (fig. 17).

Dowel pins

29 In addition to flat or countersunk-headed pins, Hi-shear dowel pins are manufactured (Table 21); these have a particular application to sloping

surfaces (fig. 18), where the face of the metal on both sides of the joint is not normal to the centre-line of the pin; the collars adapt themselves to the surfaces as the pins are set. Where only one surface is not at right angles to the pin, an ordinary, headed pin is used with the collar applied to the sloping face of the work.

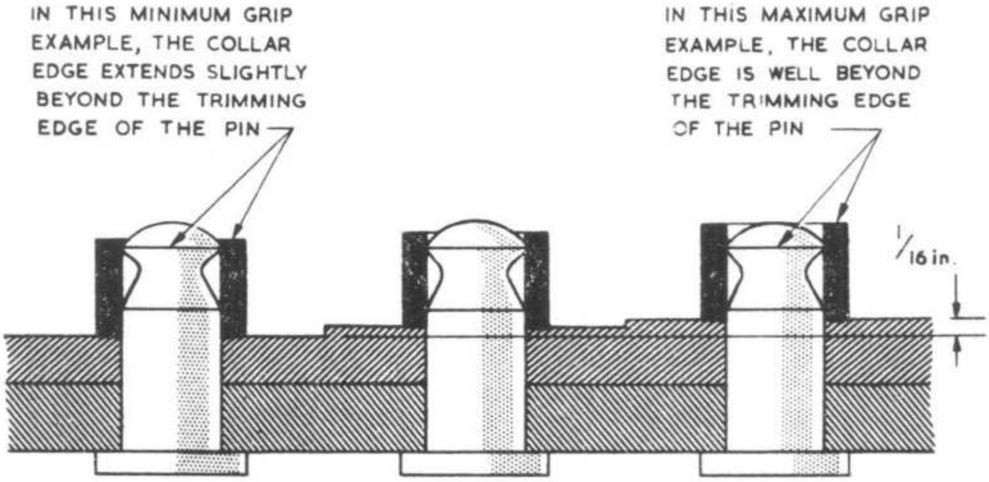


Fig. 17 Variations in material thickness

Coding

30 A typical pin code reference is BBH.101 FN/08/10, this represents the following:-

BBH	Brown Bros Hi-shear
101FN	Flat head, 55/65 ton steel, cadmium plated (established by reference to Table 15)
/08	Pin diameter in 1/32 in increments = 1/4 in pin dia.
/10	Thickness of joint to be gripped in 1/16 in increments = 5/8 in. A No. 10 pin would be required at its maximum grip. If the thickness of the materials is 9/16 in, then a No. 10 pin at minimum grip could be used. Alternatively a 9/16 in thickness could be secured by a No. 9 pin at its maximum grip.

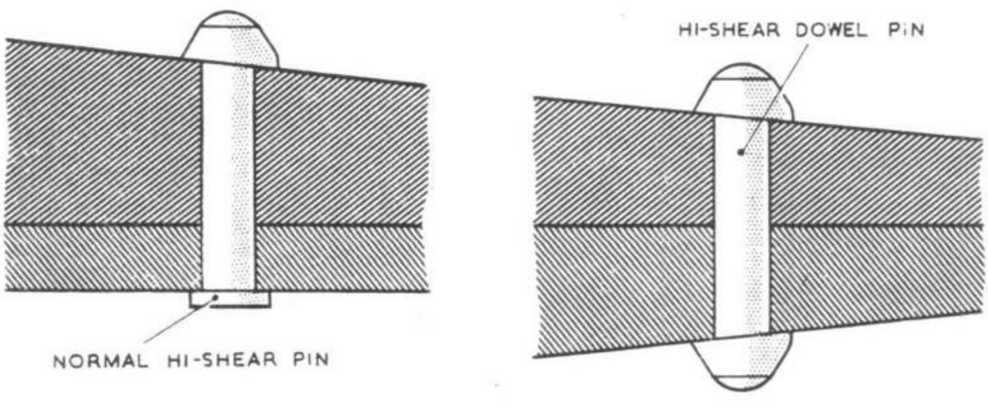


Fig. 18 Hi-shear collars on sloping surfaces

Note ...

Increases in pin length of 1/32 in are denoted by an additional half, e.g. $/10\frac{1}{2}$ = 10/16 + 1/32 = 21/32 in.

31 Collar references are similar to pin references but the stroke number indicates the internal diameter of the collar in 1/32 in increments, thus BBH.104/08 indicates:-

BBH	Brown Bros. Hi-shear
104	Collar, aluminium alloy L69. Anodised dyed violet and lubricated (established by reference to Table 15).
/08	8/32 in or 1/4 in internal diameter, for use with a 1/4 in dia. pin.

TABLE 15 PART NUMBERS FOR CLOSE TOLERANCE HI-SHEAR PINS AND COLLARS

(Tolerance: Nominal - 0.001 in)

Part No.	Head	Material	Finish
	PINS for use with aluminium alloy collars BBH 104		
101/CN/	100 deg. csk.	55/65 ton steel	Cadmium plated
101/CH/	100 deg. csk.	75/85 ton steel	Cadmium plated
101/CS/	100 deg. csk.	55/65 ton stainless steel	Natural
101/CC/	100 deg. csk.	'K' monel, grade C	As issued
101/CC/	100 deg. csk.	'K' monel, grade F	As issued
	Csk.		
S1/CN/	1/64 in oversize	55/65 ton steel	Cadmium plated
S1/CH/	1/64 in oversize	75/85 ton steel	Cadmium plated
S1/CS/	1/64 in oversize	55/65 ton stainless steel	Natural
S1/CC/	1/64 in oversize	'K' monel, grade C	As issued
S1/CK/	1/64 in oversize	'K' monel, grade F	As issued
	Csk.		
S2/CN/	1/32 in oversize	55/65 ton steel	Cadmium plated
S2/CH/	1/32 in oversize	75/85 ton steel	Cadmium plated
S2/CS/	1/32 in oversize	55/65 ton stainless steel	Natural
S2/CC/	1/32 in oversize	'K' monel, grade C	As issued
S2/CK/	1/32 in oversize	'K' monel, grade F	As issued
101/FN/	Flat	55/65 ton steel	Cadmium plated
101/FH/	Flat	75/85 ton steel	Cadmium plated
101/FS/	Flat	55/65 ton stainless steel	Natural
101/FC/	Flat	'K' monel, grade C	As issued
101/FK/	Flat	'K' monel, grade F	As issued

TABLE 15 PART NUMBERS FOR CLOSE TOLERANCE HI-SHEAR PINS AND COLLARS (continued)

Part No.	Head	Material	Finish
	Flat		
S1/FN/	1/64 in oversize	55/65 ton steel	Cadmium plated
S1/FH/	1/64 in oversize	75/85 ton steel	Cadmium plated
S1/FS/	1/64 in oversize	55/65 ton stainless steel	Natural
S1/FC/	1/64 in oversize	'K' monel, grade C	As issued
S1/FK/	1/64 in oversize	'K' monel, grade F	As issued
	Flat		
S2/FN/	1/32 in oversize	55/65 ton steel	Cadmium coated
S2/FH/	1/32 in oversize	75/85 ton steel	Cadmium coated
S2/FS/	1/32 in oversize	55/65 ton stainless steel	Natural
S2/FC/	1/32 in oversize	'K' monel, grade C	As issued
S2/FK/	1/32 in oversize	'K' monel, grade F	As issued
101/DN/	Dowel pin	55/65 ton steel	Cadmium plated
101/DH/	Dowel pin	75/85 ton steel	Cadmium plated
101/DS/	Dowel pin	55/65 ton stainless steel	Natural
101/DC/	Dowel pin	'K' monel,grade C	As issued
101/DK/	Dowel pin	'K' monel,grade F	As issued
121/CN/	120 deg. csk.	55/65 ton steel	Cadmium plated
121/CH/	120 deg. csk.	75/85 ton steel	Cadmium plated
121/CS/	120 deg. csk.	55/65 ton stainless steel	Natural
121/CC/	120 deg. csk.	'K' monel, grade C	As issued
121/CK/	120 deg. csk.	'K' monel, grade F	As issued
201/CA/	100 deg. csk.	Aluminium alloy L65	Anodized,dyed blue
201/DA/	Flat head	Aluminium alloy L65	Anodized,dyed blue
201/DA/	Dowel pin	Aluminium alloy L65	Anodized,dyed blue
	PINS for use with MS, S1 and monel collars BBH206 and 207		
200/CN/	100 deg. csk.	55/65 ton steel	Cadmium plated
200/CH/	100 deg. csk.	75/85 ton steel	Cadmium plated
200/CS/	100 deg. csk.	55/65 ton stainless steel	Natural
200/CC/	100 deg. csk.	'K' monel, grade C	As issued
200/CK/	100 deg. csk.	'K' monel, grade F	As issued
	Csk.		
2S1/CN/	1/64 in oversize	55/65 ton steel	Cadmium plated
2S1/CH/	1/64 in oversize	75/85 ton steel	Cadmium plated
2S1/CS/	1/64 in oversize	55/65 ton stainless steel	Natural
2S1/CC/	1/64 in oversize	'K' monel, grade C	As issued
2S1/CK/	1/64 in oversize	'K' monel, grade F	As issued
	Csk.		
2S2/CN/	1/32 in oversize	55/65 ton steel	Cadmium plated
2S2/CH/	1/32 in oversize	75/85 ton steel	Cadmium plated
2S2/CS/	1/32 in oversize	55/65 ton stainless steel	Natural
2S2/CC/	1/32 in oversize	'K' monel, grade C	As issued
2S2/CK/	1/32 in oversize	'K' monel, grade F	As issued

TABLE 15 PART NUMBERS FOR CLOSE TOLERANCE HI-SHEAR PINS AND COLLARS (continued)

Part No.	Head	Material	Finish
200/FN/	Flat	55/65 ton steel	Cadmium plated
200/FH/	Flat	75/85 ton steel	Cadmium plated
200/FS/	Flat	55/65 ton stainless steel	Natural
200/FC/	Flat	'K' monel, grade C	As issued
200/FK/	Flat	'K' monel, grade F	As issued
	Flat		
2S1/FN/	1/64 in oversize	55/65 ton steel	Cadmium plated
2S1/FH/	1/64 in oversize	75/85 ton steel	Cadmium plated
2S1/FS/	1/64 in oversize	55/65 ton stainless steel	Natural
2S1/FC/	1/64 in oversize	'K' monel, grade C	As issued
2S1/FK/	1/64 in oversize	'K' monel, grade F	As issued
	Flat		
2S2/FN/	1/32 in oversize	55/65 ton steel	Cadmium plated
2S2/FH/	1/32 in oversize	75/85 ton steel	Cadmium plated
2S2/FS/	1/32 in oversize	55/65 ton stainless steel	Natural
2S2/FC/	1/32 in oversize	'K' monel, grade C	As issued
2S2/FK/	1/32 in oversize	'K' monel, grade F	As issued
200/DN/	Dowel pin	55/65 ton steel	Cadmium plated
200/DH/	Dowel pin	75/85 ton steel	Cadmium plated
200/DS/	Dowel pin	55/65 ton stainless steel	Natural
200/DC/	Dowel pin	'K' monel, grade C	As issued
200/DK/	Dowel pin	'K' monel, grade F	As issued
221/CN/	120 deg. csk.	55/65 ton steel	Cadmium plated
221/CH/	120 deg. csk.	75/85 ton steel	Cadmium plated
221/CS/	120 deg. csk.	55/65 ton stainless steel	Natural
221/CC/	120 deg. csk.	'K' monel, grade C	As issued
221/CK/	120 deg. csk.	'K' monel, grade F	As issued
COLLARS			
BBH.104/	Aluminium alloy L69	-	Anodized, dyed violet and lubricated
This collar is for use with Hi-shear pins BBH 101,S1,S2 and 201 series			
*BBH.206	Mild steel 6S1	-	Cadmium plated and lubricated
*BBH.207	Annealed monel	-	Self or cadmium plated, as issued, and lubricated
*These collars are for use with Hi-shear pins BBH 200, 2S1, 2S2 and 221 series			

Identification

32 The identification markings of Hi-shear pins and collars are given in Tables 16 and 17 respectively. Part numbers quoted in these tables are explained in greater detail in Table 15. The general dimensions of pins and dowels are given in Tables 18 to 21.

TABLE 16 IDENTIFICATION OF HI-SHEAR PINS

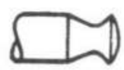
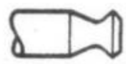
Part No.	Material	Identification marking
101/CN/		B+
101/FN/	55/65 ton steel	
101/DN/		Domed ends 
101/CH/		Ⓑ
101/FH/	75/85 ton steel	
101/DH/		Flat ends 
101/CS/		
101/FS/	55/65 ton corrosion resisting steel	
101/DS/		Z
101/CK/		
101/FK/	'K'-monel grade F	BM
101/DK/		M
101/CC/		
101/FC/	'K'-monel grade C	BC
101/DC/		C
201/CA/		
201/FA/	Aluminium alloy L.65	Dyed blue
201/DA/		

TABLE 16 IDENTIFICATION OF HI-SHEAR PINS (continued)

Part No.	Material	Identification marking
121/CN/	55/65 ton steel	B +
121/CH/	75/85 ton steel	Ⓑ
121/CS/	55/65 ton stainless steel	$\overset{B}{\circ\!-\!-\!\circ}$
121/CK/	'K'-monel, grade F	M
121/CC/	'K'-monel, grade C	C
S1/CN S1/FN	55/65 ton steel	B + 64
S1/CH S1/FH	75/85 ton steel	BO 64
S1/CS S1/FS	55/65 ton stainless steel	$\circ\frac{B}{64}\circ$
S1/CK S1/FK	'K'-monel, grade F	BM 64
S1/CC S1/FC	'K'-monel, grade C	BC 64
S2/CN S2/FN	55/65 ton steel	B + 32
S2/CH S2/FH	75/85 ton steel	BO 32
S2/CS S2/FS	55/65 ton stainless steel	$\circ\frac{B}{32}\circ$

TABLE 16 IDENTIFICATION OF HI-SHEAR PINS (continued)

Part No.	Material	Identification marking
S2/CK	'K'-monel, grade F	PM 32
S2/FK		
S2/CC	'K'-monel, grade C	PC 32
S2/FC		

TABLE 17 IDENTIFICATION OF HI-SHEAR COLLARS

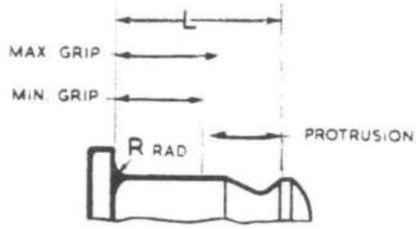
Part No.	Material	Identification marking
104/	Aluminium alloy L86	Dyed mauve

TABLE 18 HI-SHEAR PIN LENGTHS AND PROTRUSIONS

Notes ...

(1) All dimensions in inches

(2) On csk. headed pin, dimensions are measured from the top face of the head



Nom. dia. of pin	Length L	Protrusion
1/8	Nom. max. grip +0.103 $^{+0}_{-0.010}$	0.093 - 0.135
5/32	Nom. max. grip +0.134 $^{+0}_{-0.010}$	0.124 - 0.166
3/16	Nom. max. grip +0.135 $^{+0}_{-0.020}$	0.115 - 0.199
7/32	Nom. max. grip +0.151 $^{+0}_{-0.020}$	0.131 - 0.215
1/4	Nom. max. grip +0.175 $^{+0}_{-0.020}$	0.155 - 0.239

TABLE 18 - HI-SHEAR PIN LENGTHS AND PROTRUSIONS (continued)

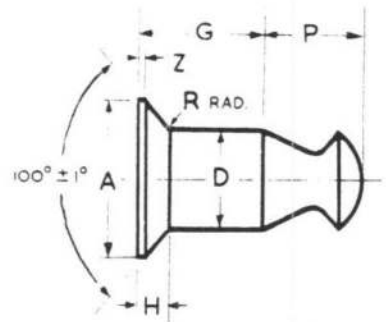
Nom. dia. of pin	Length L	Protrusion
9/32	Nom. max. grip + 0.193 $^{+0}_{-0.020}$	0.173 - 0.257
5/16	Nom. max. grip + 0.217 $^{+0}_{-0.020}$	0.197 - 0.281
3/8	Nom. max. grip +0.258 $^{+0}_{-0.020}$	0.238 - 0.322
7/16	Nom. max. grip +0.299 $^{+0}_{-0.020}$	0.279 - 0.363
1/2	Nom. max. grip +0.340 $^{+0}_{-0.020}$	0.320 - 0.404
9/16	Nom. max. grip +0.381 $^{+0}_{-0.020}$	0.361 - 0.445
3/8	Nom. max. grip +0.423 $^{+0}_{-0.020}$	0.403 - 0.487

TABLE 19 DIMENSIONS OF COUNTERSUNK-HEAD HI-SHEAR PINS, TYPE 'C'

Notes ...

(1) All dimensions in inches

(2) G = Maximum grip length (Table 18)



D dia +0 -0.001	A dia. (min)	H (min)	H (max)	Z (max)	R rad. (min)	R rad. (max)	P Maximum protrusion of pin through joint
1/8	0.1980	0.0320	0.0350	0.0042	0.010	0.020	0.18
5/32	0.2440	0.0390	0.0420	0.0045	0.010	0.020	0.22
3/16	0.2900	0.450	0.0480	0.0047	0.010	0.020	0.25
7/32	0.3360	0.0510	0.0560	0.0050	0.015	0.030	0.28
1/4	0.3820	0.0570	0.0620	0.0052	0.015	0.030	0.31
9/32	0.4210	0.0610	0.0660	0.0055	0.015	0.030	0.34

TABLE 19 DIMENSIONS OF COUNTERSUNK-HEAD HI-SHEAR PINS, TYPE 'C' (continued)

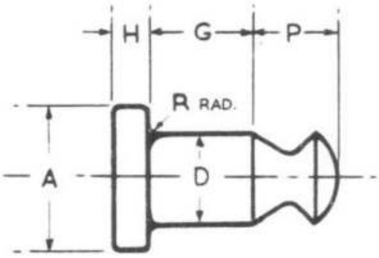
D dia	A dia	H		Z	R rad.		P
+0 -0.001	(min)	(min)	(max)	(max)	(min)	(max)	Maximum protrusion of pin through joint
5/16	0.4600	0.0640	0.0690	0.0057	0.015	0.030	0.37
3/8	0.5460	0.0740	0.0790	0.0061	0.015	0.030	0.42
7/16	0.6520	0.0920	0.0980	0.0068	0.015	0.030	0.48
1/2	0.7370	0.1020	0.1080	0.0072	0.015	0.030	0.53
9/16	0.8190	0.1100	0.1170	0.0078	0.015	0.030	0.58
5/8	0.9050	0.1200	0.1280	0.0082	0.015	0.030	0.64

TABLE 20 DIMENSIONS OF FLAT HEAD HI-SHEAR PINS, TYPE 'F'

Notes ...

(1) All dimensions in inches.

(2) G = Maximum grip length (Table 18)



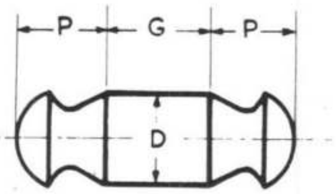
D dia	A dia		H		R rad.		P
+0 -0.001	(min)	(max)	(min)	(max)	(min)	(max)	Maximum protrusion of pin through joint
1/8	0.188	0.208	0.029	0.039	0.010	0.020	0.18
5/32	0.242	0.262	0.037	0.047	0.010	0.020	0.22
3/16	0.295	0.315	0.045	0.055	0.010	0.020	0.25
7/32	0.344	0.364	0.051	0.061	0.015	0.030	0.28
1/4	0.387	0.412	0.059	0.069	0.015	0.030	0.31
9/32	0.435	0.455	0.063	0.073	0.015	0.030	0.34
5/16	0.475	0.505	0.068	0.078	0.015	0.030	0.37
3/8	0.565	0.600	0.078	0.088	0.015	0.030	0.42
7/16	0.641	0.676	0.093	0.105	0.015	0.030	0.48
1/2	0.735	0.770	0.103	0.115	0.015	0.030	0.53
9/16	0.829	0.864	0.112	0.127	0.015	0.030	0.58
5/8	0.918	0.953	0.122	0.137	0.015	0.030	0.64

TABLE 21 HI-SHEAR DOWEL PINS, TYPE 'D'

Notes ...

(1) All dimensions in inches.

(2) G = Maximum grip length (Table 18).



Dia dia. +0 -0.001	P Maximum protrusion of pin through joint
1/8	0.18
3/16	0.25
1/4	0.31
5/16	0.37
3/8	0.42
7/16	0.48
1/2	0.53
9/16	0.58
5/8	0.64

SOLID PLUG RIVETS

33 Plug riveting shown in fig. 19, is a form of blind riveting and may be used where metal sheets have to be secured to heavy extruded members which are too thick to be drilled right through in the usual manner. The rivets used for plug riveting are made of aluminium alloy to BS.L37 or L69. Aluminium alloy rivets to BS.L58 must not be used for this purpose.

RIVETS USED FOR BLIND RIVETING

TUCKER HOLLOW RIVETS

34 Tucker rivets are made in two forms, pop rivets, which have partially closed tails, and cup rivets, which have closed tails and are placed with a dolly and punch as for solid rivets; both forms of rivet are provided with either dome heads or 120 deg. countersunk heads.

Pop rivets

35 Pop rivets are tubular rivets with individual mandrels which permit rivet setting from one side of the work only, using hand or power operated tools. Pop rivets which are manufactured from aluminium alloy are dyed

green, but those made from monel are cadmium plated as their major use is with light alloy plating; as a result of a recent modification, pop rivets are now being made with the alternative tail formation illustrated in fig.20.

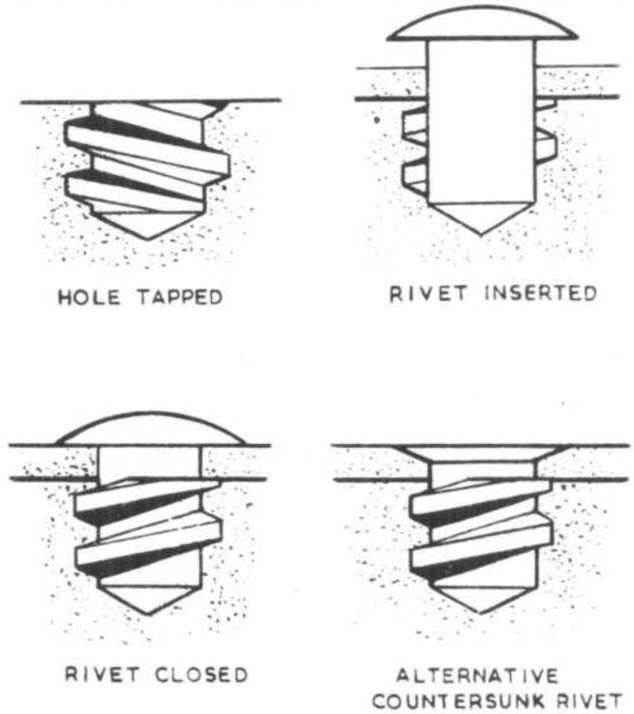


Fig. 19 Plug riveting

36 The mandrels are made in various lengths and diameters, and have different breaking loads, to agree with the sizes and materials of the rivets for which they are intended; mandrels are in two forms, break-head mandrels, which have their shanks undercut directly below the heads, and break-stem mandrels, which have their shanks waisted adjacent to the heads. The break-head type allows the mandrel head to be ejected automatically in one direction as the mandrel shank is withdrawn in the opposite direction; with the break-stem type of mandrel, the head and a small portion of the mandrel shank will remain within the tail of the rivet as the mandrel fractures. The preformed head of a rivet may be either domed or countersunk but all subsequent formed tail ends are tulip headed. Break-stem mandrels have also recently been modified and are now being made with oval heads to improve their retention by the rivets, and these mandrels, unlike the break-head variety, are either cadmium plated, or zinc plated and passivated, as an anti-corrosion measure.

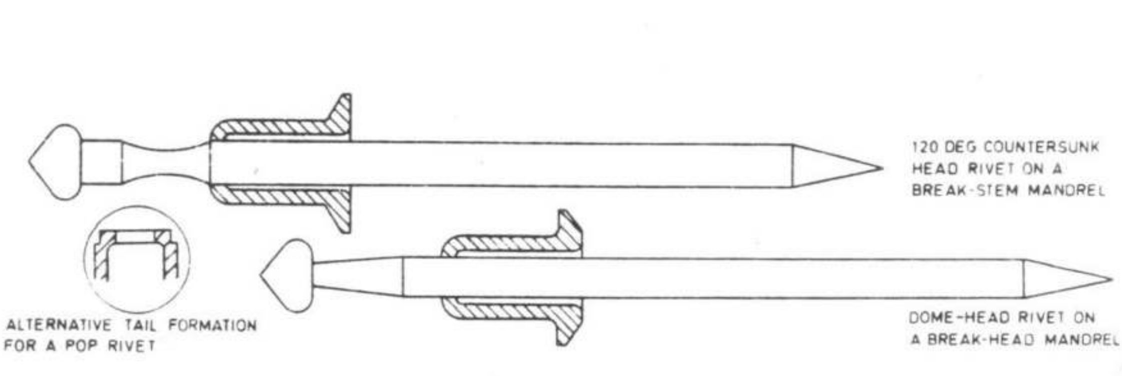


Fig. 20 Tucker pop rivets

37 Although pop rivets were originally intended for blind riveting, they are now used extensively for general riveting in place of solid rivets, however, it must not be assumed that pop rivets may replace solid rivets unless specific instructions in the relevant airframe Vol. 6 indicate that the use of pop rivets is fully approved.

38 Tucker pop rivets must be used as directed in AP 970 leaflet 405/2.

CAUTION ...

When using pop rivets care must be taken either to drive out the rivet heads and remove them from the structure after completion of the riveting operation, or to ensure that there is no possibility of loose heads entering parts of the structure where there are moving parts or electrical installations.

Material

39 The mandrels on which pop rivets are assembled are of high tensile steel. The actual rivets are manufactured from aluminium alloy or monel metal. The material specifications are protective treatments are listed in Table 22.

Rivet sizes

40 Pop rivets with either domes or countersunk heads are supplied in lengths suitable for riveting material up to 0.64 in in thickness. Rivet diameters range from 3/32 in to 3/16 in as listed in Table 23. Correct rivet lengths for various thicknesses of material are listed in Tables 24 and 25, and detailed dimensions are given in Tables 26 and 27, in conjunction with fig. 21.

TABLE 22 TUCKER POP AND CUP RIVETS : MATERIAL SPECIFICATIONS

Item	Material	Type of head	AGS No.
1 (Pop)	Aluminium alloy (Mg. 5%) L58	Domed	2048 2074
2 (Pop)	Monel DTD.10	Domed	2050 (unplated) 2059 (cadmium plated)
3 (Pop)	Monel DTD.10	Csk 100 deg.	2070 (cadmium plated) 2071 (unplated)
4 (Cup)	Aluminium alloy (Mg. 5%) L58	Domed	2053
5 (Cup)	Monel DTD.10	Domed	2055

TABLE 22 TUCKER POP AND CUP RIVETS : MATERIAL SPECIFICATIONS (continued)

Item	Material	Type of head	AGS No.
6 (Pop)	Aluminium alloy	Csk. 120 deg.	2049
7 (Pop)	Monel DTD.10	Csk. 120 deg.	2051
8 (Cup)	Aluminium alloy	Csk.	2054
9 (Cup)	Monel	Csk.	2056

TABLE 23 POP RIVET TYPES AVAILABLE

Mandrel	Head	AGS No.	Diameter available (in)	Material
BH	Csk.120	2049	1/8,5/32,0.2	)
BH	Csk.120	2073	3/16	)
BH	Domed	2048	1/8,5/32,0.2	)
BH	Domed	2074	3/16	)
				) All alloy L58
BS	Csk.120	2049	3/32,1/8,5/32,0.2	)
BS	Csk.120	2073	3/16	)
BS	Domed	2048	3/32,1/8,5/32,0.2	)
BS	Domed	2074	3/16	)
BH	Csk.120	2051	7/64,1/8,5/32,3/16	)
BH	Domed	2050	7/64,1/8,5/32,3/16	)
				) Monel metal DTD.10
BS	Csk.120	2051	7/64,1/8,5/32,3/16	)
BS	Domed	2050	7/64,1/8,5/32,3/16	)

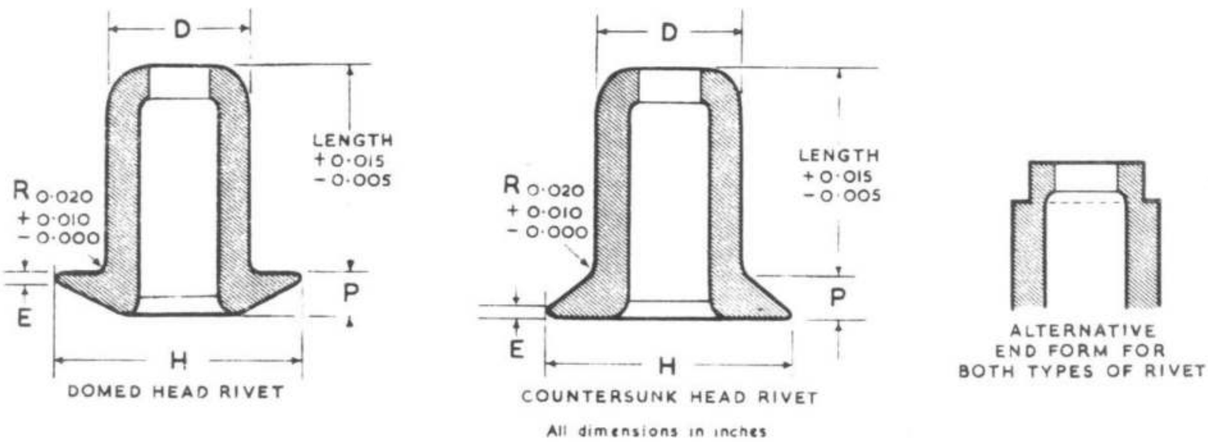


Fig. 21 Pop rivet dimensions

TABLE 24 GRIP RANGE FOR ALUMINIUM ALLOY POP RIVETS

Rivet dia (in)	Rivet Code No.	Break-head mandrels Domed head rivets Grip (in)	Break-head mandrels Csk. head rivets Grip (in)	Break-stem mandrels Domed head rivets Grip (in)	Break-stem mandrels Csk. head rivets Grip (in)
3/32	320	-	-	-	0.03 - 0.10
1/8	414	0.01 - 0.05	0.01 - 0.08	0.01 - 0.03	0.01 - 0.06
	420	0.051 - 0.09	0.081 - 0.12	0.031 - 0.07	0.061 - 0.10
	423	0.091 - 0.12	0.121 - 0.15	0.071 - 0.10	0.101 - 0.13
	429	0.121 - 0.19	0.151 - 0.21	0.101 - 0.17	0.131 - 0.19
5/32	518	0.01 - 0.08	0.01 - 0.11	0.01 - 0.06	0.01 - 0.09
	523	0.081 - 0.13	0.111 - 0.16	0.061 - 0.11	0.091 - 0.14
	529	0.131 - 0.19	0.161 - 0.22	0.111 - 0.17	0.141 - 0.20
	537	0.191 - 0.25	0.221 - 0.28	0.171 - 0.23	0.201 - 0.26
3/16 or 0.20	625	0.01 - 0.12	0.01 - 0.15	0.01 - 0.10	0.01 - 0.13
	629	0.121 - 0.16	-	0.101 - 0.14	-
	635	0.161 - 0.22	-	0.141 - 0.20	0.171 - 0.23
	640	0.221 - 0.23	0.251 - 0.28	0.201 - 0.23	0.231 - 0.26
	649	0.251 - 0.35	-	0.231 - 0.33	0.251 - 0.33

TABLE 25 GRIP RANGE FOR MONEL METAL POP RIVETS

Rivet dia (in)	Rivet Code No.	Break-head mandrels Domed head rivets Grip (in)	Break-head mandrels Csk. head rivets Grip (in)	Break-stem mandrels Domed head rivets Grip (in)	Break-stem mandrels Csk. head rivets Grip (in)
7/64	319	0.01 - 0.09	0.01 - 0.11	0.02 - 0.07	0.02 - 0.09
	321	-	0.111 - 0.13	0.071 - 0.09	-
1/8	413	0.01 - 0.05	0.01 - 0.08	0.01 - 0.03	0.01 - 0.06
	419	0.051 - 0.09	0.081 - 0.12	0.03 - 0.07	0.061 - 0.10
	424	0.091 - 0.14	0.121 - 0.17	0.071 - 0.12	0.101 - 0.15
	429	0.141 - 0.19	0.171 - 0.21	0.121 - 0.17	0.151 - 0.20
	435	0.191 - 0.25	0.221 - 0.28	0.171 - 0.23	0.201 - 0.26
	440	0.251 - 0.30	0.281 - 0.33	0.231 - 0.28	0.261 - 0.31

TABLE 25 GRIP RANGE FOR MONEL METAL POP RIVETS (continued)

Rivet dia (in)	Rivet Code No.	Break-head mandrels: Domed head rivets Grip (in)	Break-head mandrels: Csk. head rivets Grip (in)	Break-stem mandrels: Domed head rivets Grip (in)	Break-stem mandrels: Csk. head rivets Grip (in)
5/32	519	0.01 - 0.08	0.01 - 0.11	0.02 - 0.05	0.04 - 0.08
	524	0.081 - 0.14	0.111 - 0.17	0.051 - 0.10	0.081 - 0.13
	530	0.141 - 0.20	0.171 - 0.23	0.101 - 0.16	0.131 - 0.19
	537	0.201 - 0.25	0.231 - 0.28	0.161 - 0.23	0.191 - 0.26
	540	0.251 - 0.29	0.281 - 0.32	0.231 - 0.26	0.261 - 0.29
	545	0.291 - 0.34	0.321 - 0.37	0.261 - 0.31	0.291 - 0.34
3/16 or 0.20	624	0.01 - 0.12	0.01 - 0.15	0.02 - 0.09	0.05 - 0.12
	630	0.121 - 0.17	0.151 - 0.20	0.091 - 0.15	0.121 - 0.18
	636	0.171 - 0.23	0.201 - 0.26	0.151 - 0.20	0.181 - 0.23
	639	0.231 - 0.25	0.261 - 0.28	0.201 - 0.23	0.231 - 0.26
	650	0.251 - 0.36	0.281 - 0.39	0.231 - 0.34	0.261 - 0.37
	665	0.361 - 0.51	0.391 - 0.54	0.341 - 0.49	0.371 - 0.52
	675	0.511 - 0.61	0.541 - 0.64	0.491 - 0.59	0.521 - 0.62

TABLE 26 DIMENSIONS OF ALUMINIUM ALLOY POP RIVETS

D +0.003 -0.001 Nominal diameter		H	P Domed head	P Csk. head	E Domed head	E Csk. head
3/32	0.093	0.185 ±0.007	0.027 ±0.003	0.033 ±0.003	0.010 ±0.005	0.008 ±0.005
1/8	0.125	0.236 ±0.007	0.028 ±0.003	0.036 ±0.003	0.010 ±0.005	0.008 ±0.005
5/32	0.156	0.263 ±0.007	0.028 ±0.003	0.039 ±0.003	0.015 ±0.005	0.008 ±0.005
3/16	0.187	0.375 ±0.010	0.057 ±0.004	0.064 ±0.004	0.010 ±0.005	0.009 ±0.006
7/32	0.218	0.324 ±0.010	0.032 ±0.004	0.039 ±0.004	0.015 ±0.005	0.009 ±0.006

Notes ...

(1) Table to be read in conjunction with fig. 21.

(2) All dimensions in inches.

(3) Rivet lengths are measured from under the head; both domed and countersunk.

TABLE 27 DIMENSIONS OF MONEL POP RIVETS

D +0.003 -0.001		H	P		E	
Nominal diameter			Domed head	Csk. head	Domed head	Csk. head
7/64	0.109	0.192 ±0.007	0.020 ±0.003	0.028 ±0.003	0.008 ±0.003	0.006 ±0.003
1/8	0.125	0.236 ±0.007	0.025 ±0.003	0.036 ±0.003	0.010 ±0.005	0.008 ±0.005
5/32	0.156	0.263 ±0.007	0.028 ±0.003	0.039 ±0.003	0.010 ±0.005	0.003 ±0.005
3/16	0.187	0.320 ±0.010	0.040 ±0.010	0.045 ±0.006	0.015 ±0.010	0.010 ±0.008
1/4	0.250	0.427 ±0.010	0.053 ±0.010	0.059 ±0.010	0.020 ±0.010	0.014 ±0.008

Notes ...

(1) Table to be read in conjunction with fig. 21

(2) All dimensions in inches.

(3) Rivet lengths are measured from under the head; both domed and countersunk.

Coding

41 The code reference for a Tucker pop rivet can be divided into three parts, this applies when using the manufacturer's special Part number or the AGS number. Code letters are as follows:-

T indicates Tucker

L indicates MoneL

A indicates Alum. alloy

P indicates Pop rivet

D indicates Domed-head

K indicates C/sunK-head

BH indicates Break-Head

BS indicates Break-Stem

42 A typical manufacturer's reference is as follows:-

TAP/D/BS420

this indicates a Tucker aluminium alloy pop rivet with a domed head and break-stem mandrel. The figures indicate rivet diameter in 1/32 in and length in multiples of 0.010 in; in this instance the rivet is 1/8 in dia and 0.20 in long.

43 The AGS reference is made up of the AGS drawing number (listed in Table 23), followed by a three-figured reference for the diameter and length, and finally the code letters for the type of mandrel. A typical reference is as follows:-

AGS 2048/537 BH

this indicates (by reference to break-head mandrels in Table 23) an aluminium alloy domed-head rivet, 5/32 in dia., 0.37 in long with a break-head mandrel. It must be noted that AGS figure references which commence with the figure 6 may indicate a rivet of 3/16 in dia. or a rivet of 0.2 in dia. These rivets are virtually the same diameter, as all sizes are nominal, but by reference to AP 1086 it may appear as an inconsistency in the figure code which otherwise holds good for the manufacturer's and the AGS reference system. Rivets of 0.2 in dia. are now obsolescent.

Note ...

(1) Rivet lengths are measured from under the head, both domed and countersunk.

(2) The grip lengths shown in Tables 24 and 25 for countersunk-head rivets are those where the plates have been countersunk by machining and not dimpling. The thickness of plates which can be used with countersunk-head rivets where dimpling is employed is equal to that of the domed-head rivet.

Cup rivets

44 Tucker cup rivets (fig. 22) are manufactured to AGS drawings, and the drawing numbers are used in the identification code to denote the head formations of the rivets and the materials of which they are made (Table 22). Particulars of the drawing numbers are as follows:-

AGS.2053 - Dome-head cup rivets in aluminium alloy

AGS.2054 - 120 deg. csk. head cup rivets in aluminium alloy

AGS.2055 - Dome-head cup rivets in monel

AGS.2056 - 120 deg. csk. head cup rivets in monel

45 Cup rivets are readily distinguishable from pop rivets by the formation of their tails and the absence of mandrels, although the other characteristics of both forms of rivet are the same. The identification code for a cup rivet apart from the AGS number, is the same as that for a pop rivet without the appended letters, for example:-

AGS.2054/641 is a Tucker cup rivet with a 120 deg. csk. head, 0.2 in dia. and 0.41 in long.

AGS.2055/631 is a Tucker cup rivet with a dome head, 0.3 in dia., and 0.31 in long.

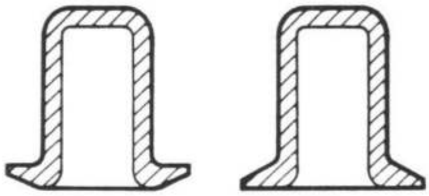


Fig. 22 Tucker cup rivets

AM RIVETS

46 The AM rivets although made by a different manufacturer, are an extension of the Tucker range of monel pop rivets; the AM rivets are of proprietary manufacture and are not made to AGS or SBAC drawings. The rivets are manufactured from monel to DTD.204A and are cadmium plated; the major difference between the AM and the Tucker pop rivets is that AM rivets are turned whereas Tucker pop rivets are pressed. AM rivets are provided in 1/8 in, 5/32 in, and 3/16 in dia, each of which is obtainable in five lengths; as the maximum lengths of the Tucker range of monel pop rivets for these diameters are 0.40 in, 0.45 in, and 0.75 in, respectively, any similar rivet longer than these belongs to the AM range.

47 The code for the identification of an AM rivet consists of a series of letters followed by a part number and further letters; the final letters denote the type of mandrel as for the Tucker range of pop rivets. The code letters are as follows:-

A - Aircraft Materials Ltd.

N - Nickel alloy (monel)

P - Pin type

D - Dome-head

K - 120 deg. countersunk-head

48 The dimensions of an AM rivet are given by the part number, the first digit of which indicates the diameter of the rivet (para. 46) expressed in increments of 1/32 in, whilst the remaining figures denote the length, which is measured from the tail of the rivet to below the head, expressed in hundredths of an inch. Examples of the identification code are as follows:-

ANP/K/550/BH is an AM, nickel alloy, pin type rivet, with a 120 deg. csk. head, 5/32 in dia., and 0.50 in long, mounted on a break-head mandrel.

ANP/D/450/BH is an AM, nickel alloy, pin type rivet, with a dome head, 1/8 in dia., and 0.50 in long, mounted on a break-head mandrel.

CHOBERT RIVETS

49 Chobert rivets (fig. 23) are hollow with partially tapered tails, and are

made to AGS drawings, with either snap heads, 100 or 120 deg. countersunk heads. Where additional strength, or water tightness, is required, the rivets, when they have been placed, are plugged by sealing pins. The rivets are manufactured of aluminium alloy to BS.L86 and steel to DTD.720; the sealing pins used with the aluminium alloy rivets are of aluminium alloy to BS.L102, while steel pins to BS.S1 are used with the steel rivets.

Note ...

Steel sealing pins must not be used with aluminium alloy rivets and vice versa.

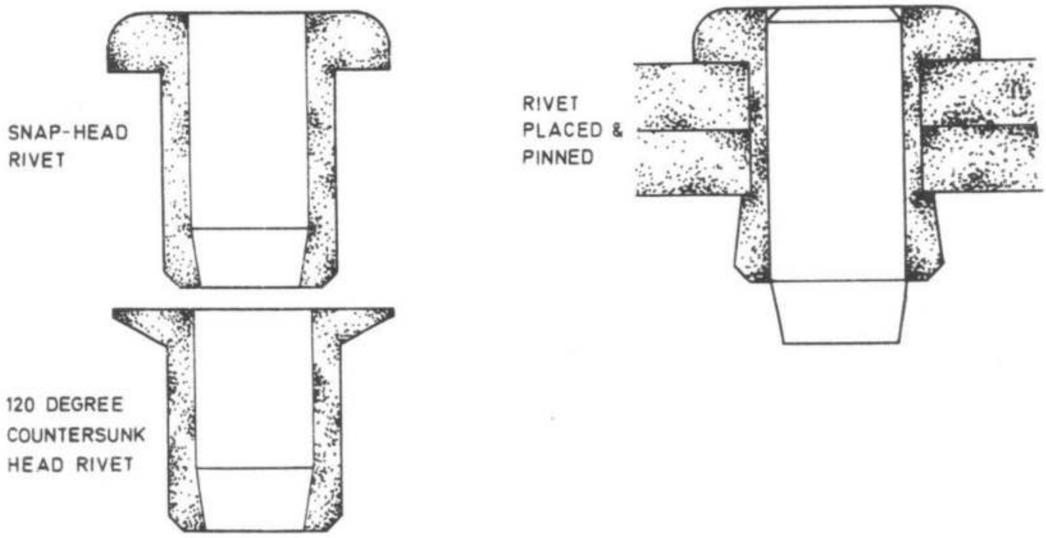


Fig.23 Chobert rivets

50 Rivets manufactured from aluminium alloy are dyed violet, aluminium alloy sealing pins are natural or self-colour, and steel rivets and sealing pins are cadmium plated; aluminium alloy sealing pins can be distinguished from their steel counterparts by their appearance and by the difference in the weight. The various rivets and sealing pins do not bear any direct identification letters, figures, or other markings, the AGS identification code for the rivets and sealing pins is described in Table 28.

51 Chobert rivets are supplied in diameters from 3/32 in to 1/4 in and these diameters are provided in various lengths and in both the materials quoted in para. 49; sealing pins are available for rivets of all diameters and lengths. It should be noted that the length of a Chobert snap-head rivet is measured from the tail of the shank to below the head and that of a countersunk-head rivet from the tail of the shank to the face of the head.

52 Chobert rivets are manufactured to AGS drawings, and the drawing numbers are utilized in the identification coding to indicate the head formations of the rivets and the materials from which they are made. Details of the drawing numbers are given in Table 28.

53 The identification coding for a Chobert rivet consists of the AGS drawing number followed by a part number; the last two figures of the part number represent the length of the rivet expressed in increments of 1/32 in, and the remaining figure or figures indicate the diameter of the shank of the rivet also expressed in increments of 1/32 in. Examples of the identification coding are as follows:-

AGS 2040/410 is a Chobert rivet with a snap-head, made of steel, 1/8 in dia., and 5/16 in long.

AGS 2044/619 is a Chobert rivet with a 120 deg csk. head, made of duralumin, 3/16 in dia., and 19/32 in long.

TABLE 28 AGS CHOBERT RIVET CODE

AGS No.	Head form	Material
	Rivets	
2040	Snap	Steel DTD.720
2041	120 deg csk.	Steel DTD.720
2045	Snap	Alum. alloy L86
2046	120 deg csk.	Alum. alloy L86
2067	100 deg csk.	Steel DTD.720
2068	100 deg csk.	Alum. alloy L86
	Sealing pins	
2042	-	Mild steel S1
2047	-	Alum. alloy L102

Sealing pins

54 Sealing pins are provided to suit Chobert rivets of all sizes, but steel pins must be used only with steel rivets. The AGS identification code for a sealing pin consists of the AGS drawing number, which denotes the material from which it is made (Table 28), followed by a part number, which is the same as that of the rivet for which the pin is intended; it should be noted that if the rivet which is to be plugged has a countersunk head, a sealing pin of the same length as that of the rivet will project when the rivet has been placed and the pin inserted, and it is recommended, therefore, that the next shorter length of pin should be used. Examples of the code for sealing pins are as follows:-

AGS 2042/410 is a steel sealing pin, for a Chobert rivet with a snap-head, made of steel, 1/8 in dia., and 5/16 in long.

AGS 2047/613 is an aluminium alloy sealing pin, for a Chobert rivet with a snap-head, made of aluminium alloy, 3/16 in dia, and 13/32 in long.

Alternative replacements

55 The manufacturers of the proprietary Chobert rivets have recently advised that certain lengths within their ranges are not now being stocked and will,

in future, only be manufactured in quantities which it will be completely uneconomical to purchase. Furthermore, it is likely that this non-availability will become progressively worse over the years.

56 This type of fastener is used on many aircraft and in numerous specific locations. In consequence, it is not possible to obtain 'across-the-board' clearance from design authorities to substitute other types of fastener. However, it is understood that in general, substitutes are available provided that the specific application can be assessed by the appropriate designers.

57 In some locations it may not be acceptable to mix rivet types within a repair. In order to minimise the problems of non-availability of Chobert rivets, with immediate effect all units are to be advised:

57.1 Not to commence repairs involving Chobert rivets until it has been ascertained that all rivets required and their appropriate sealing pins are available.

57.2 When it is found that a particular rivet is not available, to take action i.a.w. AP(N) 140 article 0105 and 0106, for the Royal Navy.

AVDEL RIVETS

58 Avdel rivets (fig.24) which are of proprietary manufacture, are hollow ▶with counterbored tails and either snap, 100 deg, or 120 deg countersunk heads, and are supplied mounted on stems of the break-stem type. The rivets are fully self-sealing and manufactured in both aluminium alloy to BS.L86 and stainless steel DTD.189. The stems are also of aluminium alloy and stainless steel respectively but of a different specification; neither the rivets nor their stems bear any direct identification marking other than the following:-

Al. alloy snap-head - head anodised, stem anodised

Al. alloy 100 deg csk - head anodised, stem anodised, dyed red

The stems on 5/32 in and 3/16 in diameter only, stainless steel rivets have pull grooves to assist placing. ◀

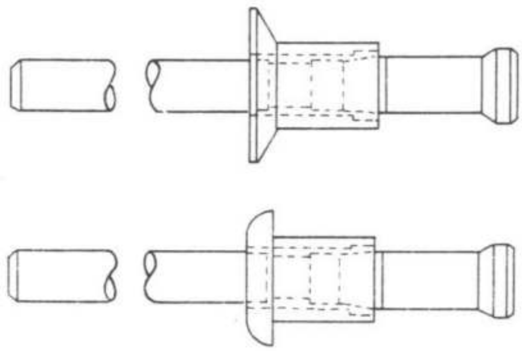


Fig.24 Avdel rivets

59 Avdel rivets are supplied in diameters of 1/8 in, 5/32 in, and 3/16 in and are available in various lengths to suit the material grip range; particulars of the grip range and also of the stem protrusions of the various rivets are given in Chapter 1 of this publication. It should be noted that the length of a snap-head rivet is measured from the tail of its shank to

below the head, and that of a 100 deg countersunk-head rivet from the tail of its shank to the face of the head.

60 The code for the identification of an Avdel self-sealing rivet consists of the AGS drawing number followed by a part number. The AGS drawing number indicates the class of rivet, the head formation and the material specification; thus:-

2065 Self-sealing rivet, snap-head, aluminium alloy to BS.L86.

3922 Self-sealing rivet, snap-head, stainless steel to DTD.189, cadmium plated to DTD.904.

2066 Self-sealing rivet, 100 deg countersunk-head, aluminium alloy to BS.L86.

61 The dimensions of an Avdel rivet are denoted by the part number which follows the AGS drawing number. The first digit denotes the rivet diameter, expressed in increments of 1/32 in, and the remaining digits indicate the length, also expressed in increments of 1/32 in. Examples of the identification code are as follows:-

AGS 2065/405 is a snap-head rivet made of aluminium alloy, 1/8 in dia., and 5/32 in long.

AGS 2066/510 is a 100 deg countersunk-head rivet made of aluminium alloy, 5/32 in dia., and 5/16 in long.

TABLE 29 AVDEL SELF-SEALING RIVETS

AGS No.	Avdel No.	Head form	Material
2065	4002	Snap	Aluminium alloy BS.L86.
2066	4032	100 deg csk.	Aluminium alloy BS.L86.
3920	4051	Snap	Stainless steel DTD.189.
3921	4057	100 deg csk.	Stainless steel DTD.189.
3922	4061	Snap	Stainless steel DTD.189, cadmium plated DTD.904.
3923	4067	100 deg csk.	Stainless steel DTD.189, cadmium plated DTD.904.
4716	4022	120 deg csk.	Aluminium alloy BS.L86.

IMEX BLIND RIVETS

Description

62 The Imex blind rivet (fig. 25) is similar to the conventional pop rivet but with the important difference that the rivet itself has a permanently sealed end which completely encloses the mandrel head. When the rivet is set, the rapid radial expansion of the formed head ensures a joint which is pressure tight up to 34 bar (500 lbf/in^2).

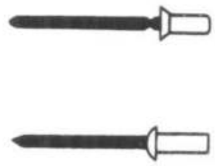


Fig.25 Imex rivets

CONTINUED ON PAGE 59

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Demand No. 117388, 569, 1/80, 1909, (13550-4)

63 Mandrels are supplied as short-break or long-break types, similar to the normal pop rivets, but the Imex form of rivet ensures that mandrel heads remain permanently captured. When the long-break mandrel fractures, it does so outside the rivet and the protruding portion must be nipped off and sanded to achieve a flush finish. Imex rivets are supplied with domed or countersunk-heads. The countersunk-heads are normally 120 deg. but 100 deg. heads are manufactured for a limited range of rivet sizes.

64 Not all materials are suitable for use with Imex rivets as the rapid expansion of the formed head is unsatisfactory in very soft or very brittle materials. For this reason the rivets should not be employed on repair work unless the appropriate aircraft Vol. 6 indicates that such rivets may be used in the particular area and in the material(s) under consideration.

Material

65 Imex rivets are manufactured from 5 per cent magnesium aluminium alloy to BS.L58.

Coding

66 The code sequence used for Imex rivets is as follows:-

Material (A for aluminium alloy).

Type of head (D for domed-head, K for countersunk-head).

Rivet diameter (in 1/32 in increments).

Rivet grip length (in 1/32 in increments).

Type of mandrel (no additional code for short-break, letter R added for reinforced long-break mandrel).

67 A typical code reference is 'Imex rivet AD46R',which indicates an aluminium alloy rivet with a domed head, 1/8 in in diameter capable of riveting up to 3/16 in thickness on a long-break mandrel. Rivet dimensions are shown in Table 30.

Notes ...

(1) In the case of countersunk rivets, the second digit of the code number indicates the maximum thickness of material to be gripped when dimpling is employed. When machined countersinking is used, the maximum thickness is increased by an amount equal to the depth of the head.

(2) Where identification of rivets is involved, the length under the head of an unformed rivet is equal to the maximum thickness capable of being riveted plus approximately 3/16 in. For example, the length under the head of rivet AD56 is (6 x 1/32) + 3/16 = 3/8 in.

DE BERGUE RIVETS

Applicability

68 This type of rivet is used mainly for the construction of rigid fuel and oil tanks where thin metal sheets are joined together to form the tank shell and internal baffles.

69 The rivets are fitted in one operation, the tail of each being formed on

the inner face of the sheeting by a pneumatic squeeze riveting machine which also dimples the material as shown in fig. 26; the dimpling and rivet forming in one operation assists in resisting shear stresses to which a tank may be subjected.

TABLE 30 RIVET DIMENSIONS

Nominal size (in)	Shank dia. (in) +0.003 -0.001	Head dia. (in) ±0.007	Head thickness (in) ±0.003	Mandrel dia. (in) ±0.001	Angle of csk. head (in)
1/8	0.125	0.236	0.035	0.064	120
5/32	0.156	0.312	0.050	0.086	120
3/16	0.187	0.375	0.060	0.104	120

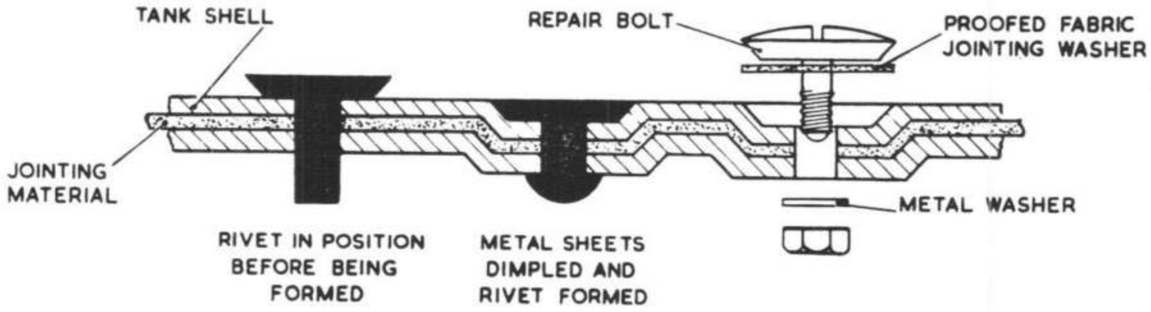


Fig. 26 De Bergue rivet and repair bolt

70 To ensure that rivet seam joints are fuel or oil tight, fluid-resisting jointing material is fitted between the metal sheets prior to the riveting operation.

Repairs to De Bergue riveted tanks

71 Repairs to damaged tanks are confined to removing the affected rivets and fitting special repair bolts (fig. 26). The repair bolts, listed in AP 1086. Section 28D, are manufactured to SBAC Spec. AGS.159 and are available in two types as shown in Table 31.

72 Bolts designed for used in repairing single rivets which have become loose or are causing a tank to leak around the rivet hole, have a slotted countersunk-head which will fit snugly in the dimpled upper surface of the metal sheet, after the rivet has been drilled out of the existing hole.

73 Where a number of closely-grouped rivets are defective, repair bolts are available which have slotted mushroom-heads and are inserted through the

existing rivet holes from the inside of the tank, to fit flush with the inner surface.

TABLE 31 DE BERGUE REPAIR BOLT DATA

Section 28D Ref.No.	High tensile steel bolts		
	Thread size	Shank length (in)	Type of head
6392	6BA	0.415	Countersunk
6394	4BA	0.570	Countersunk
6396	2BA	0.730	Countersunk
6393	6BA	0.515	Mushroom
6395	4BA	0.670	Mushroom
6397	2BA	0.830	Mushroom

CHERRYLOCK RIVETS

74 Cherrylock rivets are locked-spindle and flush-fracturing structural blind rivets. Two types of rivets are available; a Cherrylock and bulbed Cherrylock as shown in fig. 27.

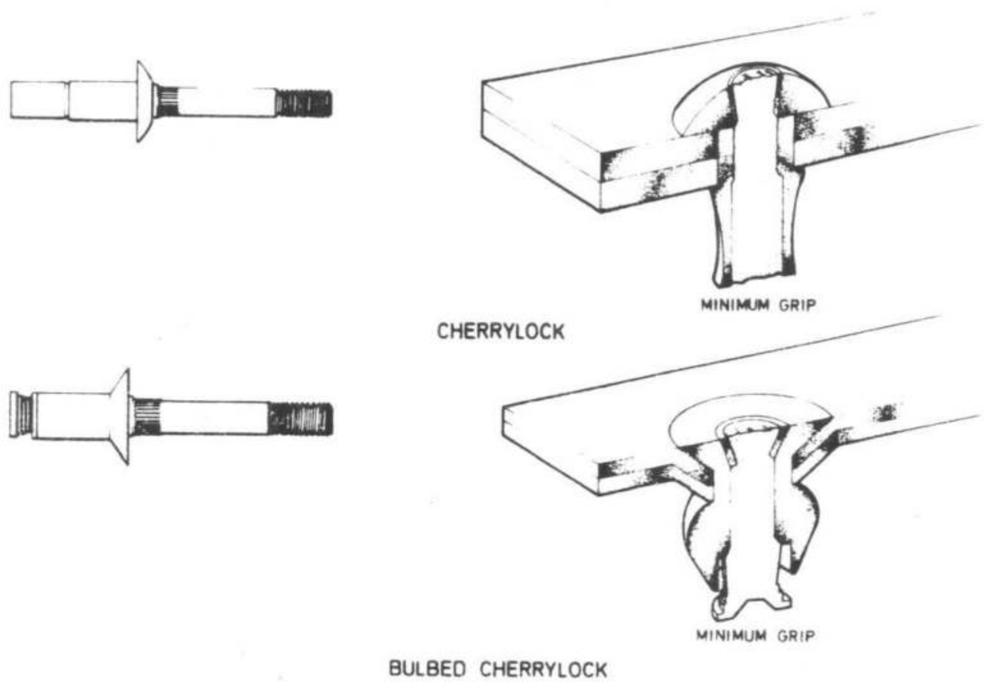


Fig. 27 Cherrylock and bulbed Cherrylock rivets

75 The bulbed Cherrylock rivet is used where a high strength fastener is required and is particularly suitable for high vibration areas, double-dimple applications and for use with thin sheets.

76 The large blind head of the bulbed Cherrylock is of particular use with thin blind sheets where sheet bearing failure under load is a problem, especially in applications where a blind sheet is equal to or less than the thickness shown in Table 32.

TABLE 32 THIN BLIND SHEET APPLICATION - CHERRYLOCK RIVET

Rivet dia.	Aluminium blind sheet thickness	Titanium blind sheet thickness
1/8 in	0.040 in	0.020 in
5/32 in	0.040 in	0.032 in
3/16 in	0.050 in	0.032 in

Rivet heads and sizes

77 Rivets are available with a variety of protruding and countersunk-heads (fig. 28) each having special applications as follows:-

77.1 Univeral (MS 20470) - For protruding head application in Cherrylock and bulbed Cherrylock rivets

77.2 100° Countersunk - Two types of countersunk rivets are used:-

77.2.1 MS 20426 For normal sheet thickness in Cherrylock and bulbed Cherrylock

77.2.2 NAS 1097 For thin top sheet machine countersunk application in Cherrylock only.

77.3 Unisink - A combination countersunk and protruding head for use in very thin top sheets. Strength equal to double-dimpling. Bulbed Cherrylock only.

77.4 156° Countersunk - A large diameter, shallow countersunk-head providing a wide bearing area for honeycomb application.

78 Cherrylock and bulbed Cherrylock rivets are available for diameters up to 1/4 in and 3/16 in respectively in increments of 1/32 in and in lengths suitable for material thicknesses up to 1 in in increments of 1/16 in.

Grip length (fig. 29)

79 The grip length of the rivet refers to the maximum total sheet thickness to be riveted and is measured in increments of 1/16 in. All rivets have their grip length (maximum grip), marked on the rivet head and have a total grip range of 1/16 in. Table 33 details the grip number of the rivet to be used for ranges in material thicknesses.

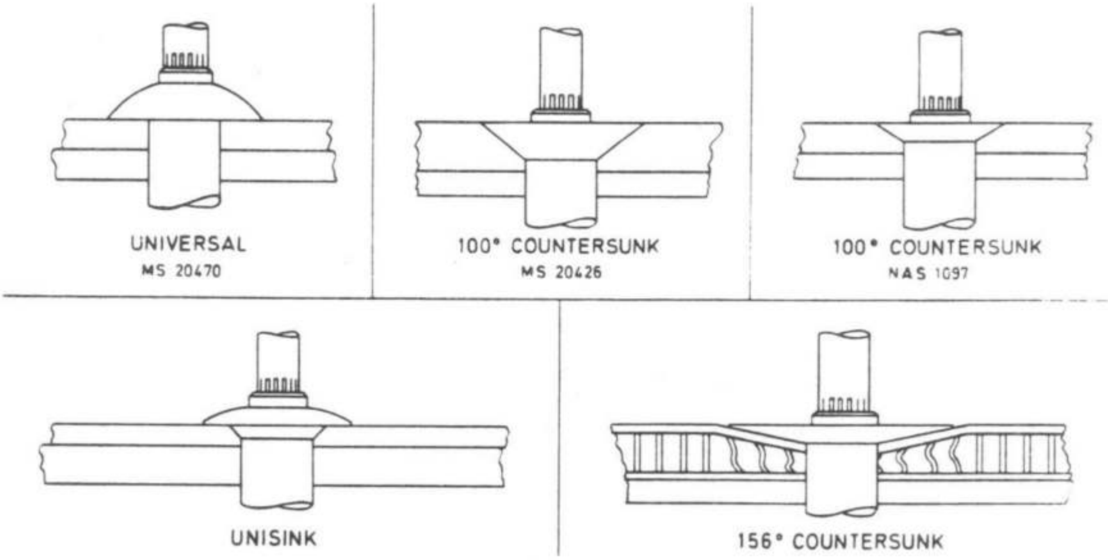


Fig. 28 Cherrylock rivet heads

TABLE 33 RIVET GRIP NUMBER FOR MATERIAL THICKNESS

Rivet Grip No.	Material thickness Minimum mm	in	Maximum mm	in
1	-	-	1.6	1/16
2	-	-	3.2	1/8
3	3.2	1/8	4.7	3/16
4	4.7	3/16	6.4	1/4
5	6.4	1/4	7.9	5/16
6	7.9	5/16	9.5	3/8
7	9.5	3/8	11.1	7/16
8	11.1	7/16	12.7	1/2
9	12.7	1/2	14.3	9/16
10	14.3	9/16	15.9	5/8
11	15.9	5/8	17.5	11/16
12	17.5	11/16	19.1	3/4
13	19.1	3/4	20.6	13/16
14	20.6	13/16	22.2	7/8
15	22.2	7/8	23.9	15/16
16	23.8	15/16	25.4	1

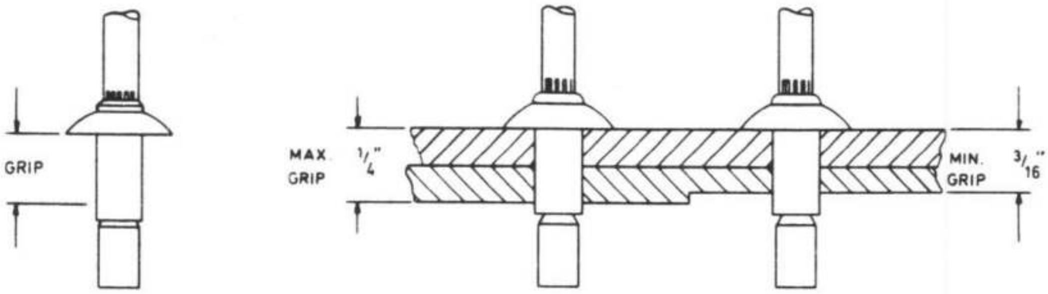


Fig. 29 Grip length of rivet (Cherrylock)

Rivet identification

80 The part number of the rivet identifies the type of rivet, maximum grip length and the nominal shank diameter as shown in the following example:-

CR 2163 - 5 - 4

RIVET TYPE	SHANK DIAMETER (NOMINAL)	GRIP LENGTH (MAXIMUM)
Cherrylock or bulbed Cherrylock, head style and material	In increments of 1/32 in e.g. -5 = 5/32 in	In increments of 1/16 in e.g. -4 = 4/16 in

TUBULAR AND SPLIT-TUBULAR RIVETS

TUBULAR RIVETS

81 Tubular rivets (fig. 30) are made of aluminium (AGS 501-A), duralumin (AGS 501-D), mild steel (AGS 501-H), nickel alloy or monel (AGS 501-J),and monel (AGS 501-K). further information on these rivets is given in Table 34.

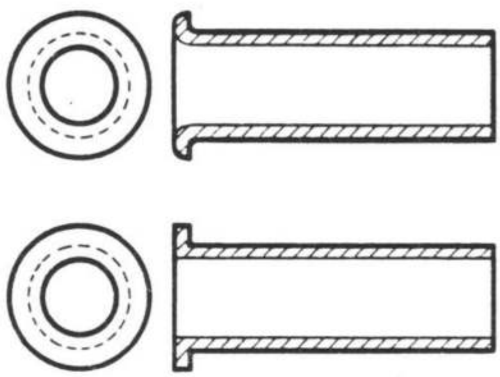


Fig. 30 Tubular rivets

82 A tubular rivet to AGS 501 is identified by a special code which consists of the AGS drawing number, the letter which denotes the material (that is, A, D, H, J or K), and a number which indicates the outside diameter, length and gauge of the rivet; for example, AGS 501/H/49 is a tubular rivet made of mild steel, 1/8 in dia, 1 in long and 26 s.w.g. The part number, unlike those mentioned in previous paragraphs, is arbitrarily chosen, and bears no relation

to the dimensions of the rivet concerned; for this reason, a full list of the rivets available is given in Table 35 and 36.

TABLE 34 DETAILS OF TUBULAR RIVETS

AGS 501	Material	Minimum tensile strength		Protective treatment	Identification
		hbar	$tonf/in^2$		
A	Aluminium BS.L54	11	7	Anodic	Black film
D	Duralumin BS.L37	39	25	None	Natural
H	Mild steel BS.T26	31	20	Cadmium	Magnetic
J	Nickel alloy DTD.268 or Monel DTD.204A	54	35	Cadmium plated	Non-magnetic
K	Monel DTD.204A	54	35	None	Non-magnetic

Note ...

Nickel alloy and monel are slightly magnetic, but the pull exerted upon it is very much less than upon steel.

SPLIT TUBULAR RIVETS

83 A shortage of rivet tubing led to the development of split tubular rivets (fig. 31), which are manufactured from sheet or strip material bent to form a split hollow cylinder. The rivets are manufactured from duralumin to DTD.603 or 610, and in mild steel to BS.S3, and with either flat heads or cone heads. Duralumin rivets have no protective treatment, but steel rivets are cadmium plated; the rivets are made to AGS drawings, as follows:-

'AGS 513' - Flat-head rivets in duralumin

'AGS 514' - Flat-head rivets in mild steel

'AGS 515' - Cone-head rivets in duralumin

'AGS 516' - Cone-head rivets in mild steel

84 The identification code for a split-tubular rivet consists of the AGS drawing number followed by a part number, the last two figures of the part number indicate the length of the rivet expressed in increments of 1/16 in while the remaining figure or figures denote the diameter expressed in increments of 1/32 in; the part number is followed by another figure which represents the gauge thickness of the rivet wall. Some examples of the code are as follows:-

TABLE 35 DETAILS OF TUBULAR RIVETS : AGS 501 UP TO 5/16 IN DIAMETER

Outside diameter of rivet (in)	s.w.g.	Lengths (in)							
		0.25	0.3	0.375	0.5	0.75	0.875	1	1.25
		Part numbers							
3/32	26	1		3	5	7		9	
	22		22		25	27		29	
1/8	26	41		43	45	47		49	
	22				65	67		69	70
5/32	22				105	107	108	109	110
3/16	22			123	125	127	128	129	130
	20				145	147		149	150
	17				165	167		169	170
1/4	22			183	185	187		189	190
	20				205	207		209	210
	17				225	227		229	230
5/16	20					247		249	250
	17					267		269	270
3/8	20					287		289	290
	17					307		309	310
1/2	17							329	330
	14							349	350
5/8	17								370
	14								390
3/32	26								
	22								
1/8	26								
	22	71		73	74				
5/32	22	111		113					
3/16	22	131		133	134				
	20	151		153	154	155			
	17	171		173	174	175			
1/4	22	191		193					
	20	211		213	214	215			
	17	231		233	234	235			
5/16	20	251		253	254	255	256		
	17	271		273	274	275	276		

See Chap. 1 Tables 13 to 15 for metric conversion

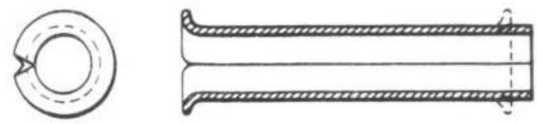
'AGS 513/404/24' is a split-tubular rivet with a flat-head, made of duralumin, 1/8 in dia., 1/4 in long, and 24 s.w.g.

'AGS 516/1032/20' is a split-tubular rivet with a cone-head, made of mild steel, 5/16 in dia., 2 in long, and 20 s.w.g.

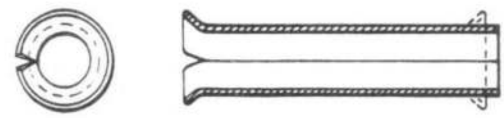
TABLE 36 DETAILS OF TUBULAR RIVETS : AGS 501, OVER 5/16 IN DIAMETER

Outside diameter of rivet (in)	s.w.g.	Lengths (in)								
		1.5	2	2.5	3	3.5	4	4.5	5	5.5
		Part Numbers								
3/8	20	291	293	294	295	296	297			
	17	311	313	314	315	316	317			
1/2	17	331	333	334	335	336	337	338	339	
	14	351	353	354	355	356	357	358	359	
5/8	17	371	373	374	375	376	377	378	379	380
	14	391	393	394	395	396	397	398	399	400

See Chap 1 Tables 13 to 15 for metric conversion.



FLAT-HEAD RIVETS



CONE-HEAD RIVETS

Fig. 31 Split-tubular rivets

MISCELLANEOUS RIVETS

LAR RIVETS

85 LAR rivets, which are also known as TST rivets and are of proprietary manufacture, are used by aircraft constructors for the flush riveting of thin metal sheets. The rivets are made from aluminium alloy to BS.L69 and are anodized and dyed violet. The heads of the rivets most commonly used are oval and countersunk (fig. 32); the tails of the rivet shanks are drilled to form the semi-tubular portion, and it is this portion which is expanded to form the driven rivet (fig. 32). LAR rivets are normally set by machines, but, in emergency, can be set by hand; ordinary solid rivets, of suitable size and material, can

be used to replace damaged LAR rivets.

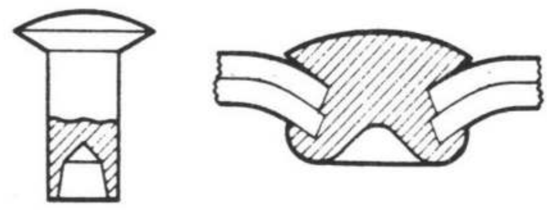


Fig. 32 LAR rivet

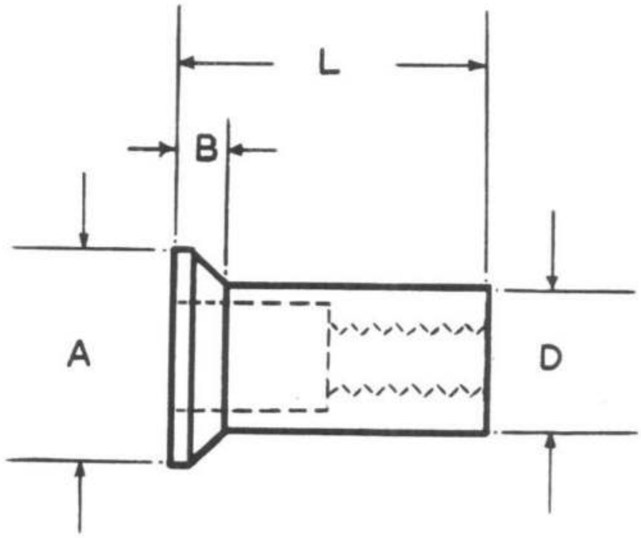


Fig. 34 90 deg. countersunk-head rivnut

TABLE 37 IDENTIFICATION AND DIMENSIONAL DATA FOR 90 DEG. COUNTERSUNK-HEAD RIVNUTS

Size	Part No.	Grip range (in)	Head dia. A (in)	Head depth B (in)	Shank dia. D (in)	Rivet length L (in)	Ident mark
4 B.A.	4-106	0.065-0.106	0.295	0.062	3/16 0.1875	0.437	Blank
	4-136	0.107-0.136	0.295	0.062	3/16 0.1875	0.437	1
	4-161	0.137-0.161	0.295	0.062	3/16 0.1875	0.437	2
	4-181	0.162-0.181	0.295	0.062	3/16 0.1875	0.500	3
	4-201	0.182-0.201	0.295	0.062	3/16 0.1875	0.500	4
	4-221	0.202-0.221	0.295	0.062	3/16 0.1875	0.500	5
2 B.A.	2-136	0.065-0.136	0.355	0.062	¼ 0.250	0.500	1
	2-181	0.137-0.181	0.355	0.062	¼ 0.250	0.562	3
	2-221	0.182-0.221	0.355	0.062	¼ 0.250	0.562	5
¼ B.S.F.	¼-161	0.065-0.161	0.445	0.062	11/32 0.3437	0.625	2
	¼-221	0.162-0.221	0.445	0.062	11/32 0.3437	0.687	5
	¼-281	0.222-0.281	0.445	0.062	11/32 0.3437	0.750	8
3/16 B.S.F.	3/16-161	0.065-0.161	0.505	0.062	13/32 0.4062	0.687	2
	3/16-221	0.162-0.221	0.505	0.062	13/32 0.4062	0.750	5
	3/16-281	0.222-0.281	0.505	0.062	13/32 0.4062	0.812	8
3/8 B.S.F.	⅜-161	0.065-0.161	0.570	0.062	15/32 0.4687	0.687	2
	⅜-221	0.162-0.221	0.570	0.062	15/32 0.4687	0.750	5
	⅜-281	0.222-0.281	0.570	0.062	15/32 0.4687	0.812	8

TABLE 38 IDENTIFICATION AND DIMENSIONAL DATA
FOR FLAT-HEAD RIVETS

Size	Part No.	Grip range (in)	Head dia. A (in)	Head depth B (in)	Shank dia. D (in)		Rivet length L (in)	Ident mark
	4-045	0.010-0.045	0.315	0.035	3/16	0.1875	0.375	Blank
	4-075	0.046-0.075	0.315	0.035	3/16	0.1875	0.375	1
	4-100	0.076-0.100	0.315	0.035	3/16	0.1875	0.375	2
	4-120	0.101-0.120	0.315	0.035	3/16	0.1875	0.437	3
	4-140	0.121-0.140	0.315	0.035	3/16	0.1875	0.437	4
4 B.A.	4-160	0.141-0.160	0.315	0.035	3/16	0.1875	0.437	5
	4-180	0.161-0.180	0.315	0.035	3/16	0.1875	0.500	6
	4-200	0.181-0.200	0.315	0.035	3/16	0.1875	0.500	7
	4-220	0.201-2.220	0.315	0.035	3/16	0.1875	0.500	8
	2-075	0.010-0.075	0.377	0.035	¼	0.250	0.438	1
	2-120	0.076-0.120	0.377	0.035	¼	0.250	0.500	3
2 B.A.	2-160	0.121-0.160	0.377	0.035	¼	0.250	0.500	5
	2-200	0.161-0.200	0.377	0.035	¼	0.250	0.562	7
	2-240	0.201-0.240	0.377	0.035	¼	0.250	0.625	9
	¼-100	0.010-0.100	0.515	0.062	11/32	0.3437	0.562	2
¼ B.S.F.	¼-160	0.101-0.160	0.515	0.062	11/32	0.3437	0.625	5
	¼-220	0.161-0.220	0.515	0.062	11/32	0.3437	0.687	8
5/16	5/16-100	0.010-0.100	0.610	0.062	13/32	0.4062	0.625	2
B.S.F.	5/16-160	0.101-0.160	0.610	0.062	13/32	0.4062	0.687	5
	5/16-220	0.161-0.220	0.610	0.062	13/32	0.4062	0.750	8
3/8	⅜-100	0.010-0.100	0.687	0.062	15/32	0.4687	0.625	2
B.S.F.	⅜-160	0.101-0.160	0.687	0.062	15/32	0.4687	0.687	5
	⅜-220	0.161-0.220	0.687	0.062	15/32	0.4687	0.750	8

Chapter 3-0
(Completely revised)
RIVETING SYSTEMS (HUCK TYPE)

CONTENTS

Introduction

1 Huck OSMLS type blind rivets are the standard oversize rivet for use in areas of aircraft structure where access to both sides of the structure is either severely limited or not possible.

2 Rivet setting is accomplished using an air operated puller tool. Which both sets the rivet and inserts the spindle locking collar.

DESCRIPTION

3 The huck oversize blind rivet comprises three separate items, a sleeve having a pre-formed head, a mechanical lock collar, and a spindle on which the sleeve and lock collar are mounted.

4 The sleeves are normally supplied in either 100 deg countersunk or protruding (snap) head types, and are 1/64 in oversize on standard rivet diameters.

5 Annular grooves on the spindle shank provide a secure grip for the puller tool during setting.

6 As the rivet is set, the spindle is drawn into the sleeve thereby forming the blind head of the rivet. During the final stages of setting, the mechanical lock collar is pressed into the lock groove in the spindle, thereby securing the spindle in position. Continued tension on the spindle causes it to fracture flush with the rivet head.

IDENTIFICATION OF RIVETS

7 Huck oversize blind rivets are manufactured in both countersink and protruding head types. The following information provides a breakdown of the identification code.

Countersink head type

8 Tables 1 and 2 supported by fig. 1 provide details of the rivet identification code and relevant dimensions for 100 deg. countersink head rivets.

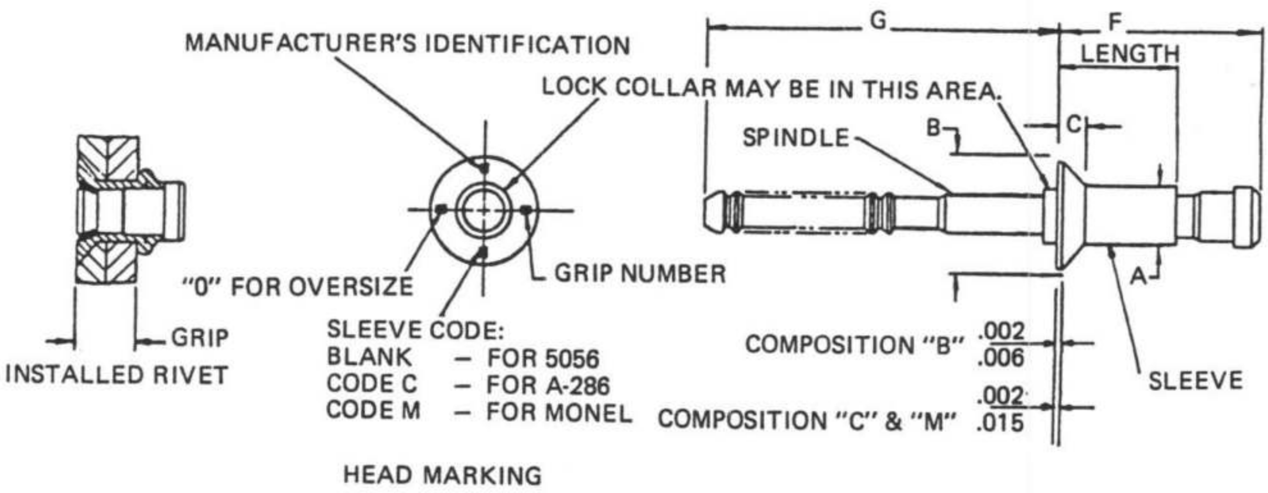


Fig. 1 OSMLS100 series rivet

TABLE 1 DIMENSIONS OF OSMLS100 SERIES BLIND RIVETS

PART NUMBER 1/64 OVERSIZE DIAMETER	DIAMETER	1/64 OVERSIZE NOMINAL	A +.003 -.001 DIAMETER	B ± .004 DIAMETER	C REF	G MINIMUM	SHEAR			TENSILE		HOLE LIMITS (g)
							ALUM	MONEL	A-286 CRES	ALUM	MONEL & A-286 CRES	
OSMLS100(*)04	04	.140	.140	.225	.035	.788	560	1090	1235	325	675	.143 .146
OSMLS100(*)05	05	.173	.173	.286	.048	.788	855	1665	1880	490	1050	.176 .180
OSMLS100(*)06	06	.201	.201	.353	.063	.788	1165	2395	2530	715	1500	.205 .209
OSMLS100(*)08	08	.266	.266	.476	.088	1.000	2015	4250	4495	1200	2600	.271 .275

TABLE 2 OSMLS100 SERIES - GRIP RANGE

GRIP	OSMLS100(*)04 (.140 DIA.)				OSMLS100(*)05 (.173 DIA.)				OSMLS100(*)06 (.201 DIA.)				OSMLS100(*)08 (.266 DIA.)			
	GRIP RANGE		LENGTH	F	GRIP RANGE		LENGTH	F	GRIP RANGE		LENGTH	F	GRIP RANGE		LENGTH	F
NO.	MIN.	MAX.	REF.	MAX	MIN.	MAX.	REF.	MAX.	MIN.	MAX.	REF	MAX.	MIN.	MAX.	REF.	MAX.
01	.057	.078	.213	.342	.075	.100	.238	.418								
02	.079	.125	.260	.391	.101	.125	.263	.446	.100	.125	.287	.500				
03	.126	.187	.323	.516	.126	.187	.326	.541	.126	.187	.350	.571	.126	.187	.427	.637
04	.188	.250	.385	.641	.188	.250	.388	.666	.188	.250	.412	.696	.188	.250	.460	.762
05	.251	.312	.448	.766	.251	.312	.451	.791	.251	.312	.475	.821	.251	.312	.522	.887
06	.313	.375	.510	.891	.313	.375	.513	.916	.313	.375	.537	.946	.313	.375	.585	1.012
07					.376	.437	.576	1.041	.376	.437	.600	1.071	.376	.437	.647	1.137
08					.438	.500	.638	1.166	.438	.500	.662	1.196	.438	.500	.710	1.262
09					.501	.562	.701	1.291	.501	.562	.725	1.321	.501	.562	.772	1.387
10					.563	.625	.763	1.416	.563	.625	.787	1.446	.563	.625	.835	1.512
11									.626	.687	.850	1.571	.626	.687	.897	1.637
12									.688	.750	.912	1.696	.688	.750	.960	1.762
13													.751	.812	1.022	1.887
14													.813	.875	1.085	2.012

* RIVET COMPOSITION CODE LETTER
DIMENSIONS IN INCHES.

Notes ...

(1) Double dimpling is recommended in the following cases;

- (i) 0.140 in dia (04) rivets where the sheet thickness is less than 0.078 ins.
- (ii) 0.173 in dia (05) rivets where the sheet thickness is less than 0.100 in.
- (iii) 0.201 in dia (06) rivets where the sheet thickness is less than 0.100 in.
- (iv) 0.266 in dia (08) rivets where the sheet thickness is less than 0.126 in.

(2) Where double dimpling cannot be used, a (01) grip range rivet must be used.

Protruding head type

9 Figure 2, supported by tables 3 and 4 provides the identification information relevant to protruding head rivets.

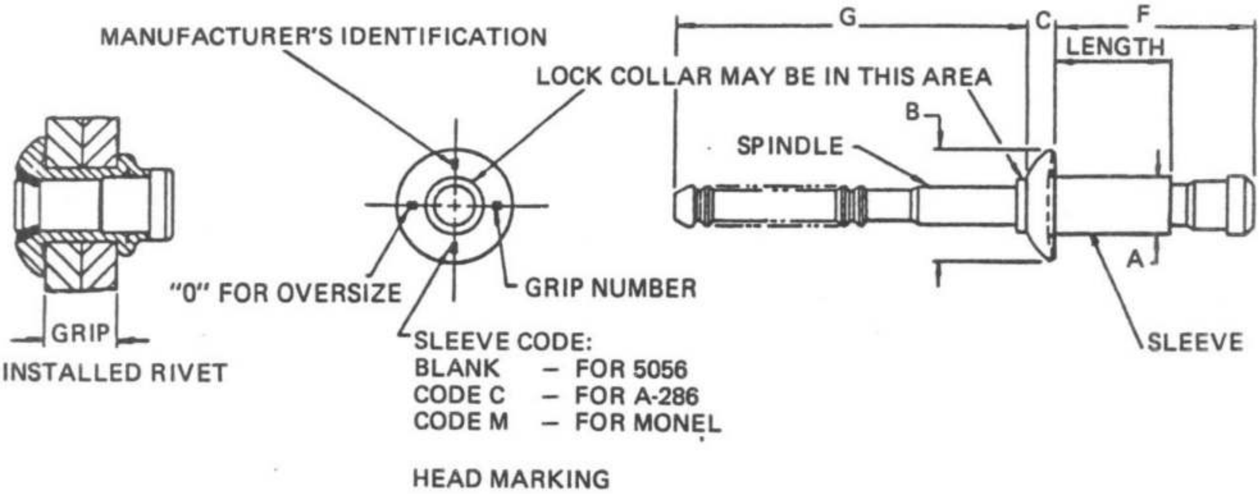


Fig. 2 OSMLSP series rivet

TABLE 3 DIMENSIONS OF OSMLSP SERIES BLIND RIVETS

PART NUMBER 1/64 OVERSIZE DIAMETER	DIAMETER	1/64 OVERSIZE NOMINAL	A +.003 -.001 DIAMETER	B DIAMETER	C +.010 -.000	G MINIMUM	SHEAR			TENSILE		HOLE LIMITS
							ALUM	MONEL	A-286 CRES	ALUM	MONEL & A-286 CRES	
OSMLSP(*)04	04	.140	.140	.250 ± .012	.054	.788	560	1090	1235	325	675	.143 .146
OSMLSP(*)05	05	.173	.173	.312 ± .016	.067	.788	855	1665	1880	490	1050	.176 .180
OSMLSP(*)06	06	.201	.201	.375 ± .019	.080	.788	1165	2395	2530	715	1500	.205 .209
OSMLSP(*)08	08	.266	.266	.500 ± .025	.107	1.000	2015	4250	4495	1200	2600	.271 .275

TABLE 4 OSMLSP SERIES GRIP RANGE

GRIP NO.	OSMLSP(*)04 (.140 DIA.) GRIP RANGE MIN.	GRIP RANGE MAX.	LENGTH REF.	F MAX	OSMLSP(*)05 (.173 DIA.) GRIP RANGE MIN.	GRIP RANGE MAX.	LENGTH REF.	F MAX.	OSMLSP(*)06 (.201 DIA.) GRIP RANGE MIN.	GRIP RANGE MAX.	LENGTH REF	F MAX.	OSMLSP(*)08 (.266 DIA). GRIP RANGE MIN.	GRIP RANGE MAX.	LENGTH REF.	F MAX.
01	.025	.062	.198	.338	.031	.062	.227	.378	.037	.062	.251	.431				
02	.063	.125	.260	.443	.063	.125	.263	.478	.063	.125	.287	.526	.063	.125	.335	.606
03	.126	.187	.323	.568	.126	.187	.326	.502	.126	.187	.350	.652	.126	.187	.397	.731
04	.188	.250	.385	.693	.188	.250	.388	.727	.188	.250	.412	.776	.188	.250	.460	.856
05	.251	.312	.448	.818	.251	.312	.451	.852	.251	.312	.475	.901	.251	.312	.522	.981
06	.313	.375	.510	.943	.313	.375	.513	.997	.313	.375	.537	1.026	.313	.375	.585	1.106
07					.376	.437	.576	1.203	.376	.437	.600	1.151	.376	.437	.647	1.231
08					.438	.500	.638	1.227	.438	.500	.662	1.276	.438	.500	.710	1.356
09					.501	.562	.701	1.352	.501	.562	.725	1.401	.501	.562	.772	1.481
10					.563	.625	.763	1.477	.563	.625	.787	1.526	.563	.625	.835	1.606
11									.626	.687	.850	1.651	.626	.687	.897	1.731
12									.688	.750	.912	1.776	.688	.750	.960	1.856
13													.751	.812	1.022	1.981
14													.813	.875	1.085	2.106

* RIVET COMPOSITION CODE LETTER
DIMENSIONS IN INCHES.

TABLE 5 MATERIALS AND FINISHES

Rivet Components	Composition B	Composition C	Composition M
		MATERIALS	
Sleeve	5056 Aluminium per QQ-A-430	A-286 Cres per chemical RQMT of AMS5737	Monel per QQ-N-281
Spindle	3. 2024 Aluminium per QQ-A-430	3. A-286 Cres per chemical RQMT of AMS5737	3. A-286 Cres per chemical RQMT of AMS5737
Lock ring	5056 Aluminium per QQ-A-430	A-286 Cres per chemical RQMT of AMS5737	A-286 Cres per chemical RQMT of AMS5737 or Monel per QQ-N-281
		FINISHES	
Sleeve	None	Passivate per QQ-P-35 or cadmium plate per QQ-P-416 Type 11 Class 3 or Aluminium coating per NAS4006	None or cadmium plate per QQ-P-416 Type 11 class 3 or Aluminium coating per NAS4006
Spindle	Anodize per MIL-A-8625 or chemically surface treat per MIL-C-5541	Passivate per QQ-P-35	Passivate per QQ-P-35 -
Lock ring	none	Passivate per QQ-P-35	Passivate per QQ-P-35 for A-286 cres only

Ordering code

10 The rivet part number provides a full coded identification of each rivet type, composition and size. It is therefore, essential that the code be fully understood as follows:

OSMLS (P or 100) (B or EU or M) -05-04 (A or AC or C or P)

- P — Protruding head
- 100 — 100 deg CSK head
- B — Composition B-Aluminium rivet
- EU — Composition C - A-286 Cres rivet
- M — Composition M - Monel rivet
- 05 — diameter in 0.0312 inch increments.
- 04 — maximum grip in 0.0625 inch increments
- A — chemical film, ref MIL-C-5541
- AC — aluminium coating
- C — cadmium plated sleeve
- P — dry film lubrication

Example:

OSMLS100M0504AC	-	Monel rivet, 0.173 in diameter, 0.188 - 0.250 in grip range, aluminium coated sleeve.

Chapter 3-1

JO-BOLTS

CONTENTS

Introduction (fig. 1)

1 The Jo-bolt is a high tensile steel, blind fastener which can be placed and set with a simple ratchet hand tool, although for production work the Jo-bolt is normally set by a power operated tool. The bolt has the characteristic clenching qualities of a conventional nut and bolt with the additional advantages of being self-locking at a pre-determined torque. As a blind fastener it does not suffer the weight penalty of captive nuts. After a Jo-bolt has been set it can only be removed by drilling and the removal procedure can be carried out accurately, and without damage, to the original hole. The bolts are available in 3/16, 1/4 and 5/16 in diameters, and 0.164, 0.200 and 0.260 in diameters, with a grip range from 1/10 in upwards.

2 Each Jo-bolt consists of a nut of countersunk or hexagon head form with a reduced diameter shank extension, tapered at the tail end, a stainless steel sleeve, and a bolt with flats along the tail end of the thread, the flats terminating at a waisted portion. The head of the bolt is undercut slightly to receive the sleeve when the Jo-bolt is set. The shank extension of the

nut, the sleeve and the bolt head are of approximately equal diameter. As the Jo-bolt is set by rotating the tail end and not the head of the bolt, the thread is left-handed, which allows a right-handed tightening action. When a Jo-bolt is placed (fig.2), the head of the nut is held stationary by the hand ratchet tool nose piece, the tail of the bolt is rotated, and the head of the bolt grips the sleeve against the tapered tail of the nut. The sleeve then expands over the taper to clench the sheet metal and so form a head on the blind side of the work. The sleeve also compresses the tail of the nut to effect a frictional lock on the thread of the bolt. At a pre-determined torque, the bolt fractures at the waisted portion to produce a flush finish with the nut on the face side of the work. As the ratchet is removed, the fractured tail is ejected by a spring-loaded plunger within the ratchet.

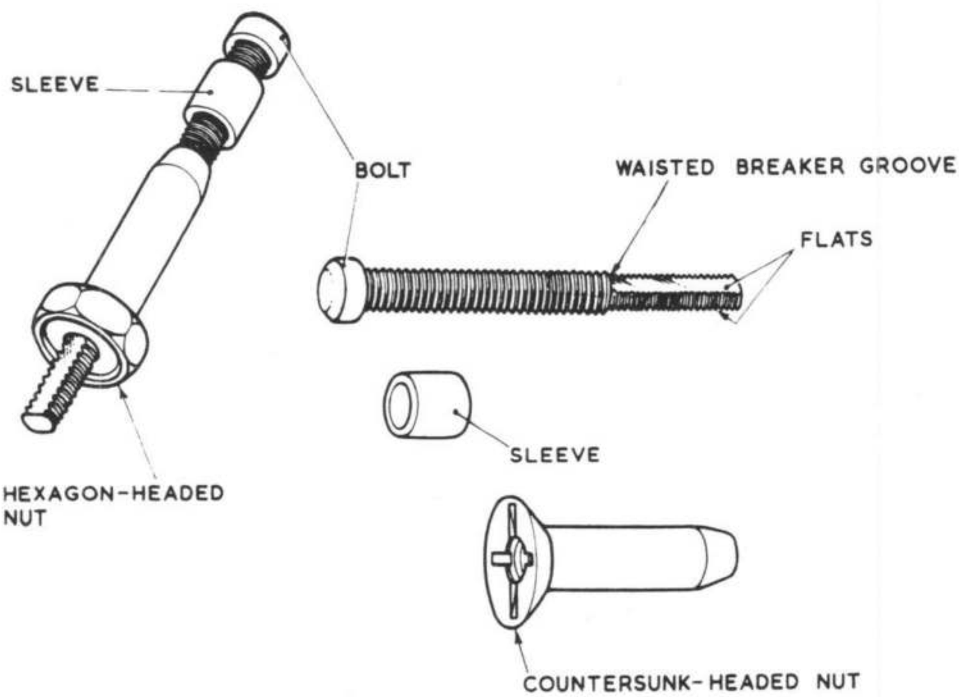
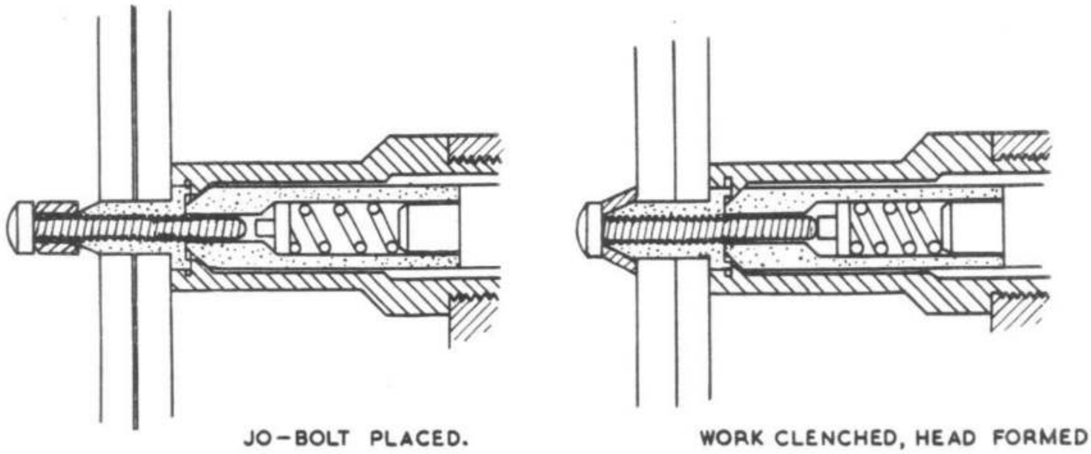


Fig.1 Jo-bolts, countersunk and hexagon heads

3 All Jo-bolts are manufactured in steel, cadmium plated to DTD.904. The bolts and nuts are alloy steel to BS.S148 and the sleeves, stainless steel annealed to DTD.5036.

Bolt sizes

4 Six diameters of Jo-bolt and two head forms are available. The complete range of grip sizes are listed in Tables 2, 3, 5 and 6 and the general dimensions of the Jo-bolts are given in Tables 1 and 4. The 'dash' numbers which are quoted in the Tables indicate nominal grip lengths in sixteenths of an inch. The nominal Jo-bolt diameters of 3/16 in, 1/4 in, and 5/16 in are more precisely referred to as 190, 249 and 312 respectively; these figures represent the maximum nut shank diameters in decimals of an inch.



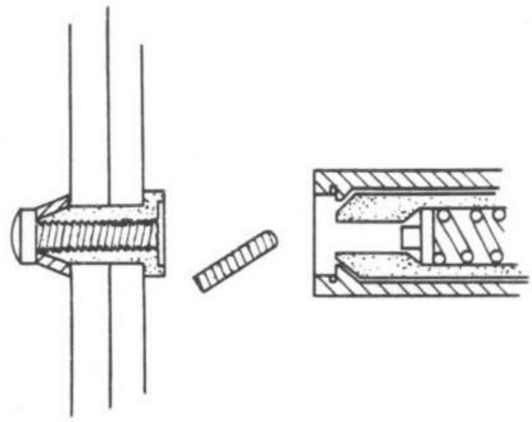


Fig.2 Jo-bolt driving sequence

Coding

5 The coding system for calling up Jo-bolts is as follows:-

5.1 Countersunk heads. A typical code reference is 2103-0807, this indicates a 100 deg. flush countersunk head in high-tensile steel with the maximum diameter of the bolt in increments of 1/32 in (1/4 in) and a nominal grip length in sixteenths of an inch (7/16 in).

5.2 Hexagon heads. A typical code reference is 2101-0806. This indicates a protruding hexagon head in high-tensile steel with the maximum diameter of the bolt in decimals of an inch (0.249 in) and a nominal grip length in sixteenths of an inch (3/8 in).

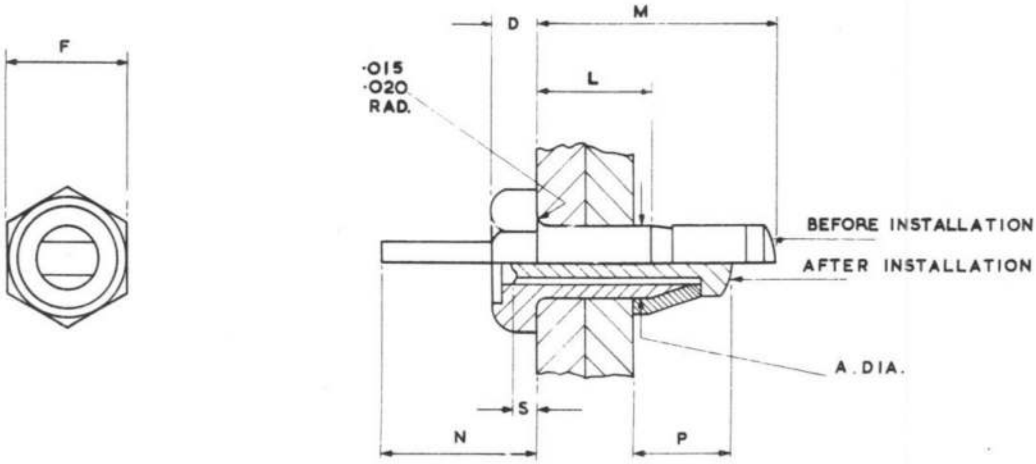


Fig.3 Hexagon-headed Jo-bolt, general dimensions

TABLE 1 GENERAL DIMENSIONS HEXAGON-HEAD JO-BOLTS

Nom dia.	Part No.	A	D	F	N Max	P Max	S	Recommended hole size
3/16	2101-06	0.190 0.188	0.113 0.103	0.310 0.304	0.457	0.28	0.103 0.015	0.194 0.191
1/4	2101-08	0.249 0.247	0.135 0.125	0.375 0.367	0.467	0.32	0.135 0.047	0.253 0.250
5/16	2101-10	0.3115 0.3095	0.160 0.150	0.437 0.429	0.523	0.39	0.136 0.033	0.3155 0.3122
0.164	2111-05	0.1625 0.1645	0.096 0.086	0.250 0.244	-	0.215	0.088 0.000	0.168 0.165
0.200	2111-06	0.1970 0.1990	0.113 0.103	0.312 0.305	-	0.265	0.098 0.010	0.202 0.199
0.260	2111-08	0.2580 0.2600	0.135 0.125	0.375 0.367	-	0.292	0.135 0.047	0.263 0.260

Note ...

All dimensions are in inches

TABLE 2 GRIP RANGES HEXAGON-HEAD JO-BOLTS (2101 SERIES)

Dash No.	Grip range Min	Grip range Max	L Nom	M Max 2101-06	M Max 2101-08	M Max 2101-10
*02	*0.094	*0.156	*0.156	0.524	0.587	-
03	0.156	0.219	0.219	0.587	0.649	0.754
04	0.219	0.281	0.281	0.649	0.712	0.816
05	0.281	0.344	0.344	0.712	0.774	0.879
06	0.344	0.406	0.406	0.774	0.837	0.941
07	0.406	0.469	0.469	0.837	0.899	1.004
08	0.469	0.531	0.531	0.899	0.962	1.066
09	0.531	0.594	0.594	0.962	1.024	1.129
10	0.594	0.656	0.656	1.024	1.087	1.191
11	0.656	0.719	0.719	1.087	1.149	1.254
12	0.719	0.781	0.781	1.149	1.212	1.316
13	0.781	0.844	0.844	1.212	1.274	1.379
14	0.844	0.906	0.906	1.274	1.337	1.441
15	0.906	0.969	0.969	1.337	1.399	1.504
16	0.969	1.031	1.031	1.399	1.462	1.566

Note ...

All dimensions are in inches

*Not 2101-10

TABLE 3 GRIP RANGES HEXAGON-HEAD JO-BOLTS (2111 SERIES)

Dash No.	Grip range Min	Grip range Max	2111-05 L Min	2111-05 M Max	2111-06 L Min	2111-06 M Max	2111-08 L Min	2111-08 M Max
02	0.094	0.156	0.146	0.49	0.156	0.55	0.156	0.60
03	0.156	0.219	0.209	0.55	0.219	0.61	0.219	0.67
04	0.219	0.281	0.271	0.61	0.281	0.68	0.281	0.73
05	0.281	0.344	0.334	0.68	0.344	0.74	0.344	0.79
06	0.344	0.406	0.396	0.74	0.406	0.80	0.406	0.85
07	0.406	0.469	0.459	0.80	0.469	0.86	0.469	0.92
08	0.469	0.531	0.521	0.86	0.531	0.93	0.531	0.98
09	0.531	0.594	0.584	0.93	0.594	0.99	0.594	1.04
10	0.594	0.656	0.646	0.99	0.656	1.05	0.656	1.10
11	0.656	0.719	0.709	1.05	0.719	1.11	0.719	1.17
12	0.719	0.781	0.771	1.11	0.787	1.18	0.781	1.23

Note ...

All dimensions are in inches

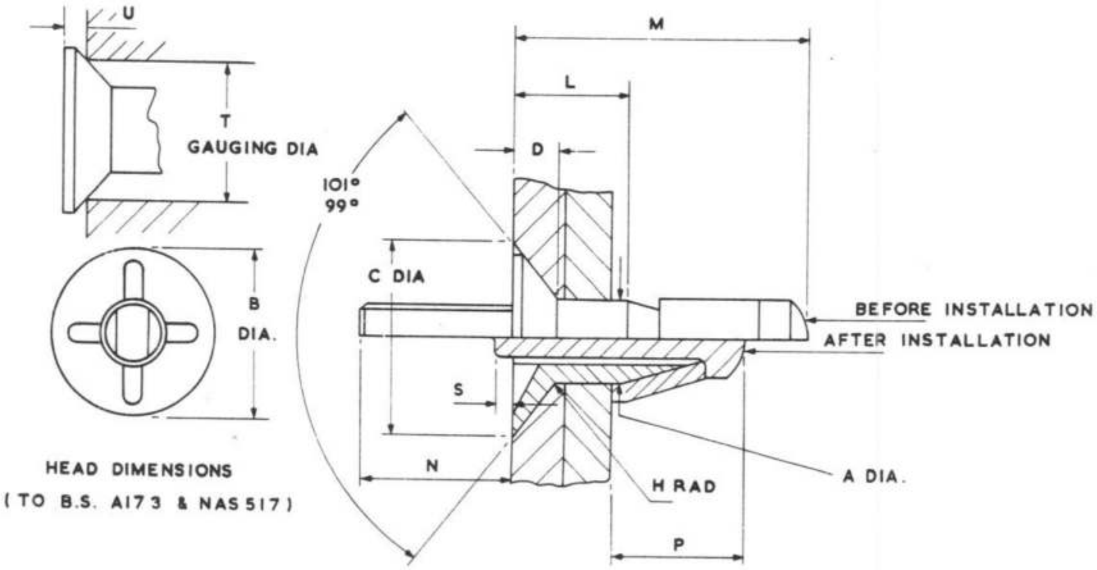


Fig.4 Countersunk-head Jo-bolt, general dimensions

TABLE 4 GENERAL DIMENSIONS COUNTERSUNK-HEAD JO-BOLTS

Nom dia	Part No.	A dia	B Min dia	C Nom dia	D Nom	H Rad	N Max	P Max	S	T dia	U
3/16	2103-06	0.190 0.188	0.342	0.381	0.080	0.020 0.010	0.374	0.28	+0.005 −0.083	0.3147	0.0299 0.0259
1/4	2103-08	0.249 0.247	0.463	0.503	0.106	0.030 0.015	0.342	0.32	+0.010 −0.078	0.4245	0.0353 0.0307
5/16	2103-10	0.3115 0.3095	0.577	0.630	0.133	0.030 0.015	0.398	0.39	+0.000 −0.093	0.5389	0.0409 0.0357
0.164	2113-05	0.1625 0.1645	0.301	0.3285	0.069	0.020 0.030	-	0.215	+0.020 −0.068	0.2671	0.0276 0.0238
0.200	2113-06	0.1970 0.1990	0.352	0.381	0.077	0.020 0.030	-	0.265	+0.015 −0.079	0.3147	0.0299 0.0259
0.260	2113-08	0.2580 0.2600	0.470	0.503	0.102	0.020 0.030	-	0.292	+0.010 −0.078	0.4245	0.0353 0.0307

Note ...

All dimensions are in inches

TABLE 5 GRIP RANGES COUNTERSUNK-HEAD JO-BOLTS (2103 SERIES)

Dash No.	Grip range Min	Grip range Max	L Nom	M Max 2103-06	M Max 2103-08	M Max 2103-10
†02	†0.094 *0.116	†0.156	†0.156	0.524	0.587	-
†03	†0.156	†0.219	†0.219	0.587	0.649	-
04	0.219	0.281	0.281	0.649	0.712	0.816
05	0.281	0.344	0.344	0.712	0.774	0.879
06	0.344	0.406	0.406	0.774	0.837	0.941
07	0.406	0.469	0.469	0.837	0.899	1.004
08	0.469	0.531	0.531	0.899	0.962	1.066
09	0.531	0.594	0.594	0.962	1.024	1.129
10	0.594	0.656	0.656	1.024	1.087	1.191
11	0.656	0.719	0.719	1.087	1.149	1.254
12	0.719	0.781	0.781	1.149	1.212	1.316
13	0.781	0.844	0.844	1.212	1.274	1.379
14	0.844	0.906	0.906	1.274	1.337	1.441
15	0.906	0.969	0.969	1.337	1.399	1.504
16	0.969	1.031	1.031	1.399	1.462	1.566

Note ...

All dimensions are in inches

† Not 2103-10
* 2103-08 only

TABLE 6 GRIP RANGES COUNTERSUNK-HEAD JO-BOLTS (2113 SERIES)

Dash No.	Grip range Min	Grip range Max	2113-05 L Min	2113-05 M Max	2113-06 L Min	2113-06 M Max	2113-08 L Min	2113-08 M Max
02	0.094 *0.112	0.156	0.146	0.49	0.156	0.55	0.156	0.60
03	0.156	0.219	0.209	0.55	0.219	0.61	0.219	0.67
04	0.219	0.281	0.271	0.61	0.281	0.68	0.281	0.73
05	0.281	0.344	0.334	0.68	0.344	0.74	0.344	0.79
06	0.344	0.406	0.396	0.74	0.406	0.80	0.406	0.85
07	0.406	0.469	0.459	0.80	0.469	0.86	0.469	0.92
08	0.469	0.531	0.521	0.86	0.531	0.93	0.531	0.98
09	0.531	0.594	0.584	0.93	0.594	0.99	0.594	1.04
10	0.594	0.656	0.646	0.99	0.656	1.05	0.656	1.10

TABLE 6 GRIP RANGES COUNTERSUNK-HEAD JO-BOLTS (2113 SERIES) (continued)

Dash No.	Grip range Min	Grip range Max	2113-05 L Min	2113-05 M Max	2113-06 L Min	2113-06 M Max	2113-08 L Min	2113-08 M Max
11	0.656	0.719	0.709	1.05	0.719	1.11	0.719	1.17
12	0.719	0.781	0.771	1.11	0.781	1.18	0.781	1.23

Note ...

All dimensions are in inches

* 2113-06 only

Driving tool

6 Hand ratchet tools are supplied for bolt driving, one for the 3/16 and 1/4 in bolts and one for the 5/16 in bolts. Fig.5 illustrates the general form of the tool, together with the wrench adapter and nose piece required for individual bolt heads. Table 7 lists the complete range of components together with their particular application.

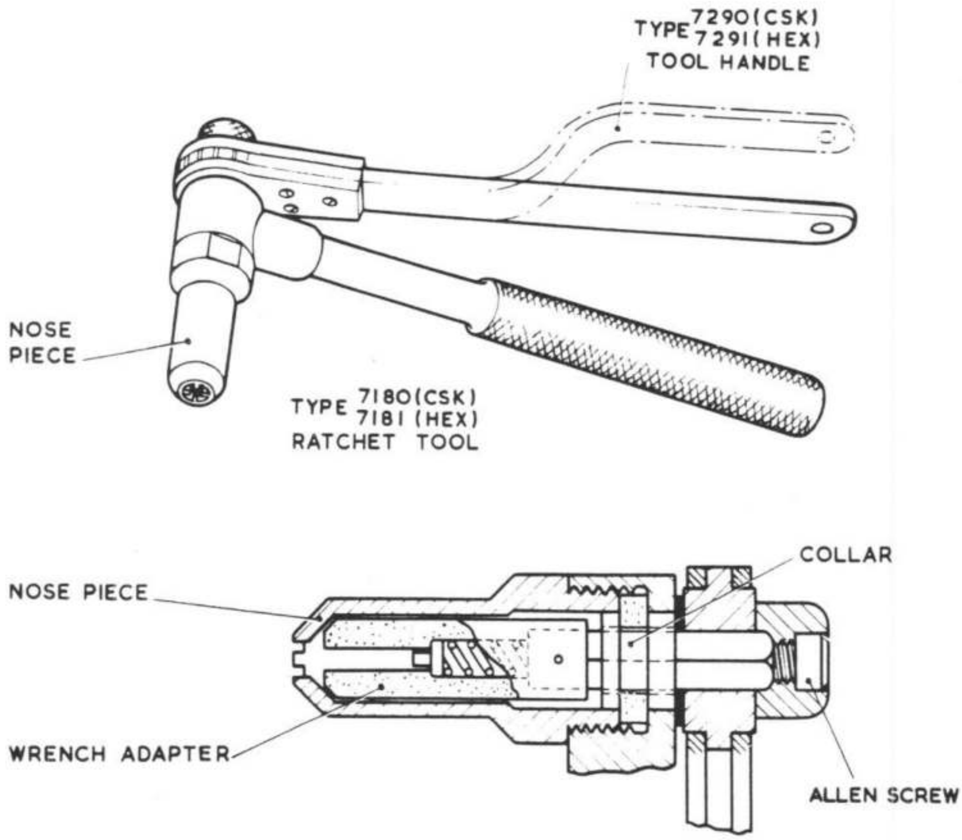


Fig.5 Jo-bolt driving tool

TABLE 7 DRIVING TOOLS AND COMPONENTS

Hand ratchet tool	Bolt series	Wrench adapter	Nose piece
7180-0006	.190 Csk	7180-0600	7280-3006
7181-0006	190 Hex	7180-0600	7280-4006
7180-0008	249 Csk	7180-0800	7280-3008
7181-0008	249 Hex	7180-0800	7280-4008
7290-0010	312 Csk	7290-0201	7280-3010
7291-0010	312 Hex	7290-0201	7280-4010

Removal of existing nose piece and adapter

7 To remove an existing nose piece and adapter, unscrew the nose piece from the handle assembly and remove the Allen screw from the head of the ratchet; this will release the wrench adapter. The wrench adapter contains a return spring and plunger, both form an integral part of the adapter.

Assembling nose piece and adapter

8 To re-assemble the ratchet, insert the required wrench adapter through the handle assembly and secure the adapter with the Allen screw in the head of the ratchet. Complete the assembly by screwing the nose piece on to the handle assembly.

Drilling data

9 For maximum joint strength, close tolerance fitting is necessary and drill reaming must be employed to provide bolt acceptance. However, in aircraft repair work it is not necessary to achieve close tolerance fitting unless it is clearly specified in the relevant aircraft publication. If close tolerance fitting is not specified in the aircraft publication the normal drilling technique should be followed, using drills as listed in Table 8.

TABLE 8 DRILL SIZES

Jo-bolt	Pilot drill	Final Drill	Permissible limits on holes
190	No. 17 (0.173 in)	No. 11 (0.191 in)	0.191-0.194 in
249	15/64 in	1/4 in	0.250-0.253 in
312	Letter L (0.290 in)	5/16 in	0.3125-0.3155 in

Bolt driving

10 Normal riveting practice must be employed in the preparation of parts which are to be united by Jo-bolts. Mating faces must be free of burrs to eliminate the possibility of the driving tool fracturing the bolt tail before the sheet metal surfaces are nipped together as intended. When the bolts are driven, all tail ends must be collected for removal from the structure.

Note ...

When jo-bolts are used for repair work, the aircraft publication may specify wet assembly, using chromate jointing compound or Araldite; in this event the assembled Jo-bolt must be dipped in the sealing compound in the condition in which the bolt is supplied by the manufacturer. If the sleeve is free to slide up and down the threaded bolt, too much jointing compound will adhere and may cause hydraulic lock, with the result that the tail end will shear before the work is gripped as intended.

Inspection

11 Fracture of the bolt tail end should occur at a near flush position with the head of the nut, where bolts are employed at the minimum grip length, down to a fixed maximum depth when maximum grip length is used. To ensure that the Jo-bolt has been correctly set, reference should be made to Table 1 or 4, column S.

12 After installation the Jo-bolts may be individually checked for looseness. The nose piece of the driving tool may be adapted to a torque wrench and the following maximum torque values used to determine looseness. (This torque must be applied in a counter-clockwise direction):-

3/16 in units	0.677 Nm (6 lbf.in)
1/4 in units	1.129 Nm (10 lbf.in)
5/16 in units	1.258 Nm (20 lbf.in)

Bolt removal

13 Removal tools are available for all three sizes of countersunk and hexagon-headed Jo-bolts (Table 9). Each tool consists of two drill guides that are formed to engage with the head of the Jo-bolt (fig.6). One end of the tool is intended for use with a pilot drill and the other end for use with a final drill. Recommended drill sizes are given in Table 9. The removal procedure is as follows:-

13.1 Apply the appropriate tool to the nut head, using the pilot drill end of the tool.

13.2 Using the pilot drill, drill to the depth of the head.

13.3 Reverse the tool, and with the final drill, again drill to the depth of the head.

13.4 At this stage the head is practically severed and a final tap with a suitable punch will eject the Jo-bolt to the far side of the work.

Note ...

It is important that all bolt ends are removed from the aircraft structure and if the locality is normally inaccessible, then special care should be taken to remove loose ends before repair work again closes off the area. Physical obstruction by loose bolt ends, such as the blocking of drain holes, may not be the only danger in a closed area. Subsequent chemical action between dissimilar metals may start corrosion which cannot be detected at an early stage.

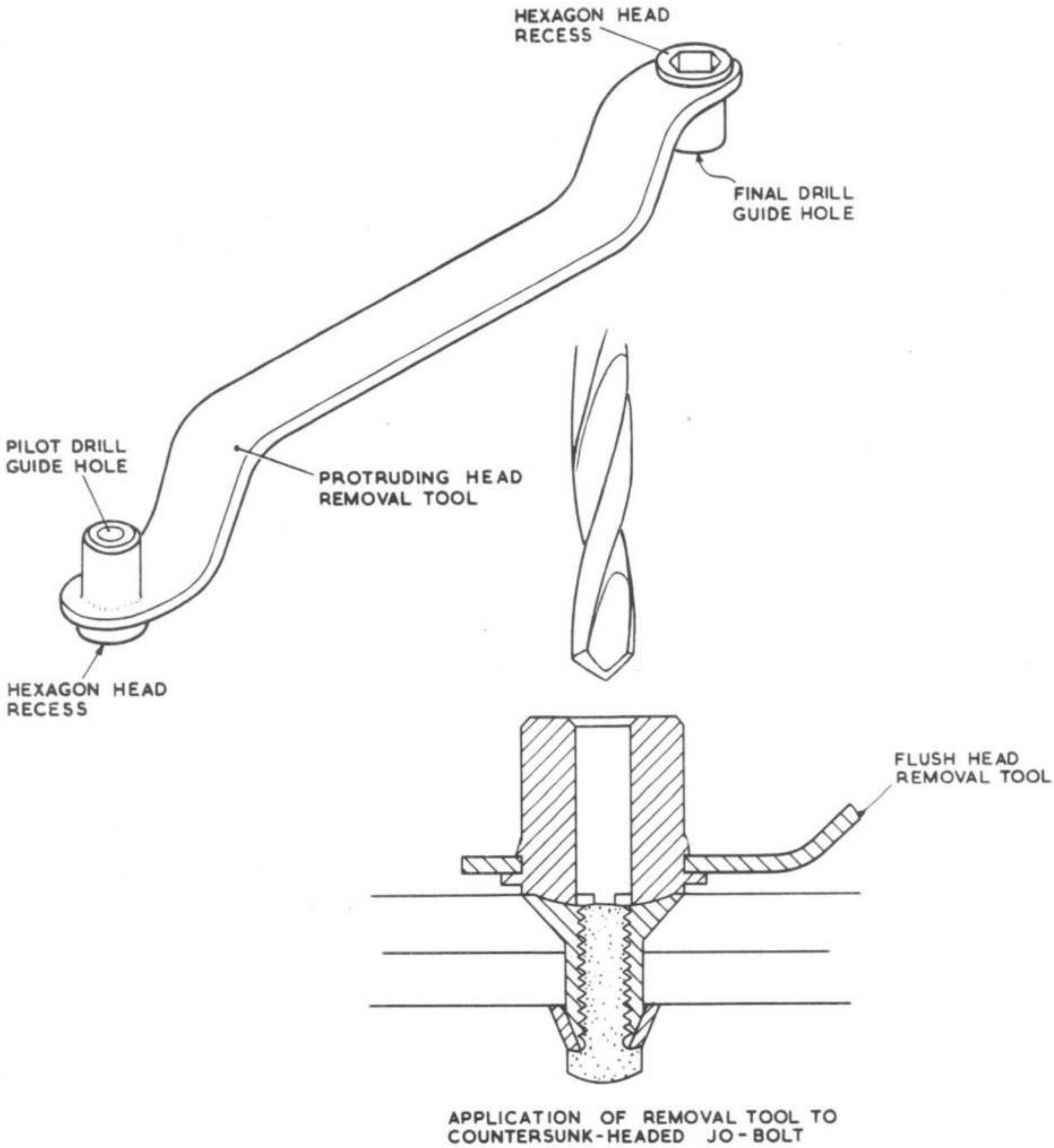


Fig.6 Jo-bolt removal tools

General data

14 The average torque loads required to fracture the bolt tail ends are given in Table 10, together with minimum strength of the Jo-bolt in shear and tension.

TABLE 9 JO-BOLT REMOVAL TOOLS AND REMOVAL DRILLS

Jo-bolt	Tool Pt. No.	Pilot drill	Final drill
190 Csk 190 Hex	7994-0164 7994-0113	3.2 mm	4.6 mm
249 Csk 249 Hex	7994-0167 7994-0120	3.5 mm	6.1 mm
312 Csk 312 Hex	7994-0170 7994-0128	4.3 mm	7.4 mm

TABLE 10 GENERAL DATA

Bolt size	Average torque	Double shear	Tension
3/16 in dia (190 series)	24 lb in	4100 lb	1300 lb
1/4 in dia (249 series)	57 lb in	7000 lb	2050 lb
5/16 in dia (312 series)	66 lb in	12,000 lb	3900 lb

Chapter 3-6

HI-LOK/HI-TIGUE FASTENING SYSTEM
(Completely revised)

CONTENTS

INTRODUCTION

1 The Hi-Lok/Hi-Tigue fastening system is a high strength threaded fastener which combines the best features of a rivet and a bolt. Three primary design advantages include:

1.1 A controlled pre-load or clamp-up which is consistent to within ±10%.

1.2 Minimum size and weight.

1.3 Simple, quiet and rapid installation, carried out by one man from one side of the work.

2 The pin is threaded like a bolt with a hexagonal recess in the threaded end. The collar is threaded and has a shear-off hexagonal nut connected to it by a thin wall. A hexagonal wrench engages the recess to prevent rotation of the pin while the collar is being secured with a ring spanner. As the collar is tightened, the plates are drawn together as the torque is increased. When the designed pre-load is attained in the fasteners, during installation, the hexagonal nut shears off and the fastener is secured (fig. 1).

3 The Hi-Tigue bead protects the plating on the pin shank during installation by reducing the frictional forces. These forces are reduced by the burnishing action on the hole surfaces and by the partial relief of the elastic stresses in the hole which reduces the radial shank (pin) load.

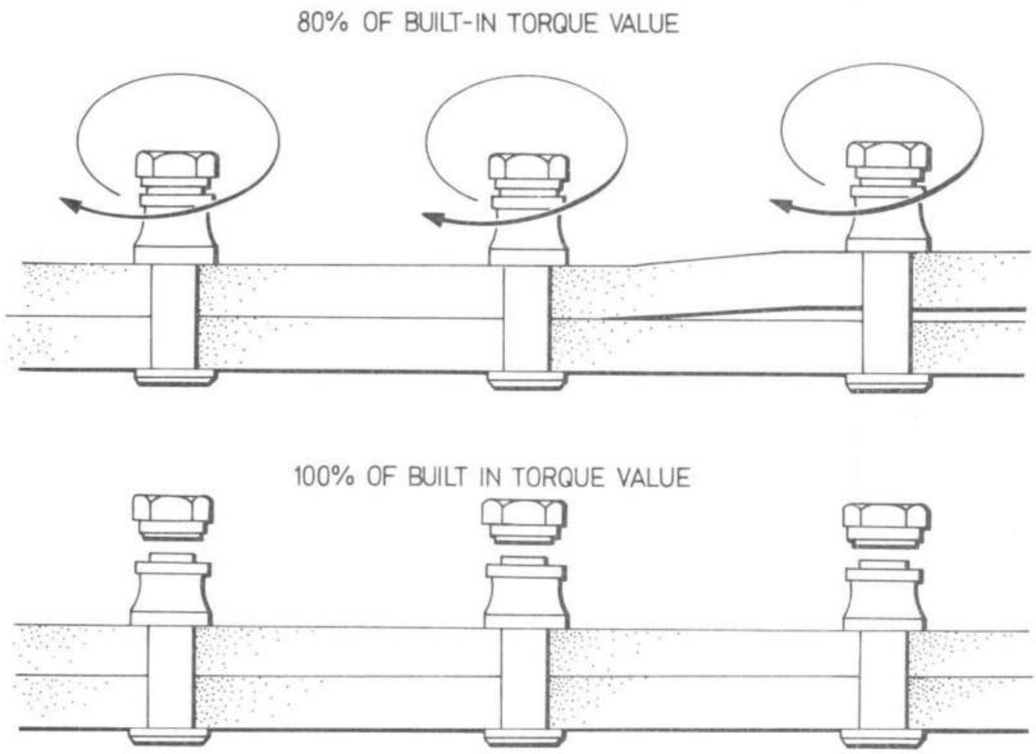


Fig. 1 Installation of fasteners

4 The loads required to insert the Hi-Lok/Hi-Tigue pin in the hole are as much as 40 % less than those needed for a straight shank installation of the same amount of interference. The reduction is achieved because of the reduced friction on the shank and the elastic recovery of the hole surface behind the Hi-Tigue bead.

5 The combination of controlled interference, a cold-worked hole and the consistent pre-load provided by the Hi-Lok/Hi-Tigue system results in increased structural fatigue life.

6 While designed for use in interference fit conditions, the Hi-Lok/Hi-Tigue fastener can be used as a non-interference fit fastener.

DESCRIPTION

Hi-Lok/Hi-Tigue pin and threaded collar (fig. 2)

7 The Hi-Lok/Hi-Tigue type interference fit pin provides improved fatigue benefits to the airframe structure. The Hi-Tigue feature on the end of the pin shank makes it possible to use a straight shank interference fit fastener in a standard straight drilled hole to obtain the maximum fatigue life of the structure.

8 The pin can be pressed into an interference fit hole by standard methods, simply requiring a straight push action to insert it in the hole. When the pin is pressed into the hole, its Hi-Tigue bead works on the surface of the hole so that the hole surface is sized, burnished and cold worked.

9 The pin is designed in two basic head styles (see fig. 6). For shear applications, the pin is manufactured in the lightweight Hi-Shear countersunk style and in a compact protruding head style. For tension applications, the MS24694 (AN509) flush and protruding head styles are available.

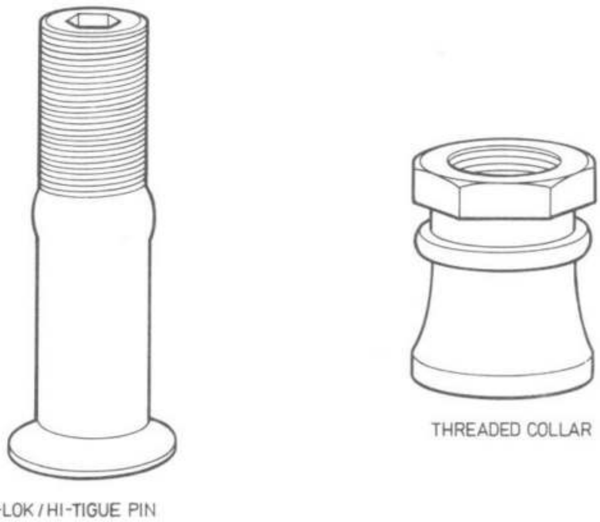


Fig. 2 Hi-Lok/Hi-Tigue pin and threaded collar

10 The self-locking, threaded Hi-Lok collar has an internal counterbore at the base to accommodate variations in material thickness. At the opposite end of the collar is a wrenching device which is torqued by the driving tool until it shears off during installation; this shear-off point occurs when a pre-determined pre-load or clamp-up is attained in the fastener during installation (see fig. 2). The internal recess of the collar permits a variation of 1/16 inch in material thickness without the use of a washer (fig. 3).

11 The collars are available in a variety of configurations and materials for various applications. There are types for tension and shear application; weight saving, and low profile models.

12 The automatic break-off of the collar's wrenching device at the pre-established torque level eliminates torque inspection and the need for torque wrenches.

Assembly

13 The material thickness can vary 1/16 in. without changing pin lengths. Adjustment for variations in material thickness in between the pin 1/16 in. graduations is automatically made by the counterbore in the collar (fig. 3). The protrusion of the pin will thus vary as the counterbore accommodates the pin shank that protrudes. When the collar is fully tightened, and the hex nut has sheared off, the protrusion of the threaded end of the pin is to be within the limits indicated in Table 1.

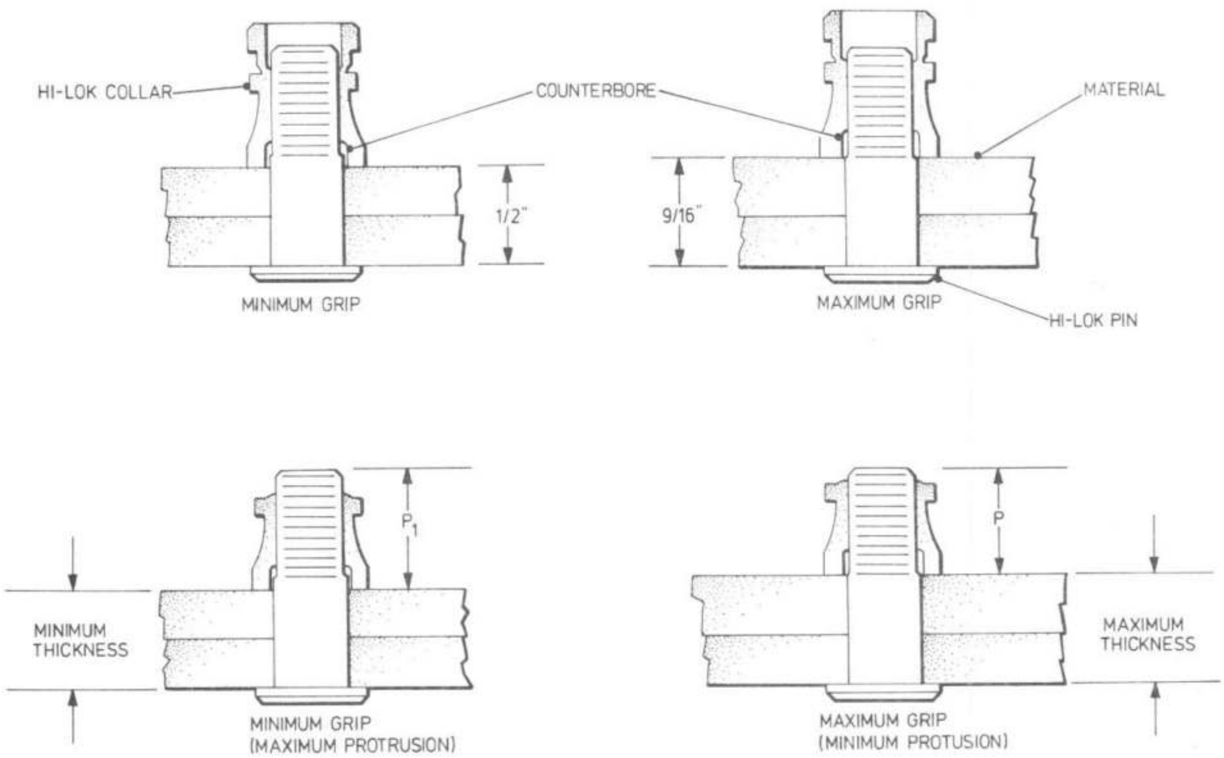


Fig. 3 Fastener assembly

14 In the pin part number, HL18-8-9, the last dash number, -9 is used to specify the maximum grip length of the pin shank. The fitting example shown in fig. 3 gives a 9/16 in. grip length, indicating the use of a -9 pin.

TABLE 1 PIN PROTRUSTION LIMITS

Standard Hi-Lok pin			
First dash number	Nominal diameter	Minimum Protrusion P	Maximum Protrusion P1
-5	5/32	0.302	0.384
-6	3/16	0.315	0.397
-8	1/4	0.385	0.467
-10	5/16	0.490	0.572
-12	3/8	0.535	0.617
-14	7/16	0.625	0.707
-16	1/2	0.675	0.757
-18	9/16	0.760	0.842
-20	5/8	0.815	0.897
-24	3/4	1.040	1.122
-28	7/8	1.200	1.282
-32	1	1.380	1.462

15 Checking of the protrusion limits may conveniently be carried out using the Hi-Lok Protrusion Gauges (Part No. 2-1522) as shown in fig. 4. Individual gauges accommodate Hi-Lok pin diameter sizes 5/32 in., 3/16 in., 1/4 in., 5/16 in. and 3/8 in. The gauges are manufactured from 0.012 in. stainless steel and are assembled as a set on a key chain.

16 In the exampled measurement, the 3/8 in. gauge is used to check the protrusion of a -12 or 3/8 in. diameter Hi-Lok pin. Left sketch shows the minimum grip condition with an allowable protrusion limit of 0.617 in. Right sketch shows how the gauge can extend over an assembled Hi-Lok; in maximum grip the minimum protrusion limit is 0.535 in. Any protrusion in between 0.535 in. and 0.617 in. is satisfactory (Table 1 refers).

Sealing collar (fig. 5)

17 The sealing collar is used for wet rings and tank areas. The type illustrated contains a teflon sealing insert and is capable of use up to a temperature of 270 deg.C (520 deg.F).

Materials, size and styles

18 The Hi-Lok/Hi-Tigue pin can be produced in any of the weight saving, high strength and high temperature materials such as titanium alloys, alloy steels and stainless steels. The fasteners are designed for use in 'INTERFERENCE FIT' conditions and the prepared hole should be reamed out i.a.w. Table 2 data. They are available in varying sizes from 0.156 in. to 0.375 in. diameter and may be installed by one man from one side of the work, although this is not a blind fastener. Head styles include shear or tension types of

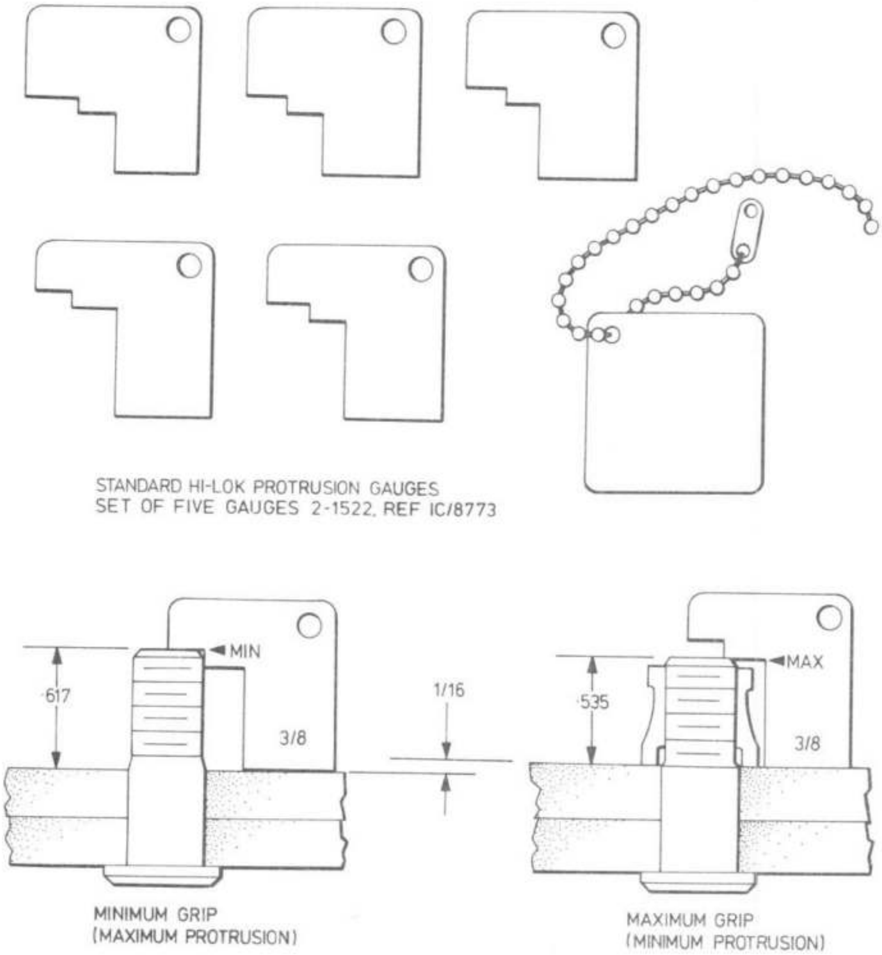


Fig. 4 Use of Hi-Lok protrustion gauges

protruding or 100 degree flush head types. The pin and collar diameters are graduated in 1/32 in. increments and the first dash No. is used to indicate the nominal thread size. The second dash No. indicates the pin maximum grip, graduated in 1/16th of an inch. To designate a captive washer the letter W (stainless steel) or T.W. (aluminium alloy) is used. The material being secured can vary ± 0.0625 in. without changing pin lengths and this adjustment is catered for automatically by the counterbore in the collar.

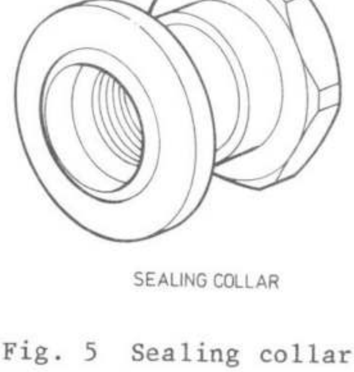


Fig. 5 Sealing collar

Selecting the fastener assembly

19 The basic part number indicates the assembly of the pin and the collar part numbers.

Example: HL1870-8-12

- 12 — Second dash number in the maximum grip length of pin in 1/16ths (12/16 in. or 3/4 in. grip length).
- 8 — First dash No. is the nominal diameter of pin in 1/32nds (8/32 in. or 1/4 in. nominal diameter).
- 70 — Collar basic part number
- 18 — Pin basic part number
- HL — Designation for Hi-Lok fastener

HLT1070-8-12

- HLT — Designation for Hi-Tigue type Hi-Lok fastener

Matching collar materials to pin head styles

20 It is important that the proper Hi-Lok collar be used with the selected Hi-Lok pin head style (shear or tension types) to maintain a proper design balance between the pin and collar. Refer to fig. 13 and 14 for recommended pin/collar combinations.

21 In general, the following pin/collar combinations are acceptable:

21.1 When the Hi-Tigue version of the Hi-Lok system is used, a Hi-Tigue type collar should be used with a Hi-Tigue type pin. The Hi-Tigue collar has a deeper internal counterbore to mate with a Hi-Tigue pin which has the Hi-Tigue feature at the end of its cylindrical shank.

21.2 For Hi-Lok pins HL20, typical collars are HL75, HL86 and HL87.

21.3 For Hi-Lok pins HL64, typical collars are HL75 and HL87.

Selecting pin grip length (fig. 6, 7 and 8)

22 The pin grip length is determined by the use of folding or one piece grip scales as shown in fig. 7 and 8 to measure the hole depth and check the pin shank for correct length. Note that the maximum grip length of a protruding head pin is taken from the underside or mating face of the head, and a countersunk head pin from the top of the head (see fig. 6).

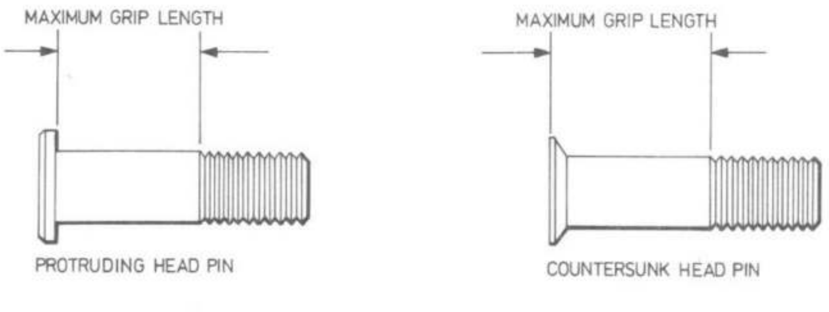


Fig. 6 Pin maximum grip lengths

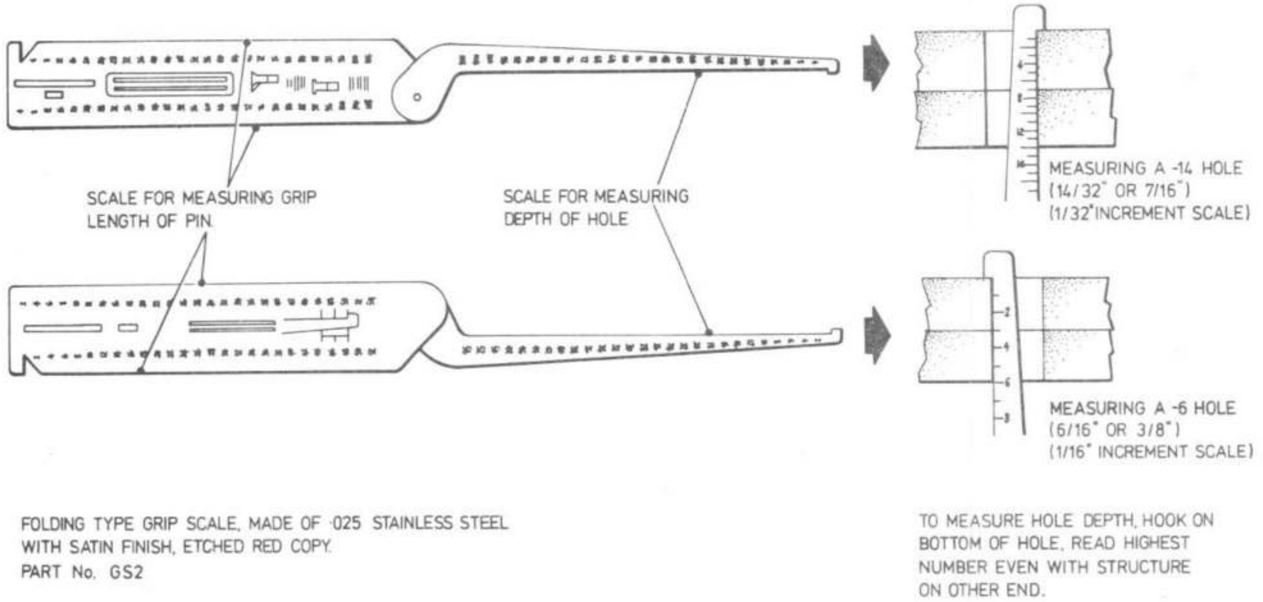


Fig. 7 Use of folding type grip scale

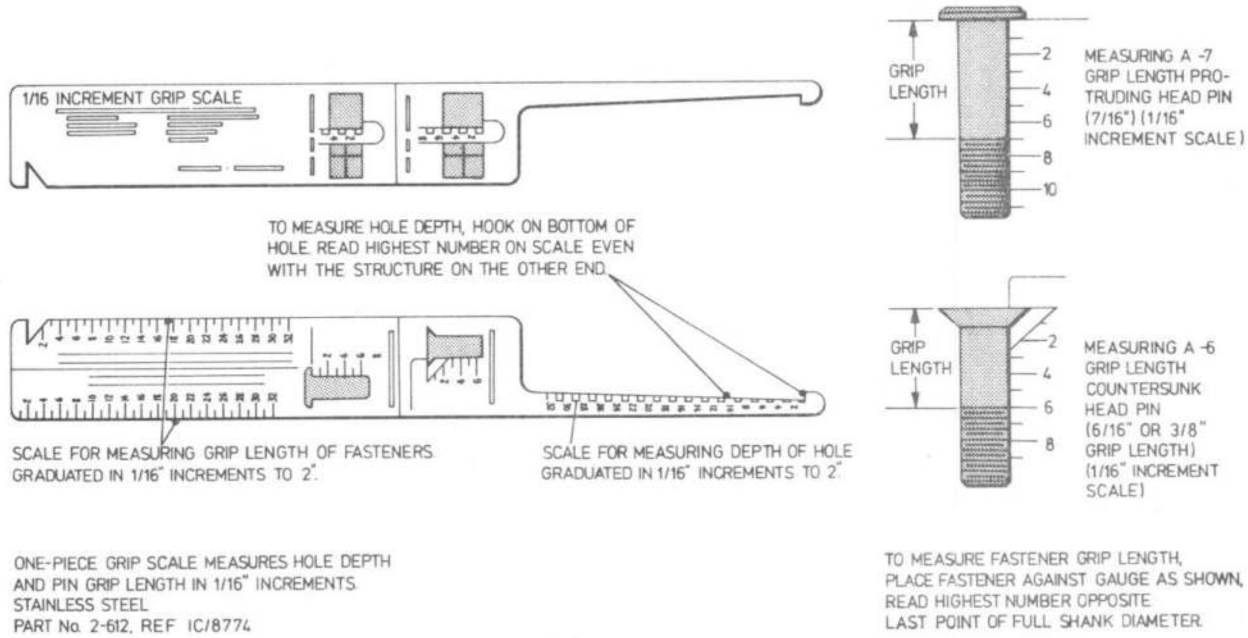


Fig. 8 Use of one piece grip scale

Selecting pin diameter

23 The pin diameters are graduated into 1/32 in. increments. In the pin part number HL18-8-10, the first dash number, -8, is used to specify the nominal diameter of the pin. In this instance an 8/32 in. or 1/4 in. diameter pin is required, indicating use of a -8 pin.

24 The major diameter of the thread is reduced from the shank diameter (reference 'TD' dimension, fig. 15, 16 and 17) to prevent scoring of the holes when the pin is installed into an interference fit hole.

Selecting the collar

25 In the collar part number HL70-8, the dash number indicates the inside nominal diameter of the collar in 1/32 in. increments. In this instance an 8/32 in. or 1/4 in. inside diameter collar is designated, indicating use of a -8 collar for a -8 diameter pin.

Hole preparation

26 Table 2 details the common Hi-Lok fasteners in use and the relevant details on nominal hole sizes, drills and reamers. The holes should be drilled and reamed in accordance with these specifications.

27 For standard Hi-Lok pins, it is generally recommended that the maximum interference fit shall not exceed 0.002 in. The Hi-Tigue type Hi-Lok pin is normally installed in a hole at 0.002 in. to 0.004 in. diametrical interference.

28 The Hi-Lok pin has a slight radius under its head. After drilling, deburr the edge of the hole (fig. 9). This permits the head to fully seat in the hole. See Tables 2 and 3 for head radius dimension. For instance, the 3/16 in. protruding head has a 0.015/0.025 in. radius while the 3/16 in. flush head has a 0.025/0.030 in. radius.

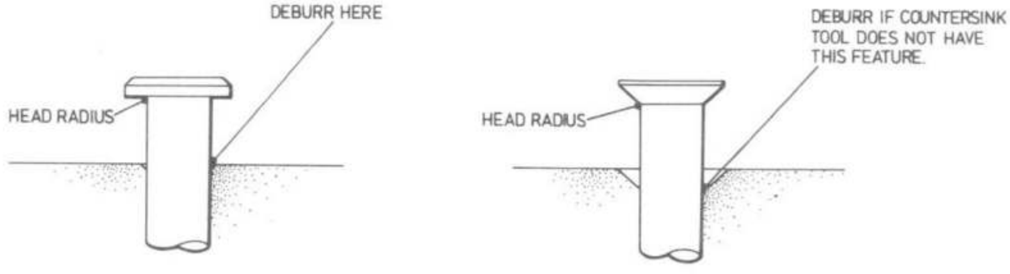


Fig. 9 Hole deburring detail

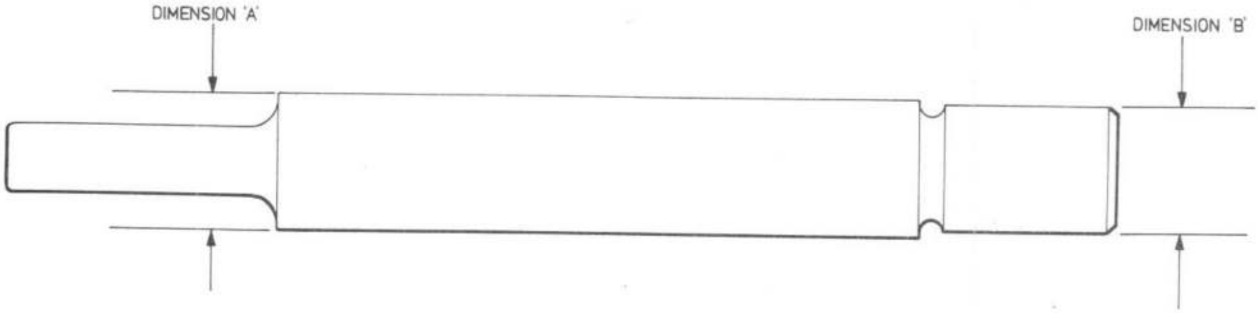


Fig. 10 Hi-Lok reamer

TABLE 2 PIN SIZE, DRILLS AND REAMERS

Nominal pin size		Drill size	Hi-Lok reamers (Sect 1G)			
Hi-Lok size	Pin dia.	Drill size	Dim A	Dim B	Part No.	NSN
HL20-5	5/32	3.9 mm	0.1630	0.1480	FJ1931-1	5110-99-7790832
HL20-6	3/16	4.5 mm	0.1880	0.1730	FJ1931-2	5110-99-7790833
HL20-8	1/4	6.1 mm	0.2480	0.2350	FJ1931-7	5110-99-7790838
HL20-10	5/16	7.5 mm	0.3110	0.2950	FJ1931-5	5110-99-7790836
HL20-12	3/8	9.3 mm	0.3730	0.3570	FJ1931-6	5110-99-7790837
First oversize pins (1/64 in.)						
HL64-6	13/64	4.8 mm	0.2010	0.1840	FJ1931-3	5110-99-7790834
HL64-8	17/64	6.4 mm	0.2636	0.2470	FJ1931-4	5110-99-7790835
HL64-10	21/64	8.0 mm	0.3260	0.3100	FJ1931-10	5110-99-7790841
Second oversize pins (1/64 in.)						
HL220-6	7/32	5.2 mm	0.2167	0.1990	FJ1931-8	5110-99-7790839
HL220-8	9/32	6.9 mm	0.2790	0.2620	FJ1931-9	5110-99-7790840

Notes ...

(1) HL20-, HL64- and HL220- HI-LOKS are used as examples only. The reamers may be used for any HI-LOK pin part number, the nominal/first/second oversize being the deciding factor in selection of the correct reamer diameter. Mole wrench, Ref. 1C/1241042.

(2) All dimensions in inches unless otherwise stated.

(3) Refer to fig. 10 for DIM A and DIM B.

INSTALLATION (fig. 11)

29 To install the pin and collar, proceed as follows

29.1 Prepare the hole in accordance with Table 2.

29.2 Insert the pin into the prepared aperture and push firmly home.

29.3 Using the applicable Hi-Lok protrusion gauge, check that the pin protrusion is between the maximum and minimum protrusion limits (see fig. 4).

Note ...

This operation may not be significant at this stage if the pin and collar are pulling two separated plates together as in fig. 1. Carry out protrusion check at para. 29.6.

29.4 Manually thread the collar onto the pin, ensuring that at least two complete turns are taken up on the thread.

29.5 Fit the appropriate ring spanner over the collar hex head and insert the appropriate key wrench into the pin hex socket.

29.6 Retaining the key wrench in a fixed position, tighten the collar until the collar head shears from the collar. Recheck the protrusion limit with the appropriate gauge.

Note ...

When Hi-Lok pins are pressed or driven into interference fit holes, the fit is sufficiently tight to grip the pin to prevent it from rotating during assembly with the collar. This means that the key wrench tip engagement is not required to keep the pin from rotating.

REMOVAL (fig. 11 and 12)

30 In non-interference fit holes, Hi-Loks can be removed with common hand tools in a manner similar to removing a nut from a bolt (fig. 11). Use a key wrench to prevent the pin from rotating while the collar is being unscrewed with pliers or mole grips. If not damaged during collar removal, the Hi-Lok pin can be re-used.

31 To facilitate easier removal of Hi-Lok collars from pins installed in interference fit holes and in limited access areas, the HLH128 series of hand tools are available in individual sizes or in sets as in the HLK10 Hi-Lok/Hi-Tigue Collar Removal Tool Kit. The Hi-Lok pin can be re-used.

32 In interference fit holes, aluminium Hi-Lok/Hi-Tigue collars can be removed with an HLC1 Hi-Lok Collar Removal Tool fitted to a 3/8 in. square socket drive (fig. 12). The tool is pressed firmly over the Hi-Lok collar and rotated until the tool teeth bite into the collar sufficient to grip and unscrew the collar from the pin.

Note ...

Initial loosening of the -8 and larger Hi-Lok collars with the HLH128 removal tool is recommended.

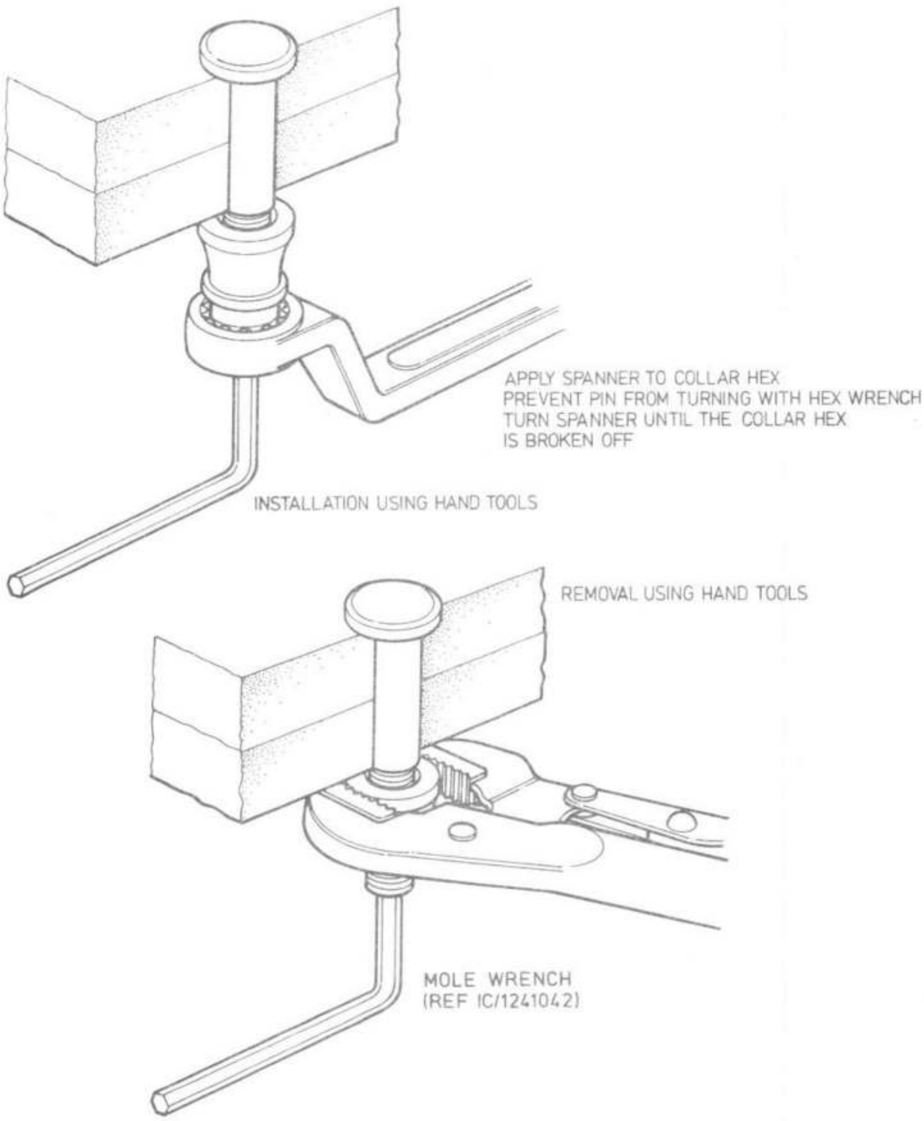


Fig. 11 Installation and removal of Hi-Lok fasteners

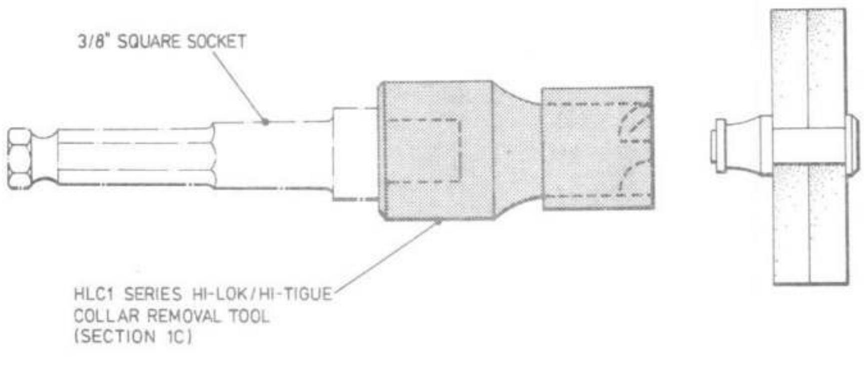
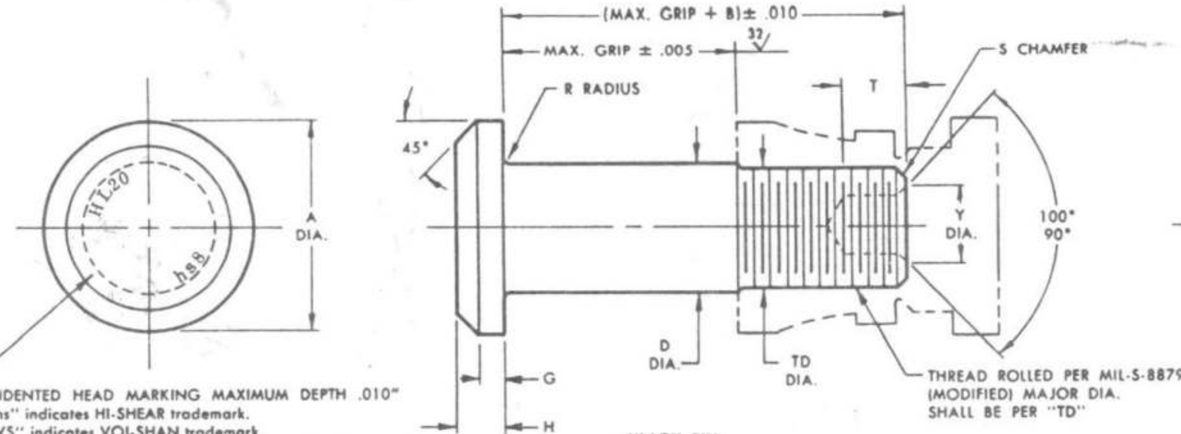


Fig. 12 Use of HLC1 Hi-Lok collar removal tool



INDENTED HEAD MARKING MAXIMUM DEPTH .010"
"hs" indicates HI-SHEAR trademark.
"VS" indicates VOI-SHAN trademark.
"SPS" indicates STANDARD PRESSED STEEL trademark.
The number or numbers following the trademark indicate first dash number. Arrangement optional.

HI-LOK PIN

FIRST DASH NO.	NOM. DIA.	A DIA.	B REF.	D DIA.	TD DIA.	G REF.	H	R RAD.
-5	5/32	.322 .306	.312	.1635 .1625	.1595 .1570	.030	.060 .055	.025 .015
-6	3/16	.377 .357	.325	.1895 .1885	.1840 .1810	.035	.074 .064	.025 .015
-8	1/4	.440 .415	.395	.2495 .2485	.2440 .2410	.045	.090 .077	.025 .015
-10	5/16	.502 .472	.500	.3120 .3110	.3060 .3020	.055	.112 .098	.030 .020
-12	3/8	.565 .530	.545	.3745 .3735	.3680 .3640	.065	.140 .130	.030 .020
-14	7/16	.627 .592	.635	.4370 .4360	.4310 .4260	.075	.160 .150	.030 .020
-16	1/2	.752 .717	.685	.4995 .4985	.4930 .4880	.085	.188 .178	.030 .020
-18	9/16	.877 .842	.770	.5615 .5605	.5550 .5500	.125	.210 .200	.040 .025
-20	5/8	.953 .918	.825	.6240 .6230	.6180 .6120	.140	.238 .228	.040 .025
-24	3/4	1.150 1.110	1.050	.7490 .7480	.7430 .7370	.200	.335 .320	.045 .030

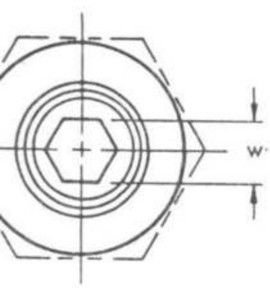
GENERAL NOTES:
1. Concentricity: "A" to "D" diameter within .010 FIR.
2. Dimensions to be met after finish.
3. Non-lubed pins must be used with wet sealant or with lubed collars.
4. Surface texture per ANSI B46.1.
5. Hole preparation per NAS618.
6. Evidence of broken edge across points.
7. Use HL64 for oversize replacement.

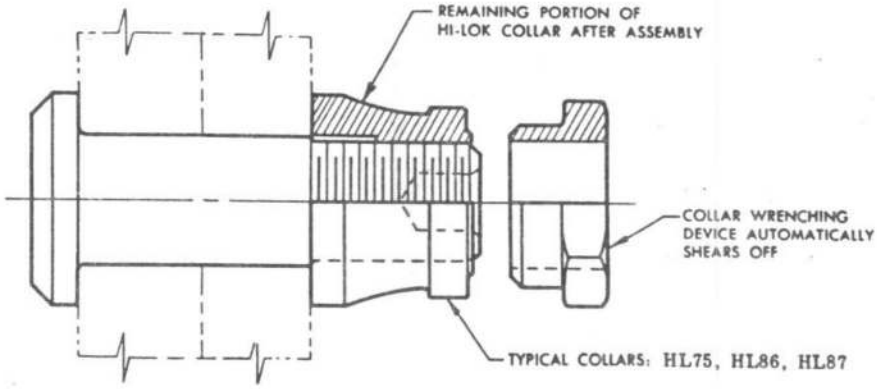
HOW TO O
EXAM

MATERIAL: Alloy steel per Spec. MIL-S-5000, MIL-S-5626 or MIL-S-6049.
HEAT TREAT: 160,000—180,000 psi tensile per Spec. MIL-H-6875.
FINISH:
HL20-( )-( ) = Cadmium plate per Spec. QQ-P-416, Type I, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
Ⓢ HL20KD-( )-( ) = Aluminum coating per Boeing BMS 10-85, Type I, Class B, with color code black on thread end and cetyl alcohol lube per Hi-Shear Spec. 305.
HL20N-( )-( ) = Diffused nickel-cadmium plate per AMS2416 and cetyl alcohol lube per Hi-Shear Spec. 305.
HL20PB-( )-( ) = Cadmium plate per Spec. QQ-P-416, Type II, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
HL20PN-( )-( ) = Cadmium plate per QQ-P-416, Type II, Class 2 (see Note 3).
HL20RB-( )-( ) = Cadmium plate per QQ-P-416, Type II, Class 2, color violet to purple, and cetyl alcohol lube per Hi-Shear Spec. 305.
SPECIFICATION: Hi-Lok Product Specification 342.

Fig. 13

Hi-Lok





HI-LOK PIN AND COLLAR AFTER ASSEMBLY

S AMFER REF.	THREAD	SOCKET W HEX.	SOCKET T DEPTH	SOCKET Y DIA.	DOUBLE SHEAR POUNDS MINIMUM	TENSION POUNDS MINIMUM
2" x 45°	8-32UNJC-3A Modified	.0801 .0791	.135 .115	6	4,010	2,180
2" x 45°	10-32UNJF-3A Modified	.0806 .0791	.135 .115	.119 .104	5,380	3,180
2" x 45°	1/4-28UNJF-3A Modified	.0967 .0947	.150 .130	.142 .122	9,300	5,820
4" x 45°	5/16-24UNJF-3A Modified	.1295 .1270	.170 .150	.180 .160	14,600	9,200
4" x 45°	3/8-24UNJF-3A Modified	.1617 .1582	.200 .180	.217 .197	21,000	14,000
4" x 45°	7/16-20UNJF-3A Modified	.1930 .1895	.230 .210	.253 .233	28,600	18,900
4" x 45°	1/2-20UNJF-3A Modified	.2242 .2207	.260 .240	.289 .269	37,300	25,600
6" x 45°	9/16-18UNJF-3A Modified	.2555 .2520	.290 .270	.326 .306	47,200	32,400
6" x 45°	5/8-18UNJF-3A Modified	.2555 .2520	.330 .305	.326 .306	58,300	41,000
6" x 45°	3/4-16UNJF-3A Modified	.3185 .3150	.395 .365	.398 .378	83,900	59,500

SEE COLLAR STANDARDS FOR COLLAR STRENGTHS. LOWER STRENGTH (PIN OR COLLAR) DETERMINES SYSTEM STRENGTH.

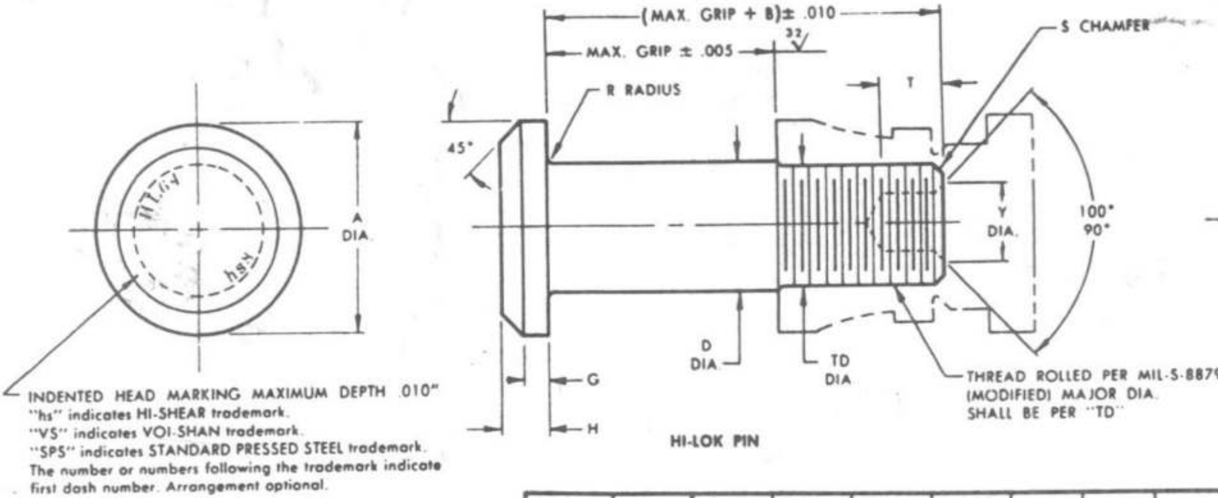
First dash number indicates nominal diameter in 1/32nds.
Second dash number indicates maximum grip in 1/16ths.
See "Finish" note for explanation of code letters.

Pin Part Number Only
HL20PB-8-8
- 8/16 or 1/2 Maximum Grip Length
- 8/32 or 1/4 Nominal Diameter Pin
- Type II Cadmium Finish
- Pin Part Number

Pin and Collar Assembly Part Number Combination
HL20PB86-8-8
- Size and Grip Length, See Above Example
- Collar Part Number
- Pin Finish
- Pin Part Number

HL20 data

Fig. 13



HI-LOK PIN

FIRST DASH NO.	NOM. DIA.	A DIA.	B REF.	D DIA.	TD DIA.	G REF.	H	R RAD.
−5	3/16					NOTE:	Use HI	
−6	13/64	.377 .357	.325	.2026 .2016	.1840 .1810	.035	.074 .064	.025 .015
−8	17/64	.440 .415	.395	.2651 .2641	.2440 .2410	.045	.090 .077	.025 .015
−10	21/64	.502 .472	.500	.3276 .3266	.3060 .3020	.055	.112 .098	.030 .020
−12	25/64	.565 .530	.545	.3901 .3891	.3680 .3640	.065	.140 .130	.030 .020
−14	29/64	.627 .592	.635	.4526 .4516	.4310 .4260	.075	.160 .150	.030 .020
−16	33/64	.752 .717	.685	.5151 .5141	.4930 .4880	.085	.188 .178	.030 .020
−18	37/64	.877 .842	.770	.5771 .5761	.5550 .5500	.125	.210 .200	.040 .025
−20	41/64	.953 .918	.825	.6396 .6386	.6180 .6120	.140	.238 .228	.040 .025
−24	49/64	1.150 1.110	1.050	.7646 .7636	.7430 .7370	.200	.335 .320	.045 .030

GENERAL NOTES:
1. Concentricity: "A" to "D" diameter within .010 FIR.
2. Dimensions to be met after plating.
3. Non-lubed pins must be used with wet sealant or with lubed collars.
4. Surface texture per ANSI B46.1.
5. Hole preparation per NAS618.
6. Use HL220 for oversize replacement.

HOW

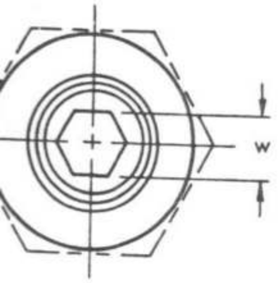
MATERIAL: Alloy steel per Spec. MIL-S-5000, MIL-S-5626 or MIL-S-6049.

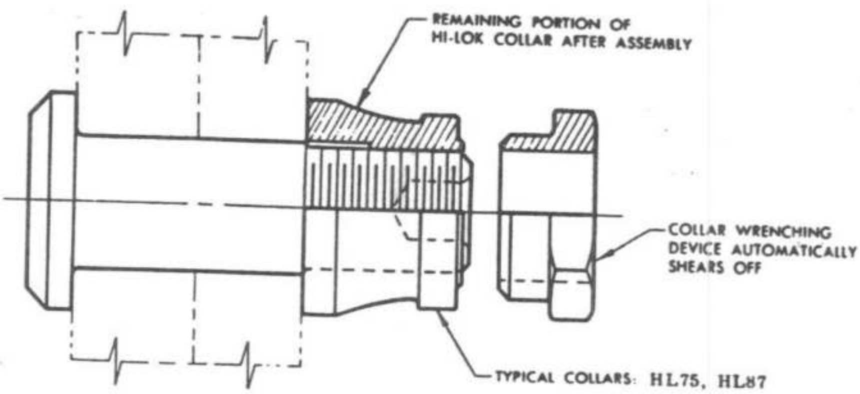
HEAT TREAT: 160,000—180,000 psi tensile per Spec. MIL-H-6875.

FINISH:
HL64-( )-( ) = Cadmium plate per Spec. QQ-P-416, Type I, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
HL64A-( )-( ) = Cadmium plate per AMS2400-3 and cetyl alcohol lube per Hi-Shear Spec. 305.
(15) HL64KD-( )-( ) = Aluminum coating per Boeing BMS10-85, Type 1, Class B, with color code black on thread end and cetyl alcohol lube per Hi-Shear Spec. 305.
HL64PB-( )-( ) = Cadmium plate per Spec. QQ-P-416, Type II, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
HL64PN-( )-( ) = Cadmium plate per Spec. QQ-P-416, Type II, Class 2 (see Note 3).

SPECIFICATION: Hi-Lok Product Specification 342.

Fig. 14 Hi-Lok pin HL64 (1





HI-LOK PIN AND COLLAR AFTER ASSEMBLY

S HAMFER REF.	THREAD	SOCKET W HEX.	SOCKET T DEPTH	SOCKET Y DIA.	** DOUBLE SHEAR POUNDS MINIMUM	TENSION POUNDS MINIMUM
or HL420-6						
2" x 45°	10-32UNJF-3A Modified	.0806 .0791	.135 .115	.119 .104	6,130	3,180
2" x 45°	1/4-28UNJF-3A Modified	.0967 .0947	.150 .130	.142 .122	10,490	5,820
4" x 45°	5/16-24UNJF-3A Modified	.1295 .1270	.170 .150	.180 .160	16,000	9,200
4" x 45°	3/8-24UNJF-3A Modified	.1617 .1582	.200 .180	.217 .197	22,700	14,000
4" x 45°	7/16-20UNJF-3A Modified	.1930 .1895	.230 .210	.253 .233	30,600	18,900
4" x 45°	1/2-20UNJF-3A Modified	.2242 .2207	.260 .240	.289 .269	39,600	25,600
6" x 45°	9/16-18UNJF-3A Modified	.2555 .2520	.290 .270	.326 .306	49,700	32,400
6" x 45°	5/8-18UNJF-3A Modified	.2555 .2520	.330 .305	.326 .306	61,000	41,000
6" x 45°	3/4-16UNJF-3A Modified	.3185 .3150	.395 .365	.398 .378	87,200	59,500

** SEE COLLAR STANDARDS FOR COLLAR STRENGTHS. LOWER STRENGTH (PIN OR COLLAR) DETERMINES SYSTEM STRENGTH.

CODE: First dash number indicates nominal diameter in 1/32nds which HL64 oversize pin replaces.
Second dash number indicates maximum grip in 1/16ths.
See the "Finish" note for explanation of code letters.

RDER
PLES: Pin Part Number Only

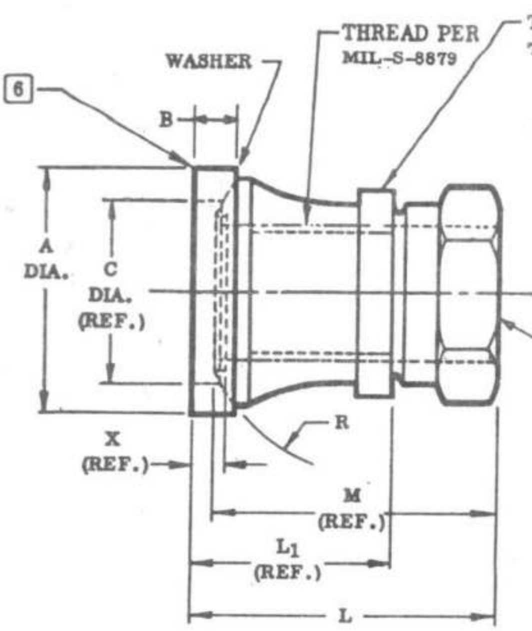
HL64PB-8-8
- 8/16 or 1/2 Maximum Grip Length
- Replaces 8/32 or 1/4 Nominal Diameter Pin
- Type II Cadmium Plate
- Pin Part Number

Pin and Collar Assembly Part Number Combination

HL64PB87-8-8
- Size and Grip Length, See Above Example
- Collar Part Number
- Pin Finish
- Pin Part Number

in. oversize) data

Fig. 14



DASH NO.	PIN NOM. DIA.	THREAD	A DIA.	B	C DIA. (REF.)		L LENGTH
-5	5/32	8-32UNJC-3B	.365 .355	.095 .085	.235		.457 .427
-6	3/16	10-32UNJF-3B	.365 .355	.095 .085	.255		.457 .427
-8	1/4	1/4-28UNJF-3B	.475 .465	.120 .110	.333		.552 .522
-10	5/16	5/16-24UNJF-3B	.620 .610	.130 .120	.417		.672 .642
-12	3/8	3/8-24UNJF-3B	.790 .780	.145 .135	.490		.745 .715
-14	7/16	7/16-20UNJF-3B	.895 .885	.180 .170	.570		.867 .837
-16	1/2	1/2-20UNJF-3B	1.005 .995	.205 .195	.648		.939 .909
-18	9/16	9/16-18UNJF-3B	1.125 1.115	.270 .260	.763		1.065 1.035

NOTES:
1. Go thread gage penetration shall be 3/4 of one revolution minimum.
2. For use on sloped surfaces up to 7° maximum on standard and 1/64 oversize Hi-Lok tension head pins.
3. Non-lubed collars must be used with lubed pins.
4. Dimensions apply after finish.
5. Use HL375 for oversize replacement.
6. For -12, -14, and -16 washers, chamfer or radius .040-.050.

MATERIAL: Collar — 303 Se stainless steel per AMS5640 or ASTM A582.
Washer — 17-4PH stainless steel per AMS5643, or 17-7PH per AMS5528, or PH15-7Mo per AMS5520.

HEAT TREAT: Collar — None.
Washer — Age to H-1025 condition for 17-4PH, age to TH1050 condition for 17-7PH and 15-7Mo per MIL-H-6875.

FINISH: Collar — HL75-

HL75N
HL75K
HL75V
HL75G

HL75D
Ⓑ HL75G
HL75T

Washer — HL75-(
HL75-(
HL75-(
HL75-(
HL75-(
HL75-(

SPECIFICATION: Hi-Lok Product S

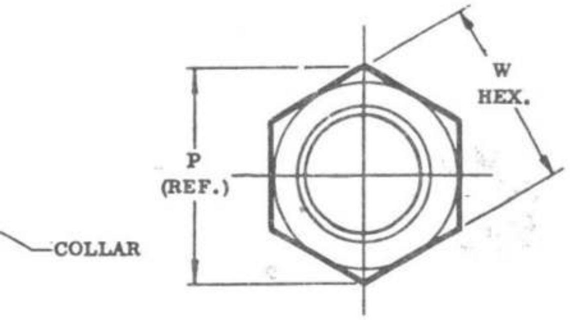
CODE: Dash number indi
Code letter "A" fo
See "Finish" note

EXAMPLE: HL75-8AW = A
HL75K-8AKW = A

Fig. 15

Hi-Lok coll

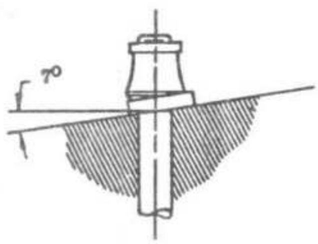
IS AREA PROVIDED WITH A PREVAILING
RQUE LOCKING FEATURE

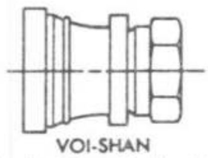


L_1 (REF.)	M (REF.)		P (REF.)	R SPHER. RAD.	W HEX.	X (REF.)	UTS LBS. MIN.	TORQUE-OFF IN.-LBS.
275	.410		.380	.20	.346 .332	.107	2,300	30-40
275	.410		.380	.20	.346 .332	.107	2,750	40-50
340	.500		.380	.26	.346 .332	.112	5,000	115-130
430	.607		.484	.34	.440 .425	.122	8,300	200-250
470	.667		.557	.38	.503 .488	.122	12,700	360-440
562	.752		.840	.45	.753 .736	.137	19,000	550-625
610	.832		.970	.51	.878 .861	.137	25,500	725-825
700	.950		.970	.71	.878 .861	.145	32,400	950-1075

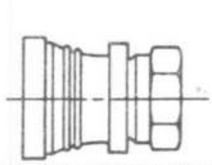
)A = Cadmium plate per QQ-P-416, Type I, Class 2, with cetyl alcohol lube per Hi-Shear Spec. 305.
-( )A = Cadmium plate per QQ-P-416, Type I, Class 2.
-( )A = Solid film lube per "Lubeco" 905.
-( )A = Solid film lube per "Lubeco" 2123.
-( )A = Silver plate per AMS2410 and cetyl alcohol lube per Hi-Shear Spec. 305.
J-( )A = Solid film lube per MIL-L-8937.
J-( )A = Silver plate per AMS2410.
F-( )A = Hi-Kote 2 solid film lube per Hi-Shear Spec. 292.
)W = Cadmium plate per QQ-P-416, Type I, Class 2.
)WU = Passivate per Hi-Shear Spec. 258.
)DW = Solid film lube per MIL-L-8937.
)KW = Solid film lube per "Lubeco" 905.
)VW = Solid film lube per "Lubeco" 2123.
)GW = Silver plate per AMS2410 and cetyl alcohol lube per Hi-Shear Spec. 305.

pecification 345.
cates nominal thread size in 1/32nds.
llowing dash number indicates Hi-Lok collar.
for explanation of other code letters.
ssembly of HL75-8A collar and HL75-8W washer.
ssembly of HL75K-8A collar and HL75-8KW washer.





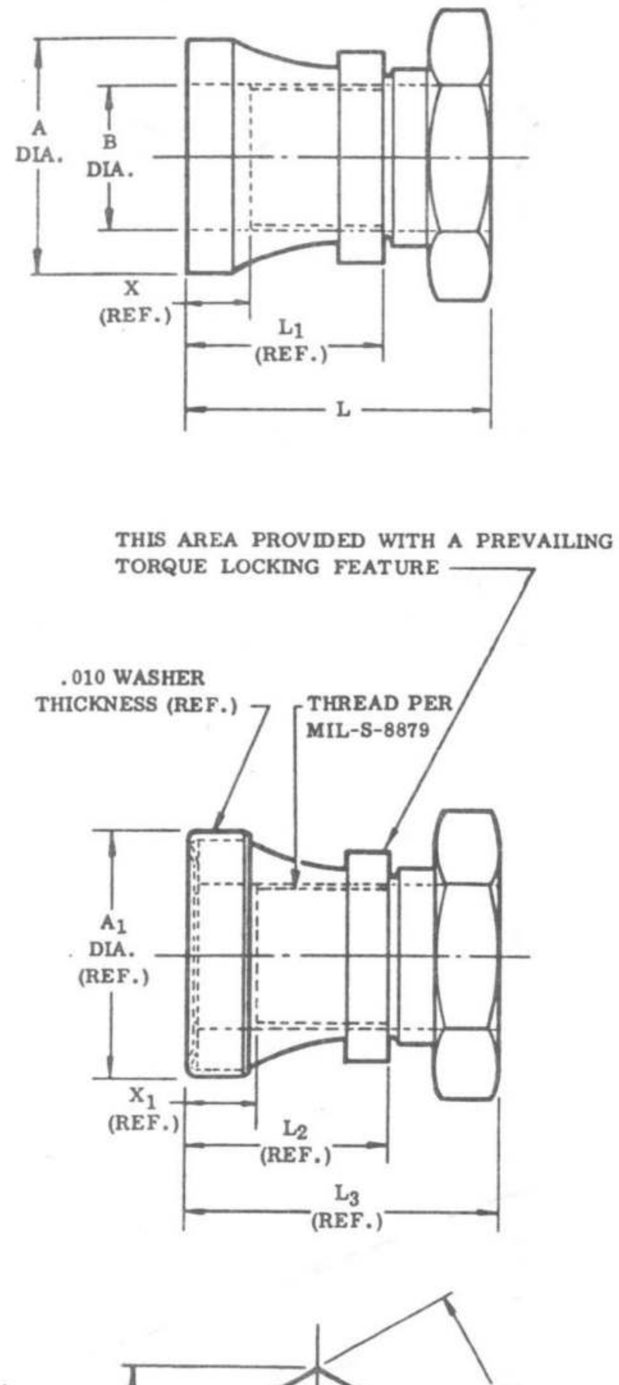
VOI-SHAN
1 raised bead indicates
VOI-SHAN identification.



STANDARD PRESSED STEEL
2 raised beads indicate STANDARD
PRESSED STEEL identification.

ar HL75 data

Fig. 15



DASH NO.	PIN NOM. DIA.	THREAD	A DIA.	A D (RI
-5	5/32"	8-32UNJC-3B	.287 .283	.
-6	3/16"	10-32UNJF-3B	.307 .303	.
-8	1/4'	1/4-28UNJF-3B	.412 .408	.
-10	5/16"	5/16-24UNJF-3B	.518 .512	.
-12	3/8"	3/8-24UNJF-3B	.628 .622	.
-14	7/16"	7/16-20UNJF-3B	.733 .727	.
-16	1/2"	1/2-20UNJF-3B	.848 .842	.
-18	9/16"	9/16-18UNJF-3B	.915 .905	.
-20	5/8"	5/8-18UNJF-3B	.995 .985	1.0
-24	3/4"	3/4-16UNJF-3B	1.120 1.110	1.1
-28	7/8"	7/8-14UNJF-3B	1.345 1.335	1.3
-32	1"	1-12UNJF-3B	1.490 1.480	1.5

NOTES:
1. Go thread gage penetration s
2. Dimensions apply after finish
3. Use HL87 for oversize repla
4. Use HL73 or HL273 for high

MATERIAL: Collar — 303 Se stainless steel pe
Aluminum Washer — 2024-T6 alu

FINISH:
HL86-( ) = Collar only wi
HL86W-( ) = Collar with ca
Steel washer w
HL86CNNW-( ) = Diffused nicke
washer finish
HL86D-( ) = Collar only wi
HL86DU-( ) = Collar only wi
HL86DUW-( ) = Collar with so
Class 2, and n
HL86G-( ) = Collar only wi
HL86GGW-( ) = Collar and stee
HL86GNW-( ) = Silver plate pe
HL86K-( ) = Collar only wi
◉ HL86KP-( ) = Collar only wi
per Hi-Shear S
◉ HL86KPW-( ) = Collar with cad
Hi-Shear Spec.
HL86PB-( ) = Collar only wit
HL86PBW-( ) = Collar with cad
Steel washer w
HL86TB-( ) = Collar only wit
HL86TF-( ) = Collar only wit
HL86TW-( ) = Collar with cad
Aluminum wash

SPECIFICATION: Hi-Lok Product Specification 345.

CODE: Dash number indicates nominal th
See "Finish" note for explanation o

EXAMPLE: HL86W-8 = 1/4-28 Hi-Lok colla
HL86TW-8 = 1/4-28 Hi-Lok colla

Fig. 16

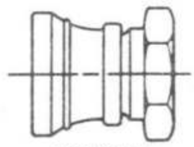
Hi-Lok col

B DIA.	L	L_1 (REF.)	L_2 (REF.)	L_3 (REF.)	P (REF.)	W HEX.	X (REF.)	X_1 (REF.)		UTS LBS. MIN.	TORQUE OFF IN. LBS.
.173 .166	.447 .427	.265	.280	.460	.344	.314 .302	.107	.120		2,300	30-40
.200 .192	.457 .437	.275	.290	.470	.344	.314 .302	.107	.120		2,750	40-50
.261 .252	.552 .532	.340	.355	.565	.380	.346 .332	.112	.125		5,000	115-130
.325 .314	.672 .652	.430	.445	.685	.484	.440 .425	.122	.135		8,300	200-250
.388 .376	.744 .724	.475	.490	.755	.557	.503 .488	.122	.135		12,700	360-420
.463 .442	.862 .842	.560	.575	.875	.840	.753 .736	.137	.150		19,000	525-675
.528 .501	.942 .922	.610	.625	.955	.970	.878 .861	.137	.150		25,500	725-1000
.598 .570	1.029 1.009	.670	.685	1.042	.970	.878 .861	.145	.158		29,000	1000-1150
.661 .634	1.123 1.103	.735	.750	1.136	1.120	1.003 .986	.145	.158		32,000	1350-1550
.786 .762	1.371 1.351	.940	.955	1.384	1.240	1.128 1.110	.156	.169		42,000	1900-2200
.911 .887	1.575 1.545	1.060	1.075	1.584	1.520	1.380 1.356	.169	.182		62,000	3200-3600
1.036 1.015	1.840 1.810	1.225	1.240	1.849	1.650	1.504 1.480	.186	.199		84,000	4500-5000

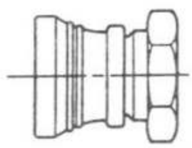
be 3/4 of one revolution minimum.

ent.
nsion application.
TM A-582 (AMS5640). Steel Washer — 300 series stainless steel.
m alloy per QQ-A-250/4 or QQ-A-250/5.
dmium plate per QQ-P-416, Type I, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
m plate per QQ-P-416, Type I, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
cadmium plate per QQ-P-416, Type I, Class 2, and no lube.
dmium plating per Spec. AMS2416, and cetyl alcohol lube per Hi-Shear Spec. 305, and steel
ssivate.
dmium plate per QQ-P-416, Type II, Class 2, and solid film lubricant per MIL-L-8937.
lid film lube per MIL-L-8937.
lm lube per MIL-L-8937 and steel washer with cadmium plate per QQ-P-416, Type II,
be.
lver plate per AMS2410 and cetyl alcohol lube per Hi-Shear Spec. 305.
sher both with silver plate per AMS2410 and cetyl alcohol lube per Hi-Shear Spec. 305.
ec. AMS2410 and cetyl alcohol lube per Hi-Shear Spec. 305, and steel washer finish is passivate.
lid film lube per "Lubeco" 905 (recommended for use on HL32 and HL33 only).
dmium plate per QQ-P-416, Type II, Class 2, color violet to purple, and cetyl alcohol lube
305.
m plate per QQ-P-416, Type II, Class 2, color violet to purple, and cetyl alcohol lube per
. Steel washer with cadmium plate per QQ-P-416, Type II, Class 2, and no lube.
dmium plate per QQ-P-416, Type II, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
m plate per QQ-P-416, Type II, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
cadmium plate per QQ-P-416, Type II, Class 2, and no lube.
-Kote 2 solid film lube per Hi-Shear Spec. 292, and cetyl alcohol lube per Hi-Shear Spec. 305.
-Kote 2 solid film lube per Hi-Shear Spec. 292.
m plate per QQ-P-416, Type I, Class 2, and cetyl alcohol lube per Hi-Shear Spec. 305.
anodize per MIL-A-8625, dye color blue.

l size in 1/32nds.
ode letters.
nd steel washer.
nd aluminum washer.

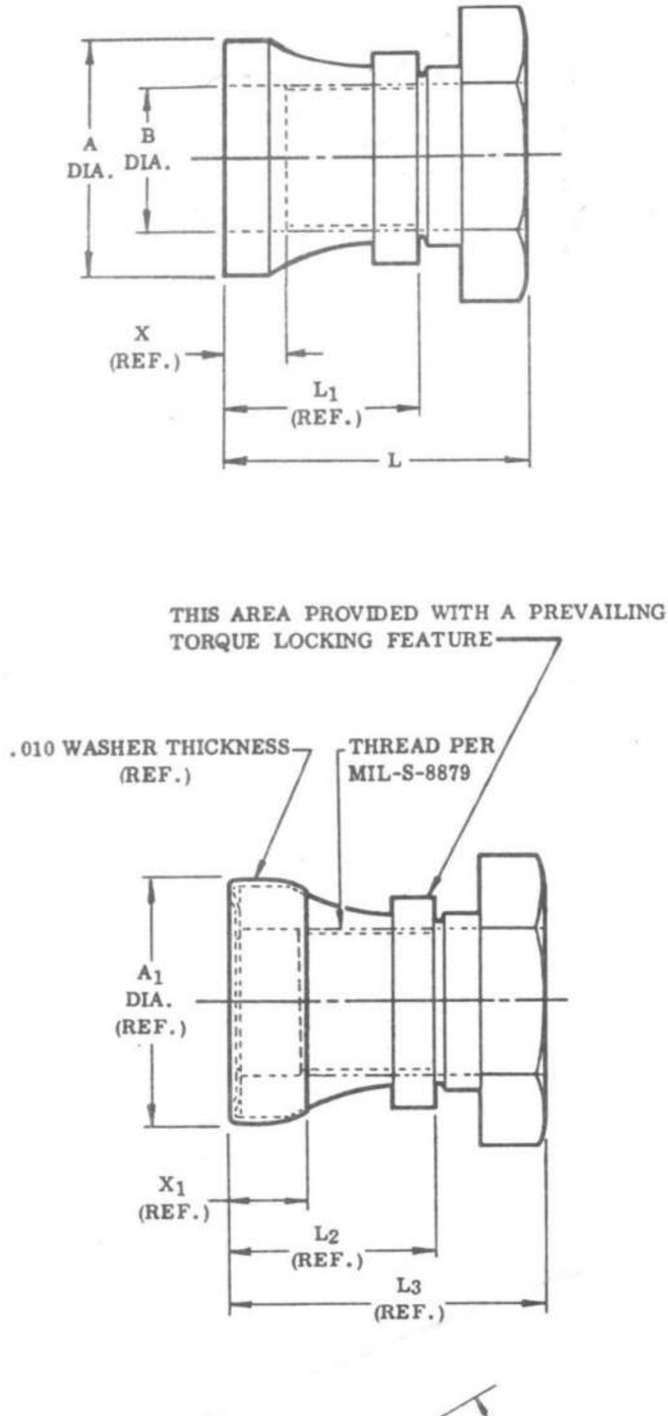


VOI-SHAN
1 raised bead indicates
VOI-SHAN identification.



STANDARD PRESSED STEEL
2 raised beads indicate STANDARD
PRESSED STEEL identification.

r HL86 data



DASH NO.	PIN NOM. DIA.	THREAD	A DIA.	A_1 DIA. (REF.
-5	5/32"	8-32UNJC-3B		
-6	13/64"	10-32UNJF-3B	.307 .303	.34
-8	17/64"	1/4-28UNJF-3B	.412 .408	.44
-10	21/64"	5/16-24UNJF-3B	.518 .512	.55
-12	25/64"	3/8-24UNJF-3B	.628 .622	.66
-14	29/64"	7/16-20UNJF-3B	.733 .727	.77
-16	33/64"	1/2-20UNJF-3B	.848 .842	.89
-18	37/64"	9/16-18UNJF-3B	.915 .905	.91
-20	41/64"	5/8-18UNJF-3B	.995 .985	1.04
-24	49/64"	3/4-16UNJF-3B	1.120 1.110	1.14
-28	57/64"	7/8-14UNJF-3B	1.345 1.335	1.36
-32	1-1/64"	1-12UNJF-3B	1.490 1.480	1.51

NOTES: 1. Go thread ga
2. Dimensions a
3. Use HL93 for
4. Use HL273 fo

MATERIAL: Collar — 303 Se
Washer — 300 se

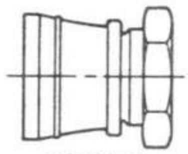
FINISH: HL87-( ) =
HL87D-( ) =
HL87DU-( ) =
HL87DUW-( ) =
HL87G-( ) =
HL87GGW-( ) =
Ⓑ HL87KP-( ) =
Ⓑ HL87KPW-( ) =
HL87W-( ) =

SPECIFICATION: Hi-Lok Product Sp
CODE: Dash number indic
See "Finish" note
EXAMPLE: HL87G-8 = 1/4-2
HL87W-8 = 1/4-2

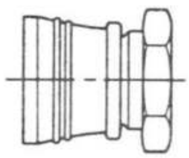
Fig. 17 Hi-Lok collar HL87

B DIA.		L	L_1 (REF.)	L_2 (REF.)	L_3 (REF.)	P (REF.)	W HEX.	X (REF.)	X_1 (REF.)	UTS LBS. MIN.	TORQUE OFF IN. LBS.
	NOTE: For -5 diameter pin, use HL86-5.										
.212 .208		.457 .437	.275	.290	.470	.344	.314 .302	.107	.120	2,750	40-50
.272 .268		.552 .532	.340	.355	.565	.380	.346 .332	.112	.125	5,000	115-130
.336 .330		.672 .652	.430	.445	.685	.484	.440 .425	.122	.135	8,300	200-250
.398 .392		.744 .724	.475	.490	.755	.557	.503 .488	.122	.135	12,700	360-420
.463 .457		.862 .842	.560	.575	.875	.840	.753 .736	.137	.150	19,000	525-675
.528 .522		.942 .922	.610	.625	.955	.970	.878 .861	.137	.150	25,500	725-1000
.598 .592		1.029 1.009	.670	.685	1.042	.970	.878 .861	.145	.158	29,000	1000-1150
.661 .655		1.123 1.103	.735	.750	1.136	1.120	1.003 .986	.145	.158	32,000	1350-1550
.786 .780		1.371 1.351	.940	.955	1.384	1.240	1.128 1.110	.156	.169	42,000	1900-2200
.911 .905		1.575 1.545	1.060	1.075	1.584	1.520	1.380 1.356	.169	.182	62,000	3200-3600
1.036 1.030		1.840 1.810	1.225	1.240	1.849	1.650	1.504 1.480	.186	.199	84,000	4500-5000

enetration shall be 3/4 of one revolution minimum.
after finish.
rsize replacement.
gher tension application.
nless steel per ASTM A-582 (AMS5640).
stainless steel.
ar only with cadmium plate per QQ-P-416, Type II, Class 2,
cetyl alcohol lube per Hi-Shear Spec. 305.
ar only with cadmium plate per QQ-P-416, Type II, Class 2,
solid film lubricant per MIL-L-8937.
ar only with solid film lube per MIL-L-8937.
ar only with solid film lube per MIL-L-8937 and washer with
nium plate per QQ-P-416, Type II, Class 2, no lube.
ar only with silver plate per AMS2410 and cetyl alcohol lube
Hi-Shear Spec. 305.
ar and steel washer both with silver plate per AMS2410 and
alcohol lube per Hi-Shear Spec. 305.
ar only with cadmium plate per QQ-P-416, Type II, Class 2,
r violet to purple, and cetyl alcohol lube per Hi-Shear Spec. 305.
ar with cadmium plate per QQ-P-416, Type II, Class 2, color violet to
le, and cetyl alcohol lube per Hi-Shear Spec. 305. Washer
cadmium plate per QQ-P-416, Type II, Class 2, no lube.
ar with cadmium plate per QQ-P-416, Type II, Class 2, and
alcohol lube per Hi-Shear Spec. 305. Washer with cadmium
per QQ-P-416, Type I, Class 2, no lube.
ication 345.
nominal thread size in 1/32nds.
explanation of code letters.
-Lok collar with silver plate.
-Lok collar and washer, both with cadmium plate.



VOI-SHAN
1 raised bead indicates
VOI-SHAN identification.



STANDARD PRESSED STEEL
2 raised beads indicate STANDARD
PRESSED STEEL identification.

/64 in. oversize) data

Fig. 17


J-1712