LIST OF CHAPTERS

(**Note.**—*A list of contents appears at the beginning of each chapter*)

GENERAL INFORMATION

LIST OF CONTENTS

INTRODUCTION

1. Section 4 was originally intended to contain standardised repairs to metal airframe structures, so that repetition of basically similar repairs in different aircraft Vols. 6 would be eliminated and a common standard of repair introduced.

2. It has been found in practice, however, that standardisation cannot successfully be carried as far as specific repair schemes, and the scope of Section 4 has therefore been limited to metal repair *information* rather than actual metal repairs.

Chapter 4.2 RIVETING, BOLTING AND PINNING

LIST OF CONTENTS

STANDARD RIVETING INFORMATION

Introduction

1. This Scheme contains general information and data on standard rivets and riveting processes used in the repair of metal aircraft components. More detailed information is given in A.P.1464B, Vol. 1, Sect. 2, Chap. 2 to 8 and Chap. 12 (*Riveting tools*), Sect. 4, Chap. 8 (*Riveting processes used on aircraft*) and Sect. 6, Chap. 10 (*Identification of rivets*).

2. The information given in this Scheme is supplemented in successive Schemes, within this Chapter, by the identification and riveting techniques for individual types of riveting processes, as indicated in the Chapter contents leaf.

General

3. In the construction of metal airframe structures, permanent joints are made with either rivets or bolts and the more extensive use of the former has enabled the manufacturers to standardize the 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.

4. The present-day 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, alighting gear main retraction sections and built-up sections in an engine bay. This method of attachment is covered in Chap. 4.4.

5. To securely attach faying surfaces together, rivets are cheaper to use and 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.

6. 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.

7. 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. Although it is sometimes necessary to fit rivets of $\frac{3}{8}$ in. diameter, the range of rivet sizes referenced in A.P.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.

8. 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. Details of the various types of rivets are given in this and other Schemes in this Chapter.

9. 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 authorised in the relevant aircraft Vol. 6. If hollow rivets are not authorized, a suitable access 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.

10. 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 Chief Technical Officer. They must never be used, however, in the repair of primary structure, unless authorised in the Vol. 6 or by the manufacturer's stress department.

Rivet holes

11. Standard holes for all rivets must be drilled slightly larger than the rivet shank to allow for its expansion when the second rivet-head is formed. The difference between the size of the drilled hole and the diameter of the rivet is known as the "clearance" and is necessary to prevent the metal surface puckering when the rivet is closed, particularly with light-alloy material. The usual clearance is between 0·003 and 0·005 in. and the recommended average drill sizes for repair work are given in the following Table:—

STANDARD RIVETING INFORMATION—*continued*

TABLE 1

Drill sizes for rivet clearance holes

Diameter of rivet (in fraction of 1 in.)		Metric size drill diameter (in. mm.)	Number or letter drill size	Decimal fraction of drill diameter (inches)
$\frac{1}{16}$	(0·0625)	1·70	51	0·067
$\frac{3}{32}$	(0·0933)	2·50	40	0·098
$\frac{7}{64}$ (pop rivets)	(0·1094)	2·88	33	0·113
$\frac{1}{8}$	(0·1250)	3·25	30	0·1285
$\frac{5}{32}$	(0·1563)	4·05	21	0·159
$\frac{3}{16}$	(0·1875)	4·85	11	0·191
0·2 (pop rivets)		5·20	6	0·204
$\frac{1}{4}$	(0·25)	6·50	F	0·257
$\frac{5}{16}$	(0·3125)	8·00	O	0·316
$\frac{3}{8}$	(0·3750)	9·80	W	0·386

Note . . .

(1) *The recommended drill sizes given in Table 1 are not mandatory. While rivets may be satisfactorily fitted in holes drilled in accordance with the sizes given in this Table, repair personnel, using hand-operated braces and drills, are more likely to fit the rivets in holes made with dead-size drills, e.g., using a $\frac{1}{8}$ in. drill for fitting a $\frac{1}{8}$ in. diameter rivet.*

(2) *If the correct drill size, as given in Table 1, is not available, the next smaller size drill should be used instead.*

(3) *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.*

Countersunk holes

12. Holes for countersunk-head rivets must be either cut-countersunk or dimpled (*Chap.* 4.3) 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 the following Table 2, 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.

13. Cut-countersinking may be done either with an approved set of cut-countersinking tools provisioned as Ref. No. 1C/6456 (comprising eight separately-referenced cutters and a key wrench), by accurately-ground drills having the correct angle of 90, 100 or 120 deg., or by using a nose-countersink tool. In all cases it is essential to ensure that the correct depth of countersink is achieved so that the rivet heads will fit flush with the surface of the metal when the work is completed.

TABLE 2

Application of cut-countersinking or dimpling methods

Sheet metal gauge	Rivet diameter (in inches)				
	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{4}$
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

Note . . .

Countersunk rivets are to be internationally standardized at 100 deg. If rivets of a lesser angle are necessary, these will be standardized at 60 deg.

14. 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, but where possible, spin dimpling machines or squeeze-dimpling tools should be used to give more accurate work. 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. A.P.1086 for the spin dimpling machines or squeeze-dimpling tools to be obtained as a general issue.

Rivet lengths

15. The length of any rivet required for repair work must be governed by its diameter, the gauge-size of the metal surfaces to be joined and 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 3.

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 the rivet. When the calculation indicates that the length of a rivet is within the range given in A.P.1086, Sect. 28Q, it may be fitted in the rivet holes and closed without filing or cutting the shank to the correct length.

Types of rivets

16. Rivets are supplied in various types and sizes, as listed in A.P.1086, Sect. 28Q, to suit different requirements. Those mostly in use for the repair of metal aircraft structures are solid, tubular and "pop"-type rivets made from mild, stainless and nickel-alloy steels, monel metal, tungum, aluminium or light-alloy material, with flat, countersunk, snap, mushroom or domed heads.

17. Solid rivets (*para.* 9) are used wherever possible, but where their use is impracticable and blind riveting is necessary, Chobert, Tucker or Avdel hollow or cup rivets must each be fitted by a mandrel with an approved mechanical or powered riveting tool, as instructed in Scheme 4.2.3, 4.2.4 and 4.2.5.

18. Tubular rivets are used in structures where a gap exists between the metal surfaces to be joined or secured, 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.

Identification of rivets

19. 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.

TABLE 3

Rivet allowances on shank length

Type of head to be formed	Rivet material	Allowance (in inches)	Remarks
Snap	Low tensile steel	1·6 × D	—
Snap	Stainless steel	1·25 × D	For two plates
Snap	Stainless steel	1·4 × D	For six plates
Snap	Light alloy	1·7 × D	Larger allowance due to greater clearance
Flat	Light alloy	1·0 × D	—
Countersunk	All materials	0·6 to 0·75 × D	—
Tubular	All materials	0·5 × D	0·75 × D if the head is to be "spun"

20. The information obtained from the visual check of the rivets should then be applied to the code systems employed for aircraft rivets under the A.S. (*Aircraft Standards*), B.S. (*British Standards*) and A.G.S. (*Aircraft General Stores*) specifications and drawings, which will enable the required rivets to be demanded by the correct Sect. 28Q reference number in A.P.1086. For detailed information on the identification of rivets, refer to A.P.1464B, Vol. 1, Part 2, Sect. 6, Chap. 10. Examples of the application of identification code systems are given in Schemes 4.2.2. to 4.2.5.

Angles of countersunk-head rivets

90 and 120 deg. heads

21. All countersunk-head rivets at present referenced in A.P.1086, Sect. 28Q are machined to angles of either 90 or 120 degrees to meet the repair requirements of existing aircraft which have these rivets fitted by the aircraft manufacturer. They are made to approved A.S. and A.G.S. specification drawings which are revised periodically, thus allowing A.S. drawings to be superseded by, or absorbed into, the B.S. range, if appropriate. When this occurs, the alteration to the drawing number is recorded and the publication amended accordingly.

100 deg. head

22. 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. A.S.162) but less accurate than those of the existing close-tolerance rivets in the A.S. series. Rivets to the new design, issued to B.S. and S.B.A.C. 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.

Introduction of new-type rivets

23. Information on new ranges of rivets, introduced by S.D.M. (*Standardization Design Memorandum*) (A) I.S.192 (Issue 3), is included in the following Tables 4 to 9. Many of the rivets listed in the Tables are not yet referenced in A.P.1086, but will be added by amendment action later. Those which are already referenced under the appropriate A.G.S. No. are marked with an asterisk in the right-hand column of each applicable Table.

TABLE 4

Solid rivets

Item	Material	Type of head	Standard
1	Aluminium L.36	Snap	B.S.Sp.77
		C'sk. 100 deg.	B.S.Sp.68
2	Aluminium alloy L.37	Snap	B.S.Sp.78
		Mushroom	B.S.Sp.83
		C'sk. 100 deg.	B.S.Sp.69
3	Aluminium alloy (Mg 5%) L.58 (Primarily for use with Magnesium-base alloys)	Snap	B.S.Sp.79
		Mushroom	B.S.Sp.84
		C' sk. 100 deg.	B.S.Sp.70
4	Mild Steel B.S.1109	Snap	B.S.Sp.76
		C'sk. 100 deg.	B.S.Sp.86
5	High Ni. Cu. alloy D.T.D.204	Snap unplated cadmium plated	B.S.Sp.81 B.S.Sp.82
		C'sk. 100 deg. unplated cadmium plated	B.S.Sp.87 B.S.Sp.88
6	Aluminium alloy L.69	Snap	B.S.Sp.80
		Mushroom	B.S.Sp.85
		C'sk. 100 deg.	B.S.Sp.71
7	Aluminium alloy (L.58) where contact with H.T.P. may occur	Snap	A.S.4732
		Mushroom	A.S.4733
		C'sk. 100 deg.	A.S.4716

TABLE 5

Tubular rivets (solid drawn)

Item	Material	Type of head	A.G.S. No. 501 Sheets 1 to 3
1	Aluminium L.54	Flat	501A*
2	Aluminium alloy L.37	Flat	501D*
3	Mild Steel T.26	Flat	501H*
4	Nickel alloy D.T.D.268 (D.T.D.204 alternative)	Flat	501K*

TABLE 6

Tucker "pop" and cup rivets

Item	Material	Type of head	A.G.S. No.
1 (Pop)	Aluminium alloy (Mg. 5%) L.58	Domed	2048* 2074
2 (Pop)	Monel D.T.D.10	Domed	2050 (unplated)* 2059 (cadmium plated)
3 (Pop)	Monel D.T.D.10	C'sk. 100 deg.	2070 (cadmium plated) 2071 (unplated)
4 (Cup)	Aluminium alloy (Mg. 5%) L.58	Domed	2053*
5 (Cup)	Monel D.T.D.10	Domed	2055*

Note . . .

These rivets must be closed with mandrels as detailed in A.G.S.2052. The precautions detailed in A.P.970 Leaflet 405/2 must also be observed.

TABLE 7

Chobert rivets

Item	Material	Type of head	A.G.S. No.
1	Mild Steel	Snap	2040*
		C'sk. 100 deg.	2067
2	Aluminium alloy L.37	Snap	2043*
3	Aluminium alloy L.69	Snap	2045*
		C'sk. 100 deg.	2068

TABLE 8

Sealing pins for chobert rivets

Item	Material	A.G.S. No.
1	Mild Steel S.1 (To be used with mild steel rivets when specified)	2042*
2	Aluminium alloy L.64 or D.T.D.423 (To be used with aluminium alloy rivets when specified)	2047*

TABLE 9

Avdel self-sealing rivets

Item	Material	Type of head	A.G.S. No.
1	Aluminium alloy L.69	Snap	2065
		C'sk. 100 deg.	2066

Close-tolerance rivets

24. These rivets are made from light alloy to B.S. L.37 and aluminium alloy to B.S. L.69. The former has a plain finish and is marked with a D or figure 7 and the latter is anodized, dyed violet and marked with an O, an S or a figure 9. The head and shank diameters, together with the rivet length, should be checked before using the rivets on work which requires close-tolerance riveting. The diameter of the heads and shanks of these rivets are controlled to within ±0·001 in. and their lengths to within 0·01 in.

25. The existing close-tolerance rivets are included in the A.S. series as A.S.2918-2919 and A.S.3362-3363, and are referenced in A.P.1086, Sect. 28Q (Book 12). For future aircraft arisings, precision-head countersunk rivets in the SP.69, SP.70 and SP.71 ranges will be provisioned but are not yet referenced. The code system for the identification of all these rivets is the same as that used for solid rivets described in Scheme 4.2.2, except that the lengths of close-tolerance rivets increase by increments expressed in thirty-seconds of an inch, the intermediate lengths being indicated by the addition of the decimal figure "·5" to the end of the part number (*Scheme* 4.2.2, *Table* 7).

★ ★ ★

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE 4.2.2

Introduction

1. This Scheme describes the visual identification and code systems employed on various types of solid rivets, together with information on the riveting processes involved in fitting and closing them. More detailed information on riveting processes may be obtained by reference to A.P.1464B, Vol. 1, Part 2, Sect. 4, Chap. 8 and, where appropriate, to the relevant aircraft Vol. 6. The identification code of solid rivets given in this Scheme is also described with more detail in A.P.1464B, Vol. 1, Part 2, Sect. 6, Chap. 10.

General

2. 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 to 16. The rivets are made to B.S. (*British Standards*) and S.B.A.C. (*Society of British Aircraft Constructors*) specification drawings, the S.B.A.C. drawings forming part of the A.S. (*Air Standards*) series, and the B.S. drawings part of the S.P. (*Standard Parts*) series.

3. The Tables contained in this Scheme indicate the type, material, diameter and length of the rivets usually required for repair work. The majority of the rivets are referenced in A.P.1086, Sect. 28Q, but some of those listed in the revised range of rivets introduced by S.D.M. (A) I.S.192 (*Scheme* 4.2.1, *Table* 4), 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/N.I.V.", quoting the appropriate B.S. or S.B.A.C. code numbers to identify them.

Identification of solid rivets

4. The identification code for any solid rivet consists of the A.S. drawing number (*S.B.A.C. Series*) or the SP. drawing number (*B.S. 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 A.S. range, "A.S.155/824" is a snap-head rivet made of aluminium to B.S. L.36, with anodized finish, $\frac{1}{4}$ in. diameter and $1\frac{1}{2}$ in. long; "A.S.2229/-1010" is a 90 deg. countersunk-head rivet made of aluminium alloy to B.S. L.69, 5/16 in. diameter and $\frac{5}{8}$ in. long; "A.S.465/404" is a 120 deg. countersunk-head rivet made of monel metal to D.T.D.204, $\frac{1}{8}$ in. diameter and $\frac{1}{4}$ in. long; "A.S.158/815" is a mushroom-head rivet made of aluminium alloy to B.S. L.37, $\frac{1}{4}$ in. diameter and 15/16 in. long and "A.S. 455/1248" is a snap-head rivet made of mild steel to B.S. 1109, $\frac{3}{8}$ in. diameter and 3 in. long.

5. 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 B.S.4 L.37, $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. long, while "SP.76/1214" is a snap-head rivet made of mild steel to B.S.1109, $\frac{3}{8}$ in. diameter and $\frac{7}{8}$ in. long.

6. The identification code system used for all close tolerance rivets is similar to that used to identify normal solid rivets in the A.S. series, but introduces additional, intermediate lengths. The normal solid rivet lengths are quoted in increments of 1/16 in. For close tolerance rivet lengths, intermediate sizes in increments of 1/32 in. are used, and in the code system, these are indicated by a decimal ·5 value, thus "A.S.2919/815·5" will identify a close tolerance, 120 deg. countersunk-head rivet made of aluminium alloy to B.S. L.37, $\frac{1}{4}$ in. diameter and 31/32 long.

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

7. 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 B.S. L.36, green for L.58 and violet for L.69. Material to B.S. 4L.37 is not coloured but left plain.

8. Mild steel rivets to B.S.1109 are cadmium-coated and those of the high chromium-copper alloys to D.T.D.204 or 10 (*monel metal*) are plain, unplated or cadmium-coated, the coating giving the rivets a greyish appearance.

9. The number or letter marks on the heads or tails of rivets are an added means of identity; the complete range of both A.S. and SP. rivet markings are given in Tables 1 and 2.

Strength of solid rivets

10. The strengths of the rivets dealt with in this Scheme 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

TABLE 1

Identification colours and marks on solid rivets to S.B.A.C. specifications

A.S. drawing number	Material specification	Material	Head formation	Colour or finish	Letter on rivet tail
155	L.36	Aluminium	Snap	Black	A
156	L.37	Aluminium alloy	Snap	Natural	D
157	L.58	Aluminium alloy (Mag. 5)	Snap	Green	X
158	L.37	Aluminium alloy	Mushroom	Natural	D
159	L.58	Aluminium alloy (Mag. 5)	Mushroom	Green	X
160	L.36	Aluminium	90 deg. countersunk	Black	A
161	L.37	Aluminium alloy	90 deg. countersunk	Natural	D
162	L.58	Aluminium alloy (Mag. 5)	90 deg. countersunk	Green	X
163	L.36	Aluminium	120 deg. countersunk	Black	A
164	L.37	Aluminium alloy	120 deg. countersunk	Natural	D
165	L.58	Aluminium alloy (Mag. 5)	120 deg. countersunk	Green	X
455	B.S.1109	Mild steel	Snap	Cadmium plating	—
457	D.T.D.204	High Ni. Cu. alloy (Monel metal)	Snap	Natural	—
459		Copper	Snap	Natural	—
460	B.S.1109	Mild steel	90 deg. countersunk	Cadmium plating	—
462	D.T.D.204	High Ni. Cu. alloy (Monel metal)	90 deg. countersunk	Natural	—
463	B.S.1109	Mild Steel	120 deg. countersunk	Cadmium plating	—
465	D.T.D.204	High Ni. Cu. alloy (Monel metal)	120 deg. countersunk	Natural	—
467		Copper	90 deg. countersunk	Natural	—
2227	L.69	Aluminium alloy	Snap	Violet	S
2228	L.69	Aluminium alloy	Mushroom	Violet	S
2229	L.69	Aluminium alloy	90 deg. countersunk	Violet	S
2230	L.69	Aluminium alloy	120 deg. countersunk	Violet	S
2918	L.37	Aluminium alloy	90 deg. countersunk (close tolerance)	Natural	D
2919	L.37	Aluminium alloy	120 deg. countersunk (close tolerance)	Natural	D

TABLE 1—*continued*

Identification colours and marks on solid rivets to S.B.A.C. specifications

A.S. drawing number	Material specification	Material	Head formation	Colour or finish	Letter on rivet tail
3362	L.69	Aluminium alloy	90 deg. countersunk (close tolerance)	Violet	S
3363	L.69	Aluminium alloy	120 deg. countersunk (close tolerance)	Violet	S
4694	D.T.D.204	High Ni. Cu. alloy (Monel metal)	Snap	Cadmium plating	—
4695	D.T.D.204	High Ni. Cu. alloy (Monel metal)	90 deg. countersunk	Cadmium plating	—
4696	D.T.D.204	High Ni. Cu. alloy (Monel metal)	120 deg. countersunk	Cadmium plating	—

TABLE 2

Identification colours and marks on solid rivets to B.S. specifications

S.P. drawing number	Material specification	Material	Head formation	Colour or finish	Letter or number on rivet tail
68	L.36	Aluminium	100 deg. countersunk	Black	—
69	*4L.37	Aluminium alloy	100 deg. countersunk	Natural	7
70	L.58	Aluminium alloy (Mag. 5)	100 deg. countersunk	Green	8
71	L.69	Aluminium alloy	100 deg. countersunk	Violet	9
76	B.S.1109	Mild steel	Snap	Cadmium plating	—
77	L.36	Aluminium	Snap	Black	I
78	*4L.37	Aluminium alloy	Snap	Natural	7
79	L.58	Aluminium alloy (Mag. 5)	Snap	Green	8
80	L.69	Aluminium alloy	Snap	Violet	O
81	D.T.D.204	High Ni. Cu. alloy (Monel metal)	Snap	Natural	M
82	D.T.D.204	High Ni. Cu. alloy (Monel metal)	Snap	Cadmium plating	M
83	*4L.37	Aluminium alloy	Mushroom	Natural	7
84	L.58	Aluminium alloy (Mag. 5)	Mushroom	Green	8
85	L.69	Aluminium alloy	Mushroom	Violet	O
86	B.S.1109	Mild steel	100 deg. countersunk	Cadmium plating	—
87	D.T.D.204	High Ni. Cu. alloy	100 deg. countersunk	Natural	M
88	D.T.D.204	High Ni. Cu. alloy	100 deg. countersunk	Cadmium plating	M

***Note . . .**

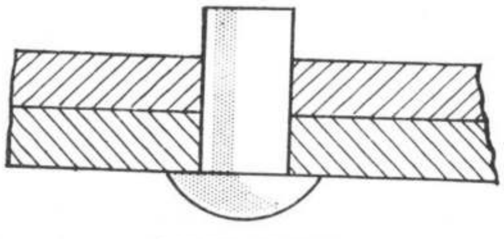
A departure from the accepted convention of not quoting the issue prefix of a standard is necessary in the starred items. This is occasioned by the identification markings, given in Table 2, differing from those applied to rivets manufactured in accordance with A.S. drawings (Table 1). This is of particular importance in relation to rivets made from L.37 material in view of the revision of British Standard 3L.37 to change from the 'L.1' to the 'L.64' type of composition. Because of that change, the use of 4L.37 material is specifically required by these rivet standards given in the Tables contained in fig. 10 to 16 inclusive.

jointing and finish vitally important to aerodynamic cleanliness and aircraft performance.

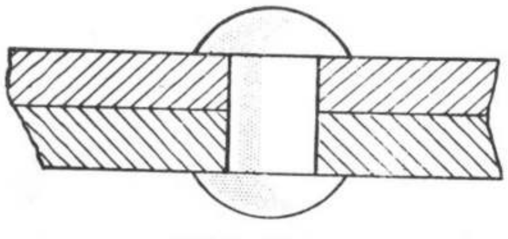
11. Normally, 100 or 120 deg. countersunk-head rivets are used in production and repair work in light-gauge skinning. The 90 deg. type of head is used for improved flush finish in heavier gauge materials. Rivets with a 60 deg. countersunk-head are occasionally used in very heavy gauge material where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

Rivet shank projection

12. The shank of the rivet must project sufficiently beyond the surface of the metal to be joined to allow for the satisfactory formation of the appropriate type of head. The length of the projection will vary according to the type of head to be formed, the material from which the rivet is made and the appropriate clearance between the rivet diameter and the rivet hole; it also varies for certain rivet materials, according to the overall thickness of the materials to be joined. These allowances are given in Scheme 4.2.1., Table 3.



RIVET INSERTED



HEAD FORMED

Fig. 1. Solid snap-head rivet

Riveting technique for solid rivets

13. 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 (*A.P.*1464*B*, *Vol.* 1, *Sect.* 2 *and Sect.* 4).

Manual riveting

14. 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.* 1) 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.

Reaction riveting

15. Whilst this simple method may be used on the bench, reaction riveting is now widely employed, especially when repairs to metal-skin surfaces are being effected. The clearances between the rivet shank and rivet hole are the same for both methods.

16. In the reaction riveting process, two operators are necessary, one to hold the reaction block (*flat head*) or dolly (*snap head*) and the other to hammer the rivet head. The pre-formed head of the rivet is positioned on the outer surface of the metal to be joined and a suitable hand or power tool is held against the head and hammered while the tail of the rivet is supported by a metal reaction block or dolly. The former need not be made to any special shape, but it must be flat and smooth on the face held against the tail of the rivet to ensure that it may swell without restraint and form the required type of tail.

17. The advantage of this type of formed head are as follows:—

(1) The length of the rivet shank is not critical.

(2) Deformation of the metal skin by the dolly pressing against it does not occur.

(3) A squash or cheese head is stronger than a snap head of the same diameter.

(4) The closing caused by reaction riveting eliminates the drawing-up operation necessary when normal hand riveting methods are used.

18. The principle employed in reaction riveting is one that relies on the impact of the hammer to drive the pre-formed head of the rivet against the metal skin which, being springy, will be driven against that part of the rivet nearer the tail, while the rivet shank swells from the tail, backwards, by the rebounding action of the metal block or dolly, thus forming the required type of head on the tail of the rivet.

Procedure

19. The sequence of operations for manually fitting solid rivets is as follows:—

(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.* 21 *and* 22), 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.

(2) Dismantle the drilled metal surfaces and remove all burrs and swarf around the holes.

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

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

(5) Insert rivets of the correct length (*para.* 12) and draw-up the metal surfaces so that they are close together, with each

pre-formed rivet head suitably supported by an approved dolly of the correct size.

(6) Strike the tail of the rivets with a few direct, heavy hammer blows; this action will swell the shanks and fill the clearance in the holes.

(7) Using the correct snap, form the head of each rivet to the required shape.

Riveting faults

20. 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 faulty riveting. The main causes of faulty riveting are as follows:—

(1) Excessive or insufficient shank allowance.

(2) Rivet holes not drilled straight or drilled to the wrong size.

(3) Rivet holes out of line on separate surfaces.

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

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

(6) Rivets not filling rivet holes correctly because initial hammer blows on the tail of the rivet have not swollen the shank (*para.* 19, (6) *refers*).

(7) Rivet head not central with the shank.

Riveted joints

21. 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.

22. 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. 21 are as follows (where the symbol D denotes the diameter of the rivets):—

(1) The basic minimum permissible distance between any two rivets centres is 4D. Therefore:—

(2) The minimum pitch is 4D.

(3) The minimum distance between rows of chain rivets is 4D.

(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.

(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 2½D for all material thinner than 18 gauge.

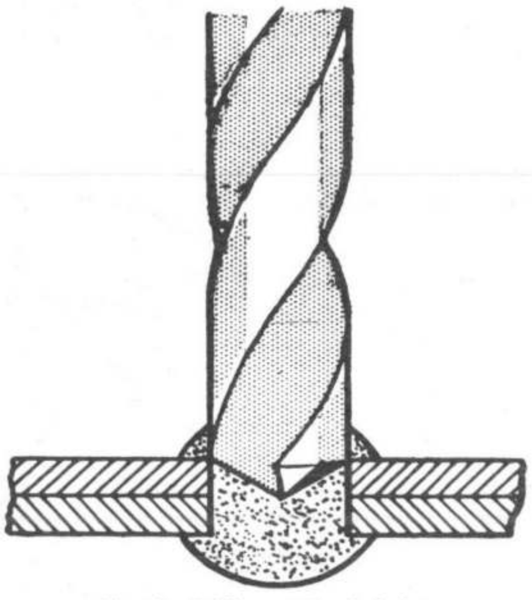


Fig. 2. Drilling out head of rivet

Removal of solid rivets

23. 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.

24. The removal of solid rivets should be effected in the following sequence of operations:—

(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.*

(2) Mark the centre of the heads with a centre-punch.

(3) Using a drill of the same nominal diameter as the rivet shanks *(fig. 2)*, carefully drill out the heads to a depth slightly more than the thickness of the centre-punched heads.

(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*).

(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.

Oversize rivet holes

25. 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.

Solid plug rivets

26. Plug riveting, shown in fig. 3, 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 B.S. L.37 or L.69. *Aluminium alloy rivets to B.S. L.58 must not be used for this purpose.*

Fitting plug rivets

27. The procedure for fitting plug rivets, which necessitates the use of a power hammer, is as follows:—

(1) Drill suitable-sized holes to the required depth in the solid member.

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

(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 (*Scheme* 4.2.1, *Table* 2).

(4) Cut the rivets to the required lengths, which must include the allowance for the shank expansion.

(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.

Removing plug rivets

28. 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.

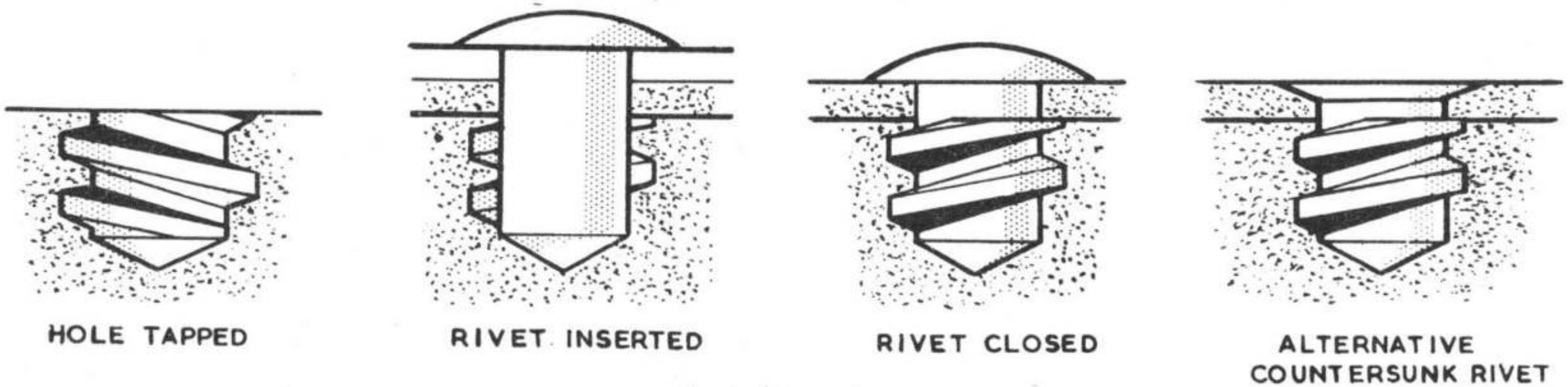
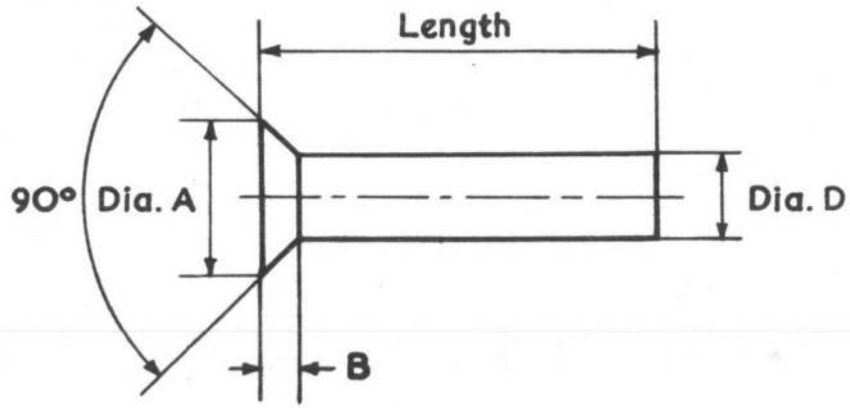


Fig. 3. Plug riveting

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
160	B.S.L.36	Aluminium	Black	A	6
161	B.S.4L.37	Aluminium alloy	Plain	D	5
162	B.S.L.58	Aluminium alloy (Mag. 5)	Green	X	5
460	B.S.1109	Mild steel	Cadmium plating	—	4
462	D.T.D.204	High nickel-copper alloy (Monel metal)	Plain	—	5
467	—	Copper	Natural	—	6
2229	B.S.L.69	Aluminium alloy	Violet	S	5
4695	D.T.D.204	High nickel-copper alloy (Monel metal)	Cadmium plating	—	5



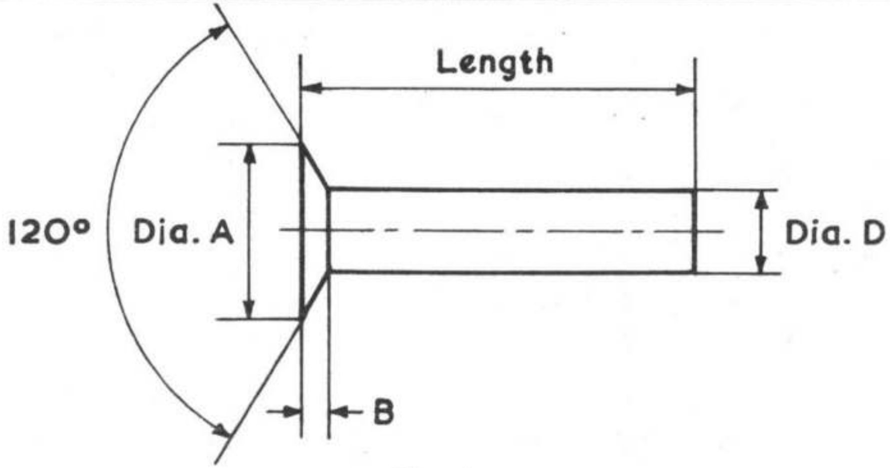
Dimensions

Nominal size of rivet (in.)	Head diameter A (in.)	Head depth B (in.)	Shank diameter D (in.)
$\frac{1}{16}$	0·115	0·029	0·062
$\frac{3}{32}$	0·170	0·041	0·094
$\frac{1}{8}$	0·225	0·053	0·125
$\frac{5}{32}$	0·279	0·065	0·156
$\frac{3}{16}$	0·334	0·077	0·187
$\frac{7}{32}$	0·387	0·091	0·219
$\frac{1}{4}$	0·444	0·103	0·250
$\frac{5}{16}$	0·555	0·128	0·312
$\frac{3}{8}$	0·666	0·156	0·375

Fig. 4. 90 deg. countersunk head rivets (A.S. series)

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
163	B.S.L.36	Aluminium	Black	A	6
164	B.S.4L.37	Aluminium alloy	Plain	D	5
165	B.S.L.58	Aluminium alloy (Mag. 5)	Green	X	5
463	B.S.1109	Mild Steel	Cadmium plating	None	5
465	D.T.D.204	High nickel copper alloy (Monel metal)	Plain	None	5
2230	B.S.L.69	Aluminium alloy	Violet	S	5
4696	D.T.D.204	High nickel copper alloy (Monel metal)	Cadmium plating	None	5



Dimensions

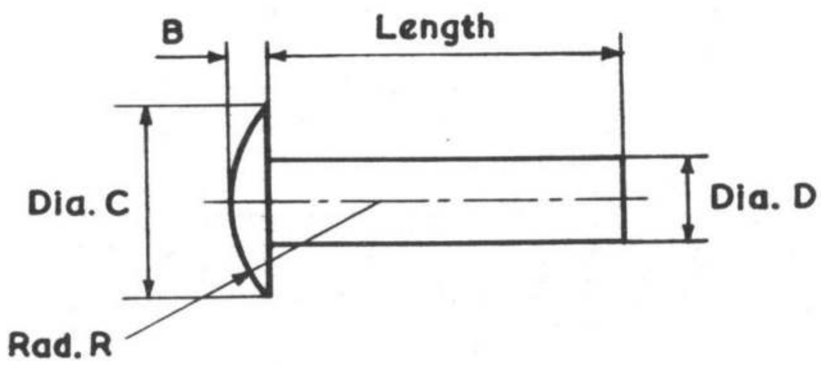
Nominal size of rivet (in.)	Head diameter A (in.)	Head depth B (in.)	Shank diameter D (in.)
$\frac{1}{16}$	0·131	0·027	0·062
$\frac{3}{32}$	0·193	0·036	0·094
$\frac{1}{8}$	0·256	0·045	0·125
$\frac{5}{32}$	0·318	0·056	0·156
$\frac{3}{16}$	0·381	0·064	0·187
$\frac{7}{32}$	0·443	0·078	0·219
$\frac{1}{4}$	0·506	0·088	0·250
$\frac{5}{16}$	0·633	0·107	0·281
$\frac{3}{8}$	0·760	0·130	0·312

Fig. 5. 120 deg. countersunk head rivets (A.S. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
158	B.S.4L.37	Aluminium alloy	Plain	D	5
159	B.S.L.58	Aluminium alloy (Mag. 5)	Green	X	5
2228	B.S.L.69	Aluminium alloy	Violet	S	5



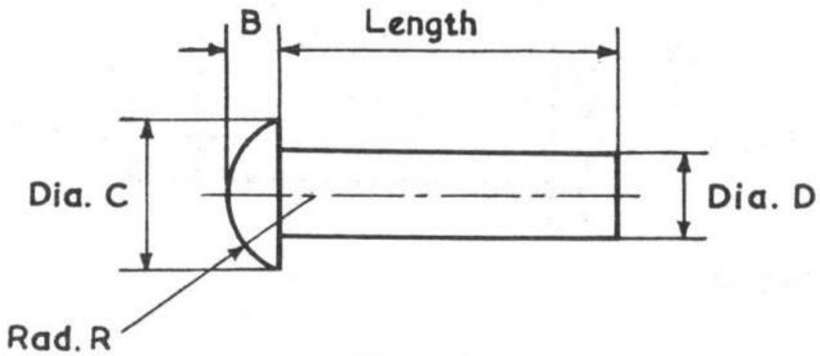
Dimensions

Nominal size of rivet (in.)	Head depth B (in.)	Head diameter C (in.)	Shank diameter D (in.)	Head radius R (in.)
$\frac{1}{16}$	0·025	0·140	0·062	0·110
$\frac{3}{32}$	0·038	0·210	0·094	0·170
$\frac{1}{8}$	0·050	0·280	0·125	0·220
$\frac{5}{32}$	0·063	0·350	0·156	0·270
$\frac{3}{16}$	0·075	0·420	0·187	0·330
$\frac{7}{32}$	0·088	0·490	0·219	0·390
$\frac{1}{4}$	0·100	0·560	0·250	0·440
$\frac{5}{16}$	0·125	0·700	0·312	0·550
$\frac{3}{8}$	0·150	0·840	0·375	0·660

Fig. 6. Mushroom head rivets (A.S. series)

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
155	B.S.L.36	Aluminium	Black	A	3
156	B.S.4L.37	Aluminium alloy	Plain	D	4
157	B.S.L.58	Aluminium alloy (Mag. 5)	Green	X	4
455	B.S.1109	Mild steel	Cadmium plating	None	4
457	D.T.D.204	High nickel-copper alloy (Monel metal)	Plain	None	4
459	—	Copper	Natural	None	6
2227	B.S.L.69	Aluminium alloy	Violet	S	4



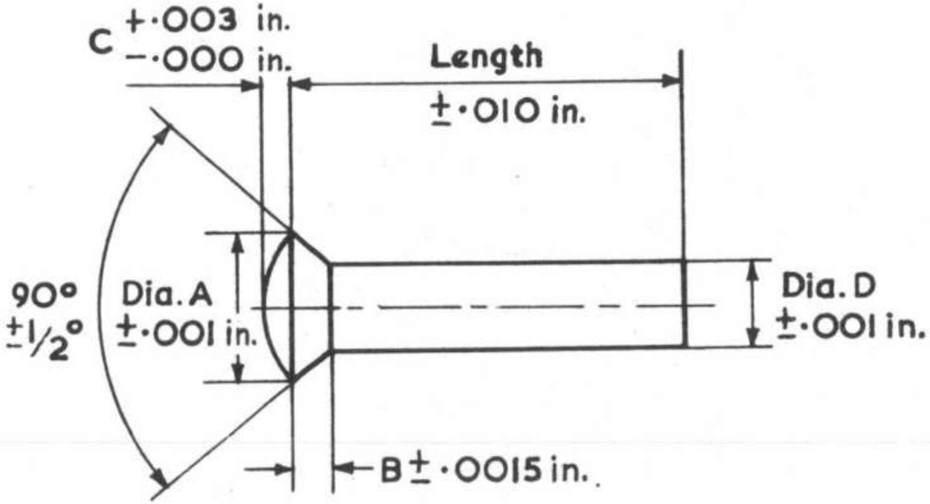
Dimensions

Nominal size of rivet (in.)	Head depth B (in.)	Head diameter C (in.)	Shank diameter D (in.)	Head radius R (in.)
$\frac{1}{16}$	0·040	0·110	0·062	0·060
$\frac{3}{32}$	0·060	0·160	0·094	0·090
$\frac{1}{8}$	0·080	0·220	0·125	0·120
$\frac{5}{32}$	0·090	0·270	0·156	0·150
$\frac{3}{16}$	0·110	0·330	0·187	0·180
$\frac{7}{32}$	0·130	0·380	0·219	0·210
$\frac{1}{4}$	0·150	0·440	0·250	0·240
$\frac{9}{32}$	0·170	0·490	0·281	0·260
$\frac{5}{16}$	0·190	0·550	0·312	0·290
$\frac{11}{32}$	0·210	0·600	0·344	0·320
$\frac{3}{8}$	0·230	0·660	0·375	0·350

Fig. 7. Snap head rivets (A.S. series)

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
2918	B.S.L.37	Aluminium alloy	Plain	7	7
3362	B.S.L.69	Aluminium alloy	Violet	9 or 0	7



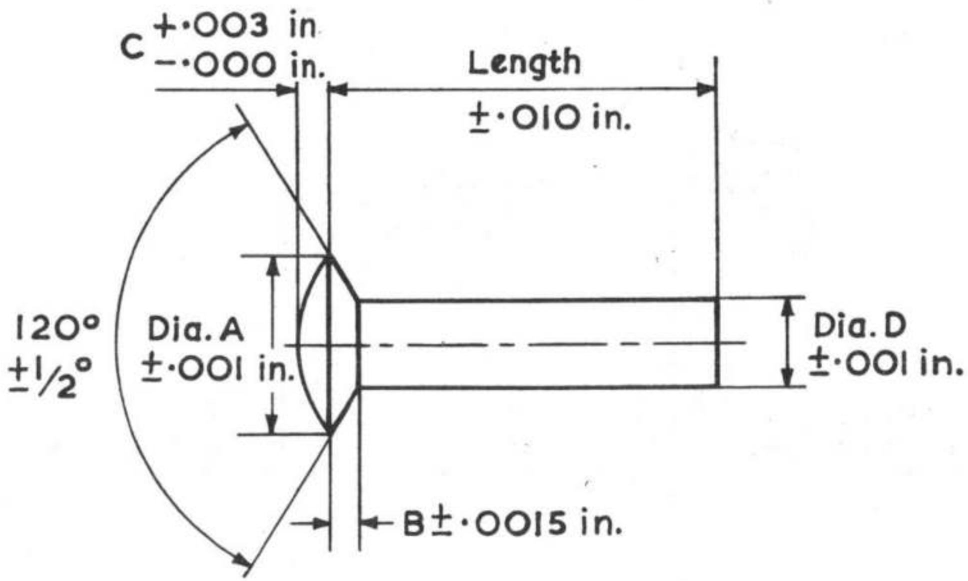
Dimensions

Nominal size of rivet (in.)	Head diameter A (in.)	Depth B (in.)	Depth C (in.)	Shank diameter D (in.)
$\frac{3}{32}$	0·157	0·035	0·003	0·094
$\frac{1}{8}$	0·212	0·046	0·003	0·125
$\frac{5}{32}$	0·267	0·058	0·003	0·156
$\frac{3}{16}$	0·322	0·070	0·004	0·187
$\frac{7}{32}$	0·377	0·082	0·004	0·219
$\frac{1}{4}$	0·432	0·094	0·005	0·250
$\frac{9}{32}$	0·487	0·106	0·005	0·281
$\frac{5}{16}$	0·542	0·118	0·006	0·312

Fig. 8. 90 deg. countersunk head, close tolerance rivets (A.S. series)

Identification data

A.S. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet	Table Ref.
2919	B.S.L.37	Aluminium alloy	Plain	7	7
3363	B.S.L.69	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. 9. 120 deg. countersunk head, close tolerance rivets (A.S. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

TABLE 3

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

EXAMPLES:—

A snap head rivet in B.S.L.36 material $\frac{1}{8}$ in. diameter and $\frac{3}{4}$ in. long is A.S.155/412 and a similar rivet $\frac{3}{8}$ in. diameter and 2 in. long is A.S.155/1232.

TABLE 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	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 1/2		324	424	524	624	724	824	1024	1224
1 3/4		328	428		628	728	828	1028	1228
2					632		832	1032	1232

Numbers outside heavy lines are for A.S. 156 rivets only.

For A.S.157 and 2227 rivets only.

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 B.S.L.58 material 1/8 in. diameter and 5/8 in. long is A.S.157/410 and a similar rivet 5/16 in. diameter and 1 1/4 in. long is A.S.157/1020.

TABLE 5

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

Numbers outside the heavy lines are for A.S.161 rivets only.

For A.S.158, 159, 161, 162, 164, 165, 457, 462, 2228, 2229, 2230 & 4695 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 B.S. L.58 material $\frac{1}{8}$ in. diameter and $\frac{7}{8}$ in. long is A.S.162/414 and a similar rivet in B.S.69 material $\frac{1}{32}$ in. diameter and $1\frac{3}{4}$ in. long is A.S.2229/728.

TABLE 6

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

Numbers above the heavy lines are for A.S.459 rivets only.

Note . . .

The last two figures of the code numbers indicate the length of the rivet in $\frac{1}{16}$ *in. and the remaining figure or figures denote the diameter in* $\frac{1}{32}$ *in.*
EXAMPLE:—A 120 *deg. countersunk head rivet in B.S. L.*36 *material* $\frac{5}{32}$ *in. diameter and* $\frac{7}{8}$ *in. long is A.S.*163/514.

TABLE 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 . . .

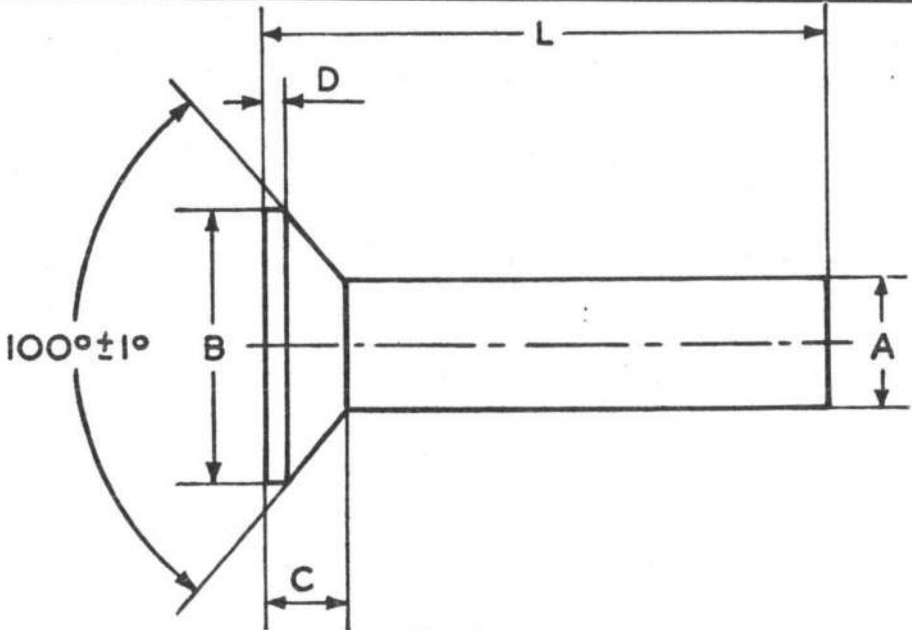
(1) *The decimal ·5 value after the standard code numbers indicates length of 1/32 in. greater than that denoted by the code number it follows.*

(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 B.S.4L.37 material 1/8 in. diameter and 5/8 in. long is A.S.2918/410 and a 120 deg. countersunk head rivet in B.S.L.69 material 5/16 in. diameter and 25/32 in. long is A.S.3363/1012·5.

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
68	B.S.L.36	Aluminium	Black	None
69	B.S.4L.37	Aluminium alloy	Plain	7
70	B.S.L.58	Alumin alloy (Mag. 5)	Green	8
71	B.S.L.69	Aluminium alloy	Violet	9



Dimensions

Nominal size of rivet (in.)	Shank diameter A (in.)		Head diameter B (in.) Absolute min.	Depth of head C (in.)	Depth of land D (in.)
	max.	min.			
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

Note . . .

(1) *These rivets have precision heads in addition to shank tolerances which lie between those applicable to A.S. and S.P. normal and A.S. 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 S.P.*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 S.P.*68 *to* 71 *range and* 0·012 *in. in the S.P.*87 *and* 88 *range.*

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

Fig. 10. 100 deg. countersunk precision-head, aluminium and aluminium-alloy rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed in fig. 10

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.) ± 0·010			PART IDENTIFICATION NUMBERS					
$\frac{1}{8}$	202	302						
$\frac{3}{16}$	203	303	403					
$\frac{1}{4}$	204	304	404	504				
$\frac{5}{16}$	205	305	405	505	605			
$\frac{3}{8}$	206	306	406	506	606	806		
$\frac{7}{16}$	207	307	407	507	607	807	1007	
$\frac{1}{2}$	208	308	408	508	608	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	810	1010	1210
*$\frac{11}{16}$	*211	*311	*411	*511	*611	*811	*1011	*1211
$\frac{3}{4}$	*212	312	412	512	612	812	1012	1212
*$\frac{13}{16}$	*213	*313	*413	*513	*613	*813	*1013	*1213
$\frac{7}{8}$	*214	314	414	514	614	814	1014	1214
*$\frac{15}{16}$	*215	*315	*415	*515	*615	*815	*1015	*1215
1	*216	316	416	516	616	816	1016	1216
$1\frac{1}{8}$		*318	418	518	618	818	1018	1218
$1\frac{1}{4}$		*320	420	520	620	820	1020	1220
$1\frac{3}{8}$		*322	422	522	622	822	1022	1222
$1\frac{1}{2}$		*324	424	524	624	824	1024	1224
$1\frac{3}{4}$			428	528	628	828	1028	1228
2				532	632	832	1032	1232
$2\frac{1}{2}$					640	840	1040	1240
3					648	848	1048	1248

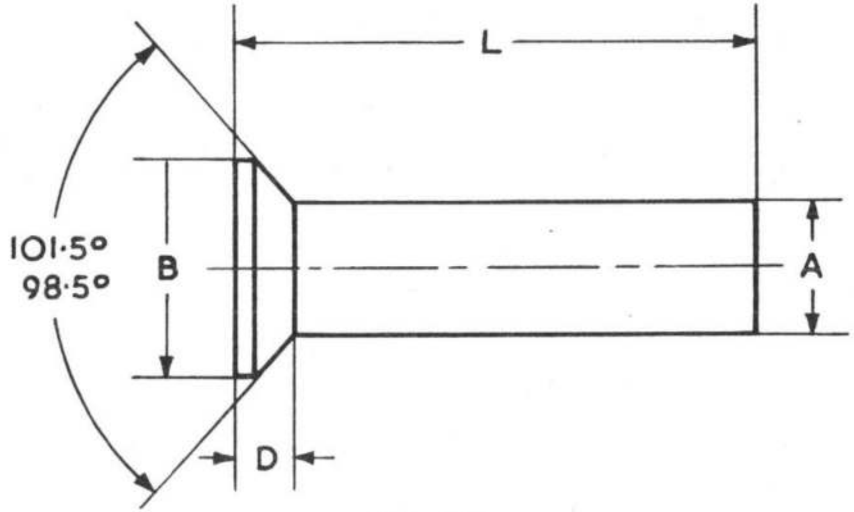
Note . . .

(1) *Asterisks shown against rivet lengths and/or part numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.*1086, *Sect.* 28*Q* (*Book* 12).

(2) *The last two figures of the code numbers denote the length in* $\frac{1}{16}$ *in., the remaining figure or figures denoting the diameter in* $\frac{1}{32}$ *in., e.g. a rivet in* 4*L*.37 *material of* $\frac{1}{8}$ *in. diameter and* $\frac{5}{8}$ *in. long is S.P.*69/410.

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
87	D.T.D.204	High-nickel-copper alloy	Plain	M
88	D.T.D.204	High-nickel-copper alloy	Cadmium plating	M



Dimensions

Nominal size of rivet (in.)	Shank diameter A (in.)		Head diameter B (in.) Absolute min.	Depth of head D (in.)
	max.	min.		
$\frac{1}{16}$ (0·062)	0·065	0·059	0·111	0·032
$\frac{3}{32}$ (0·094)	0·097	0·091	0·162	0·041
$\frac{1}{8}$ (0·125)	0·128	0·122	0·204	0·048
$\frac{5}{32}$ (0·156)	0·160	0·154	0·262	0·061
$\frac{3}{16}$ (0·187)	0·191	0·185	0·323	0·078
$\frac{7}{32}$ (0·219)	0·223	0·215	0·381	0·091
$\frac{1}{4}$ (0·250)	0·254	0·246	0·439	0·103
$\frac{5}{16}$ (0·312)	0·316	0·306	0·515	0·115
$\frac{3}{8}$ (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. 11. 100 deg. countersunk head, high nickel-copper alloy rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed 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								
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.*

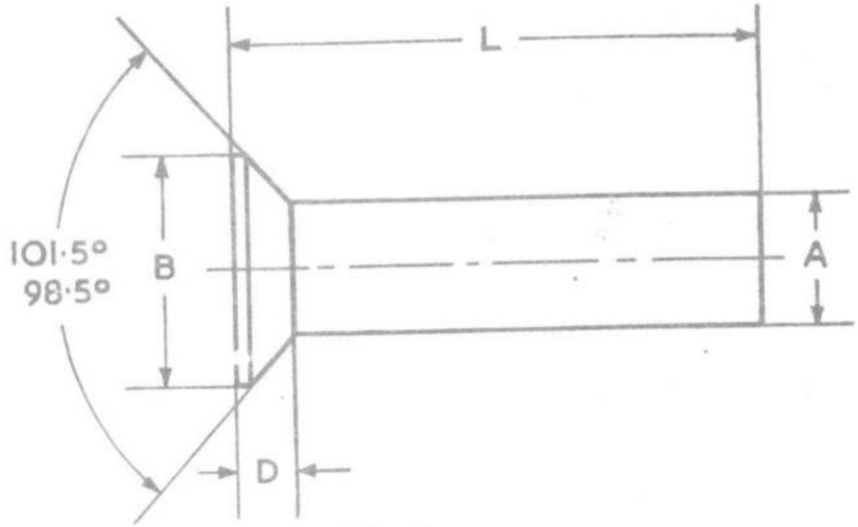
(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.1086, Sect. 28Q (Book 12).*

(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 D.T.D.204 material, cadmium plated, of 1/8 in. diameter and 3/4 in. long is S.P.88/412.*

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
86	B.S.1109	Mild Steel	Cadmium plating	None



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. 12. 100 deg. countersunk head mild steel rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—continued

Table of size range for rivets listed in fig. 12

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.)			PART IDENTIFICATION NUMBERS						
$\frac{1}{8}$	202	302							
$\frac{3}{16}$	203	303	403						
$\frac{1}{4}$	204	304	404	504					
$\frac{5}{16}$	205	305	405	505	605				
$\frac{3}{8}$	206	306	406	506	606	706	806		
$\frac{7}{16}$	207	307	407	507	607	707	807		
$\frac{1}{2}$	208	308	408	508	608	708	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	709	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	710	810	1010	1210
†$\frac{11}{16}$	†211	†311	†411	†511	†611	†711	†811	†1011	†1211
$\frac{3}{4}$	†212	312	412	512	612	712	812	1012	1212
†$\frac{13}{16}$	†213	†313	†413	†513	†613	†713	†813	†1013	†1213
$\frac{7}{8}$	†214	314	414	514	614	714	814	1014	1214
†$\frac{15}{16}$	†215	†315	†415	†515	†615	†715	†815	†1015	†1215
1	†216	316	416	516	616	716	816	1016	1216
$1\frac{1}{8}$		†318	418	518	618	718	818	1018	1218
$1\frac{1}{4}$		†320	420	520	620	720	820	1020	1220
$1\frac{3}{8}$		†322	422	522	622	722	822	1022	1222
$1\frac{1}{2}$		†324	424	524	624	724	824	1024	1224
$1\frac{3}{4}$			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
$2\frac{1}{2}$					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 $\frac{3}{16}$ in. is $\pm 0{\cdot}010$ in. and that for rivets of $\frac{7}{32}$ in. diameter and larger is $\pm 0{\cdot}015$ in.*

(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.1086, Sect. 28Q (Book 12).*

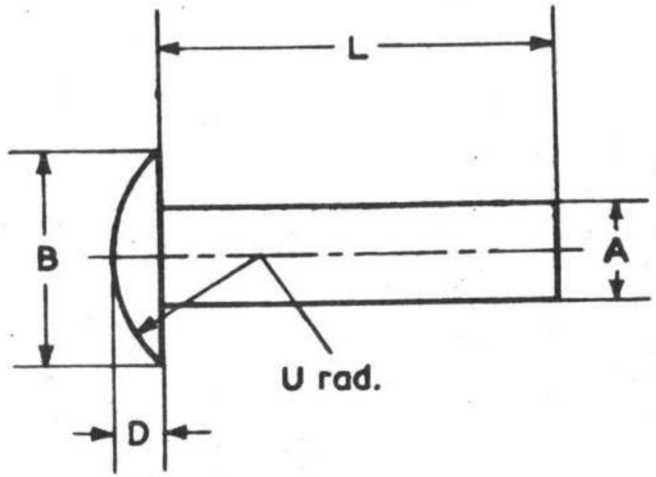
(3) *The last two figures of the code numbers denote the length of rivet in $\frac{1}{16}$ in. and the remaining figure or figures denote the diameter in $\frac{1}{32}$ in.*

EXAMPLE:—A rivet in B.S.1109 material $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. length is S.P.86/410.

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
83	B.S.4L.37	Aluminium alloy	Plain	7
84	B.S.*L.58	Aluminium alloy (Mag. 5)	Green	8
85	B.S.*L.69	Aluminium alloy	Violet	0

**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. 13. Mushroom head aluminium-alloy rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed in fig. 13

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.)				PART IDENTIFICATION NUMBERS					
$\frac{1}{8}$	202	302							
$\frac{3}{16}$	203	303	403						
$\frac{1}{4}$	204	304	404	504					
$\frac{5}{16}$	205	305	405	505	605				
$\frac{3}{8}$	206	306	406	506	606	706	806		
$\frac{7}{16}$	207	307	407	507	607	707	807	1007	
$\frac{1}{2}$	208	308	408	508	608	708	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	709	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	710	810	1010	1210
†$\frac{11}{16}$	†211	†311	†411	†511	†611	†711	†811	†1011	†1211
$\frac{3}{4}$	†212	312	412	512	612	712	812	1012	1212
†$\frac{13}{16}$	†213	†313	†413	†513	†613	†713	†813	†1013	†1213
$\frac{7}{8}$	†214	314	414	514	614	714	814	1014	1214
†$\frac{15}{16}$	†215	†315	†415	†515	†615	†715	†815	†1015	†1215
1	†216	316	416	516	616	716	816	1016	1216
$1\frac{1}{8}$		†318	418	518	618	718	818	1018	1218
$1\frac{1}{4}$		†320	420	520	620	720	820	1020	1220
$1\frac{3}{8}$		†322	422	522	622	722	822	1022	1222
$1\frac{1}{2}$		†324	424	524	624	724	824	1024	1224
$1\frac{3}{4}$			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
$2\frac{1}{2}$					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 $\frac{3}{16}$ in. is $\pm$0·010 in. and that for rivets of $\frac{7}{32}$ in. diameter and larger is $\pm$0·015 in.*

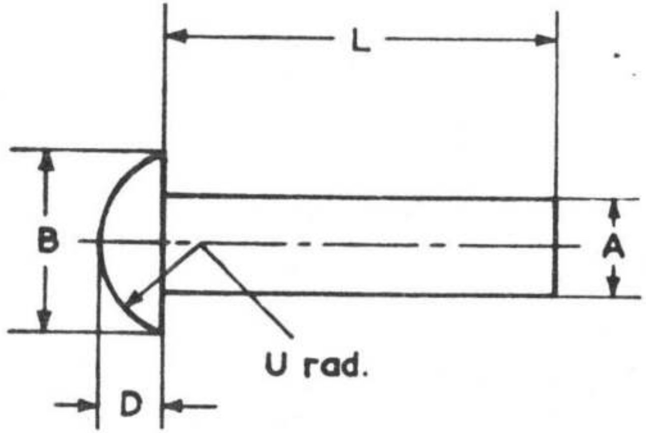
(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.1086, Sect. 28Q (Book 12).*

(3) *The last two figures of the code numbers denote the rivet length in $\frac{1}{16}$ in. and the remaining figure or figures denote the diameter in $\frac{1}{32}$ in.*
EXAMPLE:—A rivet in L.58 material $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. long is S.P.84/410.

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
76	B.S.1109	Mild steel	Cadmium plating	None



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 mild steel rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed in fig. 14

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.)	PART IDENTIFICATION NUMBERS								
$\frac{1}{8}$	202	302							
$\frac{3}{16}$	203	303	403						
$\frac{1}{4}$	204	304	404	504					
$\frac{5}{16}$	205	305	405	505	605				
$\frac{3}{8}$	206	306	406	506	606	706	806		
$\frac{7}{16}$	207	307	407	507	607	707	807	1007	
$\frac{1}{2}$	208	308	408	508	608	708	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	709	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	710	810	1010	1210
†$\frac{11}{16}$	†211	†311	†411	†511	†611	†711	†811	†1011	†1211
$\frac{3}{4}$	†212	312	412	512	612	712	812	1012	1212
†$\frac{13}{16}$	†213	†313	†413	†513	†613	†713	†813	†1013	†1213
$\frac{7}{8}$	†214	314	414	514	614	714	814	1014	1214
†$\frac{15}{16}$	†215	†315	†415	†515	†615	†715	†815	†1015	†1215
1	†216	316	416	516	616	716	816	1016	1216
$1\frac{1}{8}$		†318	418	518	618	718	818	1018	1218
$1\frac{1}{4}$		†320	420	520	620	720	820	1020	1220
$1\frac{3}{8}$		†322	422	522	622	722	822	1022	1222
$1\frac{1}{2}$		†324	424	524	624	724	824	1024	1224
$1\frac{3}{4}$			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
$2\frac{1}{2}$					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 $\frac{3}{16}$ in. is $\pm$0·010 in. and that for rivets of $\frac{7}{32}$ in. diameter and larger is $\pm$0·015 in.*

(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.*1086, *Sect.* 28*Q* (*Book* 12).

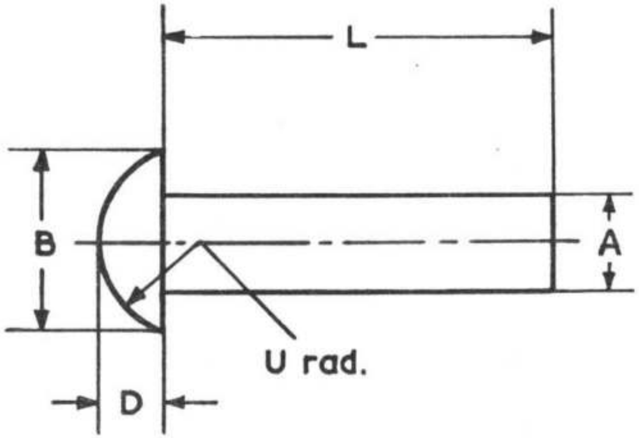
(3) *The last two figures of the code numbers denote the rivet length in $\frac{1}{16}$ in. and the remaining figure or figures denote the diameter in $\frac{1}{32}$ in.*
*EXAMPLE:—A rivet in B.S.*1109 *material $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. long is S.P.*76/410.

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
77	B.S.*L.36	Aluminium	Black	I
78	B.S.4L.37	Aluminium alloy	Plain	7
79	B.S.*L.58	Aluminium alloy (Mag. 5)	Green	8
80	B.S.*L.69	Aluminium alloy	Violet	9

**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.	
$\frac{1}{16}$ (0·062)	0·065	0·061	0·114	0·103	0·039	0·035	0·058
$\frac{3}{32}$ (0·094)	0·097	0·093	0·170	0·157	0·059	0·053	0·088
$\frac{1}{8}$ (0·125)	0·128	0·124	0·227	0·210	0·079	0·071	0·117
$\frac{5}{32}$ (0·156)	0·160	0·155	0·282	0·263	0·098	0·090	0·146
$\frac{3}{16}$ (0·187)	0·191	0·186	0·338	0·317	0·117	0·107	0·175
$\frac{7}{32}$ (0·219)	0·223	0·218	0·394	0·371	0·136	0·126	0·206
$\frac{1}{4}$ (0·250)	0·254	0·249	0·450	0·425	0·156	0·144	0·234
$\frac{5}{16}$ (0·312)	0·316	0·311	0·562	0·531	0·194	0·180	0·292
$\frac{3}{8}$ (0·375)	0·379	0·374	0·673	0·638	0·233	0·217	0·352

Fig. 15. Snap head aluminium and aluminium alloy rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed in fig. 15

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.)			PART IDENTIFICATION NUMBERS						
$\frac{1}{8}$	202	302							
$\frac{3}{16}$	203	303	403						
$\frac{1}{4}$	204	304	404	504					
$\frac{5}{16}$	205	305	405	505	605				
$\frac{3}{8}$	206	306	406	506	606	706	806		
$\frac{7}{16}$	207	307	407	507	607	707	807	1007	
$\frac{1}{2}$	208	308	408	508	608	708	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	709	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	710	810	1010	1210
†$\frac{11}{16}$	†211	†311	†411	†511	†611	†711	†811	†1011	†1211
$\frac{3}{4}$	†212	312	412	512	612	712	812	1012	1212
†$\frac{13}{16}$	†213	†313	†413	†513	†613	†713	†813	†1013	†1213
$\frac{7}{8}$	†214	314	414	514	614	714	814	1014	1214
†$\frac{15}{16}$	†215	†315	†415	†515	†615	†715	†815	†1015	†1215
1	†216	316	416	516	616	716	816	1016	1216
$1\frac{1}{8}$		†318	418	518	618	718	818	1018	1218
$1\frac{1}{4}$		†320	420	520	620	720	820	1020	1220
$1\frac{3}{8}$		†322	422	522	622	722	822	1022	1222
$1\frac{1}{2}$		†324	424	524	624	724	824	1024	1224
$1\frac{3}{4}$			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
$2\frac{1}{2}$					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 $\frac{3}{16}$ in. is* ±0·010 *in. and that for rivets of $\frac{7}{32}$ in. diameter and larger is* ±0·015 *in.*

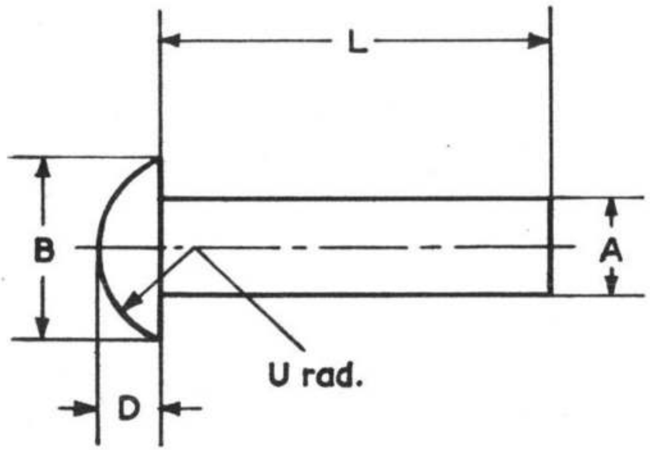
(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.*1086, *Sect.* 28*Q* (*Book* 12).

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

*EXAMPLE:—A rivet in L.69 material $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. long is S.P.*80/410.

Identification data

S.P. No.	Material Spec. No.	Material	Colour	Mark on tail or head of rivet
81	D.T.D.204	High nickel-copper alloy	Plain	M
82	D.T.D.204	High nickel-copper alloy	Cadmium plating	M



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.	
$\frac{1}{16}$ (0·062)	0·065	0·059	0·114	0·103	0·039	0·035	0·058
$\frac{3}{32}$ (0·094)	0·097	0·091	0·170	0·157	0·059	0·053	0·088
$\frac{1}{8}$ (0·125)	0·128	0·122	0·227	0·210	0·079	0·071	0·117
$\frac{5}{32}$ (0·156)	0·160	0·154	0·282	0·263	0·098	0·090	0·146
$\frac{3}{16}$ (0·187)	0·191	0·185	0·338	0·317	0·117	0·107	0·175
$\frac{7}{32}$ (0·219)	0·223	0·215	0·394	0·371	0·136	0·126	0·206
$\frac{1}{4}$ (0·250)	0·254	0·246	0·450	0·425	0·156	0·144	0·234
$\frac{5}{16}$ (0·312)	0·316	0·306	0·562	0·531	0·194	0·180	0·292
$\frac{3}{8}$ (0·375)	0·379	0·367	0·673	0·638	0·233	0·217	0·352

Fig. 16. Snap head high nickel-copper alloy rivets (S.P. series)

SOLID RIVETS, IDENTIFICATION AND RIVETING TECHNIQUE—*continued*

Table of size range for rivets listed in fig. 16

Rivet diameter A (in.)	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
Rivet length L (in.)	PART IDENTIFICATION NUMBERS								
$\frac{1}{8}$	202	302							
$\frac{3}{16}$	203	303	403						
$\frac{1}{4}$	204	304	404	504					
$\frac{5}{16}$	205	305	405	505	605				
$\frac{3}{8}$	206	306	406	506	606	706	806		
$\frac{7}{16}$	207	307	407	507	607	707	807	1007	
$\frac{1}{2}$	208	308	408	508	608	708	808	1008	1208
$\frac{9}{16}$	209	309	409	509	609	709	809	1009	1209
$\frac{5}{8}$	210	310	410	510	610	710	810	1010	1210
†$\frac{11}{16}$	†211	†311	†411	†511	†611	†711	†811	†1011	†1211
$\frac{3}{4}$	†212	312	412	512	612	712	812	1012	1212
†$\frac{13}{16}$	†213	†313	†413	†513	†613	†713	†813	†1013	†1213
$\frac{7}{8}$	†214	314	414	514	614	714	814	1014	1214
†$\frac{15}{16}$	†215	†315	†415	†515	†615	†715	†815	†1015	†1215
1	†216	316	416	516	616	716	816	1016	1216
$1\frac{1}{8}$		†318	418	518	618	718	818	1018	1218
$1\frac{1}{4}$		†320	420	520	620	720	820	1020	1220
$1\frac{3}{8}$		†322	422	522	622	722	822	1022	1222
$1\frac{1}{2}$		†324	424	524	624	724	824	1024	1224
$1\frac{3}{4}$			428	528	628	728	828	1028	1228
2				532	632	732	832	1032	1232
$2\frac{1}{2}$					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 $\frac{3}{16}$ in. is* $\pm 0{\cdot}010$ *in. and that for rivets of $\frac{7}{32}$ in. diameter and larger is* $\pm 0{\cdot}015$ *in.*

(2) *Dagger symbols shown against rivet lengths and/or code numbers indicate that these are quoted in the specification as "Non-preferred sizes" and may not be listed in A.P.*1086, *Sect.* 28*Q* (*Book* 12).

(3) *The last two figures of the code numbers denote the rivet length in $\frac{1}{16}$ in. and the remaining figure or figures denote the diameter in $\frac{1}{32}$ in.*
*EXAMPLE:—A cadmium plated rivet in D.T.D.*204 *material $\frac{1}{8}$ in. diameter and $\frac{5}{8}$ in. long is S.P.*82/410.

★ ★ ★

TUCKER POP RIVETS

Description

1. 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. The mandrels may be of a break-head or break-stem pattern; the former 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 pre-formed head of a rivet may be either domed or countersunk but all subsequent formed tail ends are tulip headed. 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.

2. The stages of pop riveting are illustrated in fig. 1. 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. When using break-head mandrels in what will eventually be a closed area, it is essential to remove the mandrel heads from the rivets if they do not eject automatically, otherwise they may subsequently fall into the surrounding structure. The correct retention of the break-stem 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.

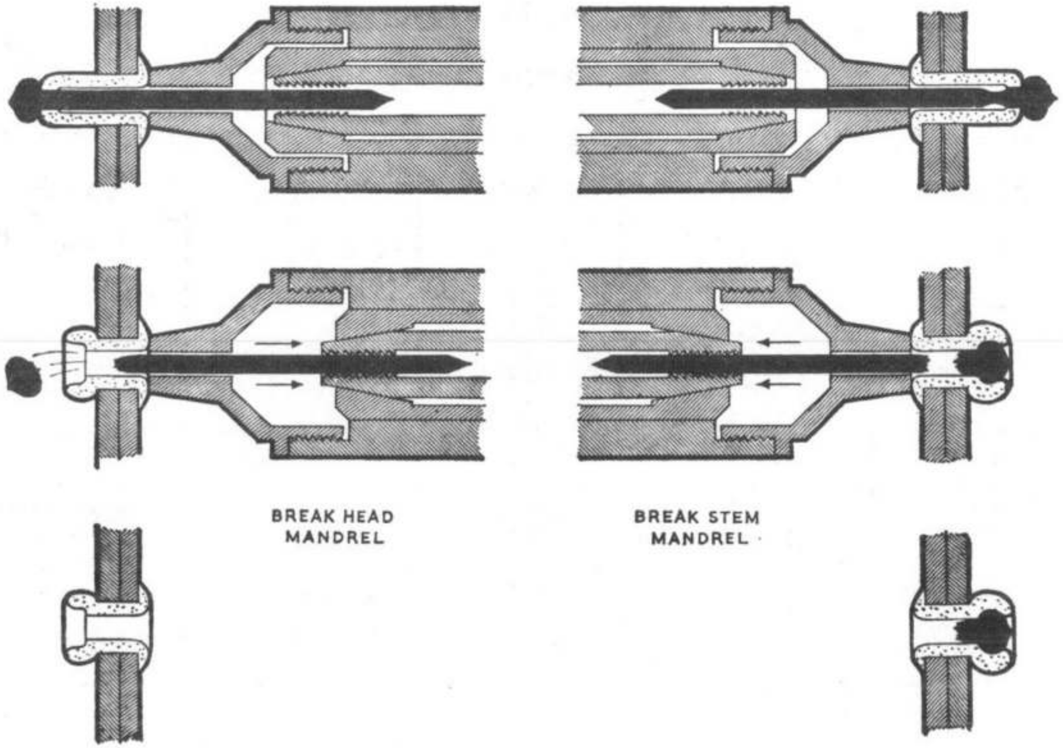


Fig. 1. Rivet development

3. If there is any possibility of loose mandrel heads entering areas of the structure where there are moving parts or electrical installations, or there is the danger of them being drawn into turbine engine compressors, either directly or though clearance holes, the break-stem mandrel should be used in preference to the break-head mandrel. Precautions must always be taken to ensure that the captive portion of the mandrel does not eventually become loose due to vibration and an acceptable method of ensuring this is to dip the rivet in a cold-setting adhesive before insertion.

Material

4. 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 and protective treatments are listed in Table 6, Scheme, 4.2.1.

Rivet sizes

5. Pop rivets with either domed or countersunk heads, are supplied in lengths suitable for riveting material up to 0·64 in. in thickness. Rivet diameters range from $\frac{3}{32}$ in. to $\frac{3}{16}$ in. as listed in Table 1. Correct rivet lengths for various thicknesses of material are listed in Tables 2 and 3.

Coding

6. 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 A.G.S. number. Code letters are listed below:

T indicates **T**ucker

L indicates Mone**L**

A indicates **A**lum. alloy

P indicates **P**op rivet

D indicates **D**omed head

K indicates **C**/sun**K** head

BH indicates **B**reak **H**ead

BS indicates **B**reak **S**tem

7. 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 $\frac{1}{32}$ in. and length in multiples of 0·010 in.; in this instance the rivet is $\frac{1}{8}$ in. dia. and 0·20 in. long.

8. The A.G.S. reference is made up of the A.G.S. drawing number (listed in Table 1), 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:—

A.G.S.2048/537 BH

this indicates (by reference to break-head mandrels in Table 1) an aluminium alloy domed head rivet, $\frac{5}{32}$ in. dia., 0·37 in. long with a break-head mandrel. It must be noted that A.G.S. figure references which commence with the figure 6 may indicate a rivet of $\frac{3}{16}$ 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 A.P.1086 it may appear as an inconsistancy in the figure code which otherwise holds good for the manufacturer's and the A.G.S. 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 2 and 3 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.*

TABLE 1

Pop rivet types available

Mandrel	Head	A.G.S. No.	Diameter available (in.)	Material
BH	Csk 120	2049	$\frac{1}{8}$, $\frac{5}{32}$, 0·2	Al. alloy L.58
BH	Csk 120	2073	$\frac{3}{16}$	
BH	Domed	2048	$\frac{1}{8}$, $\frac{5}{32}$, 0·2	
BH	Domed	2074	$\frac{3}{16}$	
BS	Csk 120	2049	$\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, 0·2	
BS	Csk 120	2073	$\frac{3}{16}$	
BS	Domed	2048	$\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, 0·2	
BS	Domed	2074	$\frac{3}{16}$	
BH	Csk 120	2051	$\frac{7}{64}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$	Monel metal D.T.D.10
BH	Domed	2050	$\frac{7}{64}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$	
BS	Csk 120	2051	$\frac{7}{64}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$	
BS	Domed	2050	$\frac{7}{64}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$	

TUCKER POP RIVETS—*continued*

TABLE 2

Grip range for aluminium alloy rivets

Rivet diameter (in.)	Rivet code number	BREAK-HEAD MANDRELS		BREAK-STEM MANDRELS	
		Domed head rivets Grip (in.)	Countersunk head rivets Grip (in.)	Domed head rivets Grip (in.)	Countersunk 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

TUCKER POP RIVETS—*continued*

TABLE 3

Grip range for monel metal rivets

Rivet diameter (in.)	Rivet code number	BREAK-HEAD MANDRELS Domed head rivets Grip (in.)	BREAK-HEAD MANDRELS Countersunk head rivets Grip (in.)	BREAK-STEM MANDRELS Domed head rivets Grip (in.)	BREAK-STEM MANDRELS Countersunk 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
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

Drilling data

9. Drill sizes are listed in Table 4. The angle of countersink for standard pop rivets is 120 deg. but certain sizes of monel rivet have a 100 deg. countersunk head. De-burring of rivet holes should conform to the radii indicated in fig. 2.

TABLE 4

Drill sizes

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

Riveting tools

10. Reference should be made to the appropriate tools list in Chapter 1 of the relevant airframe Vol. 6 to ascertain the tools available for pop riveting.

Rivet removal

11. 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 of an area on re-assembly, this is particularly important as the mandrel heads and the rivets are of disimilar metals.

TUCKER POP RIVETS *(continued)*

TABLE 5 Aluminium Alloy Rivets

D+0·003 −0·001	H	P		E	
Nominal diameter		Domed head	Csk head	Domed head	Csk head
$\frac{3}{32}$ 0·093	0·185 ±0·007	0·027 ±0·003	0·033 ±0·003	0·010 ±0·005	0·008 ±0·005
$\frac{1}{8}$ 0·125	0·236 ±0·007	0·028 ±0·003	0·036 ±0·003	0·010 ±0·005	0·008 ±0·005
$\frac{5}{32}$ 0·156	0·263 ±0·007	0·028 ±0·003	0·039 ±0·003	0·015 ±0·005	0·008 ±0·005
$\frac{3}{16}$ 0·187	0·375 ±0·010	0·057 ±0·004	0·064 ±0·004	0·010 ±0·005	0·009 ±0·006
$\frac{7}{32}$ 0·218	0·324 ±0·010	0·032 ±0·004	0·039 ±0·004	0·015 ±0·005	0·009 ±0·006

TABLE 6 Monel Rivets

D+0·003 −0·001	H	P		E	
Nominal diameter		Domed head	Csk head	Domed head	Csk head
$\frac{7}{64}$ 0·109	0·192 ±0·007	0·020 ±0·003	0·028 ±0·003	0·008 ±0·003	0·006 ±0·003
$\frac{1}{8}$ 0·125	0·236 ±0·007	0·025 ±0·003	0·036 $\frac{3}{32}$0·003	0·010 ±0·005	0·008 ±0·005
$\frac{5}{32}$ 0·156	0·263 ±0·007	0·028 ±0·003	0·039 ±0·003	0·010 ±0·005	0·003 ±0·005
$\frac{3}{16}$ 0·187	0·320 ±0·010	0·040 ±0·010	0·045 ±0·006	0·015 ±0·010	0·010 ±0·008
$\frac{1}{4}$ 0·250	0·427 ±0·010	0·053 ±0·010	0·059 ±0·010	0·020 ±0·010	0·014 ±0·008

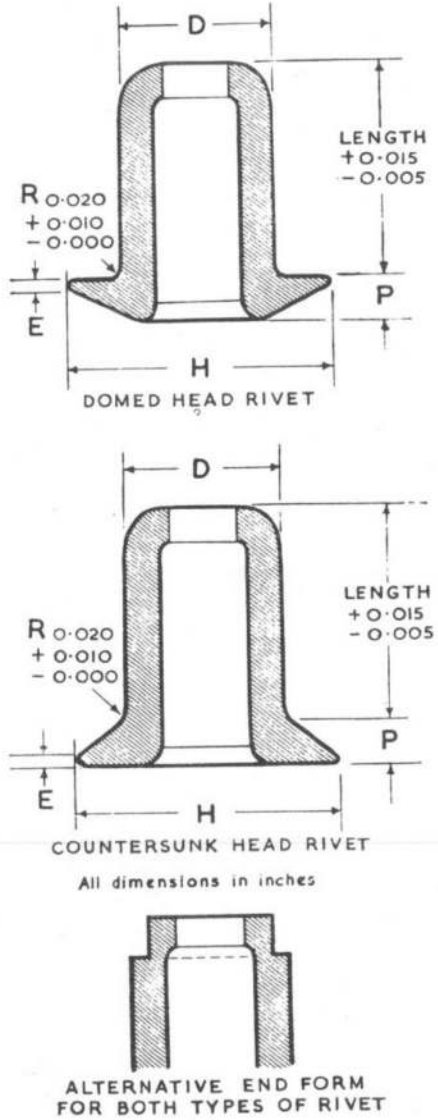


Fig. 2. Rivet dimensions

Note . . . *All dimensions are in inches. Rivet lengths are measured from under the head, both domed and countersunk.*

★ ★ ★

CHOBERT RIVETS

Introduction

1. Chobert riveting is a blind riveting process which involves mandrel broaching with a special riveting tool. When set, the tubular rivet (*fig.* 1) may be plugged with a sealing pin (*fig.* 2) if it is necessary to increase its shear strength or to produce the effect of a solid rivet for any other purpose, such as sealing. Steel or aluminium alloy Chobert rivets are available in diameters from $\frac{3}{32}$ in. to $\frac{3}{8}$ in. with snap or countersunk heads (100 or 120 deg.).

Operation

2. 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 A.P.1464B, Vol. 1, Pt. 2, Sect. 2, Chap. 7. Automatic hand-operated riveting tools which are provisioned for setting rivets up to $\frac{3}{16}$ in. dia., are described in Sect. 2, Chap. 2 of the same publication.

3. The action of a riveting mandrel is shown in fig. 2. When the rivet and mandrel are inserted into the rivet hole and held firmly in

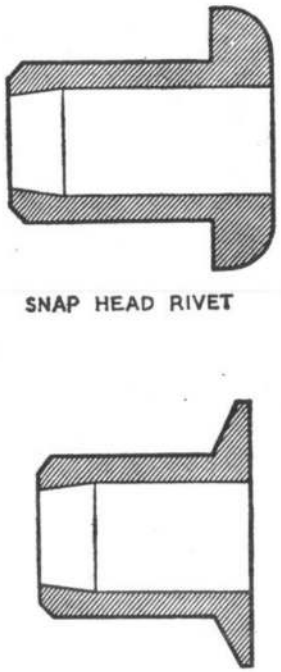


Fig. 1. Chobert rivets

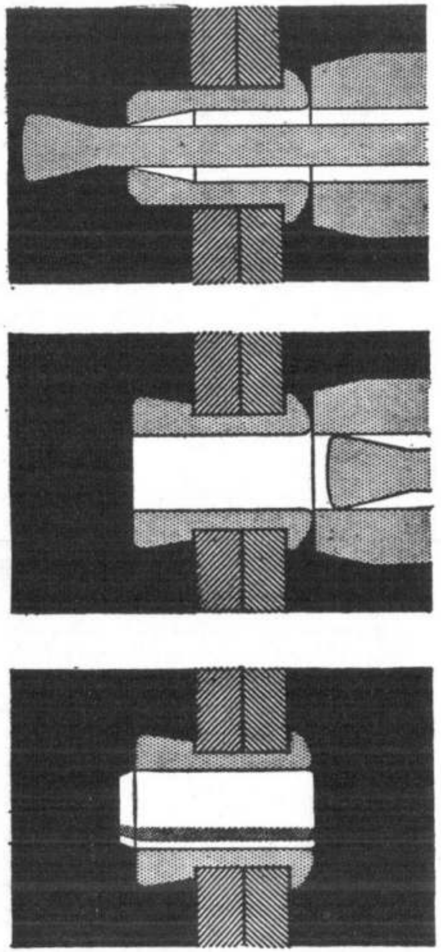


Fig. 2. Rivet setting

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

Material

4. Rivets are produced in aluminium alloy to B.S. Spec. L.37 and L.69. Steel rivets are produced to D.T.D. Spec. 720. Sealing pins for aluminium alloy rivets are also of aluminium alloy to B.S. Spec. L.64 or D.T.D. Spec. 423. Steel rivet sealing pins are of mild steel to B.S. Spec. S.1. Steel pins must not be used with aluminium alloy rivets and vice versa.

Protective treatment and identification of rivets

5. Rivets to B.S. Spec. L.37 have no protective treatment and are uncoloured. Aluminium alloy rivets to B.S. Spec. L.69 are anodised and coloured violet. Steel rivets and sealing pins are cadmium plated to D.T.D. Spec. 904 and left uncoloured. Sealing pins in aluminium alloy to B.S. Spec. L.64 or D.T.D. Spec. 423 are anodised to D.T.D. Spec. 910.

Coding for rivets

6. Chobert rivets and sealing pins are referenced in A.P.1086, Sect. 28Q/–, together with Avdel part numbers, where these apply, and A.G.S. numbers. Table 1 gives information on the A.G.S. drawing numbers which indicate material and head form. The code reference is completed by the addition of three or four figures which represent the diameter and length in increments of $\frac{1}{32}$ in. For example, A.G.S.2040/809 represents a steel snap head rivet $\frac{1}{4}$ in. in dia. $\frac{9}{32}$ in. long under the head. The length of countersunk-head rivets is given as an overall dimension. Snap head rivet lengths are measured from under the head.

TABLE 1

A.G.S. Chobert rivet code

A.G.S. No.	Head form	Material
	Rivets	
2040	Snap	Steel D.T.D. 720
2041	120 deg. csk	Steel D.T.D. 720
2043	Snap	Al. alloy L.37
2044	120 deg. csk	Al. alloy L.37
2045	Snap	Al. alloy L.69
2046	120 deg. csk	Al. alloy L.69
2068	100 deg. csk	Al. alloy L.69 ($\frac{3}{32}$ in. dia × $\frac{3}{16}$ in)
2068	120 deg. csk	Al. alloy L.69 ($\frac{5}{16}$ in. dia × $\frac{11}{32}$ in)
	Sealing pins	
2042	—	Mild steel S.1
2047	—	Al. alloy L.64 or D.T.D. 423

TABLE 2

Rivet length in relation to material thickness

Joint thickness (in.)	Rivet length* (in.)
Up to 0·064	$\frac{1}{8}$ or $\frac{5}{32}$
0·064—0·125	$\frac{3}{16}$ or $\frac{7}{32}$
0·125—0·188	$\frac{1}{4}$ or $\frac{9}{32}$
0·188—0·250	$\frac{5}{16}$ or $\frac{11}{32}$
0·250—0·312	$\frac{3}{8}$ or $\frac{13}{32}$
0·312—0·375	$\frac{7}{16}$ or $\frac{15}{32}$
0·375—0·437	$\frac{17}{32}$
0·437—0·500	$\frac{19}{32}$
0·500—0·562	$\frac{21}{32}$
0·562—0·625	$\frac{23}{32}$
0·625—0·687	$\frac{25}{32}$

Note . . .

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

TABLE 3 Drill and mandrel size in relation to rivet diameter

Rivet dia. (in.)		Rivet types	Hole dia. (in.)	Drill	Mandrel head dia. (in.)
Nominal	Actual				
$\frac{3}{32}$	0·094—0·096	Al. alloy .100 deg.	0·098	40	0·072
	0·096—0·098	Steel .100 deg	0·098	40	0·072
$\frac{1}{8}$	0·125—0·127	All types	0·128	30	0·088
$\frac{5}{32}$	0·156—0·158	All types	0·161	20	0·107
$\frac{3}{16}$	0·186—0·188	Al. alloy/snap/120 deg.	0·191	11	0·132
	0·188—0·190	Steel/snap/120 deg	0·191	11	0·132
	0·186—0·188	Al. alloy .100 deg	0·194	10	0·132
	0·188—0·190	Steel .100 deg	0·194	10	0·132
$\frac{1}{4}$	0·245—0·247	Al. alloy	0·250	E	0·184
	0·247—0·249	Steel	0·250	E	0·184
$\frac{5}{16}$	0·311—0·313	Al. alloy	0·316	O	0·210
	0·313—0·315	Steel	0·316	O	0·210
$\frac{3}{8}$	0·373—0·375	All types	0·377	V	0·250

Coding for sealing pins

7. Sealing pins are identified by their own A.G.S. number as given in Table 1, and the final three of four figures of the complete code are identical with the final figures of the code for the rivet being used, with one exception; where countersunk rivet heads are being used, choose a pin one size shorter than the rivet, otherwise the pin will project too far beyond the end of the rivet. For example A.G.S. 2046/809 is an alluminium alloy countersunk head rivet, $\frac{1}{4}$ in. dia. and $\frac{9}{32}$ in. long, the correct pin being A.G.S.2047/807.

Preparation for riveting

8. By reference to Table 2 the appropriate rivet length for the thickness to be riveted can be ascertained. The correct drill size for the rivet diameter is given in Table 3. 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 Vol. 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.

9. Owing to the relatively slight lengthwise contraction of Chobert rivets during setting, it is essential to secure the work together with sheet grippers or service bolts before riveting starts; failure to do so may result in local distortion of the skin.

Rivet removal

10. 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 centralised 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

Description (*fig.* 1)

1. The Avdel rivet assembly consists of a tubular rivet, with a preformed countersunk or snap head, attached to a headed mandrel. There are two tapers on the mandrel; one near a waisted break point, to expand the shank of the rivet and completely fill the rivet hole, and the other to expand and form a tulip head at the tail of the rivet.

2. When a rivet has been placed and the materials about to be fastened are gripped firmly together, the rivet is set or "broached" by drawing the mandrel part-way through the rivet, thus swelling the rivet shank and forming a rivet head, which in turn traps the mandrel head. The mandrel then fractures at a predetermined tension, leaving part of the mandrel which is in the rivet projecting on the near side of the work. The stub is eventually cropped off and milled or otherwise finished flush with the head of the rivet. The result is virtually a solid rivet produced by a blind riveting technique.

Materials and identification

3. All Avdel rivets and mandrels are manufactured to close tolerances in aluminium alloy. The rivets are to B.S. Spec. L.69 and the mandrels to D.T.D. Spec. 5074; both components are anodically protected. Each rivet is secured to its mandrel during manufacture. For identification, all rivets are dyed violet and the mandrels are either plain aluminium alloy for a 120 deg. countersunk head or snap head rivet, and red for a 100 deg. countersunk head rivet.

Coding

4. Each rivet assembly is referenced either by a manufacturer's code, or an A.G.S. number and code suffix, or by an A.P.1086, Sect. 28Q/ reference number. The manufacturer's code is as follows:—

Trade name	AVDEL
Head form: Snap	... 402
100 deg. csk	100/422
120 deg. csk	120/422
Diameter ...	In $^1/_{32}$ in. increments
Length	In $^1/_{32}$ in. increments

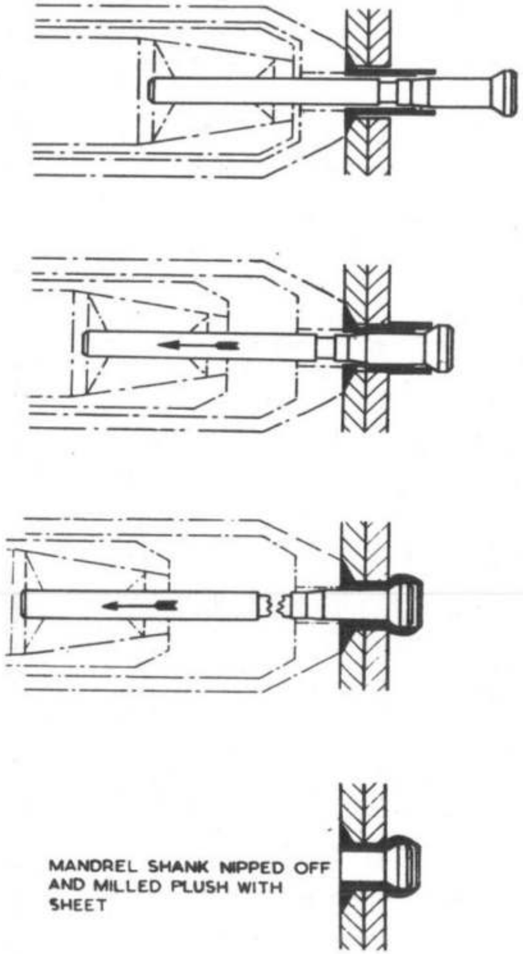


Fig. 1. Rivet broaching

5. A typical example of the code is as follows:—

AVDEL 100/422/407

this represents an Avdel self-sealing blind rivet with a 100 deg. countersunk head. As indicated by the last three digits, the size of the rivet is $\frac{1}{8}$ in. dia. and $^7/_{32}$ in. long.

6. For snap head rivets the A.G.S. number is A.G.S. 2065 followed by figures which correspond with the final figures of the manufacturer's code. Rivets with 100 deg. countersunk heads are quoted as A.G.S.2066 followed by the manufacturer's code for diameter and length. A.G.S. numbers are not quoted in A.P.1086 for 120 deg. countersunk head rivets.

Grip lengths

7. Avdel rivets are produced to suit a range of grip lengths from 0·078 in. to 0·516 in.; the complete range is given in Table 1. The rivet length (Table 1) is measured from under the head on the snap head rivet and is an overall measurement on the countersunk head rivet. If a repair involves dimple countersinking, the grip length must necessarily include the effect of dimpling as shown in fig. 2.

Avdel riveting tools

8. Two Avdel riveting tools and a pin testing tool are described in A.P.1464B, Vol. 1, Part 2, Sect. 2, Chap. 8. Pneumatic or manually operated tools are available and an angled head is provisioned for rivets which are awkwardly situated.

Rivet setting

9. To set an Avdel rivet correctly, the hole limitations in Table 2 must be strictly observed. Any departure from these limits will mean that a mandrel cannot swell the rivet shank sufficiently to fill the rivet hole or that the mandrel will be stressed to breaking point before the rivet head is completely formed.

AVDEL RIVETS (continued)

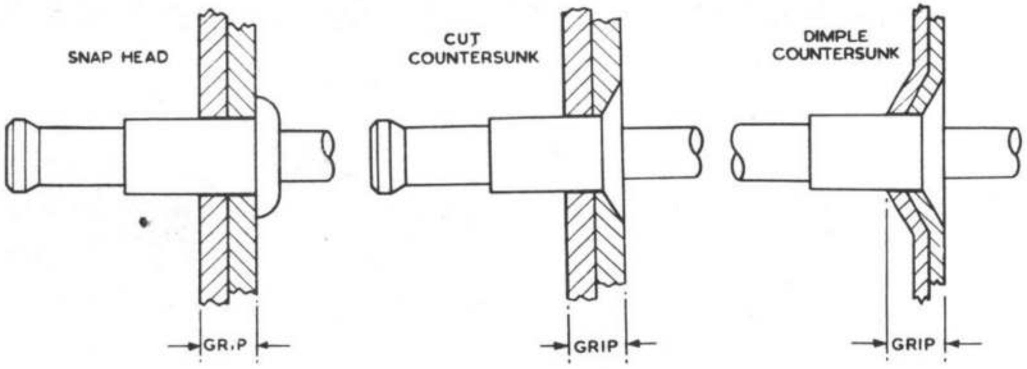


Fig. 2. Grip lengths

TABLE 1

Rivet length in relation to grip

Rivet length in.	Plate thickness to be riveted (in.) From	Plate thickness to be riveted (in.) To	Code numbers, Rivet diameter 1/8 in.	Code numbers, Rivet diameter 5/32 in.	Code numbers, Rivet diameter 3/16 in.
5/32	—	0·078	405		
3/16	—	0·078		506	
7/32	—	0·078			607
7/32	0·047	0·141	407		
1/4	0·047	0·141		508	
9/32	0·047	0·141			609
9/32	0·109	0·203	409		
5/16	0·109	0·203		510	
11/32	0·109	0·203			611
11/32	0·172	0·266	411		
3/8	0·172	0·266		512	
13/32	0·172	0·266			613
13/32	0·234	0·328	413		
7/16	0·234	0·328		514	
15/32	0·234	0·328			615
15/32	0·297	0·391	415		
1/2	0·297	0·391		516	
17/32	0·297	0·391			617
9/16	0·359	0·453		518	
19/32	0·359	0·453			619
5/8	0·422	0·516		520	
21/32	0·422	0·516			621

The standard of finish in preparing the work to be riveted will be indicated in the relevant Vol. 6. Drill reaming and radius deburring will be specified if appropriate. Sheet grippers or service bolts must be used to secure the work in close contact during riveting as the broaching action of the mandrel swells the rivet shank before the clenching action of the mandrel formed rivet head takes effect.

TABLE 2

Drilling limitations

Nominal rivet shank dia. (in.)	Drill dia. limits (in.)
1/8	0·131 0·128
5/32	0·163 0·160
3/16	0·193 0·190

Rivet testing

10. To ensure that mandrels when set are correctly retained, a special pin tester is provisioned to enable a load of 15 lb to be applied to the mandrel shank. The tester is described in A.P.1464B as referenced in paragraph 8.

Riveting faults

11. When using Avdel rivets, a check should be made to ensure that no distortion is evident in the sheet metal or the rivet heads, due to mal-alignment of the riveting tool. Countersunk heads should be set flush with the face of the work.

AVDEL RIVETS *(continued)*

TABLE 3

Pre-formed rivet head dimensions

Head	Nominal shank dia (in.)	Head dia (in.)	Depth of head (in.)
Snap head	$\frac{1}{8}$ $\frac{5}{32}$ $\frac{3}{16}$	0·210 0·250 0·344	0·039 0·052 0·045
Csk head 100 deg	$\frac{1}{8}$ $\frac{5}{32}$ $\frac{3}{16}$	0·216 0·278 0·344	0·042 0·055 0·070
Csk head 120 deg	$\frac{1}{8}$ $\frac{5}{32}$ $\frac{3}{16}$	0·239 0·320 0·364	0·036 0·045 0·054

12. If it is possible to examine the tulip head of a rivet, no concern need be felt if the mandrel head protrudes beyond the tail of the rivet by as much as $\frac{1}{64}$ in. provided that the rivet is being used at its maximum grip and subject to the mandrel standing up to the pin test *(para.* 10).

13. As a check on the correct broaching of blind rivets, it is helpful to carry out preliminary riveting practice on spare material of identical gauge and then measure the projection of the mandrel stub from the face of the work to the edge of the mandrel break groove. Any subsequent riveting which fails to produce stub lengths within $\frac{1}{16}$ in. of the average length of correctly set trial stubs will indicate under-broaching due to the rivet holes being too small.

Rivet removal

14. Mandrels may be tapped out with a parallel pin punch, to leave the bore of the rivet as a guide for subsequent drilling, provided that the force required is not liable to damage the sheet metal. If backing-up with a hollow reaction block is possible, this should be done. Where the sheet metal proves too flexible to resist the force of a hammer blow and is liable to damage, it is preferable to centre-punch the mandrel and proceed with drilling as for conventional solid rivets.

★ ★ ★

DE BERGUE RIVETS

Applicability

1. 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.

2. The rivets are fitted in one operation, the tail of each rivet being formed on the inner face of the sheeting by a pneumatic squeeze riveting machine which also dimples the material as shown in fig. 1; the dimpling and rivet forming in one operation assists in resisting shear stresses to which a tank may be subjected.

3. To ensure that riveted 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

4. Repairs to damaged tanks are confined to removing the affected rivets and fitting special repair bolts (*fig.* 1). The repair bolts, listed in A.P.1086, Section 28D, are manufactured to S.B.A.C. Spec. A.G.S. 159 and are available in two types as shown in Table 1.

5. Bolts designed for use 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.

6. 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. For detailed information on the repair of De Bergue riveted tanks, refer to A.P.4117A, Vol. 1 and 6, Sect. 2, Chap. 2.

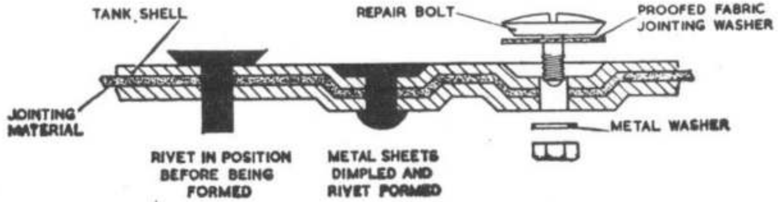


Fig. 1. De Bergue rivet and repair bolt

TABLE 1

De Bergue repair bolt data

Section 28D Ref. No.	High tensile steel bolts		
	Thread size	Shank length (in.)	Type of head
6392	6B.A.	0·415	Countersunk
6394	4B.A.	0·570	Countersunk
6396	2B.A.	0·730	Countersunk
6393	6B.A.	0·515	Mushroom
6395	4B.A.	0·670	Mushroom
6397	2B.A.	0·830	Mushroom

RIVNUTS

Introduction

1. The information contained in this Scheme describes the use of Rivnuts in the construction and repair of certain forms of metal, wooden and plastic components used on aircraft. This type of rivet *(fig.* 1 *to* 6) is available for Service use and is listed under a Section 26 reference number in the relevant airframe Vol. 3, where these items are provisioned to meet renewal or repair requirements, or in the Vol. 6, Chap. 1 repair materials Table. The basic dimensions of the range of Rivnuts are shown in the Table within fig. 2.

Application

2. Rivnuts, which are manufactured from light-alloy material to B.S.Spec.L.58, with either flat or 90 deg. countersunk heads, with or without keys under the shoulders, are essentially hollow, internally-threaded rivets which have open or closed tails, as required, and are used to fill the role of captive nuts where no direct access to the rear face of the structure is possible. When formed, they are used to receive metal screws of appropriate size for securing such equipment as de-icing overshoes to aerofoils, or treadways, walkways and carpets to sheet metal skinning or flooring respectively.

3. The insertion and forming of keyed Rivnuts is accomplished by the use of two hand-operated tools; one, the notching tool, is used for cutting a keyway in the side of the holes which have been drilled to accommodate the rivets and the other, the clinching tool, for forming the rivets. Both tools are fully described and illustrated in A.P.1464B, Vol. 1, Part 2, Sect. 6, Chap. 2. Rivnuts without keys to do not require the use of the notching tool.

Preparations for fitting Rivnuts

4. In general, the material in which Rivnuts are to be fitted should be prepared in the same manner as for solid rivets. The same degree of precision is necessary in drilling a hole for a Rivnut as for an ordinary solid rivet, since the shank of the former must fit snugly into the hole. To obtain a smooth, round hole, a pilot hole should be drilled first and then be followed by the correct finished hole size.

5. When countersunk Rivnuts are to be used in cut-countersunk or dimpled holes, care must be taken to ensure that the countersinking or dimpling tools are square with the surface of the metal. All burrs and swarf must be removed from the surface of the material before the Rivnuts are inserted.

6. Sheet grippers or service bolts should be fitted to holes drilled at frequent intervals in the sheets of material to enable them to be firmly held together before drilling, notching, and head-forming operations are effected.

Fitting Rivnuts

7. Rivnuts should be fitted in the following manner:—

(1) Drill all necessary rivet holes at the correct pitch and distance between rows of rivets, ensuring a push fit for each Rivnut; slightly chamfer the edges in each hole to remove burrs.

(2) Insert the notching tool into each hole and cut a keyway *(fig.* 3) to enable the key in each rivet to be properly seated. The tool must be held firmly against the material and the handles of the tool squeezed tightly together, thus cutting a notch or keyway in the side of the hole.

(3) Screw a Rivnut on to the threaded end of the clinching tool mandrel until the head of the Rivnut is flush against the anvil of the clinching tool.

(4) Insert the Rivnut in the appropriate hole, positioning the key in line with the keyway cut in the hole (operation (2), *fig.* 3 and 4).

(5) With the tool held so that the mandrel is at 90 deg. to the surface of the material, retract the mandrel by squeezing the handles of the clinching tool together until a solid resistance is felt, thus drawing the shank of the Rivnut against the anvil of the tool and causing a bulge or head to form in the counterbored portion of the Rivnut on the inaccessible side of the material *(fig.* 5).

(6) Remove the clinching tool from the formed Rivnut by turning the handwheel or knob on the main handle anticlockwise to unthread and withdraw the mandrel *(fig.* 6).

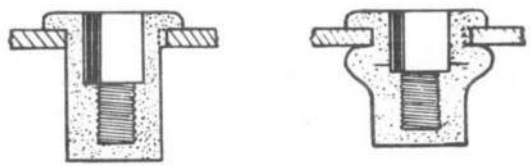


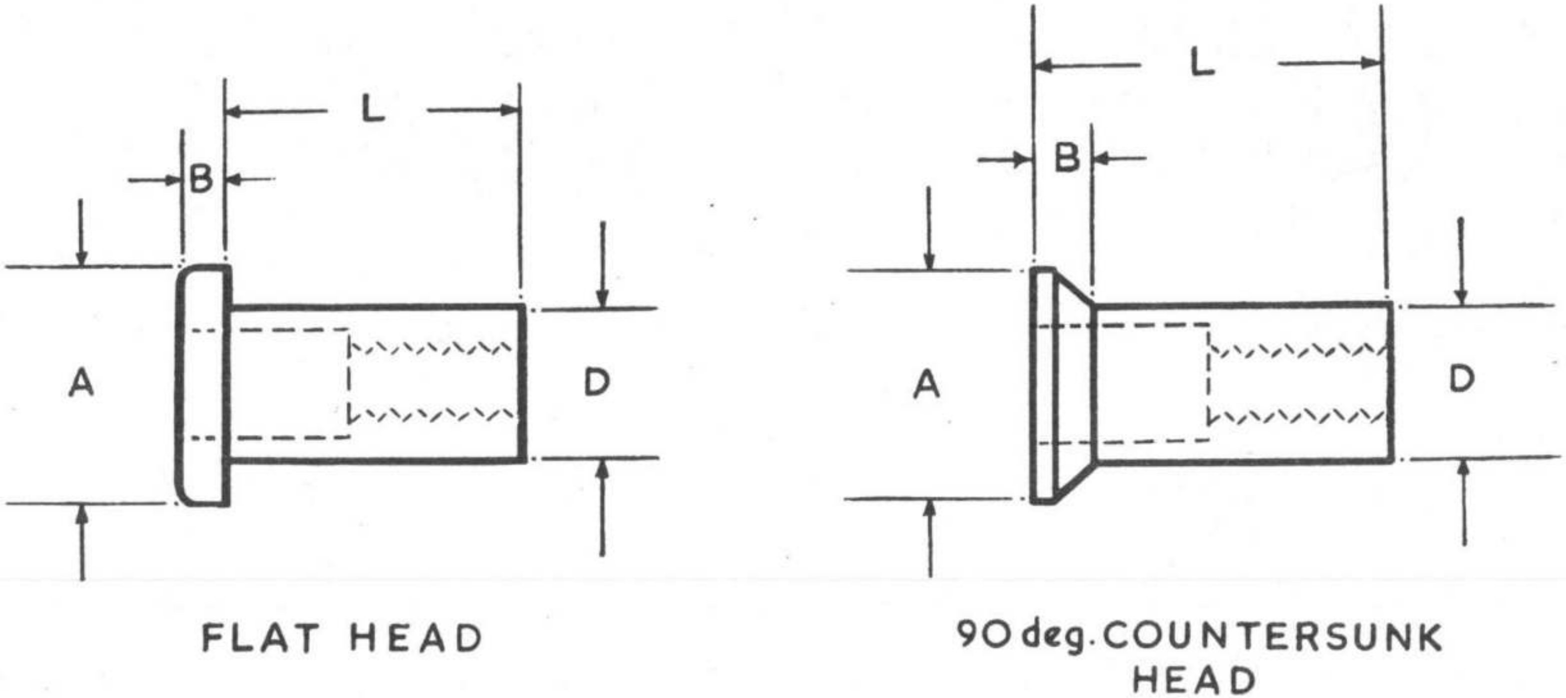
Fig. 1. Rivnuts

RIVNUTS—*continued*

Identification and dimensional data

FLAT HEAD								90 deg. countersunk head						
Part No.	Grip range (in.)	Head dia. A (in.)	Head depth B (in.)	Shank dia. D (in.)	Rivet length L (in.)	Ident'n mark	Size	Part No.	Grip range (in.)	Head dia. A (in.)	Head depth B (in.)	Shank dia. D (in.)	Rivet length L (in.)	Ident'n mark
4–045	0·010–0·045	0·315	0·035	3/16 0·1875	0·375	Blank	4 B.A.	4–106	0·065–0·106	0·295	0·062	3/16 0·1875	0·437	Blank
4–075	0·046–0·075	0·315	0·035	3/16 0·1875	0·375	1		4–136	0·107–0·136	0·295	0·062	3/16 0·1875	0·437	1
4–100	0·076–0·100	0·315	0·035	3/16 0·1875	0·375	2		4–161	0·137–0·161	0·295	0·062	3/16 0·1875	0·437	2
4–120	0·101–0·120	0·315	0·035	3/16 0·1875	0·437	3		4–181	0·162–0·181	0·295	0·062	3/16 0·1875	0·500	3
4–140	0·121–0·140	0·315	0·035	3/16 0·1875	0·437	4		4–201	0·182–0·201	0·295	0·062	3/16 0·1875	0·500	4
4–160	0·141–0·160	0·315	0·035	3/16 0·1875	0·437	5		4–221	0·202–0·221	0·295	0·062	3/16 0·1875	0·500	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	0·201–0·220	0·315	0·035	3/16 0·1875	0·500	8								
2–075	0·010–0·075	0·377	0·035	1/4 0·250	0·438	1	2 B.A.	2–136	0·065–0·136	0·355	0·062	1/4 0·250	0·500	1
2–120	0·076–0·120	0·377	0·035	1/4 0·250	0·500	3		2–181	0·137–0·181	0·355	0·062	1/4 0·250	0·562	3
2–160	0·121–0·160	0·377	0·035	1/4 0·250	0·500	5		2–221	0·182–0·221	0·355	0·062	1/4 0·250	0·562	5
2–200	0·161–0·200	0·377	0·035	1/4 0·250	0·562	7								
2–240	0·201–0·240	0·377	0·035	1/4 0·250	0·625	9								
1/4–100	0·010–0·100	0·515	0·062	11/32 0·3437	0·562	2	1/4 B.S.F.	1/4–161	0·065–0·161	0·445	0·062	11/32 0·3437	0·625	2
1/4–160	0·101–0·160	0·515	0·062	11/32 0·3437	0·625	5		1/4–221	0·162–0·221	0·445	0·062	11/32 0·3437	0·687	5
1/4–220	0·161–0·220	0·515	0·062	11/32 0·3437	0·687	8		1/4–281	0·222–0·281	0·445	0·062	11/32 0·3437	0·750	8
5/16–100	0·010–0·100	0·610	0·062	13/32 0·4062	0·625	2	5/16 B.S.F.	5/16–161	0·065–0·161	0·505	0·062	13/32 0·4062	0·687	2
5/16–160	0·101–0·160	0·610	0·062	13/32 0·4062	0·687	5		5/16–221	0·162–0·221	0·505	0·062	13/32 0·4062	0·750	5
5/16–220	0·161–0·220	0·610	0·062	13/32 0·4062	0·750	8		5/16–281	0·222–0·281	0·505	0·062	13/32 0·4062	0·812	8
3/8–100	0·010–0·100	0·687	0·062	15/32 0·4687	0·625	2	3/8 B.S.F.	3/8–161	0·065–0·161	0·570	0·062	15/32 0·4687	0·687	2
3/8–160	0·101–0·160	0·687	0·062	15/32 0·4687	0·687	5		3/8–221	0·162–0·221	0·570	0·062	15/32 0·4687	0·750	5
3/8–220	0·161–0·220	0·687	0·062	15/32 0·4687	0·750	8		3/8–281	0·222–0·281	0·570	0·062	15/32 0·4687	0·812	8

RIVNUTS—*continued*



Note . . .

The basic dimensions of Rivnuts with Whitworth threads are as follows:—
$\frac{1}{8}$ in. Whitworth are the same as 4 B.A., $\frac{3}{16}$ in. Whitworth the same as 2 B.A. and $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in. Whitworth are the same as the corresponding B.S.F. sizes.

Fig. 2. Basic dimensions of Rivnuts

RIVNUTS—*continued*

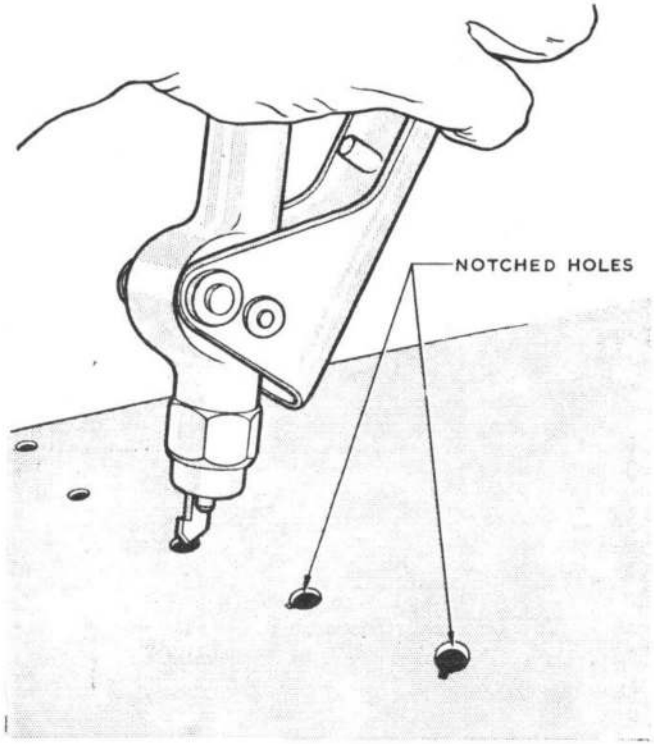


Fig. 3. Using the notching tool

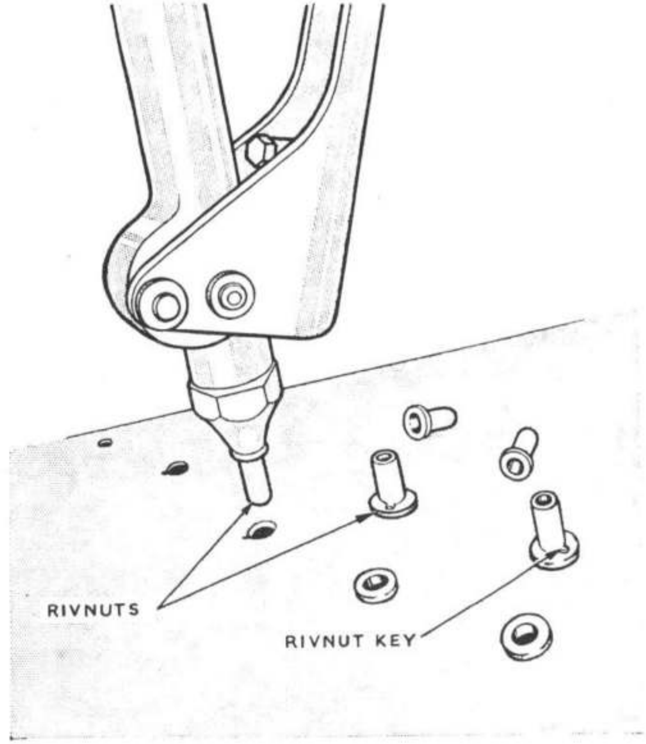


Fig. 4. Insertion of Rivnuts

(7) Continue with the series of operations (1) to (6) until all Rivnuts have been inserted in the holes provided.

Note . . .

Hand tools only are illustrated, but pneumatic or hydraulically-operated tools are available for use on Rivnuts of ¼ in. dia. and upwards, the threading, forming and withdrawing operations being effected by compressed air, operated by finger-tip controls.

Removal of Rivnuts

8. Where a Rivnut has become loose in its seating, or the internal threads have been damaged, it should be renewed as soon as possible. Removal of the Rivnut from the structure can be effected by drilling through the head of the Rivnut in such a manner that it can be separated from the shank by a hammer and cold chisel.

Note . . .

Loose Rivnut shanks must not be allowed to remain in any closed compartment.

RIVNUTS—*continued*

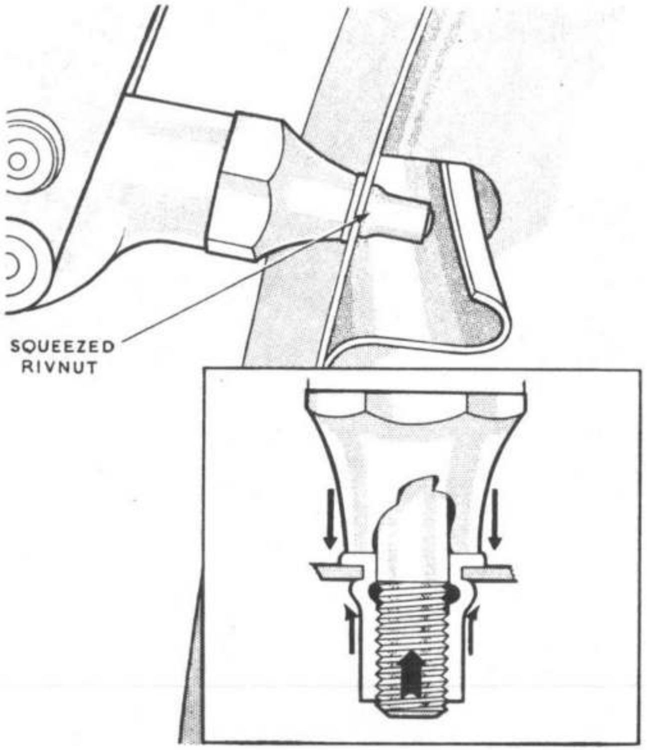


Fig. 5. Using the clinching tool

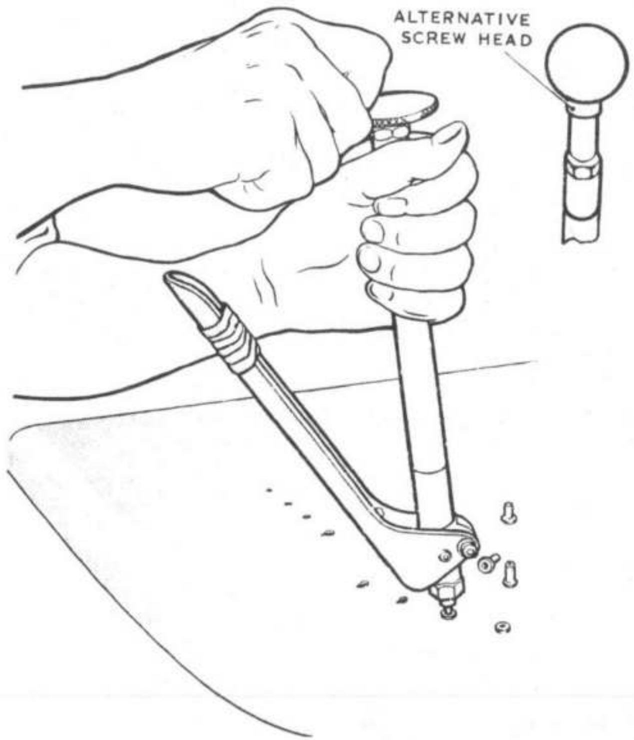


Fig. 6 Removing the mandrel from the formed Rivnut

Blanking off Rivnuts

9. Where Rivnuts have been fitted and are not in use due to the removal of some components, the threaded portion of the Rivnut should be blanked off by the use of special Allen-type screws which have a thin countersunk head, slotted cross-wise, and must be fitted or removed by a cruciform screwdriver bit.

HI-SHEAR PINS

Introduction

1. 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.

2. 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.

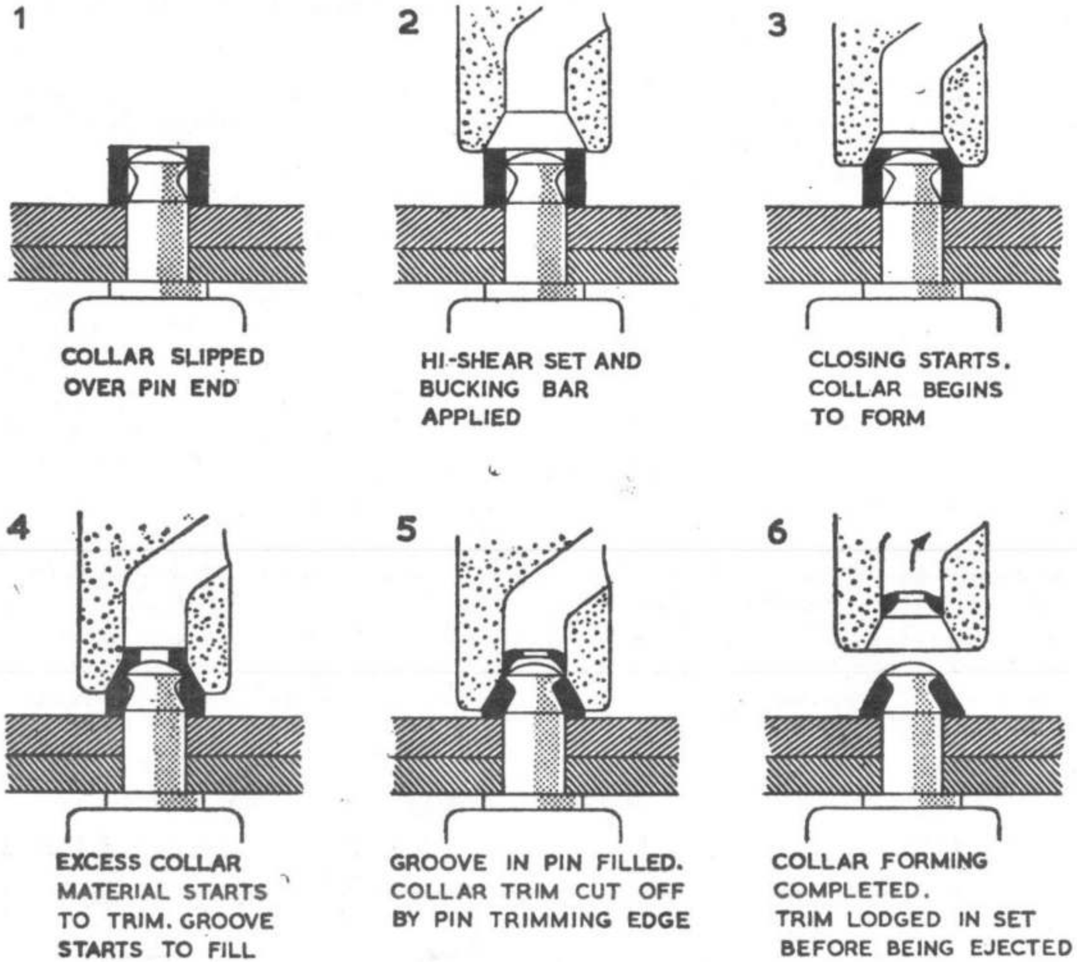


Fig. 1. Collar forming sequence

Description

3. The Hi-shear assembly consists of two components; a flat-headed 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 or K Monel metal. The collar is usually of anodised aluminium alloy (to B.S. Spec. L.69) 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.

4. The complete closing sequence is illustrated in fig. 1. Normally the collars are driven with standard riveting guns or squeezers fitted with a Hi-shear set, but pins up to $\frac{3}{16}$ 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 servered 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.

5. The amount of collar which is trimmed off is dependent upon the assembled thickness of the joined material and the length of pin selected. The incremental length of pins is normally $\frac{1}{16}$ in. but pins below $\frac{3}{16}$ in. dia. can be supplied in increments of $\frac{1}{32}$ in. All collars for a certain diameter pin are produced to a standard length and variations in pin length, within the incremental range, are thus trimmed off automatically by the rivet set. Fig. 2 illustrates the effect of variations in material thickness when using a common length of pin.

6. In addition to flat or countersunk-headed pins, Hi-shear dowel pins are manufactured (*Table* 7); these have a particular application to sloping surfaces (*fig.* 3), where the face of

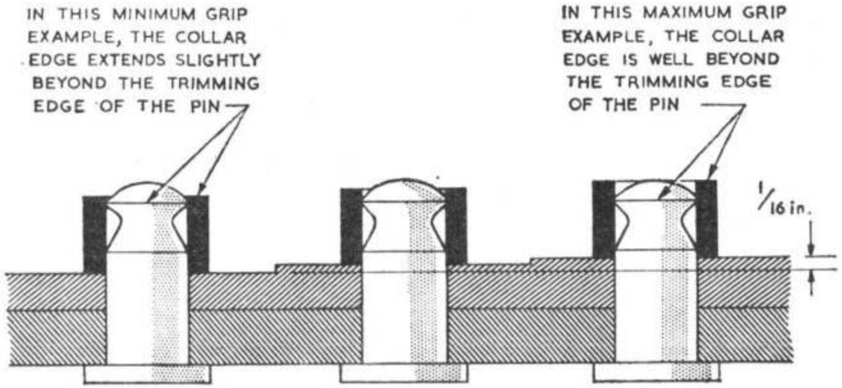


Fig. 2. Variations in material thickness

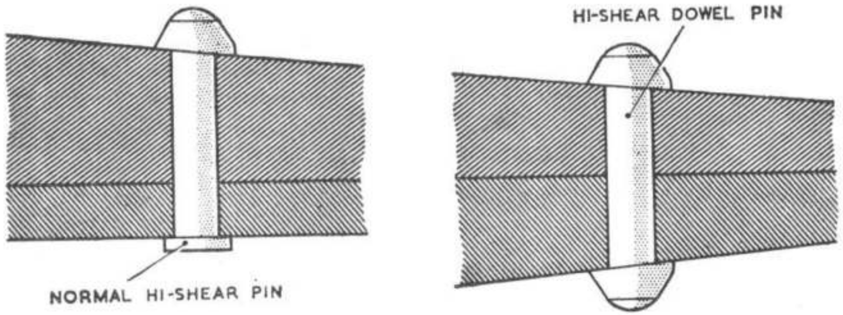


Fig. 3. Hi-shear collars on sloping surfaces

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.

Coding

7. 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 coated (established by reference to Table 1)

/08 Pin diameter in $\frac{1}{32}$ in. increments $= \frac{1}{4}$ in. pin dia.

/10 Thickness of joint to be gripped in $\frac{1}{16}$ in. increments $= \frac{5}{8}$ in. A No. 10 pin would be required at its maximum grip. If the thickness of materials is $\frac{9}{16}$ in. then a No. 10 pin at minimum grip could be used. Alternatively a $\frac{9}{16}$ in. thickness could be secured by a No. 9 pin at its maximum grip.

Note . . .
Increases in pin length of $\frac{1}{32}$ in. are denoted by an additional half, e.g. $/10\frac{1}{2} = \frac{5}{8} + \frac{1}{32} = \frac{21}{32}$ in.

8. Collar references are similar to pin references bu the stroke number indicates the internal diameter of the collar in $\frac{1}{32}$ in. increments, thus BBH. 104/08 indicates:—

BBH Brown Bros. Hi-shear

104 Collar, aluminium alloy L.69. Anodised, dyed violet and lubricated (established by reference to Table 1)

/08 $\frac{8}{32}$ in. or $\frac{1}{4}$ in. internal diameter, for use with a $\frac{1}{4}$ in. dia. pin.

HI-SHEAR PINS—*continued*

TABLE 1

Part numbers for close tolerance 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 coated
101/CH/	100 deg. Csk.	75/85 ton steel	Cadmium coated
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/	$\frac{1}{64}$ in. oversize	55/65 ton steel	Cadmium coated
S1/CH/	$\frac{1}{64}$ in. oversize	75/85 ton steel	Cadmium coated
S1/CS/	$\frac{1}{64}$ in. oversize	55/65 ton stainless steel	Natural
S1/CC/	$\frac{1}{64}$ in. oversize	'K' monel, grade C	As issued
S1/CK/	$\frac{1}{64}$ in. oversize	'K' monel, grade F	As issued
	Csk.		
S2/CN/	$\frac{1}{32}$ in. oversize	55/65 ton steel	Cadmium coated
S2/CH/	$\frac{1}{32}$ in. oversize	75/85 ton steel	Cadmium coated
S2/CS/	$\frac{1}{32}$ in. oversize	55/65 ton stainless steel	Natural
S2/CC/	$\frac{1}{32}$ in. oversize	'K' monel, grade C	As issued
S2/CK/	$\frac{1}{32}$ in. oversize	'K' monel, grade F	As issued
101/FN/	Flat	55/65 ton steel	Cadmium coated
101/FH/	Flat	75/85 ton steel	Cadmium coated
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
	Flat		
S1/FN/	$\frac{1}{64}$ in. oversize	55/65 ton steel	Cadmium coated
S1/FH/	$\frac{1}{64}$ in. oversize	75/85 ton steel	Cadmium coated
S1/FS/	$\frac{1}{64}$ in. oversize	55/65 ton stainless steel	Natural
S1/FC/	$\frac{1}{64}$ in. oversize	'K' monel, grade C	As issued
S1/FK/	$\frac{1}{64}$ in. oversize	'K' monel, grade F	As issued
	Flat		
S2/FN/	$\frac{1}{32}$ in. oversize	55/65 ton steel	Cadmium coated
S2/FH/	$\frac{1}{32}$ in. oversize	75/85 ton steel	Cadmium coated
S2/FS/	$\frac{1}{32}$ in. oversize	55/65 ton stainless steel	Natural
S2/FC/	$\frac{1}{32}$ in. oversize	'K' monel, grade C	As issued
S2/FK/	$\frac{1}{32}$ in. oversize	'K' monel, grade F	As issued

HI-SHEAR PINS—*continued*

TABLE 1 (*continued*)

Part No.	Head	Material	Finish
	PINS for use with aluminium alloy collars BBH 104		
101/DN/	Dowel pin	55/65 ton steel	Cadmium coated
101/DH/	Dowel pin	75/85 ton steel	Cadmium coated
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 coated
121/CH/	120 deg. Csk.	75/85 ton steel	Cadmium coated
121/CS/	120 deg. Csk.	55/65 ton stainless steel	Natural
121/CC/	120 deg. Csk.	'K' monel, grade	As issued
121/CK/	120 deg. Csk.	'K' monel, grade F	As issued
201/CA/	100 deg. Csk.	Aluminium alloy L.65	Anodised, dyed blue
201/FA/	Flat head	Aluminium alloy L.65	Anodised, dyed blue
201/DA/	Dowel pin	Aluminium alloy L.65	Anodised, dyed blue
	PINS for use with M.S., S.1 and monel collars, B.B.H. 206 and 207		
200/CN/	100 deg. Csk.	55/65 ton steel	Cadmium coated
200/CH/	100 deg. Csk.	75/85 ton steel	Cadmium coated
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/	$\frac{1}{64}$ in. oversize	55/65 ton steel	Cadmium coated
2S1/CH/	$\frac{1}{64}$ in. oversize	75/85 ton steel	Cadmium coated
2S1/CS/	$\frac{1}{64}$ in. oversize	55/65 ton stainless steel	Natural
2S1/CC/	$\frac{1}{64}$ in. oversize	'K' monel, grade C	As issued
2S1/CK/	$\frac{1}{64}$ in. oversize	'K' monel, grade F	As issued
	Csk.		
2S2/CN/	$\frac{1}{32}$ in. oversize	55/65 ton steel	Cadmium coated
2S2/CH/	$\frac{1}{32}$ in. oversize	75/85 ton steel	Cadmium coated
2S2/CS/	$\frac{1}{32}$ in. oversize	55/65 ton stainless steel	Natural
2S2/CC/	$\frac{1}{32}$ in. oversize	'K' monel, grade C	As issued
2S2/CK/	$\frac{1}{32}$ in. oversize	'K' monel, grade F	As issued
200/FN/	Flat	55/65 ton steel	Cadmium coated
200/FH/	Flat	75/85 ton steel	Cadmium coated
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

HI-SHEAR PINS *(continued)*

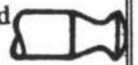
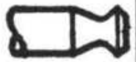
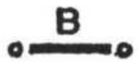
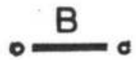
TABLE 1 *(continued)*

Part No.	Head	Material	Finish
	PINS for use with M.S., S.1 and monel collars, BBH 206 and 207		
	Flat		
2S1/FN/	$\frac{1}{64}$ in. oversize	55/65 ton steel	Cadmium coated
2S1/FH	$\frac{1}{64}$ in oversize.	75/85 ton steel	Cadmium Coated
2S1/FS/	$\frac{1}{64}$ in. oversize	55/65 ton stainless steel	Natural
S21/FC/	$\frac{1}{64}$ in. oversize	'K' monel, grade C	As issued
2S1/FK/	$\frac{1}{64}$ in. oversize	'K' monel, grade F	As issued
	Flat		
2S2/FN/	$\frac{1}{32}$ in. oversize	55/65 ton steel	Cadmium coated
2S2/FH/	$\frac{1}{32}$ in. oversize	75/85 ton steel	Cadmium coated
2S2/FS/	$\frac{1}{32}$ in. oversize	55/65 ton stainless steel	Natural
2S2/FC/	$\frac{1}{32}$ in. oversize	'K' monel, grade C	As issued
2S2/FK/	$\frac{1}{32}$ in. oversize	'K' monel, grade F	As issued
200/DN/	Dowel pin	55/65 ton steel	Cadmium coated
200/DH/	Dowel pin	75/85 ton steel	Cadmium coated
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 coated
221/CH/	120 deg. Csk.	75/85 ton steel	Cadmium coated
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		
B.B.H.104/	Aluminium alloy L.69	—	Anodised, dyed violet and lubricated
	This collar is for use with Hi-shear pins B.B.H.101, S1, S2 and 201 series		
*B.B.H.206	Mild steel 6S1	—	Cadmium coated and lubricated
*B.B.H.207	Annealed monel	—	Self or cadmium coated, as issued, and lubricated

*These collars are for use with Hi-shear pins B.B.H.200, 2S1, 2S2, and 221 series.

TABLE 2

Identification of Hi-shear pins

Part No.	Material	Identification marking	Part No.	Material	Identification marking
101/CN/	55/65 ton steel	B+	201/CA/	Aluminium alloy L.65	Dyed blue
101/FN/			201/FA/		
101/DN/		Domed ends 	201/DA/		
101/CH/	75/85 ton steel	Ⓑ			
101/FH/			121/CN/	55/65 ton steel	B+
101/DH/		Flat ends 	121/CH/	75/85 ton steel	Ⓑ
101/CS/	55/65 ton corrosion resisting steel		121/CS/	55/65 ton stainless steel	
101/FS/			121/CK/	'K'-monel, grade F	M
101/DS/		Z	121/CC/	'K'-monel grade C	C
101/CK/	'K'-monel grade F	BM			
101/FK/					
101/DK/		M			
101/CC/	'K'-monel grade C	BC			
101/FC/					
101/DC/		C			

Identification

9. The identification markings of Hi-shear pins and collars are given in Tables 2 and 3 respectively. Part numbers quoted in these tables are explained in greater detail in Table 1. The general dimensions of pins and dowels are given in Tables 4 to 7.

TABLE 2 (*continued*)

Identification of Hi-shear pins

Part No.	Material	Identification marking	Part No.	Material	Identification marking
S1/CN S1/FN	55/65 ton steel	B + 64	S2/CN S2/FN	55/65 ton steel	B + 32
S1/CH S1/FH	75/85 ton steel	BO 64	S2/CH S2/FH	75/85 ton steel	BO 32
S1/CS S1/FS	55/65 ton stainless steel	o B/64 o	S2/CS S2/FS	55/65 ton stainless teel	o B/32 o
S1/CK S1/FK	'K'-monel, grade F	BM 64	S2/CK S2/FK	'K'-monel, grade F	BM 32
S1/CC S1/FC	'K'-monel, grade C	BC 64	S2/CC S2/FC	'K'-monel, grade C	BC 32

TABLE 3

Identification of Hi-shear collars

Part No.	Material	Identification marking
104/	Aluminium alloy L.69	Dyed mauve

TABLE 4

Pin lengths and protrusions

Note

All dimensions in inches.
On csk headed pins, dimensions are measured from the top face of the head.

Nom. dia. of pin	Length L	Protrusion
1/8	Nom. max. grip $+0{\cdot}103^{+0}_{-0{\cdot}010}$	0·093—0·135
5/32	Nom. max. grip $+0{\cdot}134^{+0}_{-0{\cdot}010}$	0·124—0·166
3/16	Nom. max. grip $+0{\cdot}135^{+0}_{-0{\cdot}020}$	0·115—0·199
7/32	Nom. max. grip $+0{\cdot}151^{+0}_{-0{\cdot}020}$	0·131—0·215
1/4	Nom. max. grip $+0{\cdot}175^{+0}_{-0{\cdot}020}$	0·155—0·239
9/32	Nom. max. grip $+0{\cdot}193^{+0}_{-0{\cdot}020}$	0·173—0·257
5/16	Nom. max. grip $+0{\cdot}217^{+0}_{-0{\cdot}020}$	0·197—0·281
3/8	Nom. max. grip $+0{\cdot}258^{+0}_{-0{\cdot}020}$	0·238—0·322
7/16	Nom. max. grip $+0{\cdot}299^{+0}_{-0{\cdot}020}$	0·279—0·363
1/2	Nom. max. grip $+0{\cdot}340^{+0}_{-0{\cdot}020}$	0·320—0·404
9/16	Nom. max. grip $+0{\cdot}381^{+0}_{-0{\cdot}020}$	0·361—0·445
5/8	Nom. max. grip $+0{\cdot}423^{+0}_{-0{\cdot}020}$	0·403—0·487

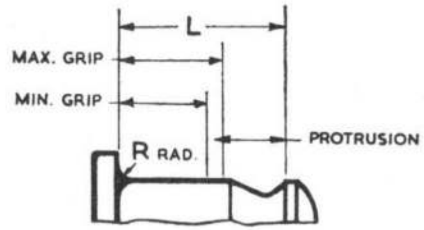


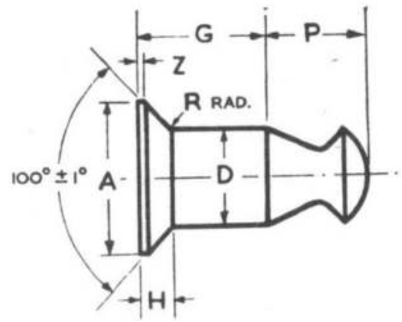
TABLE 5

Dimensions of countersunk head Hi-shear pins. Type 'C'

All dimensions in inches

D dia.	A dia.	H		Z	R rad.		P
+0 −0·001	Min.	Min.	Max.	Max.	Min.	Max.	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
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

G=Maximum grip length (Table 4)



HI-SHEAR PINS *(continued)*

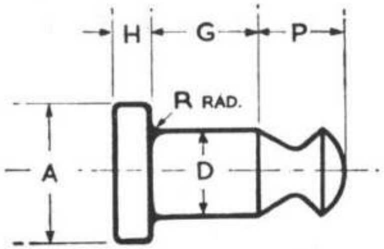


TABLE 6

Dimensions of flat head Hi-shear pins. Type 'F'

All dimensions in inches

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

G=Maximum grip length (Table 4)

HI-SHEAR PINS *(continued)*

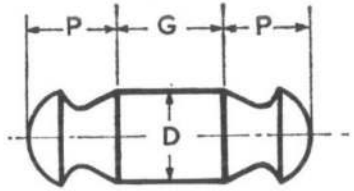


TABLE 7

Hi-shear dowel pins. Type 'D'

D dia.	P
+0 −0·001	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

G = Maximum grip length

All dimensions in inches

Pin installation

10. 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. 4)*; 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.

11. 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 90 lb/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 $\frac{3}{16}$ 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. 5. When approved for Service use details of Hi-shear tools will be found in the relevant aircraft Vol. 6.

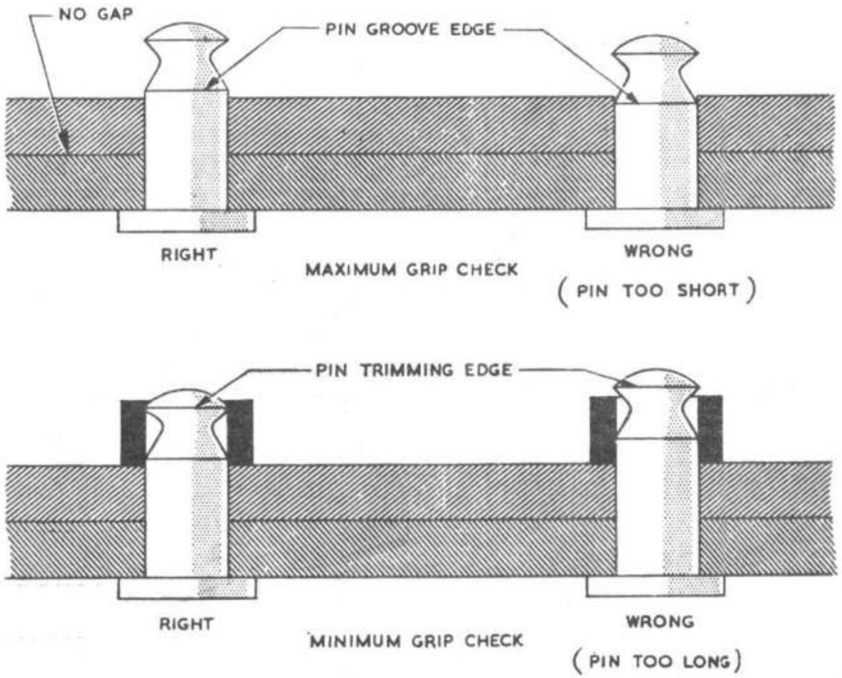


Fig. 4. Grip checks

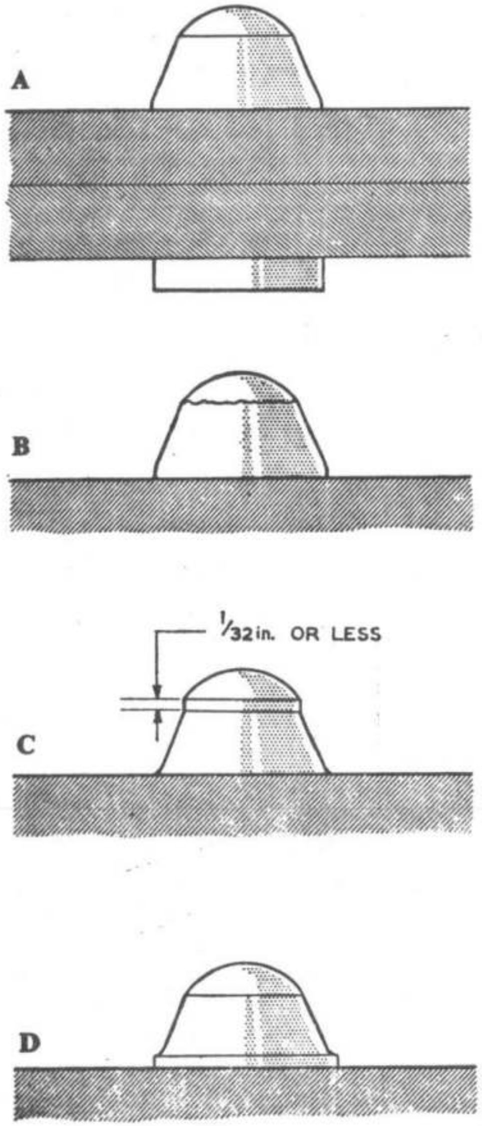


Fig. 5. Pin setting faults (1st part)

Pin removal

12. There are four methods suitable for the removal of Hi-shear pins and these are illustrated in fig. 6. 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.

A. A satisfactory Hi-shear pin and collar.

B. A ragged collar but quite acceptable.

C. An over-driven collar which is acceptable if the $\frac{1}{32}$ in. dimension is not exceeded.

D. A shouldered collar due to maximum grip length pin, this is acceptable.

E. Surplus collar material which has not been trimmed; further driving should remove excess.

F. An over-driven collar which exceeds the $\frac{1}{32}$ in. allowance mentioned at C. Remove collar and reset with new collar.

G. Gap between collar and pin shearing edge, caused by using too long a pin. Use correct length of pin or pack with washer.

H. Surplus collar material caused by using too short a pin. Remove and insert a larger pin and check for grip length before driving.

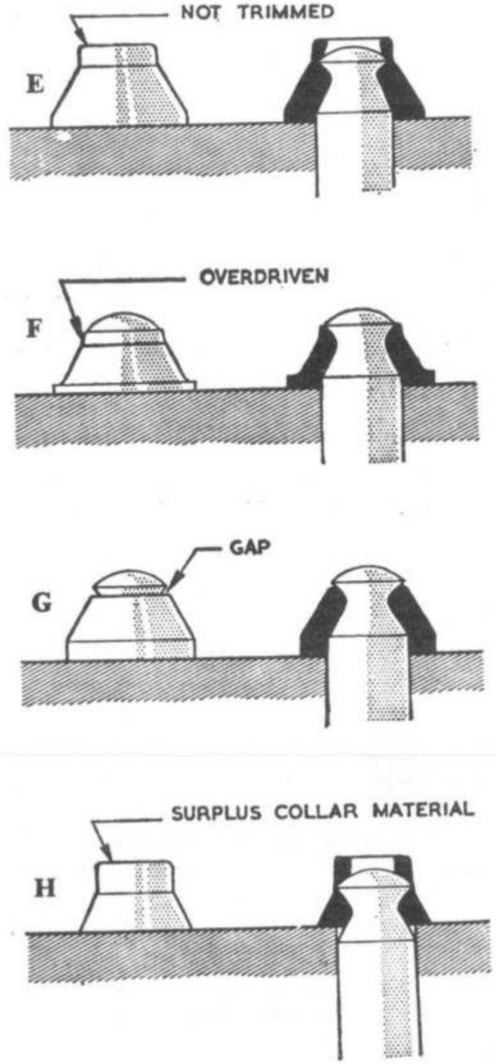


Fig. 5. Pin setting faults (2nd part)

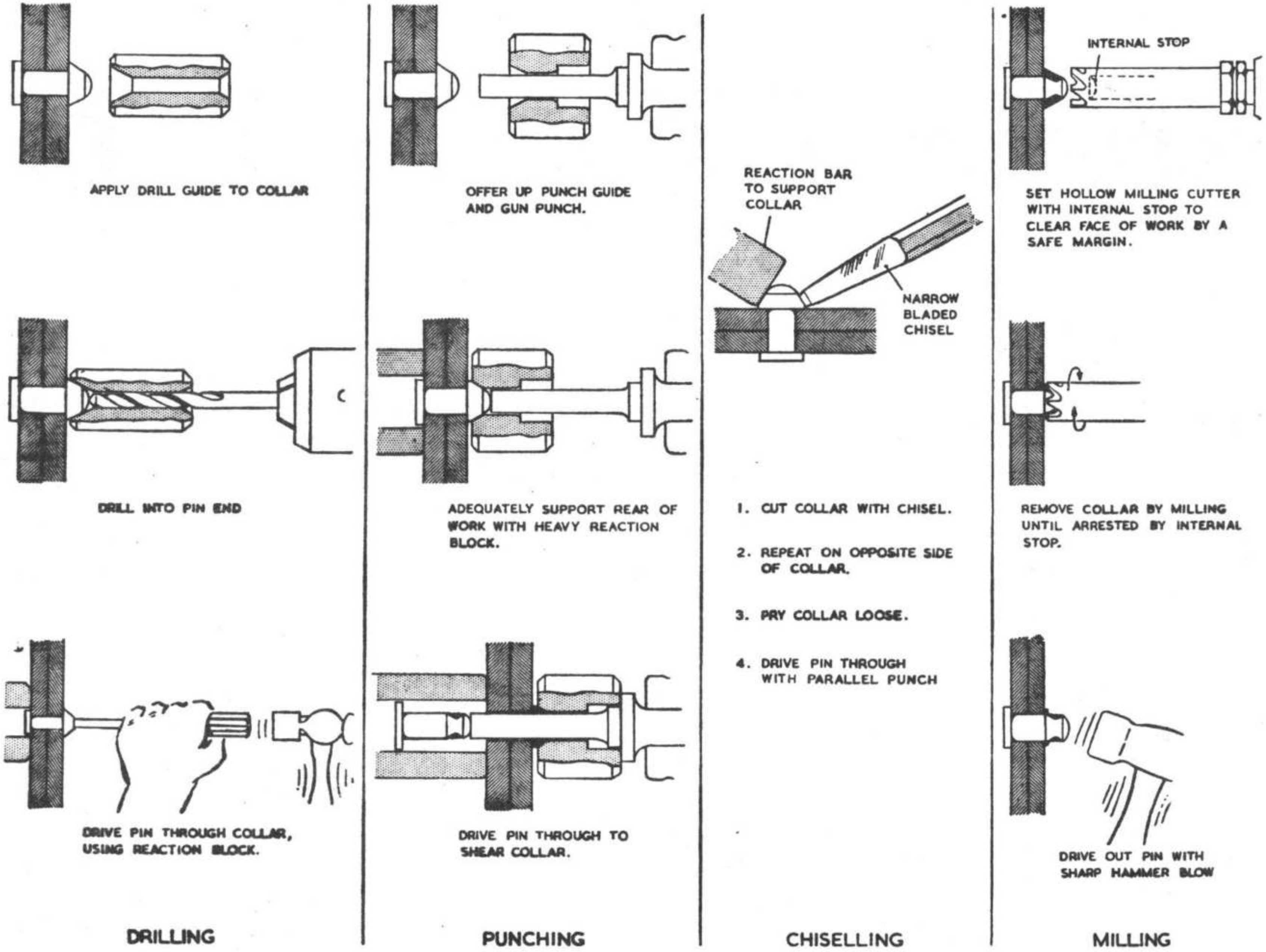


Fig. 6. Hi-shear pin removal

★ ★ ★

IMEX BLIND RIVETS

Description

1. The Imex blind rivet 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 (*fig.* 1), the rapid radial expansion of the formed head ensures a joint which is pressure tight up to 500 lb in^2.

2. 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.

3. 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.

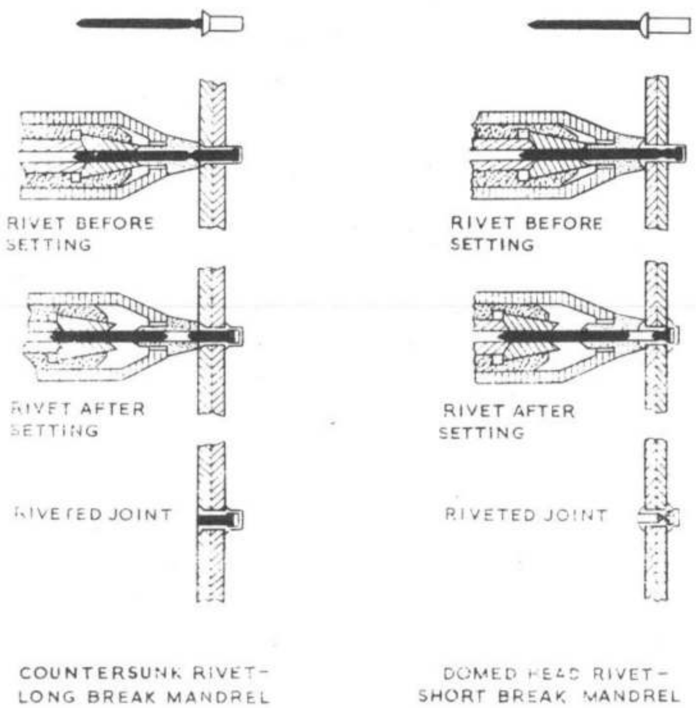


Fig. 1. Setting Imex rivets

Riveting tools

4. 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.

Material

5. Imex rivets are manufactured from 5 per cent magnesium aluminium alloy to B.S. Spec. L.58.

Coding

6. 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).

7. A typical code reference is "Imex rivet AD46R", which indicates an aluminium alloy rivet with a domed head, $\frac{1}{8}$ in. in diameter, capable of riveting up to $\frac{3}{16}$ in. thickness on a long break mandrel.

Note . . .

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.

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 $\frac{3}{16}$ in. For example, the length under the head of rivet A.D.56 is $(6 \times 1/32) + \frac{3}{16} = \frac{3}{8}$ in.

IMEX BLIND RIVETS (*Continued*)

TABLE 1
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 c'sk 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

TABLE 2
Recommended riveting thicknesses

Thickness of material (in.)	Rivet diameter 1/8 in.	5/32 in.	3/16 in.
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		

Drill sizes

8. 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.

★ ★ ★

HUCKBOLTS

Introduction

1. Huckbolts are being used in the construction of a number of modern aircraft, but at the date of issue of this amendment, Huckbolts are not provisioned for Service use. This Scheme describes the method of installing Huckbolts and provides information for their recognition and removal. Further information will be included if Huckbolts are provisioned for repair purposes.

Description

2. A Huckbolt is not a bolt in the accepted sense as it is not threaded; it is really a form of shear pin which is secured with a swaged collar. The pin is manufactured in cadmium-plated steel or anodised aluminium alloy with a pan or countersunk head. There are circular grooves along the shank of the pin which vary in appearance and purpose (*fig.* 1). Towards the tail of the pin, 'pulling' grooves provide a secure grip for the Huckbolt swaging gun. Nearer the head of the pin is a breaker groove followed by further shallow grooves which form a key on which the collar is eventually swaged to produce a 'head' on the Huckbolt.

3. Collars are produced in anodised aluminium alloy or cadmium-plated mild steel. The recessed end of the collar is applied to the face of the work. All collars are supplied lubricated to assist the swaging process.

4. A particular feature of the Huckbolt is that it can, when required, be applied to work with an interference fit; this makes it unnecessary for holes to be reamed subsequent to drilling, and ensures fuel and water-tight joints.

Huckbolt setting

5. Huckbolts are set by pneumatically or manually-operated 'pull' guns. As shown in fig. 1, the pin is inserted as far as possible

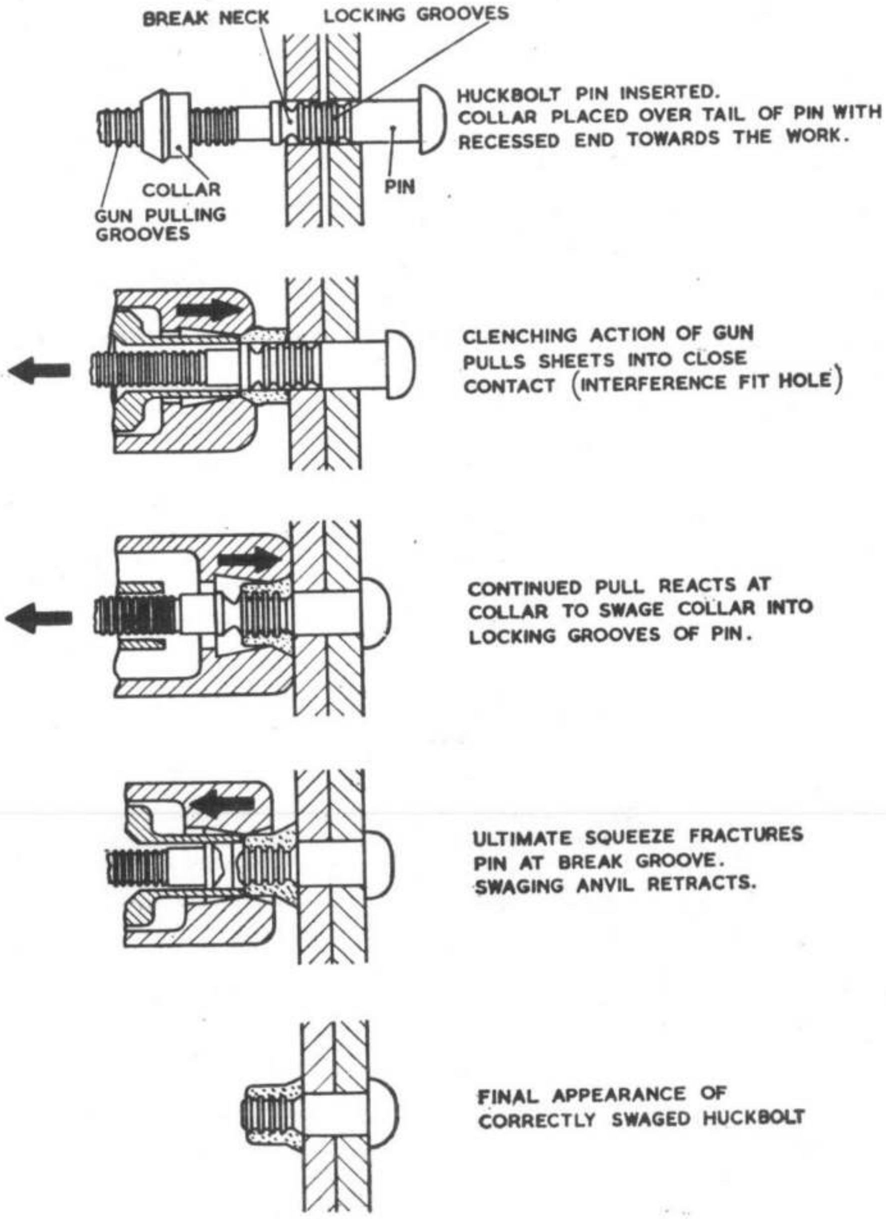


FIG. 1 HUCKBOLT DRIVING CYCLE.

HUCKBOLTS *(Continued)*

and the collar applied. If the pin is an interference fit it may be necessary to tap the pin into the hole until the shank is gripped by the gun jaws. As the gun is operated the pin is drawn towards the gun and reaction is applied to the collar by a swaging anvil in the nose of the gun. The strong clenching action of the operation makes sheet grippers unnecessary other than for local registration. After the swaging anvil forces the collar into the pin locking grooves it begins to retract as pressure on the collar is transferred to a second head within the gun, which eventually fractures the pin at the break neck, flush with the outer face of the collar.

Huckbolt removal

6. The simplest form of removal is to split the collar axially with a narrow-bladed chisel and drive out the pin with a parallel punch.

Replacement bolts

7. Close tolerance steel bolts to B.S. Spec. A.108 or A.111 may be used in place of Huckbolts, but reference must always be made to the appropriate airframe Vol. 6 to ensure that the alternative use of bolts is agreed.

★ ★ ★

JO-BOLTS

Introduction

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 but with the additional advantages of being self-locking at a predetermined torque. As a blind fastener it does not suffer the weight penalty of captive nuts. ◀After a Jo-bolt has been set as a blind fastener▶ it can only be removed by drilling, but the removal procedure can be carried out without damage to the original hole. The bolts are available in $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{5}{16}$ in. diameters with a grip range from $\frac{1}{10}$ in. upwards.

2. Each Jo-bolt (*fig*. 1) 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 collar 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 rathet 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 is then expanded over the taper to

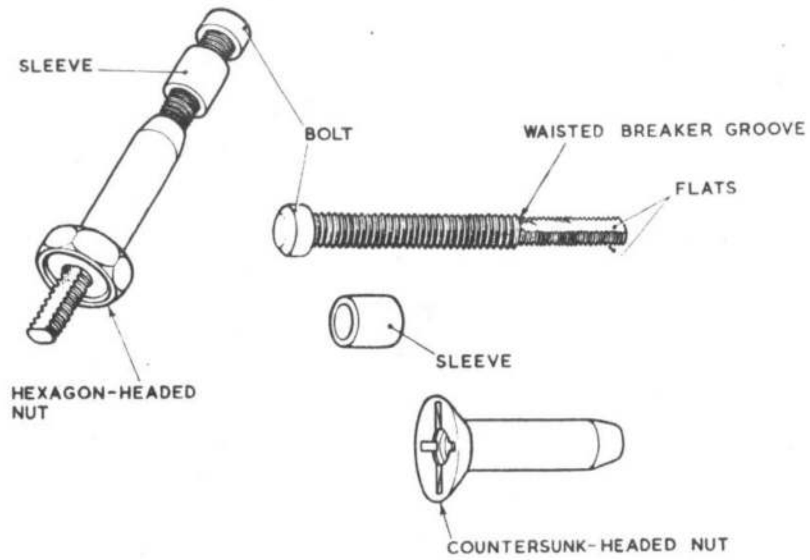


Fig. 1. Jo-bolts countersunk and hexagon heads

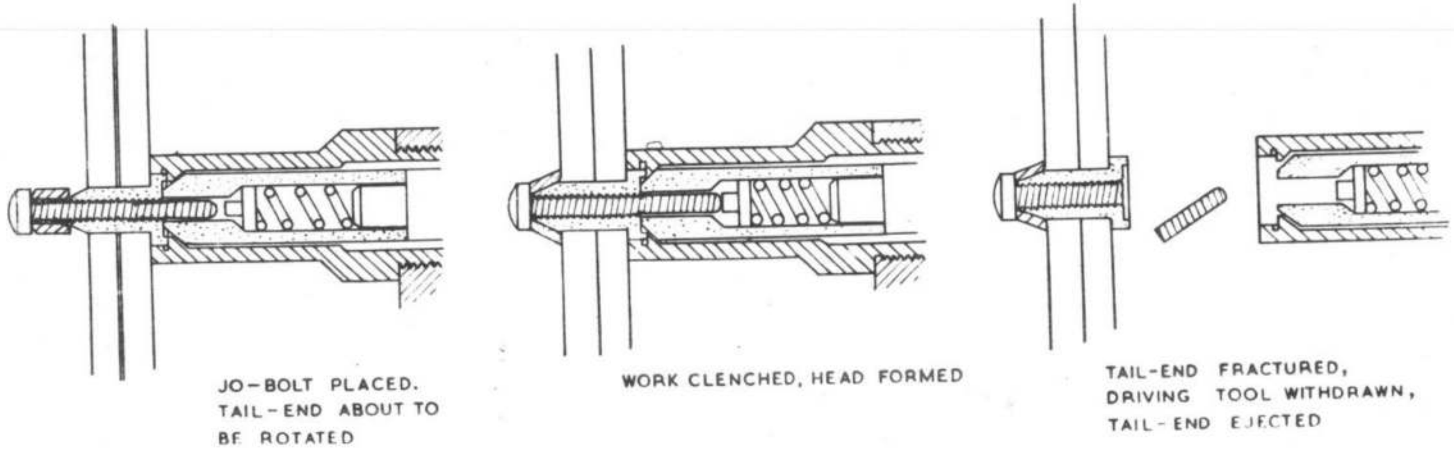


Fig. 2. Jo-bolt driving sequence

JO-BOLTS—*continued*

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 predetermined 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.

3. All Jo-bolts are manufactured in steel, cadmium-plated to D.T.D. Spec. 904. The bolts and nuts are alloy steel to B.S. Spec. S.103 and the sleeves, stainless steel annealed to D.T.D. Spec. 189.

TABLE 1

Grip ranges (hexagon heads)

Dash No.	Grip range		PH 190		PH 249		PH 312	
	Min.	Max.	B±0·015	L±0·015	B±0·015	L±0·015	B±0·015	L±0·015
2	0·094	0·156	0·228	0·936	0·246	1·005	—	—
3	0·156	0·219	0·291	0·999	0·309	1·070	0·356	1·221
4	0·219	0·281	0·353	1·061	0·371	1·130	0·418	1·283
5	0·281	0·344	0·416	1·124	0·434	1·195	0·481	1·346
6	0·344	0·406	0·478	1·186	0·496	1·255	0·543	1·408
7	0·406	0·469	0·541	1·244	0·559	1·320	0·606	1·471
8	0·469	0·531	0·603	1·311	0·621	1·380	0·668	1·533
9	0·531	0·594	0·666	1·374	0·684	1·445	0·731	1·596
10	0·594	0·656	0·728	1·436	0·746	1·505	0·793	1·658
11	—	—	—	—	—	—	0·856	1·721

Note . . .

All dimensions given in inches. For grip and reference letters refer to fig. 3.

Bolt sizes

4. Three diameters of Jo-bolt and two head forms are available, as previously mentioned. The complete range of grip sizes are listed in Table 1 and 2 and the general dimensions of the Jo-bolt are given in Tables 3 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 $\frac{3}{16}$ in., $\frac{1}{4}$ in. and $\frac{5}{16}$ 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.

TABLE 2

Grip ranges (countersunk heads)

Dash No.	Grip range		FH 190		FH 249		FH 312	
	Min.	Max.	B±0·015	L±0·015	B±0·015	L±0·015	B±0·015	L±0·015
2	0·094	0·156	0·228	0·853	0·246	0·880	—	—
3	0·156	0·219	0·291	0·916	0·309	0·944	—	—
4	0·219	0·281	0·353	0·978	0·371	1·006	0·418	1·159
5	0·281	0·344	0·416	1·041	0·434	1·069	0·481	1·221
6	0·344	0·406	0·478	1·103	0·496	1·131	0·543	1·283
7	0·406	0·469	0·541	1·166	0·559	1·194	0·606	1·346
8	0·469	0·531	0·603	1·228	0·621	1·256	0·668	1·408
9	0·531	0·594	0·666	1·291	0·684	1·319	0·731	1·471
10	0·594	0·656	0·728	1·353	0·746	1·381	0·793	1·533
11	—	—	—	—	—	—	0·856	1·596

Note . . .

All dimensions given in inches. For grip and reference letters refer to fig. 4.

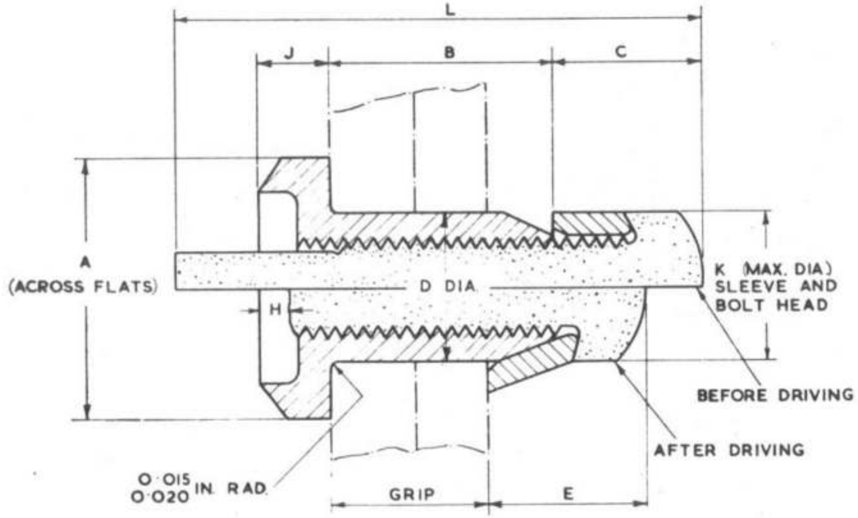


Fig. 3. Hexagon-headed Jo-bolt, general dimensions

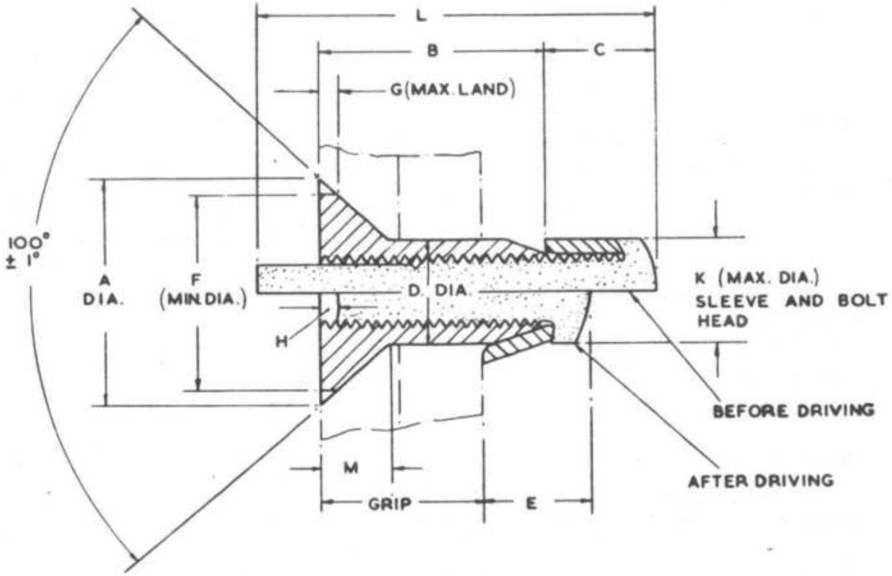


Fig. 4. Countersunk-headed Jo-bolt, general dimensions

TABLE 3

General dimensions of Jo-bolt (hexagon head)

Nom. dia.	Part No.	A	C	D	E	H	J	K
$\frac{3}{16}$	PH 190	0·312 0·302	0·277 0·257	0·190 0·188	0·240	0-0·078	0·116 0·100	0·188
$\frac{1}{4}$	PH 249	0·377 0·365	0·334 0·297	0·249 0·247	0·292	0-0·098	0·138 0·122	0·247
$\frac{5}{16}$	PH 312	0·439 0·425	0·374 0·349	0·3115 0·3095	0·343	0-0·103	0·162 0·148	0·309

Note . . .

All dimensions in inches.

Coding

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

Countersunk heads. A typical code reference is 100 FH 249-7, this indicates a 100 deg. flush (F), countersunk head in high-tensile steel (H) 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 ($\frac{7}{16}$ in.).

Hexagon heads. A typical code reference is PH 249-6, this indicates a protruding (P) hexagon head in high-tensile steel (H) 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 ($\frac{3}{8}$ in.).

Driving tool

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

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 forming 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.

TABLE 4

General dimensions of Jo-bolt (countersunk head)

Nom. dia.	Part No.	A	C	D	E	F	G	H	K	M
$\frac{3}{16}$	100 FH 190	0·375 0·387	0·257 0·277	0·188 0·190	0·240	0·351	0·010	0-0·078	0·188	0·080
$\frac{1}{4}$	100 FH 249	0·496 0·510	0·297 0·334	0·247 0·249	0·292	0·472	0·015	0-0·078	0·247	0·107
$\frac{5}{16}$	100 FH 312	0·622 0·638	0·349 0·374	0·3095 0·3115	0·343	0·590	0·020	0-0·078	0·309	0·134

Note . . .

All dimensions in inches.

TABLE 5

Driving tools and components

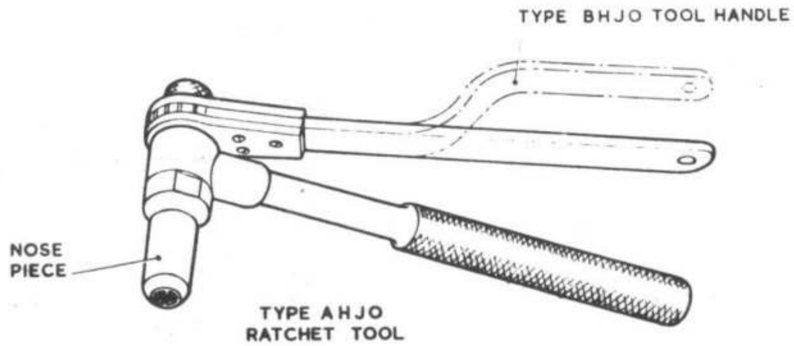
Tool	Bolt series	Wrench adapter	Nose piece
Hand ratchet Type AHJO	PH 190 FH 190	G.18/4 G.18/4	8G/17/1 2G/17/1
	PH 249 FH 249	G.18/5 G.18/5	9G/17/1 3G/17/1
Hand ratchet Type BHJO	PH 312 FH 312	1G/29/2 1G/29/2	6G/28/2 7G/28/2

TABLE 6

Drill sizes

Jo-bolt	Pilot drill	Final drill	Permissible limits on holes (in.)
190	No. 17 (0·173 in.)	No. 11 (0·191 in.)	0·191 — 0·194
299	$\frac{15}{64}$ in.	$\frac{1}{4}$ in.	0·250 — 0·253
312	Letter L (0·290 in.)	$\frac{5}{16}$ in.	0·3125 — 0·3155

JO-BOLTS—*continued*



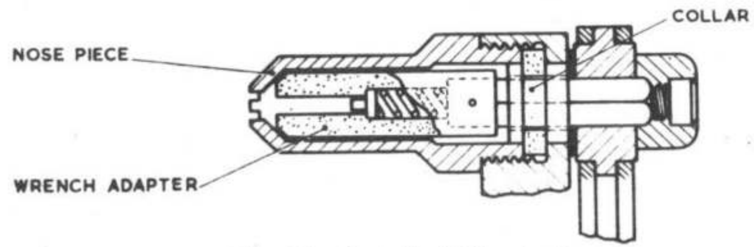


Fig. 5. Jo-bolt driving tool

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 this is clearly specified in the relevant aircraft Vol. 6. If close tolerance fitting is not specified in the Vol. 6 the normal drilling technique should be followed, using drills as listed in Table 6.

Bolt driving

10. Normal riveting practice must be employed in the preparation of parts which are to be united with 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 Vol. 6 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 bolts, too much jointing compound will adhere and may cause slight hydraulicing, 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 3 or 4, Column H. ◄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).

$\frac{3}{16}$ in. units	....	6 lb. in.
$\frac{1}{4}$ in. units	....	10 lb. in.
$\frac{5}{16}$ in. units	....	20 lb. in.►

Bolt removal

12. Removal tools are available for all three sizes of countersunk and hexagon headed Jo-bolts (Table 7). Each tool consists of two drill guides which 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 8. The removal procedure is as follows: apply the appropriate tool to the nut head, using the pilot drill end of the tool, and drill to the depth of the head. Reverse the tool, and with the final drill, again drill to the depth of the head. At this stage the head is practically severed and a final tap with a suitable punch will eject the Jo-bolt on to the far side of the work.

Note . . .

It is important that all bolt ends must be 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 reaction between dissimilar metals may start corrosion which cannot be detected at an early stage.

General data

13. The average torque loads required to fracture the bolt tail ends are given in Table 9, together with the strength of the Jo-bolt in shear and tension.

JO-BOLTS—*continued*

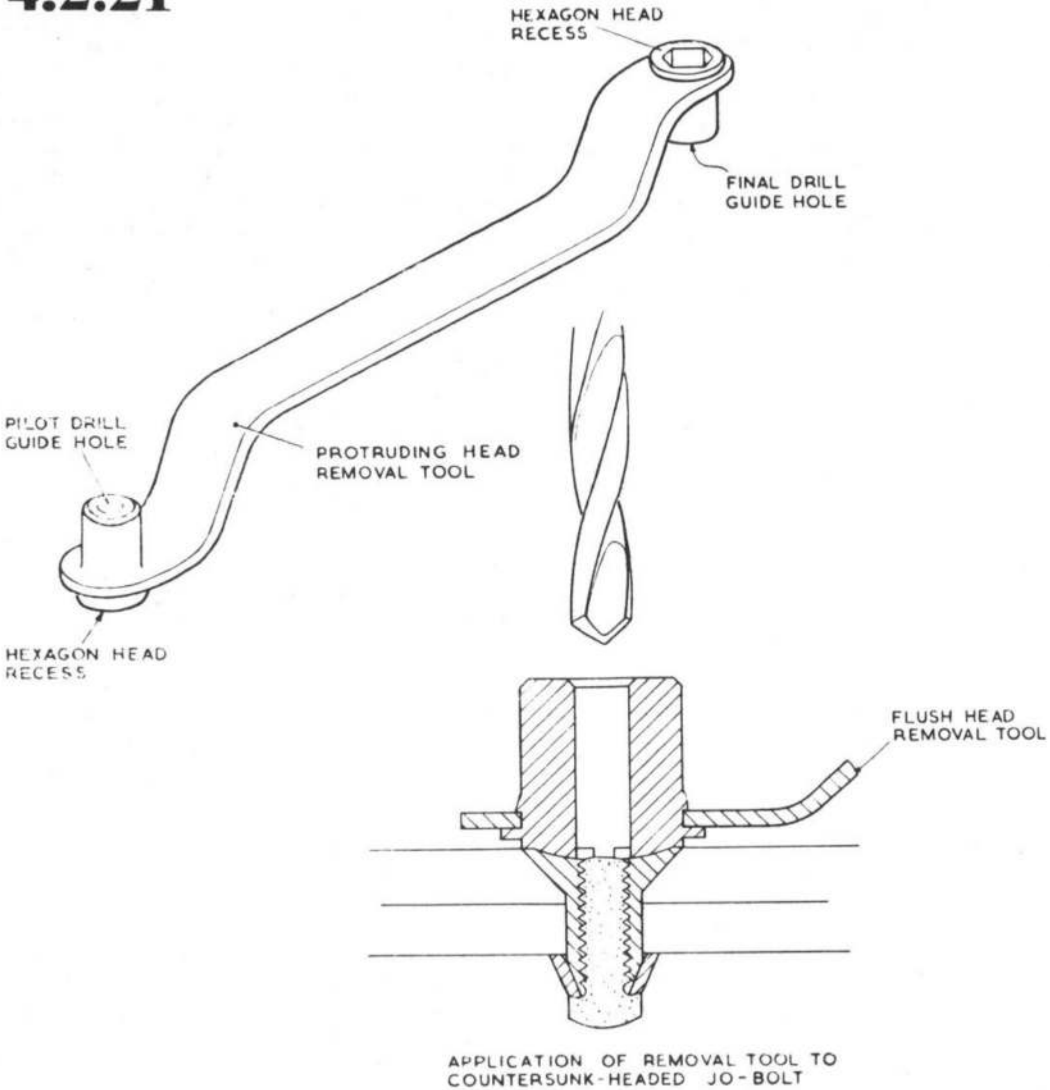


Fig. 6. Jo-bolt removal tools

TABLE 7

Jo-bolt removal tools

Jo-bolt	Tool Pt. No.	Jo-bolt	Tool Pt. No.
FH 190	6595	PH 190	6597
FH 249	6596	PH 249	6598
FH 312	6640	PH 312	6641

TABLE 8

Jo-bolt removal drills

Bolt dia.	Pilot drill	Final drill
$\frac{3}{16}$ in.	No. 30	No. 14
$\frac{1}{4}$ in.	No. 28	Letter C
$\frac{5}{16}$ in.	No. 17	Letter M

TABLE 9 General data

Bolt size	Average torque	Single shear	Tension
$\frac{3}{16}$ in. dia. (190 series)	24 lb in.	2450 lb	2250 lb
$\frac{1}{4}$ in. dia. (249 series)	57 lb in.	4200 lb	4100 lb
$\frac{5}{16}$ in. dia. (312 series)	66 lb in.	6500 lb	5000 lb

LOCTITE SEALANT

Introduction

1. Loctite is a penetrating liquid polymer which remains fluid while exposed to air but hardens into a tough plastic when excluded from the atmosphere: this hardening effect is accelerated by contact with metal surfaces. Loctite, which is approved under specification DTD900/4588, is used mainly for bolt locking and the retention of inserts, such as roller bearings and bushes. Under appropriate conditions, Loctite will effectively bond all common metals, glass, ceramics and phenolic plastics but some plated metal parts and phenolic plastics require preliminary activation in a degreasing solvent containing a hardening agent known as Loquic. Liquid Loctite is soluble in trichloroethylene and most de-greasing solvents but cured Loctite is virtually insoluble; it is resistant to aircraft fuels, lubricating oils and hydraulic fluids. Loctite, after curing, is comparable to phenolic resin as an electrical insulator and its shear strength is quite well maintained at temperatures between −65 deg. F and 300 deg. F for short periods.

Availability

2. Loctite and Loquic are provisioned as follows:—

	Grade	*Colour*	*Ref. No.*	*Quantity*
Loctite sealant	A	Red	33H/2202387	10 c.c. bottles
,,	C	Blue	33H/176	
,,	D	Orange	33H/175	
,,	E	Purple	33H/225	
,,	H	Brown	33H/226	
Loquic activator	Diluted		33H/177	4 oz. bottles
,,	Concentrated		33H/178	

Selection of grade

3. The five grades of Loctite vary in strength and thus permit a grade to be selected which meets the particular requirement of each application. The correct grade of Loctite should always be ascertained for a particular application, otherwise it may prove impossible, subsequently, to part the assembly without damage. If too strong a grade has been used it is possible to separate the components by applying a temperature of 260 deg. C. (500 deg. F.) but this in itself may damage the materials in a manner which cannot easily be detected. It is not advisable to use this removal technique for repair purposes unless the operator is certain that the applied temperature is well controlled and will not adversely affect the characteristics of the material.

4. If the grade of Loctite to be used for a particular application is not stated in the aircraft Vol. 6, fig. 1 will assist in selecting a suitable grade for thread locking. The engagement ratio must first be established and by reference to fig. 1 the appropriate grade of Loctite can be chosen. The engagement ratio is obtained by measuring the length of thread in contact with the nut or tapped hole and dividing this length by the bolt diameter. For example, a $^1/_4$ in. dia. mild steel bolt screwed into a tapped hole for $^5/_8$ in. would have an engagement ratio of $^5/_8 \times ^4/_1 = 2.5$ By reference to the chart it can be seen that a vertical line projected up from the "engagement ratio" base line indicates that grade A Loctite would give from 88 to 100 per cent. holding power: the holding power is expressed as a percentage of the ultimate torque strength of a mild steel bolt. Making allowance for variations in the final strength of a particular grade of sealant, and final strengths may vary quite considerably, it would be undesirable to use Grade A as it is possible that on subsequent removal the bolt would shear before the sealant. Grade C would therefore be the choice for maximum strength which permitted satisfactory removal but Grades E or H could quite well be used if the degree of locking required is slight.

5. It should be noted that fig. 1 is applicable to mild steel but when using aluminium or brass screws the next lower strength grade may be taken as appropriate.

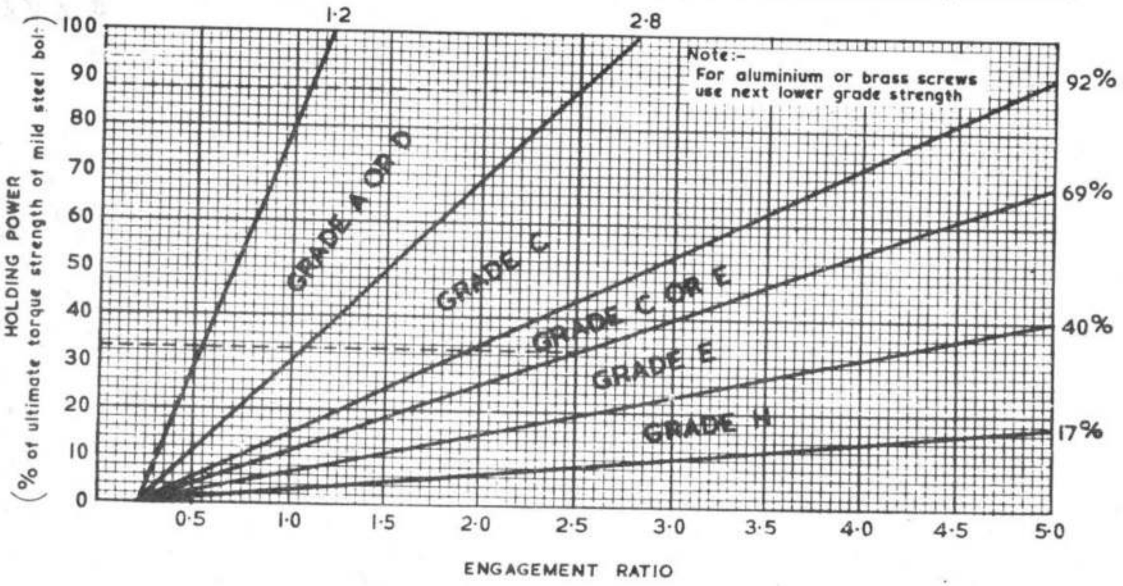


Fig. 1. Grade selection for mild steel bolts

Safety precautions

6. No special safety precautions are necessary as Loctite and Loquic are non-toxic and have not been known to arouse an allergy.

Preparation

7. The component parts should be thoroughly cleaned with a suitable de-greasing solvent such as trichlorethylene. If cadmium plated or anodised parts, zinc or non-metallic parts are involved these must be given a primary rinse in Loquic to activate the surfaces. Concentrated Loquic must be diluted with twenty parts of trichlorethylene or similar de-greasing solvent before use. Whatever the materials involved, the use of Loquic will accelerate the natural hardening of Loctite although it need not be used unless it is needed as an activator. Parts to be treated with Loquic should be dipped in the solution and allowed to drain and dry before applying Loctite. It is not necessary for parts immersed in Loquic to be used immediately.

Application

8. The sealant can be applied direct from the container to the united parts, where it will be absorbed by capillary attraction. If after a few minutes a complete ring of Loctite can be observed around the surface of the joint this will indicate that the joint is impregnated. After application, all surplus sealant should be carefully wiped away and all cleaning materials so used should be destroyed. It is important that Loctite does not enter any moving parts and does not come into contact with organic materials. Loctite can also be applied to the parts to be united before they are assembled. When large numbers of components are to be treated they can be tumbled in a plastic bag to economise in the use of the sealant, which is quite expensive. Brass screws should be used within eight to twelve hours after tumbling but other materials will remain in a satisfactory state for one or two days if kept in a plastic bag.

9. After application, Loctite begins to set within a few minutes at room temperature. Depending upon the metal, 85 per cent. of final strength is reached within four to twelve hours at 23 deg. C. (72 deg. F.) and the complete cure is achieved within twenty four hours. A pre-rinse in Locquic will accelerate the setting time and if speedier results are required, the joint should be left to cure at room temperature for ½ an hour before completing the process within another ten minutes at 100 deg. C. (212 deg. F.); where convenient this may be achieved by immersing the parts in boiling water.

Shelf-life

10. Loctite has a satisfactory shelf-life of twelve months but the entry of metal particles into a bottle will cause the sealant to harden prematurely. Do not contaminate Loctite with Loquic activator.

★ ★ ★


MIG PILOT
MIKOYAN