AP 101A-0300-1

A351.

AIRCRAFT RIGID PIPELINES

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

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CONTENTS

Preliminary material

Title page
Amendment record
Contents (this list)

Chapters

1 Marking of piping on aircraft
2 Metal tubing for aircraft rigid pipelines
3 Stainless steel tubing for aircraft pipelines
4 Arsaero pipe fittings
5 Standard couplings for aircraft metal pipelines (AGS)
6 Rotary couplings for aircraft metal pipelines
7 British metric swaged pipe couplings
8 Self-sealing couplings for aircraft metal pipelines
8-1 Self-sealing couplings, Lockheed Avery Type
8-2 Quick-release self-sealing couplings Type BSCV, BSCS, HSCV and HSCS
8-3 Self-sealing coupling units Part No. C17316 and C17317
9 Permaswage pipe fittings
10 Flexible couplings for aircraft metal pipelines
10-1 High-pressure semi-flexible couplings Avimo type
10-2 Flexible couplings Miflex AC4030 series
11 Dynatube pipe fittings
11-1 Rosan pipe fittings
12 AN (American) flared pipe fittings
13 MS (American) flareless pipe fittings
14 Aircraft pilot and static system pipe connections and unions
14-1 Pipe connections to aircraft instruments and equipment
14-2 Procedure for altering aircraft installations to suit new instruments
14-3 AGS 838 type unions - assembly instructions
15 Cleaning of rigid pipelines
16 The manufacture of rigid oxygen pipelines
► 17 Pressure/flow testing of rigid pipelines ◄

LIST OF ASSOCIATED PUBLICATIONS

AP 119G-0601-135F	Permaswage tooling system
AP 107D-0001-1	Oxygen contents gauge, control units and indicators
AP 119A-0512-1	Component cleaning processes
AP 119G-0104-1	Tube bending machines
AP 830 Vol 2	Supply regulations storage, materials handling and package
FAP 1086	The RAF catalogue of non-aircraft equipment
AP 119A-0301-1	Metals and alloys

Chapter 1

MARKING OF PIPING ON AIRCRAFT

CONTENTS

	Para
Introduction	1
Identification markers	
Basic identification	4
Supplementary identification	5
Warning symbol	6
Additional markings	7
Colour band markings	8
Application	9
Electro-chemical marking	10
Application	11

ILLUSTRATIONS

Fig		Page
1	Typical application	2
2	Identification markers	3
3	Identification of pipe-line by coloured bands	5

TABLE

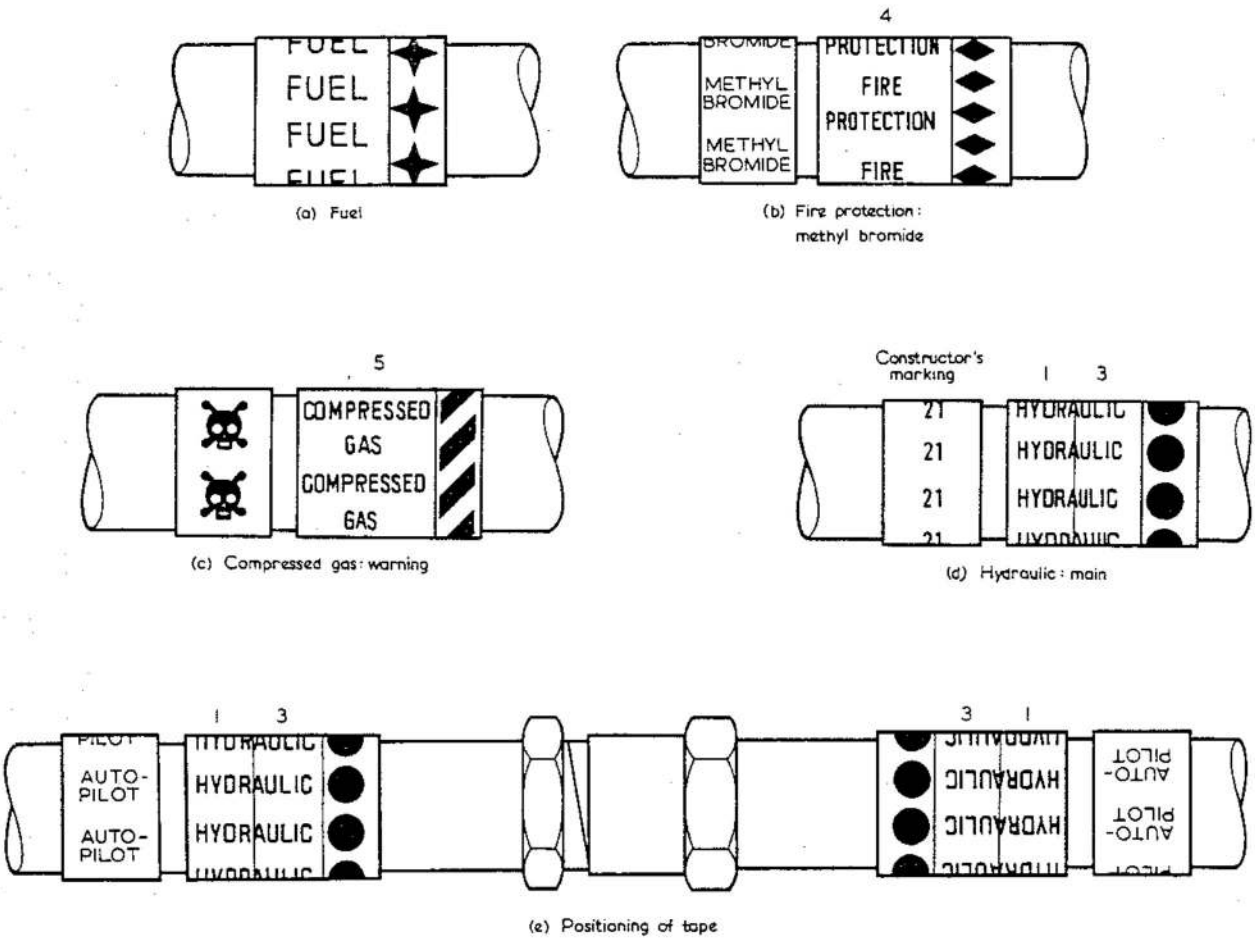
No		Page
1	Standard colours used in markings, fig 2	2

Introduction

1 For identification purposes, all pipe-lines in aircraft are marked at convenient intervals and where they pass through a structure such as a bulk-head; thus all piping can be traced throughout its length, with no possibility of confusion with other pipes in the system.

2 The identification markers are placed at both ends of a pipe-line component, at approximately 2 ft intervals along a pipe run, and adjacent to each service point or inspection cover. To prevent the over use of these markers, where long pipe runs are easily viewed markers are located at intervals which ensure that at least one is visible from all viewing positions. Similarly where a readily traced pipe-line of less than 2 ft length is installed only one marker need be used.

▶ 3 The standard method used for marking aircraft pipe-lines is to BS specification 5M.23 which complies with the international standard, using symbols. On aircraft produced before 1949 the identification is by means of coloured bands. ◀



(a) Fuel

(b) Fire protection: methyl bromide

(c) Compressed gas: warning

(d) Hydraulic: main

(e) Positioning of tape

Fig. 1. Typical application

IDENTIFICATION MARKER

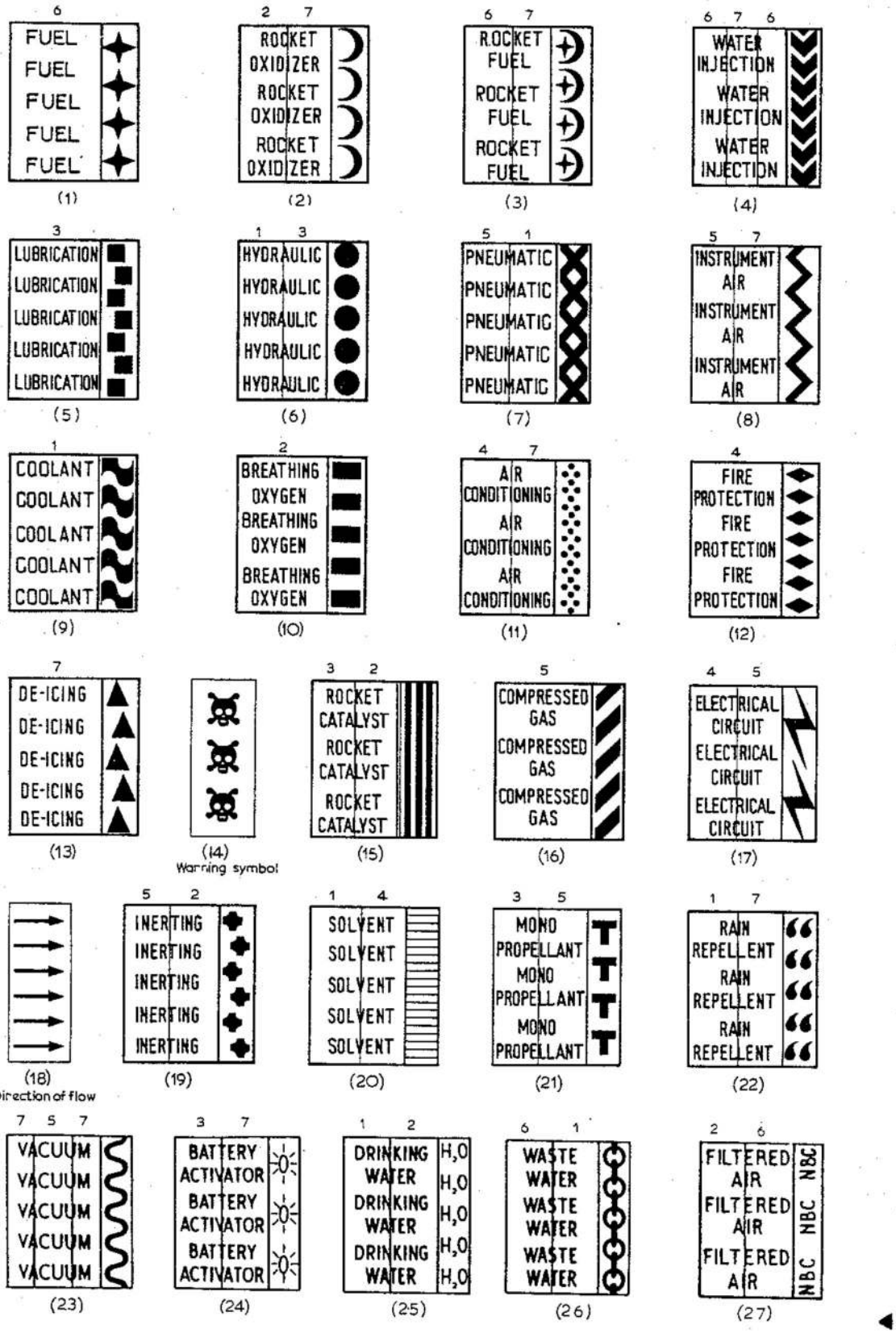
Basic identification

4. Pipe-lines from the various systems are marked with the appropriate marker; this includes filter lines, pressure transmitter lines, priming lines and drain lines from the main or related equipment. In cases where no standard marking is available e.g. drinking water, the pipe will be identified by markers bearing the name of the function only.

TABLE 1

Standard colours used in markers, fig.2

	Colour	British Standard No. BS 381C
1	Blue	166
2	Green	218
3	Yellow	309
4	Brown	412
5	Orange	592
6	Red	538
7	Grey	631



NOTE 1. The numbers above the markers are the serial numbers of the colours as given in Table 1
NOTE 2. Enlargements of the symbols, showing dimensions, are available from the British Standards Institute.

Fig.2 Identification markers

Supplementary identification

5 Where it is necessary to identify the specific function of a pipe-line in the system, sub-division of the main function is made by adding additional words describing the specific function, e.g. Methyl bromide, Auto pilot. These additional words, in black on a white background, are located on a narrow marker alongside the left-hand edge of the basic identification marker, fig 1.

Warning symbol

6 When the contents of a pipe-line is considered to be dangerous to maintenance personnel, a marker bearing the skull and cross bones symbol, fig 1, is applied adjacent to the identification marker.

Additional markings

7 Where pipelines are manufactured for uni-flow systems, flow direction markers bearing flow direction arrows must be fitted, see marker (18) on fig 2. Additional identification of pipelines may be made by using contractors markings, see fig 1 (black figures on a white background).

COLOUR BAND MARKINGS

8 Although this type of marking is now obsolete it may still be encountered on certain older types of aircraft. The marking consists of coloured rings, single or in groups, and a reference number (fig 3). The reference number when used in conjunction with the relevant aircraft Vol 1, enables any point on the system to be located.

Application

9 The coloured markings are applied by the use of one of the following:-

(1) Pigmented varnish (D.T.D.260).

(2) Approved transfers coated with clear varnish to B.S. Specification X.17.

(3) Approved adhesive paper bands coated with clear varnish B.S.S. X.17 after affixing to the pipe.

(4) Approved coloured self-adhesive paper bands.

▶ ELECTRO-CHEMICAL MARKING

10 Aircraft metal pipelines may be identified using electro-chemical marking as the preferred method. All locally manufactured, rigid pipelines are to be identified in this manner.

Application

11 Electro-chemical marking is achieved using the Metaletch 5200 Mk II marking kit and the appropriate stencil. ◀

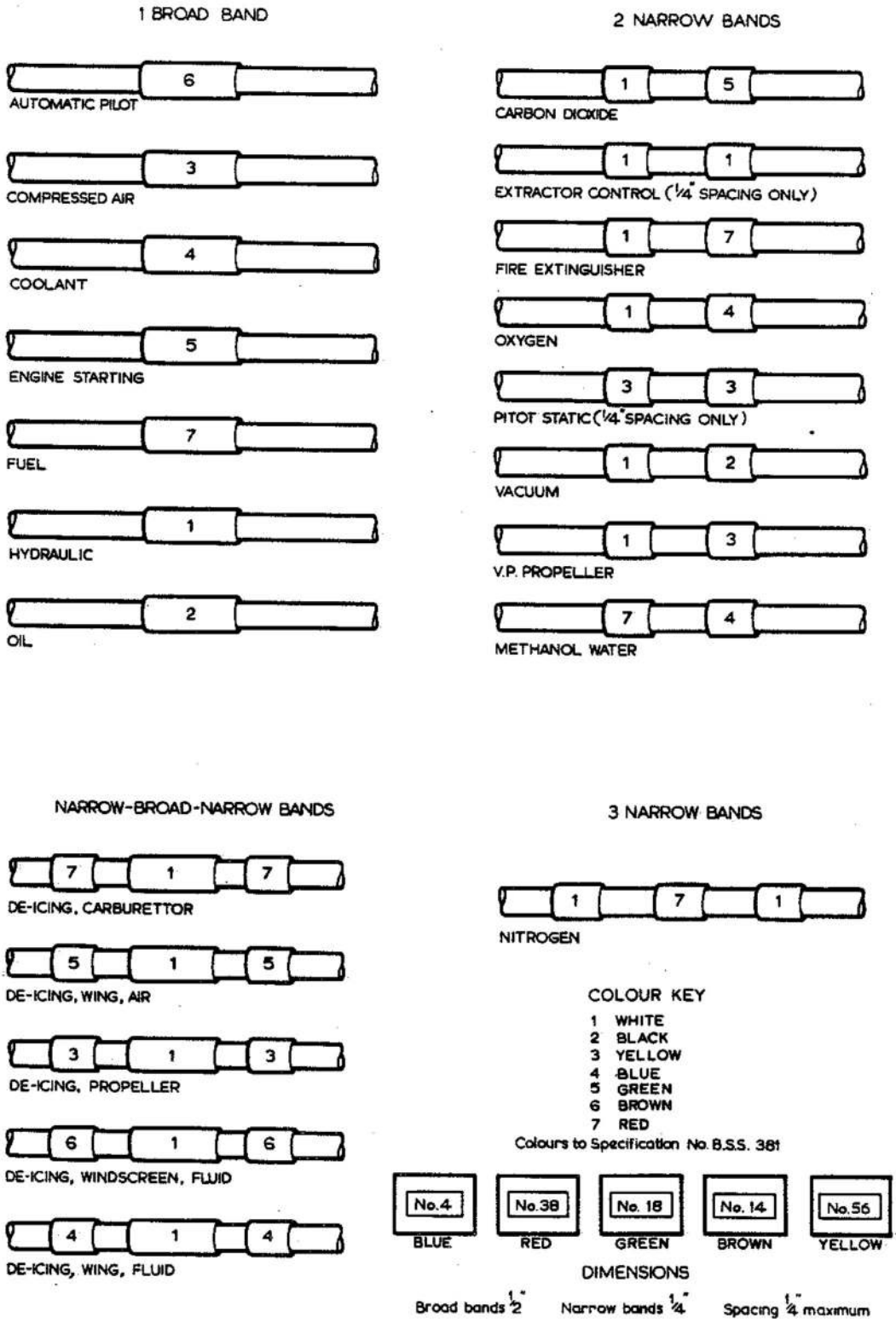


Fig. 3. Identification of pipe-line by coloured bands

Chapter 2

METAL TUBING FOR AIRCRAFT RIGID PIPELINES

CONTENTS

Para

1	Introduction
9	Tube bending
14	Local manufacture of rigid pipelines
21	Steel and stainless steel tubing
24	Nimonic 75 tubing
26	Duralumin tubing
28	Aluminium tubing
29	Aluminium-alloy tubing
32	Tungum (aluminium-nickel-silicon brass) tubing
36	Pressure tests on rigid pipelines
38	Flow test in fuel pipelines
39	Pressure tests in fuel pipelines

Fig		Page
1	Base magnetic	4
2	Establishment of 3-dimensional profile	5

Introduction

1 Metal tubing for use on aircraft is listed in AP 1086, Sect 30A and B, and is available to the Services in various sizes and materials conforming to BS and DTD Specifications, a list of which will be found in AP 119A-0301-1, Metals and Alloys. New tubing is marked for the purpose of identification and the marking conforms to the Standard Colour Scheme as laid down in AP 119A-0301-1, Metals and Alloys. This marking has no relation to the marking of pipelines installed in aircraft, particulars of which will be found in Chap 1, of this publication. The information in this particular chapter applies to pipelines in aircraft and is therefore subject to limitations which might not apply to pipelines used for ground equipment.

2 Metal tubing on aircraft must conform to the correct specification requirements and its use must be approved for inclusion in the particular system of service in which it is to be installed. The characteristics of the tubing as supplied should be ascertained before use, for example whether it has been normalised or annealed, anodised, internally or externally varnished etc. Any tubing which has been specially heat-treated or coated should be protected as much as possible during subsequent working to preserve its original qualities. Damaged or defective tubing must not be used in any of the systems in an aircraft, therefore care should be taken in handling and storing new tubing (AP 830, Vol 2, Leaflet A1).

3 When metal tubing has been coiled for convenience of packing etc, care should be taken when uncoiling it to prevent twisting; the free end should be held whilst the whole coil is rotated and the coil unwound gradually. Coiled tubing must not be pulled out in the form of a spiral in an attempt to straighten it.

4 The working of metal tubing for use on aircraft is subject to limitations depending upon the material of which it is made and the purpose for which it is to be used, therefore the various types of tubing most commonly used are described separately under appropriate headings in subsequent paragraphs.

5 Tubing used for structural purposes in airframes is not covered in this chapter and detailed instructions for the working and use of this class of tubing will be found in the repair schemes in the aircraft servicing manual for the particular type of aircraft.

6 It should be noted that no soldered joints are permissible in any pipelines forward of the fireproof bulkhead.

7 Where it is necessary to manufacture a replacement pipe, it is essential to use tubing of the same type and specification as the original. The replacement pipe should be manufactured from the relevant engineering drawings, if no drawings are available the damaged or defective pipe is to be removed from the aircraft and used as a template for the new pipe. When a suitable length of tubing has been obtained it is to be cleaned and inspected to ensure that no damage exists. When cutting a section from a length of piping ensure that the identification marking if removed, is replaced on the remaining length of tubing. In order to prevent premature failure due to fatigue great care must be taken to avoid scratching or scoring of the tube when handling or during local manufacture of replacement piping.

8 Light-alloy and copper tubing is easily damaged by handing during transport or when storing and care must be taken to avoid damage to the tubing or to its protective coating.

Tube bending

9 Bends in tubing should generally be made on a tube-bending machine, using a guide and a former to suit the diameter of the tubing, the stops being adjusted to the desired length of arc of the bend. Tube-bending machines are described in AP 119G-0104-1. Long, easy bends can generally be made by hand for sizes of tubing of any material up to 12 mm ($\frac{1}{2}$ in.) diameter. More acute bends, and bend in tubes of larger diameter must be made on a tube-bending machine.

10 There are two types of hand-operated bending machine in current service which cater for the full range of tubing in imperial and metric sizes. The first type of machine, which employs the 'compression' method, is used for bending tubes without supporting the tube internally and tubing up to 12mm ($\frac{1}{2}$ in) outside diameter can be bent satisfactorily in the majority of cases. The second type, called the 'mandrel' bending machine, which employs the 'draw' method, gives the best results on small tubes and is also essential for bending larger diameter tubing.

11 The mean bend radius in rigid pipelines should not be less than four times the diameter of the tube. Bends must conform to the original layout taken from a template or from the relevant engineering drawings. Bends of an inverted U-shape are to be avoided in tubing carrying oil, fuel or other liquid because of the possibility of air-locks forming. When the original ▶ pipelines are not available for use as a pattern, a length of mild steel wire 3.2 mm (1/8 in.) diameter (copper coated mild steel Oxy/Acet welding wire is ideal) can be used to simulate the pipeline run. ◀

12 Because of the difficulty in ensuring the complete removal of filler material the filling of tubing prior to bending is prohibited. Fine sand may be used in an emergency only, but after bending all traces must be removed taking care not to score the inside of the tube. The tube must be washed out thoroughly and dried using a stream of dry air.

WARNING ...

OIL MUST NOT BE USED ON TUBING FOR OXYGEN PIPELINES UNLESS AFTER MANUFACTURE THE TUBE IS THOROUGHLY DEGREASED INSIDE AND OUTSIDE USING AN APPROVED METHOD. REFER TO AP 107D-0001-1 CHAPTER 4.

13 It is important that the correct heat treatment is applied to the tube material before and after bending, if required. Failure to apply the correct treatment may result in embrittlement and failure of the material.

Local manufacture of rigid pipelines

14 Replacement pipelines must be manufactured in accordance with the relevant engineering drawings. If no drawings are available the following procedure, para.15 to 20 inclusive must be followed.

15 The original damaged pipeline must be carefully removed from the aircraft ensuring that the lay of the pipe is not disturbed and may be measured by passing a piece of cord through the inside of the pipe and marking the cord to coincide with the pipe ends. An extra allowance must be added to the measured cord length to cater for cord path discrepancy. The greater the number of bends the greater the required allowance.

16 A suitable length of tube material corresponding to the same specification, outside diameter and wall thickness as the damaged pipe must be selected and checked to ensure it is damage free.

17 Several bases magnetic, see fig.1, located on a flat steel surface are used to support and locate the damaged pipe. The locations are positioned near the bends of the pipe so that a comparison in shape can be made, at any stage in manufacture, between the old and new pipelines.

18 To achieve the required accuracy for the new pipeline during bending it must be located on the vee supports of the bases magnetic so that it can be directly compared with the contour of the damaged pipelines, see fig.2. The completed new pipeline must compare accurately with the shape and dimensions of the damaged pipeline.

19 Excess material must be trimmed off the ends of the new pipeline ensuring that the ends are square and de-burred.

20 Finally the new pipeline must be thoroughly cleaned using white spirit both internally and externally. A suitable fluff free pull-through must be used to ensure all contamination is removed from inside the pipe.

Steel and stainless steel tubing

21 Steel and stainless steel tubing is available in various grades and sizes and is used mainly in high pressure systems. The application of heat is usually required during the process of bending steel but stainless steel is mainly provisioned in annealed condition.

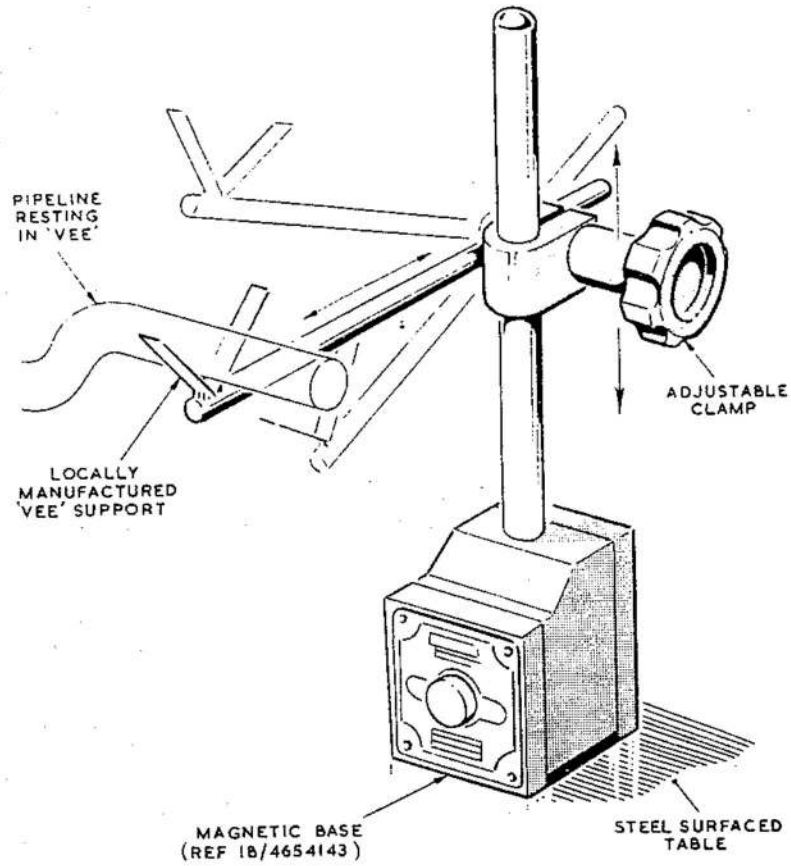


Fig.1 Base magnetic

22 Before applying heat to steel tubing reference must be made to the appropriate specification for information on its heat treatment. High tensile steel tubing is susceptible to failure by intercrystalline penetration of solders particularly when the material is under stress. Therefore sweating or soldering of such material is prohibited.

23 Stainless steel, although generally corrosion resistant may corrode when in contact with certain materials particularly at high temperatures. At no time must poly-chloroprene rubber, used for packing and sleeving, be used in contact with stainless steel as corrosion will occur after a prolonged period.

Nimonic 75 tubing

24 Nimonic 75 tubing is available in sizes up to 25 mm inside diameter. It offers high strength combined with light weight and high corrosion resistance.

25 Nimonic 75 is a nickel-chromium alloy; tubing is manufactured by hot drawing giving a strong circular seamless cross-section ideal for high pressure pipelines.

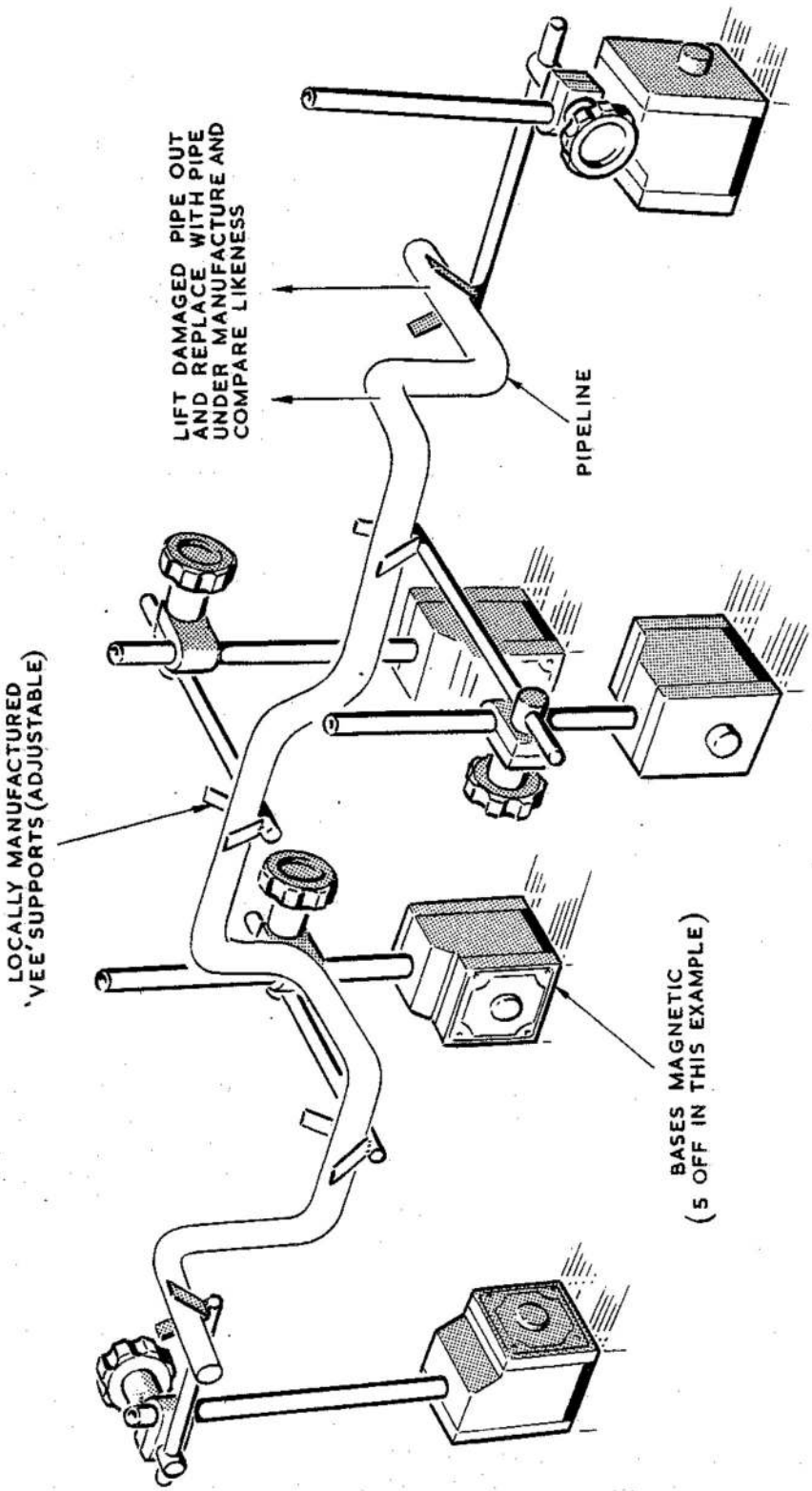


Fig.2 Establishment of 3-dimensional profile

Duralumin tubing

26 Duralumin tubing is available in sizes from $^{3}/_{16}$ to $2\frac{1}{2}$ in. Care must be taken when using tubing for fuel, oil, water, ethylene glycol, air or oxygen, to ensure that it is perfectly clean internally. It is desirable that tubing should be solution-treated immediately, or not more than two hours before flaring. To remove stresses set up during working, all tubes should be finally solution treated after flaring.

27 When installing Duralumin tubing, only specified couplings should be used and contact with other fittings made of copper, brass, tungum and steel should be avoided. Approved packings for use between clips and Duralumin pipes are vulcanised fibre to D.T.D.37, varnished cork jointing material (Langite), and varnished cambric (Systoflex). Where rubber connections are used, that portion making contact with the rubber must be treated with pigmented oil varnish to D.T.D.260.

Aluminium tubing

28 Aluminium tubing is available in sizes ranging from $^{3}/_{16}$ to 3 in. outside diameter. When used for any purpose on aircraft, aluminium tubing must be protected externally from corrosion by an approved process, tubes supplied in coils need not be anodised, but must be treated externally with an approved protective coating; other tubing must be anodised and organically protected externally. Tubing used for the conveyance or liquids or gasses must not be protected internally by organic (i.e. non-electrolytic) means.

Aluminium-alloy tubing

29 Aluminium-alloy tubing, as distinct from duralumin, is employed in certain positions in the various systems on aircraft. The tubing most generally used in this category is to B.S. 2L.56, which can be bent freely and ends flared for use with A.G.S. metal couplings.

30 Aluminium-alloy tubing to B.S. 2L.55, is used in some hydraulic systems; the composition of this tubing is similar to B.S. 2L.56, but is hard drawn and cannot therefore be flared at the ends for use with standard metal couplings.

31 To avoid corrosion caused by electrolytic action, only approved materials are to be used between aluminium alloy tubing and the securing clips. The materials, approved for packing purposes are varnished Langite, Systoflex, and red fibre; leather must not be used. The packing material and the clips should not be secured in position until it has been ascertained that the anti-corrosion treatment of the pipe is complete.

Tungum (aluminium-nickel-silicon brass) tubing

32 Tungum (aluminium-nickel-silicon brass) tubing is used in the fuel, air and hydraulic systems of several types of aircraft. It is made to various DTD specifications as medium or high-pressure tubing. Tungum tubing is supplied in the annealed condition and should be bent in this state without the application of heat. When the tubing has become hardened as a result of cold-working, stresses can be removed by heating at a carefully controlled temperature of 400 deg.C. for a period of one hour, after which it may be cooled by any convenient method.

33 Any fittings to be secured to tungum tubing should be silver-soldered in position. The solder used should have a working temperature of approximately 630 deg.C.; calcined borax should be used as a flux and this may be prepared by heating ordinary dry borax with a blow-lamp flame until ebullition ceases; the white deposit should then be powdered and used dry, or as a thick paste mixed with clean water. An oxy-acetylene flame should not be used when heating tungum tubing, as there is danger of oxidising the metal. Tungum tubing, however, may be oxy-acetylene welded, but such work must only be undertaken by qualified personnel.

34 After bending or silver-soldering operations have been completed, the pipe should be cleaned by immersion for 15 minutes in a solution of nitric acid (1 part), sulphuric acid (2 parts) and water (30 parts). The pipe should be removed from the bath, washed thoroughly in cold water and then in hot water. After washing, the pipe should be finally polished on a buffing machine.

35 Tungum pipe-lines should not be run in contact with aluminium-alloy spars, etc., when replacements are being effected, and indirect contact through moisture or water should be prevented. An approved packing for use between anchoring clips and the pipe is 80 mesh tinned brass gauze.

► Pressure tests on rigid pipelines

36 After manufacture, all pipelines are to be proof pressure tested in accordance with Chap 17 of this publication. ◄

Flow test in fuel pipelines

37 After installing fuel pipelines a flow test must be made to ensure that the system is free from restriction. Instructions for fuel flow testing are contained in the relevant aircraft servicing manual.

Note ...

Fuel collected during flow tests must not be returned to the aircraft tanks.

Pressure tests in fuel pipelines

38 To reduce the risk of leakage in the fuel system, all fuel pipelines must be tested in accordance with the following requirements:

38.1 Engine-driven pump suction system. Pipelines from the tank outlet to the inlet of the engine-drive pump, including all cocks, filters and other accessories, must be pressure tested to at least 20 lbf/in^2.

38.2 Remote fuel pump installations. Pipelines from the remote pump outlet to the inlet of the engine-driven pump, including all cocks, filters and other accessories, must be pressure tested to twice the maximum delivery of the remote pump used, or to 30 lbf/in^2, whichever is the greater.

38.3 Fuel pressure gauge pipe and fittings. Test to twice their maximum operating pressure.

Note ...

Where authorised, the remote fuel pump may be employed for obtaining the required pressure.

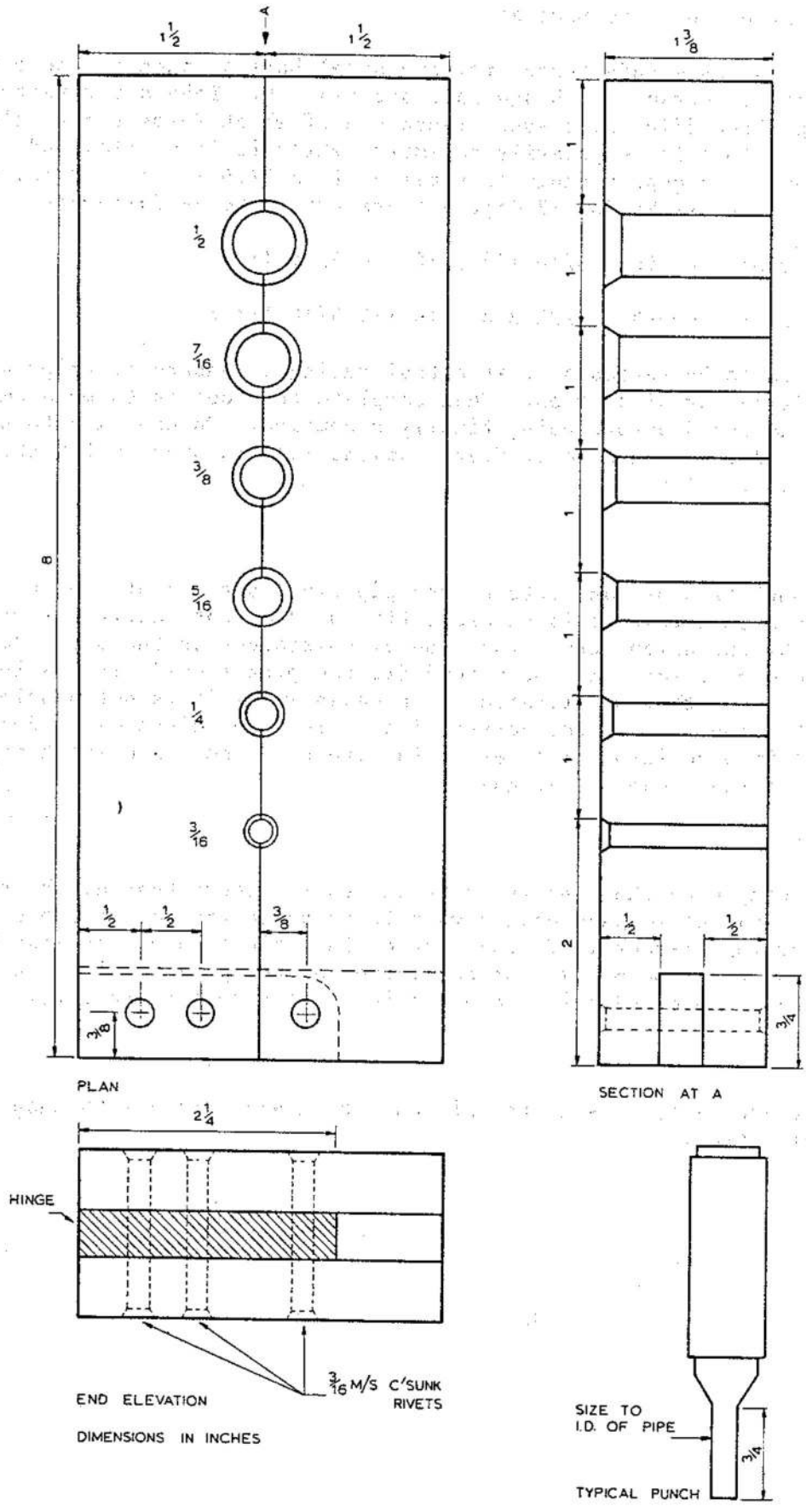


Fig.10 Hinged flaring tool and punches

Hinged flaring tool and punches

12 This tool is manufactured from two steel bars slotted at one end to accommodate a rectangular hinge bar, see fig. 10. They are rivetted to the bar using three 3/16 in. c/sunk rivets one of which forms the pintle of the hinge. The tool is temporarily assembled while it is drilled and countersunk to accept a range of pipeline from 3/16 in. to 1/2 in. diameter (O.D.). Countersinks for 32 degree flare are to be as follows:-

Pipe O.D. inch	3/16	1/4	5/16	3/8	7/16	1/2
C/sink mouth	9/32	3/8	7/16	1/2	9/16	11/16

The tool is to be tested against actual tubing to ensure it grips without causing damage or distortion. When complete the tool is to be dismantled and case hardened before being finally assembled. Punches are to be manufactured for each size of flare, having lead-in pins to fit the I.D, of the tube to be flared.

Fitting

13 On completion of manufacture, the pipeline is to be offered up to the system to ensure that it is an exact fit and does not require drawing into position by the union nuts. Under no circumstances is the pipeline to be forced into position. If not a good fit the pipe should, if possible, be returned for further modification. In cases where it is not possible to modify the pipe to give the correct fit it is to be discarded. Forcing pipelines into position will result in strain on the flare which may cause premature failure due to fatigue.

Pipe testing

14 When completed the pipe is to be tested to ensure that no obstructions exist and that no leakage occurs when it is subjected to 1.5 times its normal working pressure. In the case of fuel pipes they must also be given a fuel flow test (Chap. 2). On completion of the pipe testing, it is to be thoroughly cleaned and dried before being fitted to the aircraft.

Pressure test

15 The pressure test is to be carried out in accordance with Chap 17 of this publication.

Chapter 3

STAINLESS STEEL TUBING FOR AIRCRAFT PIPELINES
(Completely revised)

CONTENTS

Para.

1	Introduction
3	Tube bending
4	Springs
5	Sand filler
6	Tube flaring
7	Primary method
9	Secondary method
12	Hinged flaring tool and punches
13	Fitting
14	Pipe testing
15	Pressure test

Fig.

		Page
1	Flaring tool	2
2	Removal of flaring assembly	3
3	Clamp carriage	4
4	Inserting squaring tool	4
5	Inserting internal de-burring tool	5
6	External de-burring tool	6
7	Inserting stop gauge	6
8	Inserting flaring tool assembly	7
9	Use of flare gauge	8
10	Hinged flaring tool and punches	9

Introduction

1 Stainless steel tubing is used basically on high pressure systems or where pipes are exposed to conditions likely to cause corrosion, but may have a wider application in certain types of aircraft.

2 To prevent wastage during the manufacture of piping it is possible to calculate the length of tubing required by adding the length of straight sections to the calculated length of materials used in bends. This calculation is made by multiplying the radius of bend by the angle of bend, in degrees, times the constant 0·01745. The radius of curvature is measured to the centre of the pipe. It is important when using a bending machine that at least 2·5 times the pipe diameter is left between the pipe end and the bend, in order to prevent flattening of the tube.

Tube bending

3 Bending of stainless steel pipes is to be carried out as detailed in Chapter 2.

Springs

4 On larger diameter pipes, bending springs may be used when available. When using springs care must be taken to prevent score marks occurring during insertion and removal.

Sand filler

5 When tube-bending machines or springs are not available fine sand may be used. The sand must be dry and free from impurities. Plug one end of the tube and maintain in a vertical position while sand is poured in. This should be done a little at a time, light tapping or vibration being applied after each addition of sand in order to pack it down. On completion of the filling operation the open end is to be capped. When bending has been completed all traces of sand must be removed, care being taken not to score the tube. Wash out the tube and dry with a stream of dry air.

Tube flaring

6 Flaring of stainless steel tubing may be produced by the direct pressure of a mandrel or punch, or by the use of a rotary action flaring tool see 'primary method', para.7. Flaring tools listed in AP 1086 will produce satisfactory 32 degree flare, but the flare is more easily achieved by driving a mandrel or punch into the tube. Where suitable flaring tools are not available a locally manufactured hinged block and punch may be used, see para.12 and fig.10.

Primary method (as used by the Royal Navy)

7 Flares are produced in stainless steel and light alloy tubing, if required, to Imperial 32 degree and American 37 degree specifications using the cold rolling process. A flaring tool Ref.FS R5180-799-8860-S231, see fig.1, enables tubing to be squared, deburred and flared. An adaptor set Ref. NATEC ISSM 1151 is used to produce the 32 degree flare and a range of die blocks are used to produce the 37 degree flare.

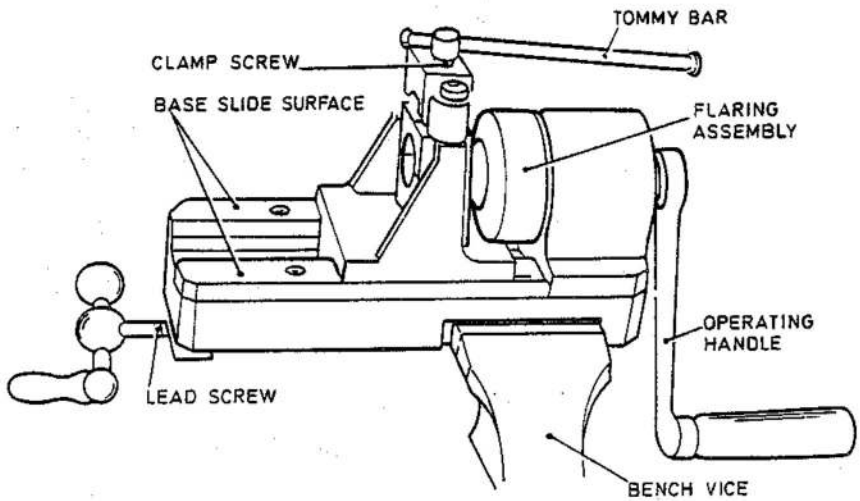


Fig.1 Flaring tool

8 The flaring tool is used as follows:-

8.1 Cutting tubing. Cut tube clearly using a hacksaw with a fine toothed blade.

8.2 Mounting the flaring tool.

8.2.1 Clamp the base of the tool securely in a bench vice, see fig.1.

8.2.2 Assemble operating handle to the spindle and tighten the retaining thumb screw.

8.2.3 Slacken the lead screw. Hold the flaring assembly, see fig.2, and turn operating handle anti-clockwise until assembly can be removed from the spindle opening.

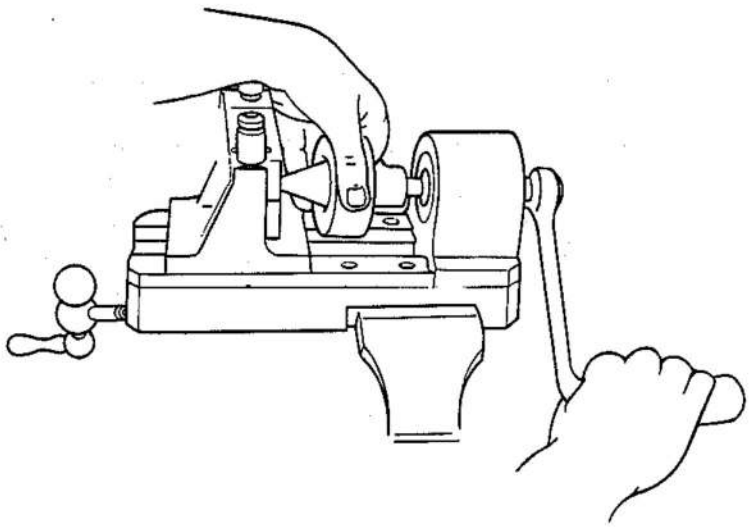


Fig.2 Removal of flaring assembly

8.3 Tool lubrication. Before use ensure that all mating surfaces are thoroughly clean then apply a light film of standard lubricating oil to the base slide surfaces, lead screw and clamp screw.

8.4 Clamping the tube.

8.4.1 Slacken the clamp screw completely and open the clamp.

8.4.2 Place two halves of jaws corresponding to the size of the tubing to be flared in the clamping slide with the chamfered side of jaws facing spindle, see fig.3

8.4.3 Swing the clamp into the closed position.

8.4.4 Insert tubing into jaws so that the end extends towards the spindle at approximately ½ inch beyond the face of the jaws.

8.4.5 Tighten the clamp and slacken the lead screw.

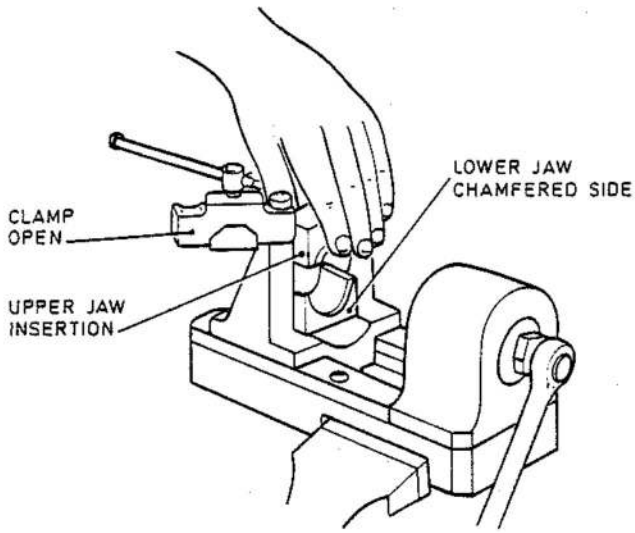


Fig.3 Clamp carriage

8.5 Squaring the tube

8.5.1 Insert squaring tool into the spindle opening, see fig.4. A pin on the shaft end locates in a hole at the bottom of the spindle opening to prevent the squaring tool from turning.

8.5.2 Advance the tube into the squaring tool slowly by advancing the lead screw, at the same time turning the spindle operating handle clockwise. Continue this operation until face of tube is completely square. Do not remove any more material than is necessary.

8.5.3 Withdraw the clamp carriage.

8.5.4 Remove the squaring tool from the spindle.

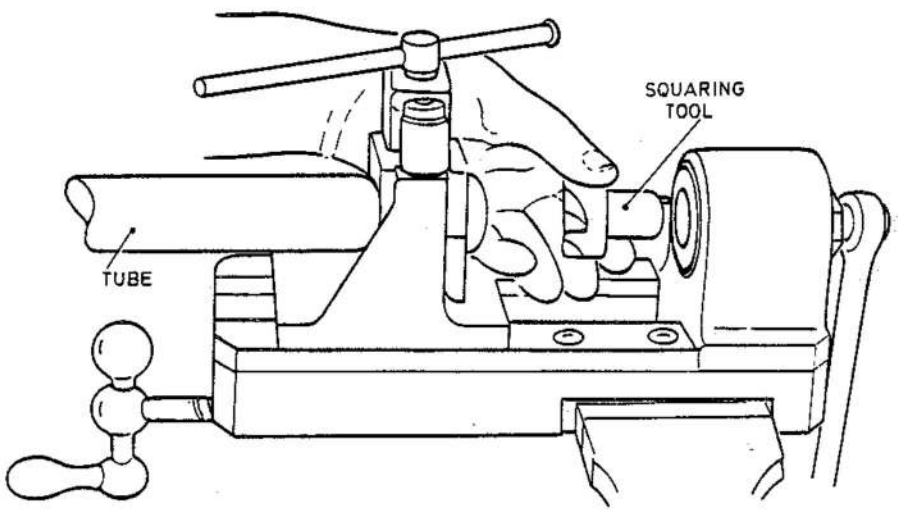


Fig.4 Inserting squaring tool

8.6 Internal deburring

8.6.1 Select the correct internal deburring tool. Small tool is used for $\frac{1}{8}$ to $\frac{1}{2}$ inch outside diameter tubes, large tool is used for $\frac{5}{8}$ to $1\frac{1}{2}$ inch outside diameter tubes.

8.6.2 Place the deburring tool in the spindle opening, see fig.5. A pin on the shaft end locates in a hole at the bottom of the spindle opening to prevent the deburring tool from turning.

8.6.3 Advance the clamp carriage until the tube abuts with the face of the cutter. The deburring tool is sprung loaded to prevent over-feeding.

8.6.4 Advance the clamp carriage an additional one revolution of lead screw. This sets up the automatic pressure feed.

8.6.5 Turn the spindle operating handle four to five revolutions without advancing the clamp carriage further.

8.6.6 Withdraw the clamp carriage completely and remove the internal deburring tool from the spindle opening.

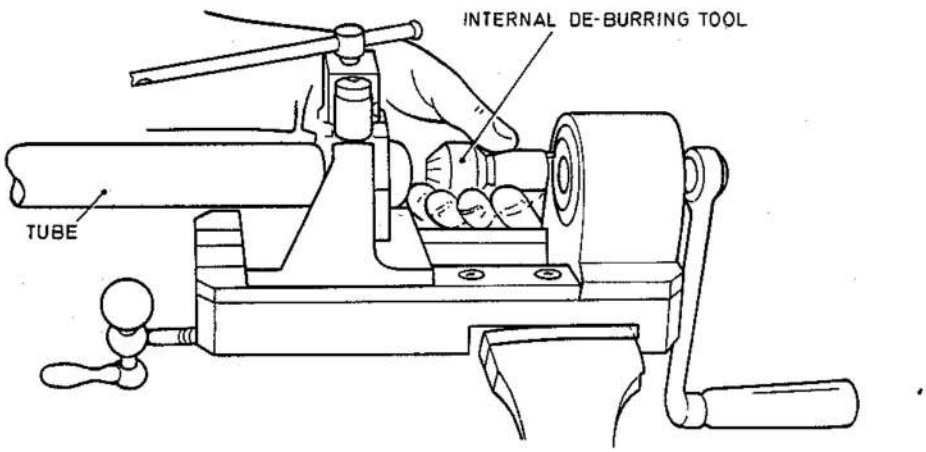


Fig.5 Inserting internal deburring tool

8.7 External deburring

8.7.1 Place external deburring tool in spindle opening. A pin on the shaft end locates in a hole at the bottom of the spindle opening to prevent external deburring tool from turning.

8.7.2 Raise the spring loaded file segment and hold, advance the clamp carriage until the end of the tube is approximately in the centre of the file, see fig.6.

8.7.3 Release the file segment and turn the spindle operating handle until deburring is completed.

8.7.4 Withdraw the clamp carriage and remove the external deburring tool from the spindle opening.

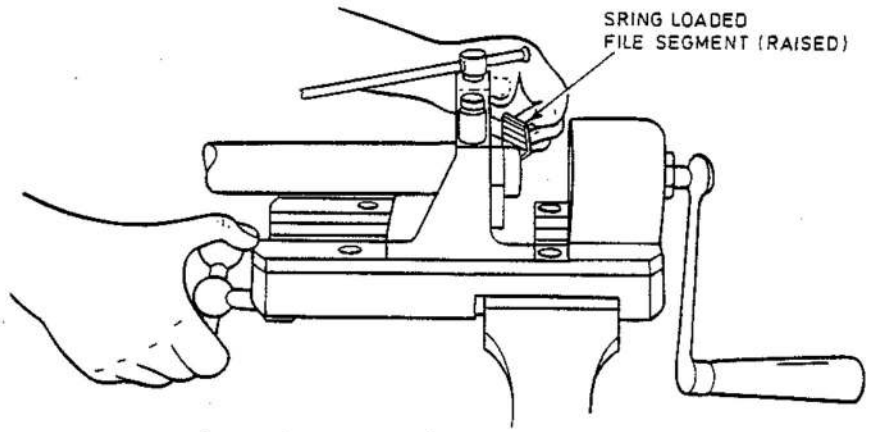


Fig.6 External deburring tool

8.8 Positioning the tube.

8.8.1 Slacken the clamping screw completely and swing clamp into the open position as shown in fig.3.

8.8.2 Remove the tube from the jaws.

8.8.3 Remove all swarf from the jaw holder slide, jaws and end of tube to be flared.

8.8.4 Replace jaws and insert the tube so that the end extends approximately $\frac{1}{4}$ inch beyond the face of the jaws.

8.8.5 Swing the clamp screw into position but do not tighten.

8.8.6 The two tube stop gauges supplied with the flaring tool are marked on their shanks with the appropriate sizes and wall thicknesses of tubing. Select the proper stop gauge and insert in the spindle opening as shown in fig.7.

8.8.7 Advance the clamp carriage until the face of the tube stop gauge contacts the face of the jaws. This operation moves the tube back to the correct depth for flaring.

8.8.8 Clamp the tubing securely in position.

8.8.9 Withdraw the clamp carriage completely and remove the tube stop gauge from the spindle opening.

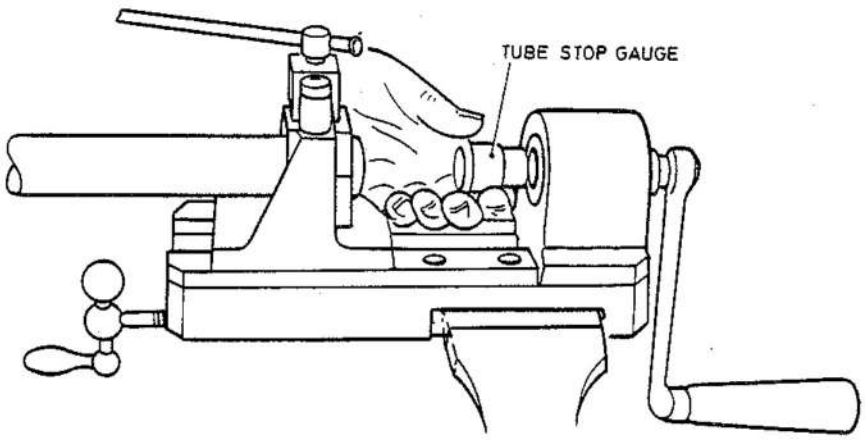


Fig.7 Inserting stop gauge

8.9 Flaring the tube.

8.9.1 Inspect the screw threads and cone surface of the flaring tool and ensure that they are free of swarf.

8.9.2 Insert the flaring tool assembly into the spindle opening as shown in fig.8. Engage the screw thread and hand tighten.

8.9.3 Advance the clamp carriage and at the same time turn the spindle operating handle clockwise.

8.9.4 As soon as the end of the tube abuts with the flaring cone continue to advance the clamp carriage slowly. It is important not to force the tube onto the revolving flaring cone, the best results being obtained with a feed rate of one quarter turn of lead screw to one turn of the spindle operating handle.

8.9.5 As soon as a resistance is felt to the feed the flare is complete and the flare will contact the clamp jaw chamfer at this stage.

8.9.6 Withdraw the clamp carriage while still revolving the spindle operating handle until the cone is clear of the flare surface on the tube. This operation will ensure a flawless concentric flare.

8.9.7 Slacken the clamping screw and swing the clamp into the open position.

8.9.8 Remove the tube.

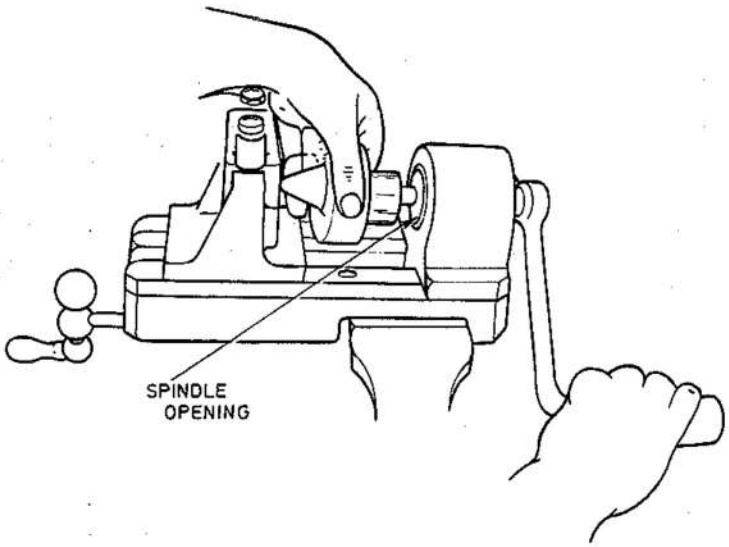


Fig.8 Inserting flaring tool assembly

8.10 Inspection of flare.

8.10.1 To inspect the Imperial 32 degree AGS flare use the procedure covered by Chap.5, para.6.

8.10.2 To inspect the American 37 degree flare use the flare OD gauge supplied with the flaring tool. The gauge has GO and NO GO openings for checking flares on each size of tube within the range of the tool, see fig.9.

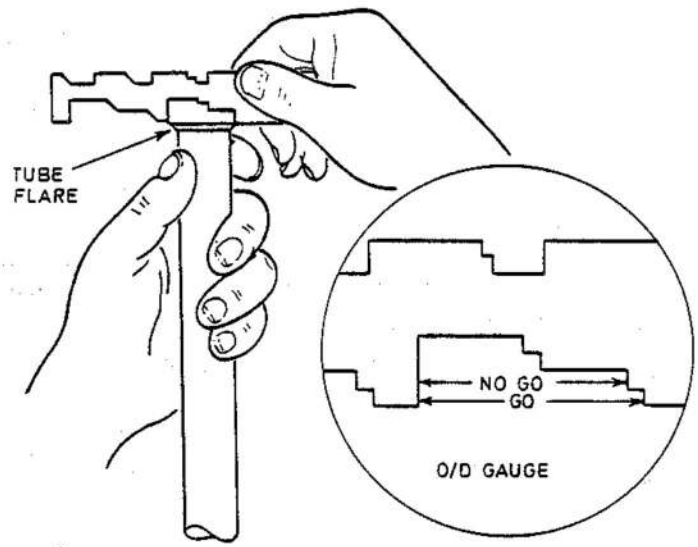


Fig.9 Use of flare guage

Secondary method

9 Flaring of stainless steel tubing may also be produced by the direct pressure of a mandrel or punch. The rotary flaring tools listed in AP 1086 will produce satisfactory 32 degree flares but the flare is more easily achieved by driving a mandrel or punch into the tube. Where suitable flaring tools are not available a locally manufactured hinged block and punch, para.12 may be used.

10 The tube is to be cut to the correct length using a sawing vice and hacksaw fitted with a fine toothed blade. Tube ends are to be squared using a squaring tool see Chap.5, on completion of squaring the tube is to be deburred and cleaned. The inner and outer surfaces of the tube at the location to be flared are to be inspected for damage. Any score marks or surface damage must be removed by burnishing before attempting to flare. Before commencing flaring operation the correct union nut and collar must be placed on the tube.

11 Clamp the tube firmly into the jaws of the flaring tool and accurately align the mandrel with the tube. Drive the mandrel until the correct flare is obtained, taking care that the tube is not being forced back through the clamping jaws. Remove the clamp and clean. Using a magnifying glass, carefully inspect the flare for signs of splitting or other damage. If the flared tube has been damaged it must be rejected.

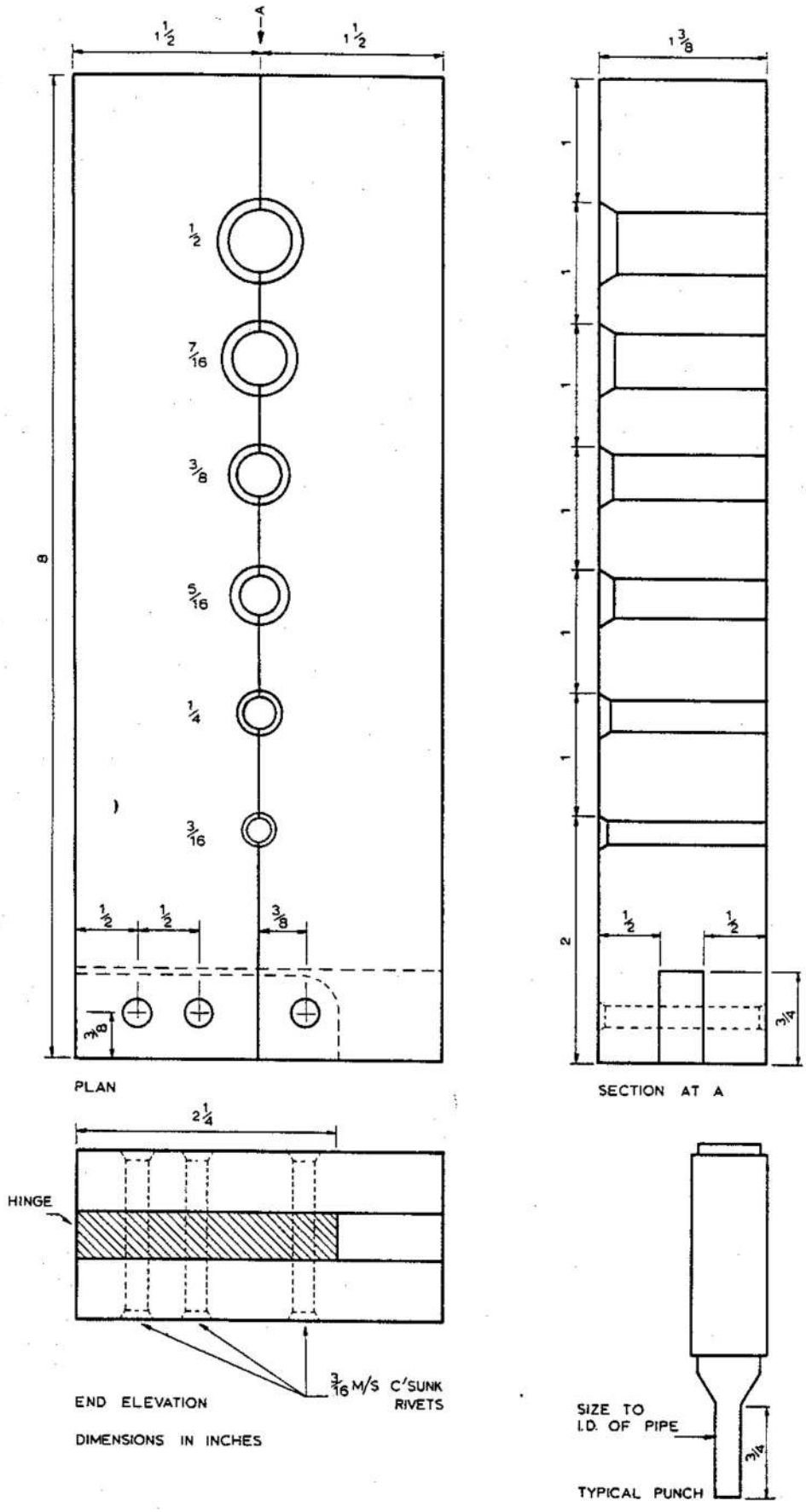


Fig.10 Hinged flaring tool and punches

Hinged flaring tool and punches

12 This tool is manufactured from two steel bars slotted at one end to accommodate a rectangular hinge bar, see fig.10. They are rivetted to the bar using three $^{3}/_{16}$ in. c/sunk rivets one of which forms the pintle of the hinge. The tool is temporarily assembled while it is drilled and countersunk to accept a range of pipeline from $^{3}/_{16}$ in. to $\frac{1}{2}$ in. diameter (O.D.). Countersinks for 32 degree flare are to be as follows:-

Pipe O.D. inch	$^{3}/_{16}$	$^{1}/_{4}$	$^{5}/_{16}$	$^{3}/_{8}$	$^{7}/_{16}$	$^{1}/_{2}$
C/sink mouth	$^{9}/_{32}$	$^{3}/_{8}$	$^{7}/_{16}$	$^{1}/_{2}$	$^{6}/_{1}$	$^{11}/_{16}$

The tool is to be tested against actual tubing to ensure it grips without causing damage or distortion. When complete the tool is to be dismantled and case hardened before being finally assembled. Punches are to be manufactured for each size of flare, having lead-in pins to fit the I.D, of the tube to be flared.

Fitting

13 On completion of manufacture, the pipeline is to be offered up to the system to ensure that it is an exact fit and does not require drawing into position by the union nuts. Under no circumstances is the pipeline to be forced into position. If not a good fit, the pipe should, if possible be returned for further modification. In cases where it is not possible to modify the pipe to give the correct fit it is to be discarded. Forcing pipelines into position will result in strain on the flare which may cause premature failure due to fatigue.

Pipe testing

14 When completed the pipe is to be tested to ensure that no obstructions exist and that no leakage occurs when it is subjected to 1·5 times its normal working pressure. In the case of fuel pipes they must also be given a fuel flow test (Chap.2). On completion of the pipe testing, it is to be thoroughly cleaned and dried before being fitted to the aircraft.

▶ WARNING...

OXYGEN PIPES ARE TO BE CLEANED AND TESTED IN ACCORDANCE WITH AP 107D-0001-1, CHAPTER 4. ◀

Pressure test

15 The pipe is loosely blanked off at one end and the other end connected to a suitable hydraulic rig. Hydraulic fluid is fed into the tube until it seeps out at the blanked end, thus forcing the air out. The blank is then tightened in position. A hydraulic pressure of 1·5 times the normal pressure of the pipe is to be applied for a period of 2 to 3 minutes. The pipe is then inspected for any leakage. Low pressure piping may be tested using nitrogen or air as detailed in Chapter 2.

Chapter 4

ARSAERO PIPE FITTINGS

CONTENTS

Para

1 Description
Types of fittings
4 General
Identification of pipe fittings
5 Part numbering
6 Designation of fittings
7 Reducer fittings with steady mounts
9 Straight reducer coupling sleeves
Operating procedures
10 Preparations
11 Selection of fittings
12 Selection of tools
13 Setting collars
14 Mandrels
18 Selection of gland washers
19 Preparation of pipe
20 Operating instructions
21 Fitting bushings
23 Identification of bushings
24 Examination
25 Repair
26 Testing
Installation
27 General
28 Procedure
29 Disassembly
Fault diagnosis and rectification
30 Checking the installation
31 Storage, preservation and packaging

Fig		Page
1	Typical pipe coupling	2
2	Coupling components	3
3	Typical styles of Arsaero fittings	6
4	Sectioned gland washer	9
5	Setting tool for female union nuts	10
6	Setting tool for male union nuts	11
7	Matching gland washers and union nuts	13
8	Preparation of pipe ends	14
9	Pipe chamfers for bushings	15
10	To disengage the female union nut	15
11	To disengage the male union nut	15
12	Presetting the gland washer	16
13	Bushing for light alloy pipes	18
14	Minimum distance between gland washer and pipe end	19
15	Correctly set gland washer	19

CONTENTS (continued)

Table		Page
1	Approved tube materials and system pressures	4
2	Locking pins, setting collars and threaded sleeves	11
3	Classified stepped plug gauges	12
4	Classified mandrels	13
5	Minimum straight required to disengage nut	14
6	Presetting standard gland washers	17
7	Presetting special gland washers	17
8	Bushings for use with special fittings	18

Description

1 The Arsaero range of pipe fittings provides a pressure tight coupling between two rigid lengths of piping or between the various elements of a hydraulic system and the flexible or rigid piping of its elements. The coupling comprises a biconic shaped ring compressed onto the pipe by a male or female nut, and a body (fig 1). The threads are to ISO metric standards.

2 The coupling is designed for use with rigid re-annealed stainless steel pipelines. When fitted to light alloy pipelines the bore is strengthened with a bush adjacent to the biconic ring. A list of tubing material specifications and system working pressures is given in Table 1.

3 The fittings are assembled on to the pipe by the use of simple tools and a set of stepped plug gauges related to the internal diameter of the pipe. These are listed in Tables 2, 3 and 4.

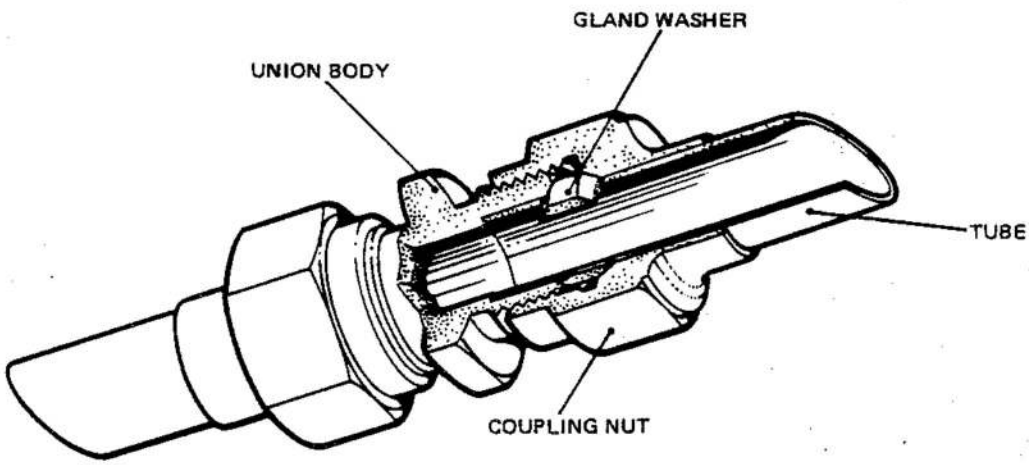
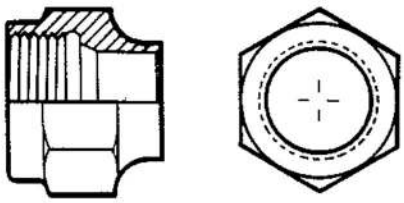
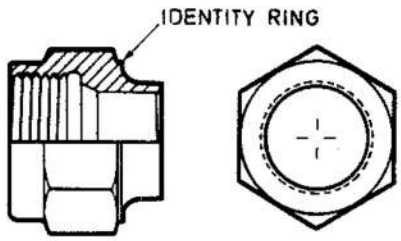


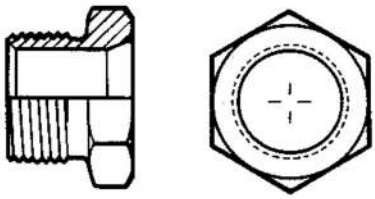
Fig 1 Typical pipe coupling



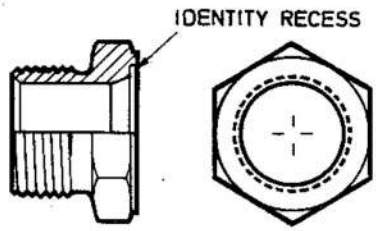
STANDARD FEMALE UNION NUT
FIG 2



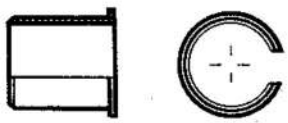
SPECIAL FEMALE UNION NUT
FIG 2



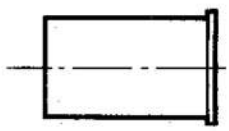
STANDARD MALE UNION NUT
FIG 3



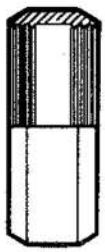
SPECIAL MALE UNION NUT
FIG 3



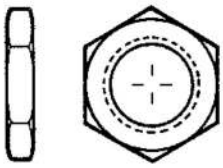
BUSHING FIG.4



PLUG FIG 8



STANDARD AND SPECIAL
GLAND WASHER FIG.1



NUT FOR STEADY MOUNTING
FIG 5 AND 6



ALUMINIUM SEALING WASHER
FIG 7

NOTE: FIG. NUMBERS SHOWN ARE FIG/INDEX NUMBERS LISTED IN AP105B-1146-3A

Fig 2 Coupling components

TABLE 1 APPROVED TUBE MATERIALS, AND SYSTEM PRESSURES

Tube material		Tube size	Hydraulic system pressure	
'Standard' fittings	'Special' fittings		bar	lbf/in²
AG5	AG5	4 to 14 mm	500	7252
XC 18S	Z10 CNT18	16 to 20 mm	300	4351
UZ 15 NS	Z3 CN18	25 to 32 mm	150	2175
XC 185 annealed		40 mm	100	1450

Notes ...

(1) Z10 CNT18 and Z3 CN18, stainless steel, to be fully annealed.

(2) 'Special' fittings must be used with Z10 CNT18 and Z3 CN18 equivalents.

(3) When 'special' fittings are used with light alloy tubing AG5 the pipe bore must be reinforced with a bushing.

TYPES OF FITTINGS

General

4 The pipe fittings fall into either of two categories standard or special:

4.1 Standard pipe fittings are provided with a black gland washer and a yellow union nut which may be male or female. According to the diameter of the pipe, the angle of the union nut surface that bears upon the gland washer may vary between 60 and 90 degrees (inclusive angle). The fittings are used to connect light alloy AG5, mild steel XC 185 or (UZ 15 NS) pipes.

4.2 Special pipe fittings are provided with a yellow gland washer which has a greater surface hardness than the standard gland washer, and a green union nut which may be male or female. The surface of the union nut that bears upon the gland washer is at an inclusive angle of 50 degrees. These fittings are for use with rigid fully annealed stainless steel piping Z3 CN18 or Z10 CNT18. They may also be used with light alloy piping AG5, provided the bore of the pipe adjacent to the gland washer is reinforced by a steel bushing.

4.3 Equipment fittings are used to connect piping to elements of equipment, such as engines, fuel tanks, component bodies and circulatory installations.

4.4 Line fittings are used to connect the pipes themselves; the main types of fitting are as follows:

4.4.1 Straight coupling sleeves

4.4.2 90° elbow fittings

4.4.3 135° elbow fittings

4.4.4 Tee fittings

4.4.5 Cross fittings

4.4.6 Steady mount fittings may also be used to connect the pipes themselves, but their main function is to be secured to a steady plate or bracket.

Note ...

The wall thickness of the steadying component must be between 2.5 mm (0.1 in) minimum and 5.0 mm (0.2 in) maximum.

4.4.7 Bulkhead fittings are used where pipe systems pass through air frame structure, such as frame members, webs and firewall. There are two types:

4.4.7.1 Rivetted flange-mounting coupling sleeves, which can only be fitted if both sides of the mounting wall are accessible.

4.4.7.2 Bulkhead coupling sleeves, which may be used when only one side of the mounting wall is accessible.

Identification of pipe fittings

Part numbering

5 The range of pipe fittings available for use with the various ranges of standardised pipes comprises a considerable number of single components which all have their own identification code. The alpha-numeric code which provides the basis for this identification system is as follows:

5.1 All the codes which identify a single component are preceded by the letters R or RA as follows:

5.1.1 Prefix R applies to a single component in light alloy, except for the gland washers R50 and R51, and male and female union nuts R52, R53, R54 and R55 which are always made of steel.

5.1.2 Prefix RA applies to a single component made in steel.

Notes ...

(1) Normally male threaded fittings with a 1.0 mm pitch thread are made of steel, whilst the male and female threaded fittings with 1.5 mm pitch thread are made of light alloy.

(2) Banjo unions and banjo bolts (swivelling coupling) are made of steel.

5.2 The first group of numbers from 5004 to 13340 is used to identify single components forming part of a complete pipe fitting as follows:

5.2.1 Gland washers from R5004 to R5020.

5.2.2 Straight coupling sleeves from RA5604 to R5620.

5.2.3 Elbow fittings from RA6804 to R6820.

5.2.4 Tee fittings from RA7604 to R7620.

5.3 The last two numbers of the component identity, (part) number indicate the diameter of the matching pipe in millimeters. Thus for example:

5.3.1 For a pipe 12 mm diameter and 1 mm wall thickness (12 x 1)

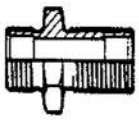
Gland washer	R5012
Male union nut	R5412
Female union nut	R5212
Straight coupling sleeve	R5612
Tee fitting	R7612



STRAIGHT COUPLING SLEEVE FIG. 9



RIVETTED FLANGE MOUNTING COUPLING SLEEVE FIG.10



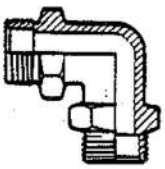
STEADY MOUNTING STRAIGHT COUPLING SLEEVE FIG.11



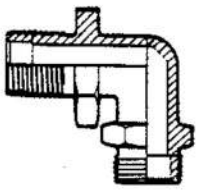
BULKHEAD COUPLING SLEEVE FIG.12



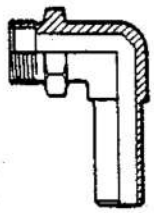
UNION FIG.13



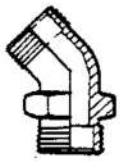
90° ELBOW FIG.14



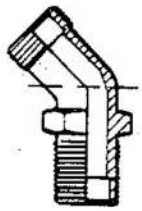
STEADY MOUNTING 90° ELBOW FIG.15



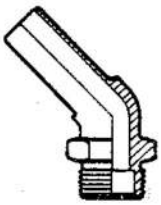
90° ELBOW WITH CYLINDRICAL CONNECTOR FIG.16



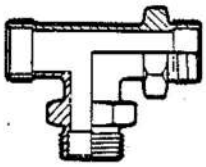
135° ELBOW FIG.17



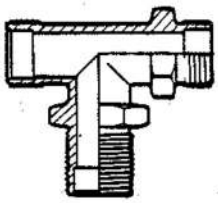
STEADY MOUNTING 135° ELBOW FIG.18



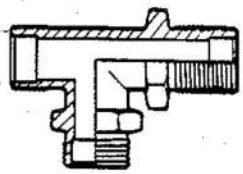
135° ELBOW WITH CYLINDRICAL CONNECTOR FIG.19



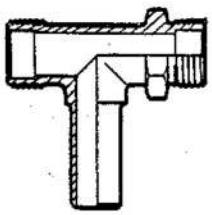
TEE FIG.20



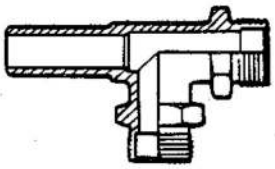
STEADY MOUNT TEE FIG.21



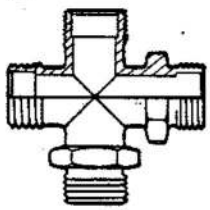
STEADY MOUNTING STREET TEE FIG.22



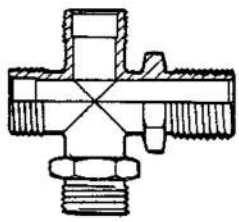
BRANCH TEE WITH CYLINDRICAL CONNECTOR FIG.23



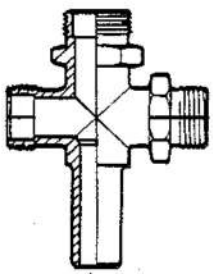
STREET TEE WITH CYLINDRICAL CONNECTOR FIG.24



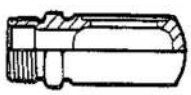
CROSS FITTING FIG.25



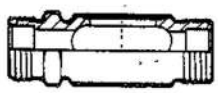
STEADY-MOUNTING CROSS FIG.26



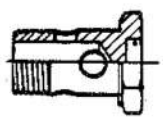
CROSS FITTING WITH CYLINDRICAL CONNECTOR



SINGLE BANJO UNION FIG.28



DOUBLE BANJO UNION FIG.29



BANJO BOLT FIG.30

NOTE: FIG NUMBERS SHOWN ARE FIG/INDEX NUMBERS LISTED IN AP105B-1146-3A

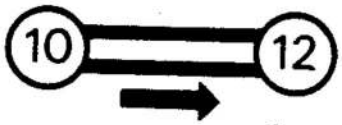
Fig 3 Typical styles of Arsaero fittings

Designation of fittings

6 To avoid errors in the part numbering of reducer fittings it is essential to observe the following rules by which they are identified:

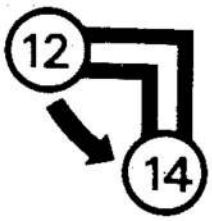
6.1 For straight coupling sleeves, 90° and 135° elbow fittings the smaller of the two diameters must be specified in the first place for example:

6.1.1



Straight coupling sleeve for 10 mm and 12 mm od pipe - R10 x 12

6.1.2 For elbow fittings add prefix E



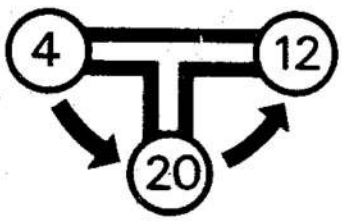
Elbow fitting for 12 mm and 14 mm od pipe - ER 12 x 14

6.2 For tee fittings the order is as follows:

6.2.1 The first diameter specified is the smallest diameter of the horizontal arm.

6.2.2 The second diameter specified is that of the vertical arm.

6.2.3 The third diameter specified is that of the other end of the horizontal arm.



Tee fitting for 4, 20 and 12 mm od pipe - R4 x 20 x 12

6.3 For cross fittings the order is as follows:

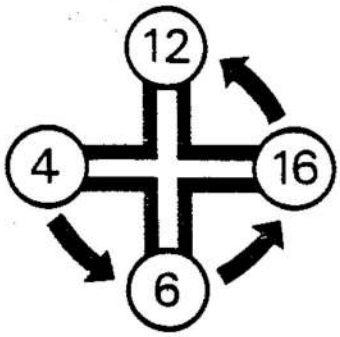
6.3.1 The first diameter specified is the smallest of the four arms.

6.3.2 The second diameter specified is that of the adjacent arm with and equal or larger diameter.

6.3.3 The third diameter specified is that of the arm opposite the first diameter.

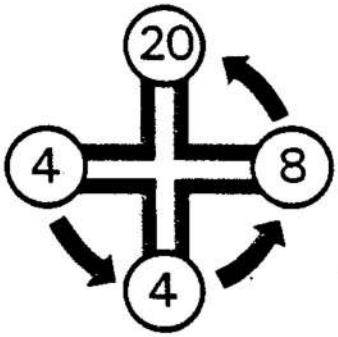
6.3.4 The fourth diameter specified is that of the remaining arm.

6.3.4.1 The first example is:



Cross fitting for 4, 6, 16 and 12 mm od pipes - R4 x 6 x 16 x 12

6.3.4.2 The second example is:



Cross fitting for 4, 4, 8 and 20 mm od pipes - R4 x 4 x 8 x 20

6.4 Steady mount fittings include extra thread on one arm, which is always the largest and carries the suffix S, for example:

6.4.1 Steady mounting tee - 10 x 8 x 10S.

6.5 Cylindrical connectors included on fittings are not normally less than the largest pipe diameter and are indicated by the suffix L, for example:

6.5.1 Cross fitting with cylindrical connector - 4 x 6 x 20L x 12.

Reducer fittings with steady mounts .

7 The bodies of reducer fittings, elbows, tees and crosses which include small diameters of 4, 6, 8 mm together with one of 10 mm or larger are always machined from light alloy, and the smaller diameters have female threads.

8 When arms with diameters of 4, 6 or 8 mm are used for steady mounting they have male threads, and a nut R84.10 is used to secure the fitting to the support.

Note ...

This style is adopted to avoid using a 16 mm x 1.5P thread for the steady thread in conjunction with a smaller female thread for the union nuts.

Straight reducer coupling sleeves

9 Reducer coupling sleeves of the straight through type of 4, 6 or 8 mm diameter on one end and 10 mm or larger on the other have the smaller end carrying a male thread. The material used for these sizes is steel.

OPERATING PROCEDURES

Preparations

10 The sealing of the joint within the fitting is by means of a gland washer, or ferrule which bites into the surface of the pipe as the union nut is tightened (fig 1). In order to assure firm attachment of the gland washer a closely fitting mandrel must be inserted within the bore of the pipe. Then a setting collar, which substitutes for the other half of the coupling being assembled, is used, in conjunction with the mandrel and the union nut being fitted to the pipe, to preset the gland washer onto the pipe. When this operation is completed the union nut is held captive on the pipe by the gland washer.

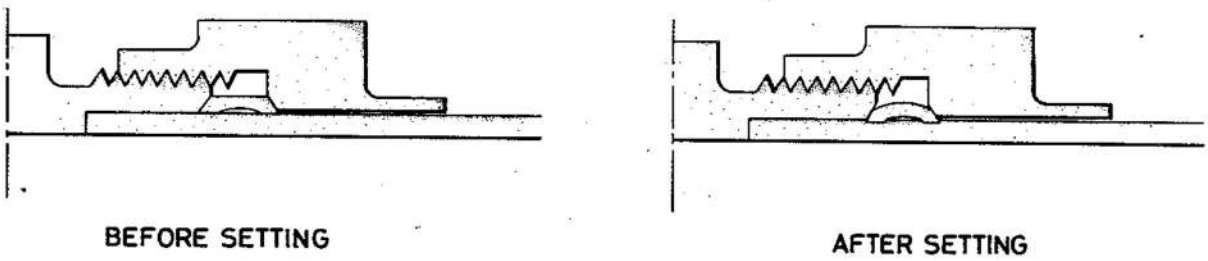


Fig 4 Sectioned gland washer

Selection of fittings

11 The range of fittings available is listed in the illustrated parts catalogue AP 105B-1146-3A. Reference must be made also to the publication relating to the aircraft or engine concerned.

Selection of tools

12 Three special types of tool are used to preset the gland washer on to the pipe and are as follows:

12.1 Hardened steel setting collars which duplicate the appropriate male or female seating configuration, with exactly the same seating depth.

12.2 Cylindrical mandrels to reinforce the pipe directly underneath the gland washers during the setting operation.

12.3 Stepped plug gauges used to check the bore diameter of the pipe and thus select the correct diameter mandrel.

Note ...

Spanners of the size to fit the appropriate union nuts, with extension pieces for the larger sizes are also required.

TABLE 2 LOCKING PINS, SETTING COLLARS AND THREADED SLEEVES

Nominal outside diameter of pipe	Locking pins	Setting collars	Threaded sleeves
6	OT 878	RPS 6K	1 DF 10 x 100 Z 13
8	OT 878	RPS 8K	1 DF 12 x 100 Z 14
10	OT 878	RPS 10K	1 DF 16 x 150 Z 15
12	OT 878	RPS 12K	1 DF 18 x 150 Z 16
14	OT 878	RPS 14K	1 DF 20 x 150 Z 17
16	OT 878	RPS 16K	1 DF 22 x 150 Z 18
20	OT 879	RPS 20K	1 DF 27 x 150 Z 20

Setting collars (fig 5 and 6)

13 Setting collars are provided for each diameter of pipe and the appropriate locking pin is to be used (Table 2). The setting collar must have a female threaded sleeve added to it when assembling fittings with male union nuts. The setting collar is designed to be held in the jaws of a bench vice while the presetting operation is carried out.

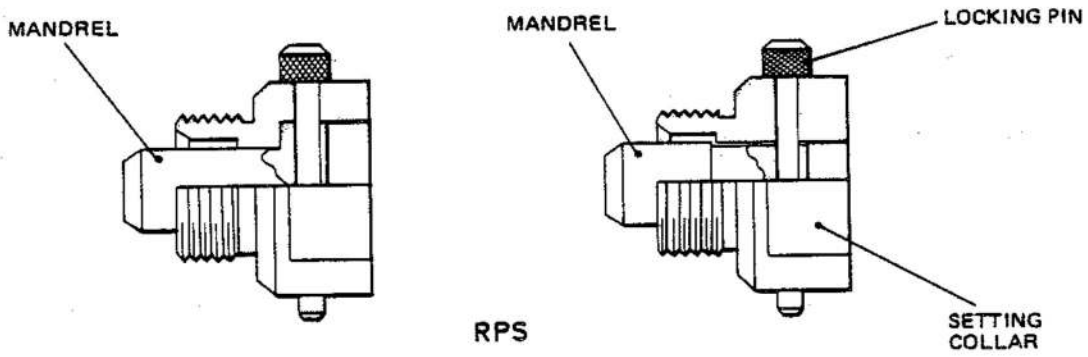


Fig 5 Setting tool for female union nuts

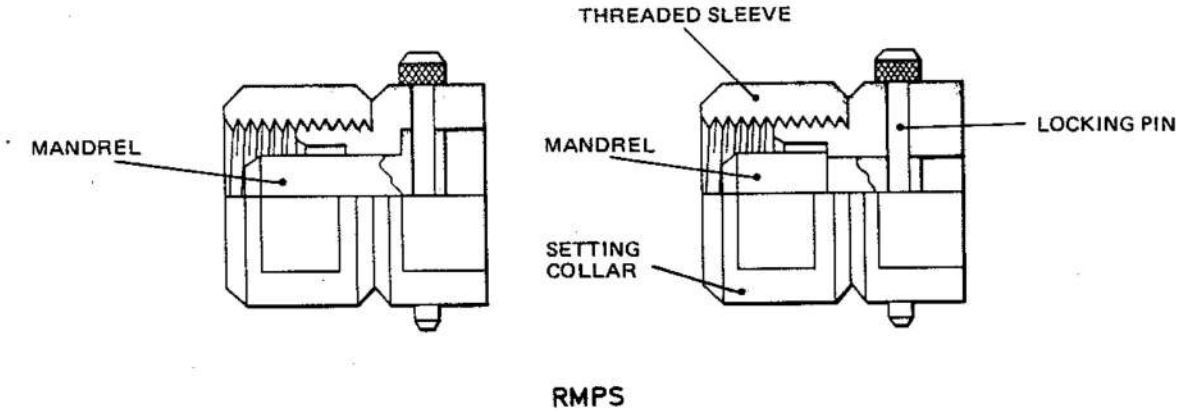


Fig 6 Setting tool for male union nuts

Mandrels

14 Mandrels must be selected so that there is a clearance of 0.15 to 0.30 mm (0.006 to 0.012 in) between the mandrel and the inside diameter of the pipe. The bore size of the pipe is measured by using the stepped plug gauges listed in Table 4 to enable the correct mandrel to be selected.

15 Stepped plug gauges are marked with the classification A, B, C, D ... on each of the stepped diameters. When in use, if the stepped diameter B enters the pipe and the stepped diameter C cannot be entered, this indicates that mandrel B must be used in conjunction with the appropriate setting collar.

Notes ...

(1) The end of the pipe must be deburred internally before using the stepped plug gauges.

(2) If the greatest stepped diameter enters the pipe the pipe is incorrect and must not be used.

TABLE 3 CLASSIFIED STEPPED PLUG GAUGES

Pipe dimensions od x wall, mm	Step diameters in mm A	B	C	D	E	F	G
* 6 x 0.8	4.10	4.25	4.40	4.55			
6 x 1	3.65	3.80	3.95	4.10	4.25		
* 8 x 0.8	6.10	6.25	6.40	6.55			
8 x 1	5.65	5.80	5.95	6.10	6.25		
10 x 1	7.65	7.80	7.95	8.10	8.25		
12 x 1	9.60	9.75	9.90	10.05	10.20	10.35	
14 x 1	11.55	11.70	11.85	12.00	12.15	12.30	
16 x 1	13.60	13.75	13.90	14.05	14.20	14.35	
20 x 1	17.60	17.75	17.90	18.05	18.20	18.35	

Note ...

* The 0.8 mm thickness is permissible solely for stainless steel pipe.

16 In Table 5, the mandrels are classified and designated in accordance with the nominal dimensions of the pipe, for which they are used. The various mandrels that are required to cover the tolerance range of a pipe of given dimensions are classified in the order A, B, C, D, E, F, G. The mandrel A is the smallest of the series and mandrel B is the next larger size and so on.

17 A mandrel is designated by the nominal dimensions of the pipe and by its suffix. For instance ... 12 x 1C.

Selection of gland washers (fig 7)

18 Before commencing the assembly operation select the correct gland washers and union nuts as follows:

18.1 The standard R50 gland washers (black) are paired with standard R52 female union nuts (yellow) or with the standard R54 male union nuts (yellow).

18.2 The special R51 gland washers (yellow) are paired with the special R53 female union nuts (green) or with the special R55 male union nuts (green).

TABLE 4 CLASSIFIED MANDRELS

Pipe dimensions od x wall, mm	Mandrel diameters to within $^{+0}_{-0.05}$ mm						
	A	B	C	D	E	F	G
* 6 x 0.8	3.95	4.10	4.25				
6 x 1	3.5	3.65	3.80	3.95			
* 8 x 0.8	5.95	6.1	6.25				
8 x 1	5.5	5.65	5.80	5.95			
10 x 1	7.50	7.65	7.80	7.95			
12 x 1	9.45	9.60	9.75	9.90	10.05		
14 x 1	11.40	11.55	11.70	11.85	12.00		
16 x 1	13.45	13.60	13.75	13.90	14.05		
20 x 1	17.45	17.60	17.75	17.90	18.05		

Note ..

* The 0.8 mm thickness is permissible solely for stainless steel piping.

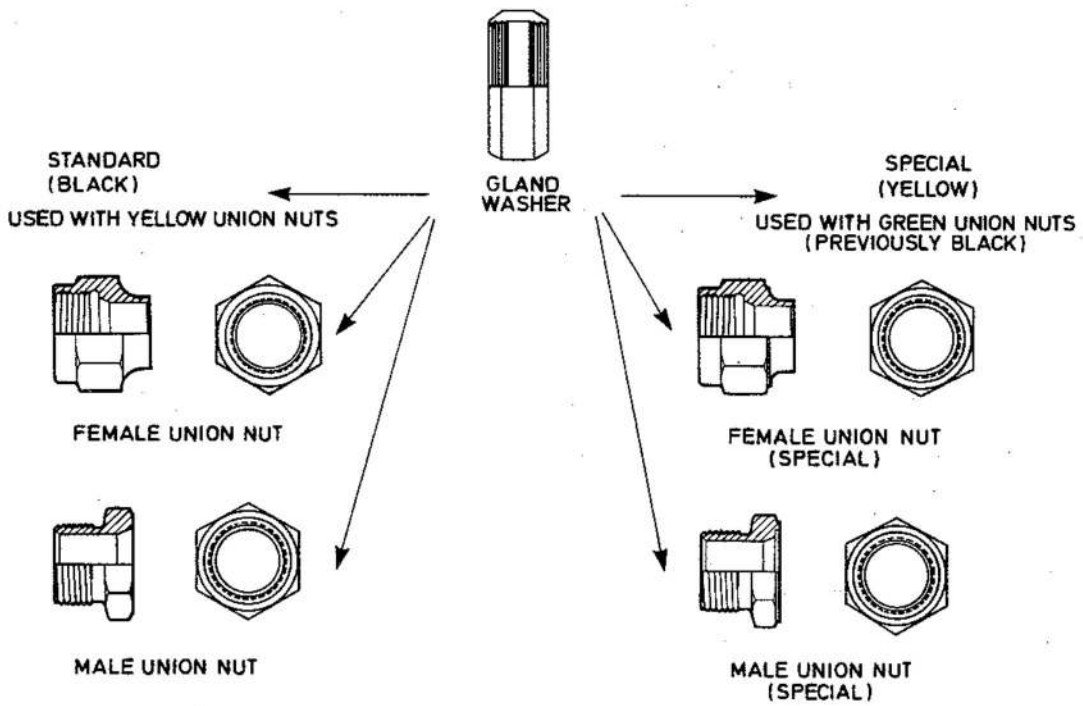


Fig 7 Matching gland washers and union nuts

Preparation of pipe

19 Ensure that the exterior of the pipe at the point where the fitting is to be attached is free from dents and scratches. The following requirements must be observed before cutting the pipe:

19.1 The length of the pipe beyond the end of an adjacent bend must not be less than that shown in Table 5 (fig 10 and 11).

Note ...

In special circumstances this length can be reduced by progressively removing the pipe from its seating in the pipe fitting, or component, as the union nut is unscrewed.

19.2 Light alloy pipes which have a protective coating must be cleaned for a distance of 15 mm from the end.

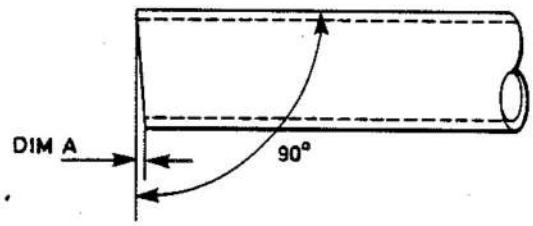
19.3 The end face of the pipe must be square with the outside diameter within the tolerance shown in fig 8.

19.4 The end of the pipe, both internally and externally must be free of burrs.

19.5 Light alloy pipes must be chamfered internally (fig 9) to accept the internal bushing (para 21)

Note ...

The internal cleanliness of the tube is to be checked and any filings, swarf or metal particles removed.



α . = 90 degrees

A = 0.5 mm maximum for 4 mm to 25 mm pipe outside diameters

Fig 8 Preparation of pipe ends

TABLE 5 MINIMUM STRAIGHT REQUIRED TO DISENGAGE NUT

Nominal Pipe Diameter	Dimensions	4	6	8	10	12	14	16	18	20
Female Union Nut	L (mm)	31	33	34	42	42	42	42	42	44
Male Union Nut	L1 (mm)	36	36	36	43	43	44	44	44	45

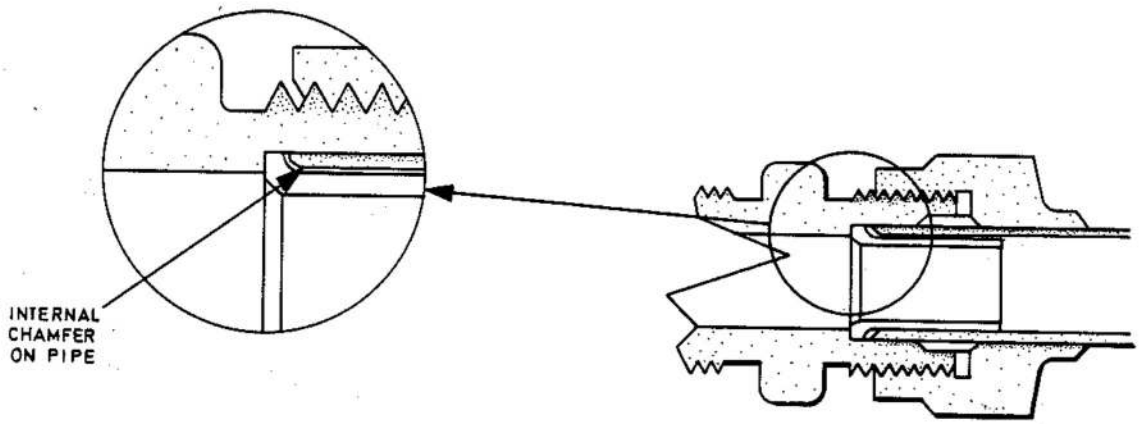


Fig 9 Pipe chamfers for bushings

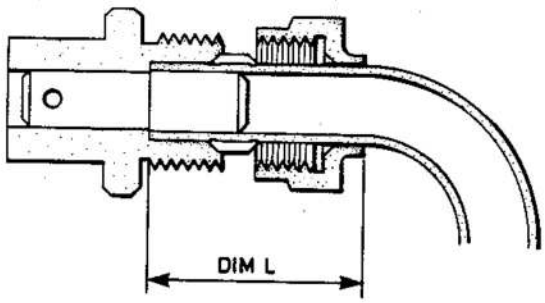


Fig 10 To disengage the female union nut

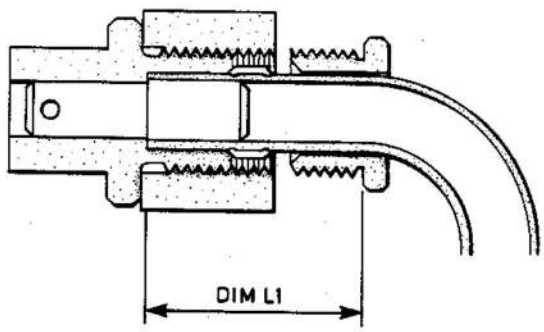


Fig 11 To disengage the male union nut

Operating instructions

20 The correct setting collar, mandrel, gland washer and union nut having been selected grip the tool in a bench vice (fig 12). Before commencing work note the limited tightening needed from Tables 6 and 7.

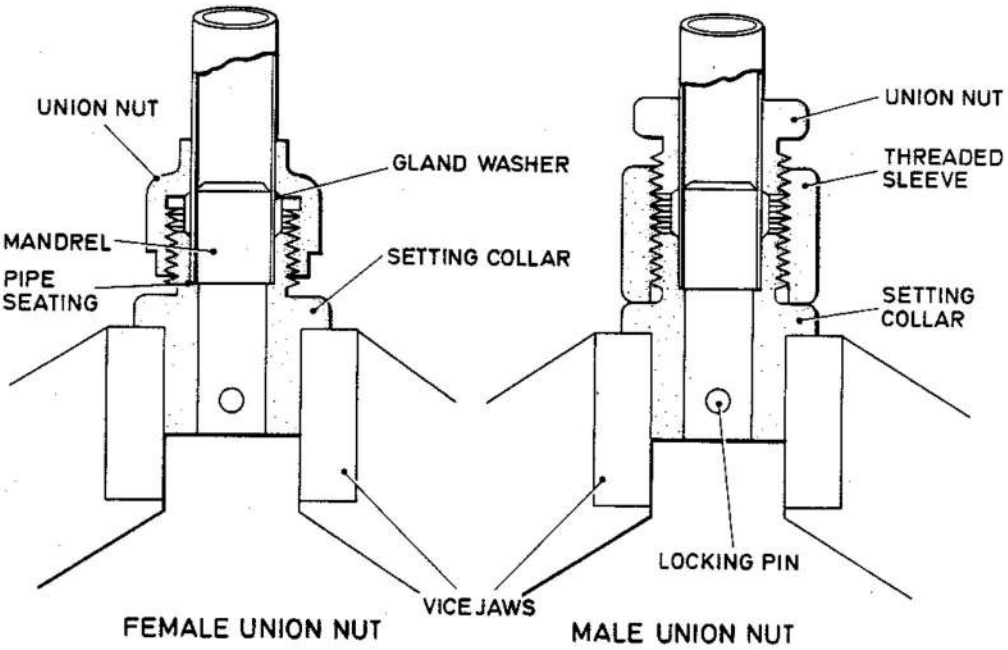


Fig 12 Presetting the gland washer

WARNING ...

DO NOT USE OIL ON OXYGEN SYSTEM PIPING. SEE PROCEDURES IN CHAPTER 16

Lightly coat the gland washer and thread of the union nut with oil Nato H515 (OM15) and proceed as follows:

20.1 Slide the union nut and then the gland washer over the end of the pipe.

20.2 Insert the end of the pipe into the setting collar and ensure that the pipe is firmly against its seating in the setting collar.

20.3 Run the union nut over, or into the setting collar until it is handtight.

Note ...

It is possible that some male union nuts, at maximum size tolerance, and female union nuts, at low size tolerance may be hard to turn by hand. It is permissible to use a spanner in these circumstances.

20.4 Mark the nut to establish its position relative to the setting collar and then continue to turn the nut to the appropriate fraction of a turn as specified in Table 6 for standard and Table 7 for special gland washers.

Note ...

It may be necessary to use a spanner extension arm for presetting the large sizes.

20.5 Continue to tighten the union nut by means of a spanner until the moment the pipe is felt to be pinched (this is ascertained when the pipe, held between thumb and forefinger, can no longer be rotated in its seating). In the case of an elbowed pipe, avoid applying leverage to turn the pipe in its seating by application of pressure on the elbowed portion and counter the effects of the weight of the pipe to ensure that it is squarely home in its seating.

20.6 At this stage, colour mark the nut to establish its position relative to the setting collar and then continue to tighten it to the appropriate fraction of a turn specified in Tables 6 and 7.

TABLE 6 PRESETTING STANDARD GLAND WASHERS

Pipe material	Nominal od pipe, mm							
	06	08	10	12	14	16	18	20
AG5 UZ 15NS				1/2 turn				
XC 18S				3/4 turn				

TABLE 7 PRESETTING SPECIAL GLAND WASHERS

Pipe material	Nominal od pipe, mm							
	06	08	10	12	14	16	18	20
AG5				1/2 turn				3/4 turn
Z3 CN18 Z10 CNT18				3/4 turn				

Note ...

It may be necessary to use a spanner extension arm when presetting large diameter fittings.

20.7 Unscrew the union nut, remove the pipe from the setting collar and use a soft brush to remove any metal particles and chips of plating.

Fitting bushings

21 Light alloy pipes to which a 'special' gland washer has been preset, for use with 'special' fittings, must have a bushing inserted into the bore for reinforcement.

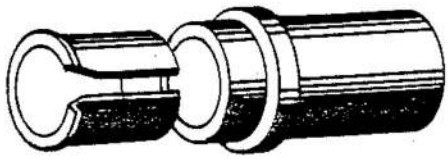


Fig 13 Bushing for light alloy pipes

22 The correct bushing is to be selected from Table 8 and after carrying out the presetting operation, inserted into the pipe, using a soft hammer, if necessary.

Notes ...

(1) The pipe must be chamfered internally to accept the bushing.

(2) The bore size of 4, 6 and 8 mm pipes must be checked since two bushings are available for each of these pipes. Use the stepped plug gauge (Table 3).

TABLE 8 BUSHINGS FOR USE WITH SPECIAL FITTINGS

Pipe diameter, mm outside	inside	Bushing part number	Colour
6	3.7 to 4	FC. 4 x 6 PI	yellow
	4 to 4.3	FC. 4 x 6 PS	black
8	5.7 to 6	FC. 6 x 8 PI	yellow
	6 to 6.3	FC. 6 x 8 PS	black
10	7.7 to 8	FC. 8 x 10 PI	yellow
	8 to 8.3	FC. 8 x 10 PS	black
12	10	FC.10 x 12	black
14	12	FC.12 x 14	black
16	14	FC.14 x 16	black
20	18	FC.18 x 20	black

Identification of bushings

23 All bushings are made of steel which is given a coloured protective treatment:

23.1 The FC ..... PI bushings are given a yellow cadmium bichromate treatment.

23.2 The FC ..... PI bushings are given a grey/black cadmium treatment.

Examination

24 Upon completion of the presetting operation, including insertion of a bushing if necessary, the gland washer/pipe and union nut must be visually checked as follows:

24.1 The minimum distance between the gland washer and pipe end is 3.5 mm (0.138 in).

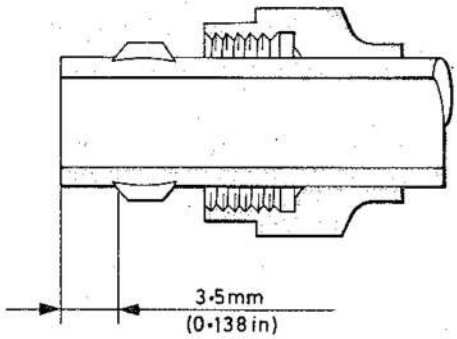


Fig 14 Minimum distance between gland washer and pipe end

24.2 The conical sides of the gland washer, formed when the union nut is tightened, must be perfectly smooth, and free from traces of metal pick-up or judder marks.

Note ...

It is an acceptable condition that the gland washer may be rotated on the pipe provided there is no perceptible longitudinal movement along the pipe.

24.3 Ensure that components are free from chips or scales of plating, especially at the ends of threads.

24.4 In the case of 'special' fittings used in conjunction with stainless steel pipe, also check to ensure that:

24.4.1 The gland washer has been correctly formed (fig 15).

24.4.2 The conical thrust surface of the union nut has contacted the entire surface of the gland washer.

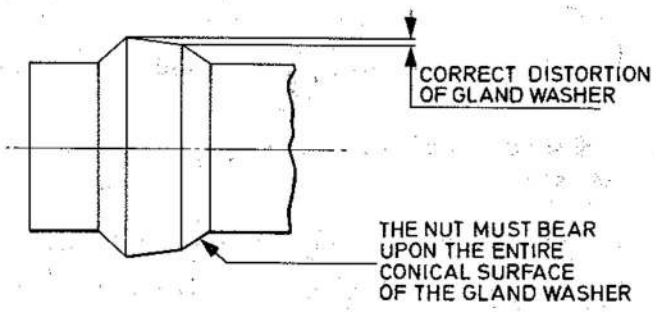


Fig 15 Correctly set gland washer

Repair

25 Repairs to this type of fitting are considered impossible so in case of damage to the pipe or fittings the whole pipe assembly is to be replaced.

Testing

CAUTION ...

Before connecting the pipe assembly fitting to test equipment refer to installation procedure para 27 and 28.

► 26 Testing is to be carried out on an hydraulic test bench at operating pressure x 2. Duration 5 minutes.

26.1 The pressure test is to be carried out in accordance with Chap. 17 of this publication. ◄

INSTALLATION

General

27 During installation it is important to ensure that the pipe is never subjected to strain, either at the couplings or on the intermediate supports. Check that the pipe assembly is the correct length by trying to move it horizontally. The gland washers must bear against the seatings at both ends. If the pipe assembly is too short, or overlong, it must be adjusted or replaced.

Procedure

28 After observing the precautions given in para 27 proceed to install the pipe assembly as follows:

28.1 Clean the union nut and the fitting onto, or into, which it is to be screwed using a lint free cloth.

WARNING ...

DO NOT USE OIL ON OXYGEN SYSTEM PIPING. SEE PROCEDURES IN CHAPTER 16

28.2 Coat the threads of the union nut with a light film of lubricant Nato H515 (OM15).

28.3 Insert the end of the pipe complete with preset gland washer, and bushing if applicable, into its seating in the fitting or element to be connected.

28.4 Run on the nut by hand until the gland washer is felt to become pinched.

28.5 From this pinched position, use a spanner to tighten the nut to the following extent:

28.5.1 Prior to a pressure test, 1/6 of a turn.

28.5.2 At first installation on the aircraft, 1/6 of a turn.

28.5.3 At subsequent installation on the aircraft 30° (1/12 of a turn).

28.5.4 For other reassembly conditions, 30° ($^1/12$ of a turn).

Note ...

Locking wire is to be fitted to all union nuts on 16 mm diameter pipe and larger.

Disassembly

29 A pipe fitted with its gland washer and union nut may be disassembled and reassembled several times to an article of equipment.

Fault diagnosis and rectification

Checking the installation

30 This can only be carried out by pressurizing the circuit. If a leak is detected at a connection proceed as follows:

30.1 Release the pressure in the system.

30.2 Unscrew the union nut until the gland washer can be examined and if the sealing mark appears to be uniform with the gland washer in good condition, check that the fitting is not under strain (para 27) then reassemble the coupling and retighten by 30° ($^1/12$ of a turn).

30.5 If the joint has deteriorated following a number of slackening and retightening operations, or if overtightened originally, replace the pipe assembly.

Note ...

If a coupling is found to be leaking, it is strictly prohibited to attempt to tighten the union nut beyond the limits specified in para 28.5.

Storage, preservation and packaging

31 Packaging and preservation is to be in accordance with specification RT50 and MAS P78.

Chapter 5

STANDARD COUPLINGS FOR AIRCRAFT METAL PIPE-LINES

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
Pipe preparation	
General	2
Use of the tube end squaring tool	3
Use of the tube end flaring tool	4
Standard couplings	
Pipe to pipe	7
Pipe to internally-coned adapter	9
Pipe to externally-coned adapter	10
Standard adapters	11
Standard hexagonal fittings for bulkheads	12
Standard flanged fittings for bulkheads	13
Standard banjo unions	14
Standard pipe unions	15
Standard end plugs and caps	16
Making a joint with standard couplings	18
Coupling security	
Use of locking wire	20
Locking-wire tool	24
Special types of coupling	
Low-pressure couplings	25
Low-pressure couplings coned rubber sleeve type	26
Metal couplings for flexible hose	27
All-metal flexible fireproof couplings	28

ILLUSTRATIONS

Fig.		Page
1	Tube end squaring tool	2
2	Tube end flaring tool	2
3	Tolerance on flared end of tube	3
4	Standard metal couplings	5
5	Bulkhead pipe fittings and banjo-type couplings	7
6	Standard pipe unions	8
7	Plugs and caps for pipe ends	8
8	Locking-wire tool	10
9	Pneumatic brake pipe coupling	11
10	Low-pressure pipe coupling	11
11	All-metal flexible fireproof coupling	11

Introduction

1. Metal couplings for joining pipe-lines in aircraft usually comprise some form of threaded coupling nut in association with a collar, or an adapter nipple and a collar. It was usual, formerly, for the metal coupling to be

made of material similar to that of the pipe-lines to be joined so as to avoid electrolytic action between the adjacent surfaces of dissimilar metals. Now, however, the material used depends upon the application; light alloy to BS L85 for low-pressure systems, non-corrodible steel for Naval use, and stainless steel for modern high-pressure systems. These metals have been found to give satisfactory results when used in conjunction with any of the metals commonly used for aircraft pipe-lines. Standard couplings are listed in AP1086, Sect. 28F.

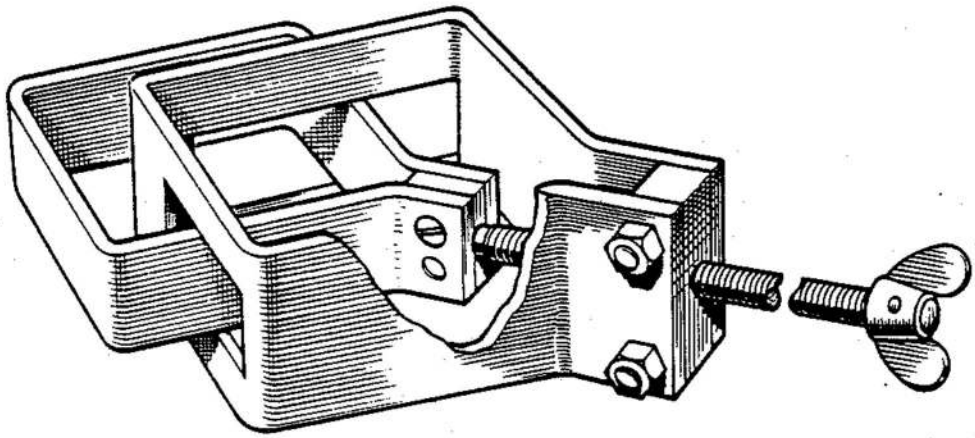


Fig.1 Tube end squaring tool

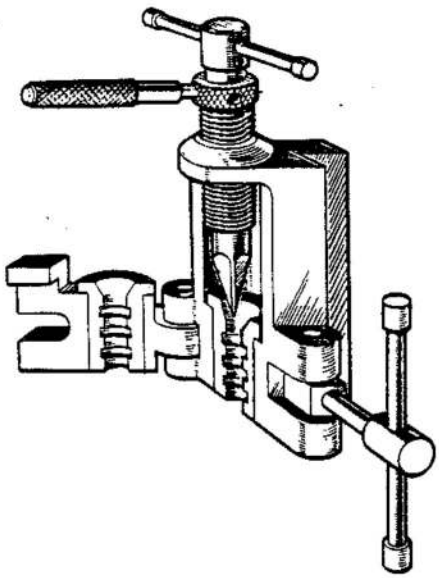


Fig.2 Tube end flaring tool

DESCRIPTION

PIPE PREPARATION

General

2. The standard types of pipe couplings require the pipe ends to be flared so that a joint capable of withstanding high mechanical and hydraulic pressures can be obtained. Special tools are necessary for squaring and

flaring the ends of the tube as follows:

Tool	Ref No
Squaring tool, tube ends	-
▶ Flaring tool, tube ends (tubes 3/16 in to ½ in od)	1C/1278212
Flaring tool, tube ends (tubes ⅝ in to 1.1/4 in od)	1C/1278213 ◀

Use of the tube end squaring tool (fig 1)

3 The tube end squaring tool consists of two rectangular parts, one sliding within the other and operated by a traversing screw. In use the tool is placed over the end of the tube to be squared so that the tube is enclosed in the space formed by the two rectangular parts of the tool. Position the tool near enough to the end of the tube to act as a guide for the saw or file being used to square up the end without distorting the tube. Next, saw or file the end of the tube so that it is level with the tool face. Unclamp the tube and remove any burrs from the squared end.

Note ...

When handling soft metal, such as light alloy to BS L85, thin strips of fibre packing must be positioned between the tube and the clamping surfaces of the tool. Oil the end of the traversing screw and the thread. Take care not to distort the tool.

Use of the tube end flaring tool (figs 2 and 3)

▶4 For tubes having outside diameters of 3/16 in to ½ in the flaring tool reference number 1C/1278212 must be used; for tubes having outside diameters of ⅝ in to 1.1/4 in the flaring tool reference number 1C/1278213 is required. ◀ Sets of half-bushes, in pairs covering the range of tube sizes quoted, are provided with each tool.

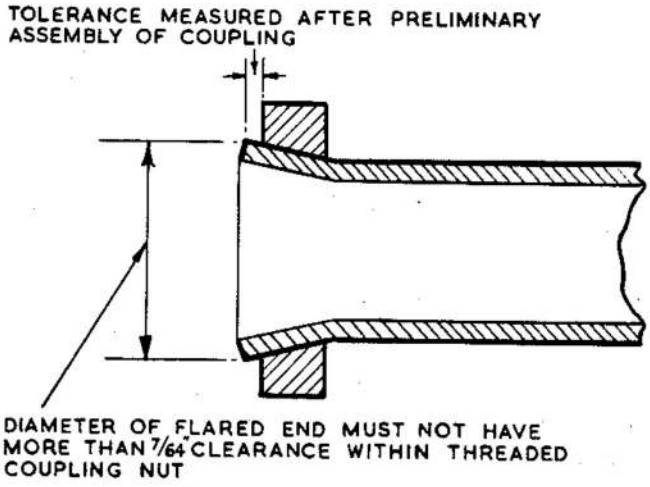


Fig 3 Tolerance on flared end of tube

5 The sequence of operations for flaring a tube end is as follows:

(1) Ensure that the previously squared tube end is free from burrs.

(2) Place the appropriate sleeve or union nut and collar correctly on the tube.

(3) Choose a pair of half-bushes of the correct size and insert them in the tool.

(4) Remove any oil or grease from the bush and tube nut.

(5) Clamp the tool on the tube so that the end of the tube is level with the outer face of the countersunk end of the split bush.

(6) Using a tommy bar, screw in the threaded sleeve until the cone spindle begins to force the tube wall outwards towards the countersunk bore of the bush.

(7) At this stage rotate the cone spindle by the handle provided and, at the same time, gradually advance the cone with the aid of the tommy bar until the tube end is flared to the limit imposed by the bush.

(8) Unclamp the tube and examine the flared end for concentricity and freedom from fracture or other damage. Check the tolerance on the flared end as shown in para 6.

Note ...

A slow forward feed of the cone spindle, and generous use of the rotating handle will assist in the obtaining of flawless, uniform results.

6 The amount of flare on the tube end can be checked as follows:

(1) Assemble and tighten the required coupling on the flared end.

(2) The flared end of the pipe should enter the union nut with not more than 7/64 in clearance (fig 3).

(3) Dismantle the coupling and slide the collar as far as it will go towards the flared end (fig 3).

(4) Measure the distance from the end of the pipe to the collar face, the following tolerances being permissible:

Outside diameter of tube	Tolerance
3/16 to 1/4 in	0.010 to 0.020 in
5/16 to 3/8 in	0.020 to 0.030 in
7/16 to 21/2 in	0.030 to 0.050 in

Note ...

For correct coupling the sleeve must seat squarely on the flared end of one pipe whilst the union nut must be pushed up to the collar on the other pipe end and rotate freely round it.

STANDARD COUPLINGS

Pipe to pipe (fig 4)

7 One form of coupling is now standard for the direct coupling of lengths of metal tubing used in aircraft pipe-lines. The coupling is made in a range

of sizes suitable for pipes from 1/8in. to 2in.o.d. and comprises a sleeve, a coupling nut, a collar and an adapter nipple (fig.4(A)). To couple the two pipes, the sleeve is pushed over one pipe end, and the union nut and collar over the other pipe end. Both ends are then flared with the flaring tool. An adapter nipple is then fitted in the pipe end on which are the union nut and collar. The nut is then screwed on to the sleeve, thereby pulling the flared pipe ends into tight contact with the coned surface of the adapter nipple. Before the pipe coupling is regarded as satisfactory, it must be taken apart and the extension of the pipe end beyond the collar measured as described in para.6.

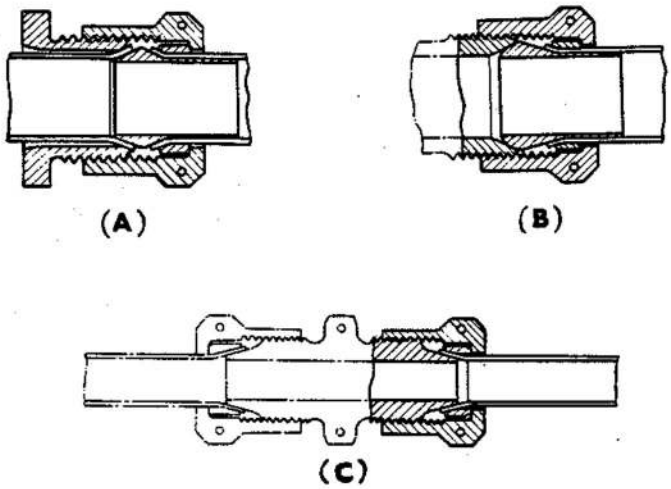


Fig.4 Standard metal couplings

8. When tightening the pipe couplings, the components of which are made of light alloy (BS L85), avoid overstressing the screw threads of the sleeve and union nut by excessive tightening. If the pipes have been flared, and the coupling assembled correctly, a pressure-tight joint will be made without difficulty.

Note...

The couplings in the range 1/8in. to 2in.o.d. are easily overtightened and careful avoidance of overstressing must be made. Special care in this respect must be exercised when tightening the 1/8in. and 3/16in.o.d. sizes.

Pipe to internally-coned adapter (fig.4)

9. This type of coupling (fig.4(B)) provides a means of connecting a pipe to an externally-threaded adapter which is countersunk at the mouth. The coupling comprises a union nut, a collar and a spherical-ended adapter nipple. To assemble the coupling, the nut and collar are pushed over the pipe end which is then flared. The skirt of the nipple is placed in the flared pipe and the union nut screwed on to the externally-threaded adapter until the nipple is tightly gripped between the collar and the internally-coned surface of the adapter. To ensure that the flaring of the pipe is satisfactory, dismantle the coupling and examine it as described in para.6.

Pipe to externally-coned adapter (fig.4)

10. This type of coupling (fig.4(C)) provides a means of connecting a pipe to an adapter having an externally-coned nozzle, and comprises a union nut and collar only. To assemble the coupling, the nut and the collar are pushed over

the pipe end which is then flared. The flared end is pushed over the conical end of the adapter and the union nut is tightened, thus compressing the flared pipe between the collar and the coned adapter. The coupling must be dismantled and examined as previously described.

Standard adapters (fig.5)

11. The standard adapter (fig.5(a)) is a double-ended fitting with a central hexagonal collar to enable it to be held securely in the jaws of a spanner whilst pipe connections are made at either end. Standard adapters are threaded externally and are coned internally or externally at each end. The range of adapters comprises fittings with both similar (fig.5(a)) and dissimilar (fig.5(b)) ends to enable various types of pipe fittings to be coupled when required. Adapters are normally made of light alloy to BS L85.

Standard hexagonal fittings for bulkheads (fig.5)

12. Hexagonal fittings for bulkheads (fig.5(c)) are similar to standard adapters except that, at one end, a longer threaded portion accommodates a nut which is used to clamp the fitting to a bulkhead through which the pipeline must pass. Two washers are provided to prevent the hexagon collar and the nut from being tightened against the surfaces of the bulkhead. Bulkhead fittings are made of light alloy to BS L85 normally and are obtainable with similar or dissimilar ends. This type of fitting must be held with a spanner to prevent rotation when connecting or disconnecting pipes.

Standard flanged fittings for bulkheads (fig.5)

13. Flanged bulkhead fittings (fig.5(d)) are similar to the hexagonal type except that each comprises one fixed and one loose flange, each with bolt holes, to enable the fitting to be mounted rigidly on the bulkhead. In addition to the externally and internally-coned fittings, a flanged fitting is available which has a long internally threaded body in which a banjo union can be screwed (fig.5(e)).

Standard banjo unions (fig.5)

14. The standard banjo union comprises an externally-threaded hollow screw fitted into a single or double-ended pipe connection to which it is sealed top and bottom by bonded seals or soft metal joint rings. Banjo unions are made in a range to suit pipe sizes from 1/8 to 1.1/4in.o.d. and are normally made of light alloy to BS L85. Fig.5(f), (g) and (h) show the various types of banjo unions, each of which may have either internally or externally-coned connections.

Standard pipe unions (fig.6)

15. A series of elbows, T-pieces and four-way pipe unions having connections which are either similar or dissimilar in type and size, are illustrated in fig.6.

Standard end plugs and caps (fig.7)

16. When it is desired to blank off a section of a system, it is normal practice to do so at a union body or at a component; pipe couplings, nipple plugs and cone caps to AGS1140 and AGS1159 (fig.7) are available for the purpose. If, however, it is desired to blank off a pipe on which is fitted an inner sleeve, an adapter nipple must be used in conjunction with a cap cone and an outer sleeve (fig.7(d)).

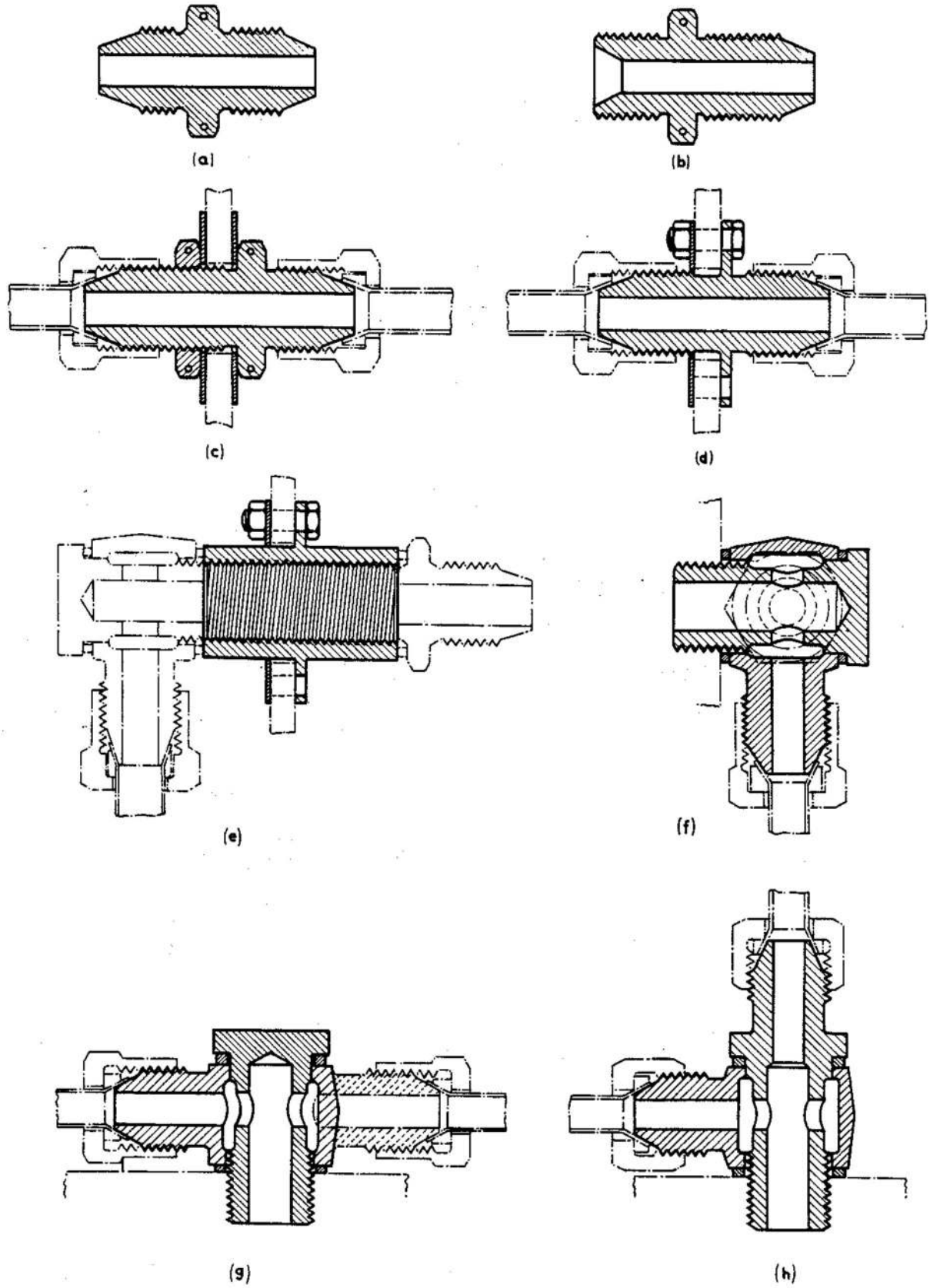


Fig.5 Bulkhead pipe fittings and banjo-type couplings

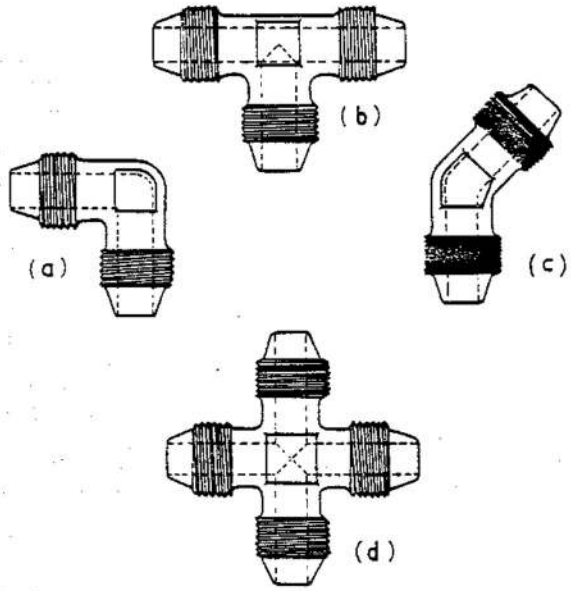


Fig.6 Standard pipe unions

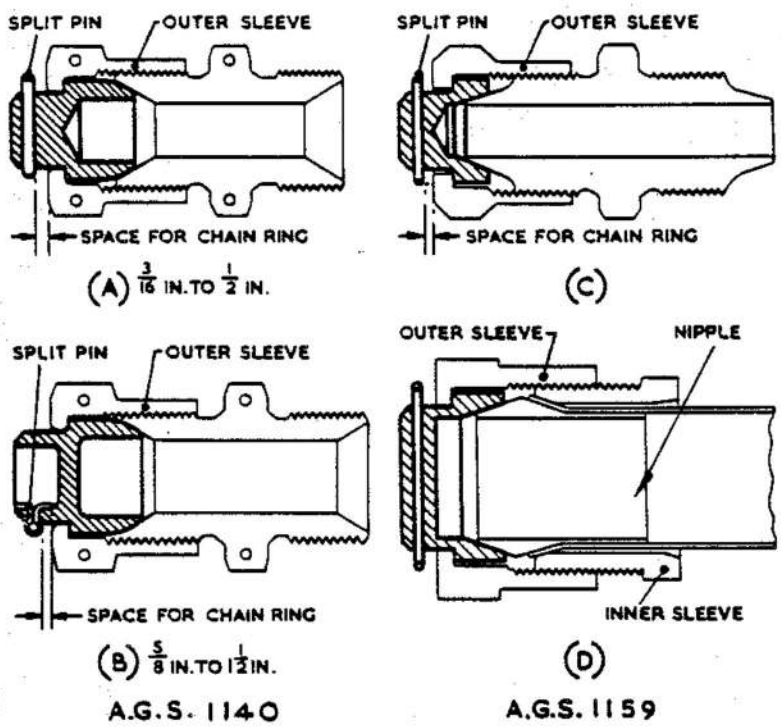


Fig.7 Plugs and caps for pipe ends

17. The working pressure of the plugs and cone caps are as follows:

Size	Pressure
Up to 1/2in. BSP	3000 lb/in^2
5/8in. to 1in. BSP	500 lb/in^2
1.1/4in. BSP	200 lb/in^2

Making a joint with standard couplings

18. Before any connection of rigid pipes is made, the flared ends must be examined for cracks (especially at the base of the flare), thinning (due to faulty flaring or subsequent tightening), or other damage which may cause fracture of the pipe or a faulty connection; the pipe ends and all the coupling parts must be perfectly clean when a joint is to be made. With the exception of oxygen pipe-lines, lubricant molybdenum disulphide anti-seize compound to DTD5530, Nato symbol S-722, (Ref.no.34B/9437518) or system fluid as described in AP1803A, Vol.1, Sect.2. Chap.1) must be applied when assembling ▶ all standard metal couplings. ◀

19. Two set-spanners must be used when tightening or loosening joints; an adjustable spanner must not be used except in an emergency. When a joint has been made it must be tested for leaks, if possible under working conditions. Do not attempt to cure a leak by tightening further the union nut until the coupling has first been dismantled and examined for a cause of leakage, e.g. damage or burrs on the flared pipe end or on the adapter nipple. Any defects must be corrected before reassembling the coupling.

COUPLING SECURITY

Use of locking wire

20. Where there is provision for the use of locking wire all such couplings must be locked, after the joints have been made satisfactorily, with non-corrodible steel wire. The gauge of the wire may vary for the different sizes of coupling, and may be 16, 18 or 20 s.w.g. The sizes of the wire holes in some fittings may also vary; in such cases, the gauge of wire which will pass through the smallest hole must be used, after a check has been made that the size variation is not due to damage or an obstruction in the hole. The wire must be given at least half-a-turn round a coupling and must be threaded through the hole provided in the direction that will prevent the union nut or sleeve from unscrewing. Alternatively the wire may be connected to some external, rigid, point to ensure that the coupling is effectively locked. Finally the ends of the wire are to be securely clinched.

21. Another form of wire locking is provided by a union nut in which a groove has been machined close to the end of the hexagon; each corner of the hexagon is closed across the groove and thus provides six positions through which the locking wire can be threaded.

22. Union nuts and bodies must be individually connected to some external rigid point, so that it is impossible for the component to move in relation to that point. However, provided that no relative movement is possible, the nut, body and external rigid point may be connected by a single circuit of the locking wire if necessary.

23. No attempt must be made to drill couplings without locking-wire holes but when renewal is necessary, preference must be given to pre-drilled replacements, particularly if the joint is forward of the fireproof bulkhead.

Note...

It is essential that, when locking couplings employing any form of adapter, the adapter itself is locked securely to some external rigid point, e.g. on a bulkhead adapter a locking plate secured to the bulkhead may be used, or the adapter may be wire-locked to a small lug bolted to the bulkhead. When the standard adapter is used (fig.5(a)) it must be locked to a suitable rigid point close to the pipe run. When locking the unions themselves, it is preferable to anchor the wire to some external point (para.22), but if necessary the unions may be locked to the adapter in the manner described in para.20.

Locking-wire tool (fig.8)

24. A locking-wire tool which can be made up by units is shown in fig.8. The tool is made from 10 s.w.g. steel wire, one end being doubled over as shown and the other being formed into a tang and fitted with a small handle. By means of this tool, locking wires can be quickly and neatly secured. The tool is particularly useful for locking couplings which are not easily accessible. Use the tool as follows:

(1) Take a length of locking-wire and pass one end through the hole in the union nut to be locked.

(2) Draw the ends of the wire together and place the hook end of the tool over them at a pre-determined distance from the nut.

(3) Bend the wires at a right-angle; twist the tool until the wires are twisted the required amount. Then pass the free ends through the opposite nut and repeat the twisting operation.

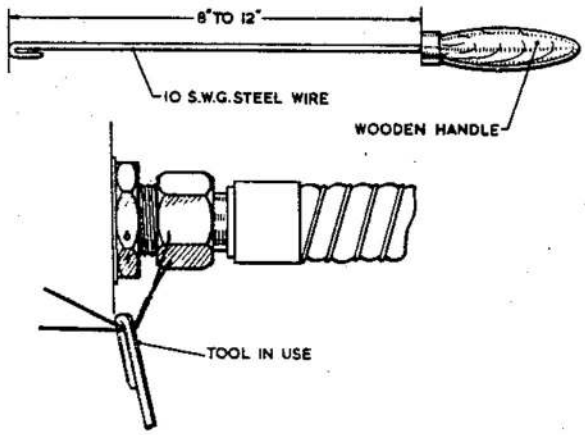


Fig.8 Locking-wire tool

SPECIAL TYPES OF COUPLING

Low-pressure pipe couplings (fig.10)

25. This type of coupling (fig.10) is available for straight, "T", or elbow unions, and incorporates a rubber ring which is compressed around the end of the pipe by the pressure exerted by the union nut. The end of the pipe, which is cut off square and is unflared, abuts against a shoulder in the body

of the union. The coupling (AGS838) is used in certain low-pressure pipelines and vent connections.

Low-pressure pipe couplings coned rubber sleeve type (fig.9)

26. This type of coupling (fig.9) comprises a conical-ended rubber sleeve, the smaller end of which fits the chamfered recess in an externally- threaded metal fitting. The metal pipe, passing through the rubber sleeve, enters a counterbore in the metal fitting, and a coupling nut enclosing the rubber sleeve screws on to the fitting so as to compress the rubber against the tube and make an air-tight joint. This coupling is designed for use in pneumatic brake systems and it must be ensured, when assembling, that the pipe end is correctly positioned and is in contact with the shoulder in the union.

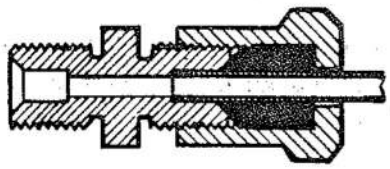


Fig.9 Pneumatic brake pipe coupling

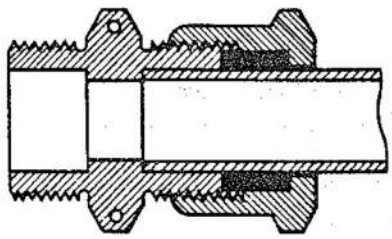


Fig.10 Low-pressure pipe coupling

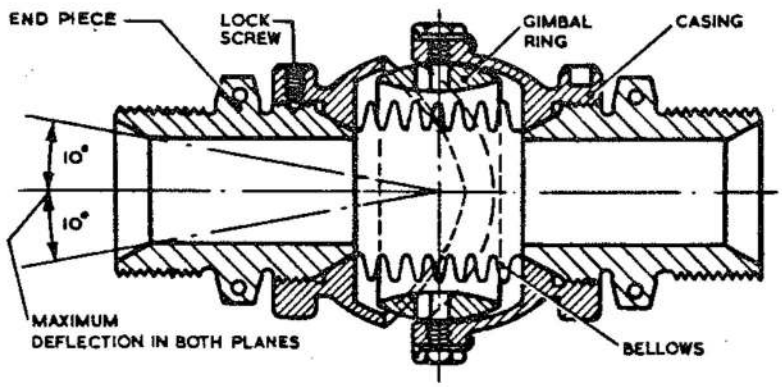


Fig.11 All-metal flexible fireproof coupling

Metal couplings for flexible hose

27. Various types of metal couplings are available for use with flexible hose. Some of these end fittings are AGS parts whilst others are peculiar to the type of flexible pipes to which they are fitted.

All-metal flexible fireproof couplings (fig.11)

28. An all-metal flexible coupling (fig.11) may be incorporated in a rigid pipeline in a coolant, oil, fuel, or air system; the available range will

accommodate pipes from 0.375in. to 3.0in. diameter. The purpose of the coupling is to absorb movement due to vibration and thus prevent its transmission to the rigid pipe-lines and their unions which might, in time, suffer fatigue or other damage; it is normally installed at both ends of pipes subject to vibration.

29 The effect of the design is to produce a universal joint through which coolant, oil, fuel, or air may pass. It comprises basically, two casings and a gimbal ring; through the centre is a bellows, each end of which is flared and held in position by the conical ends of special end pieces which are themselves screwed and coned for standard AGS fittings. In use the casings hinge through two planes and flexibility is imparted to the pipe-line union by the bellows.

30 When attaching or detaching an AGS fitting, the coupling must be held by the hexagon on the end piece to avoid damage to the locking screw and the casing with consequent loosening of the bellows.

Note ...

Some couplings have a hexagon incorporated in each casing, these must not be used for holding the coupling.

Pipe testing

31 After manufacture all pipe-lines are to be proof pressure tested in accordance with Chap 17 of this publication.

31.1 Proof testing is to be carried out at 1.5 times system pressure for a duration of five minutes.

Chapter 6

ROTARY COUPLINGS FOR AIRCRAFT METAL PIPE-LINES

Part Nos.10-20P 2325A (Port), 10-20P 2326A (Starboard)
10-20P 2069A (Port), 10-20P 2070A (Starboard)
10-20P 3357A (Port), 10-20P 3352A (Starboard)

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
General	3
SERVICING	
Dismantling	5
Examination	6
Assembly	7
Testing	8

ILLUSTRATIONS

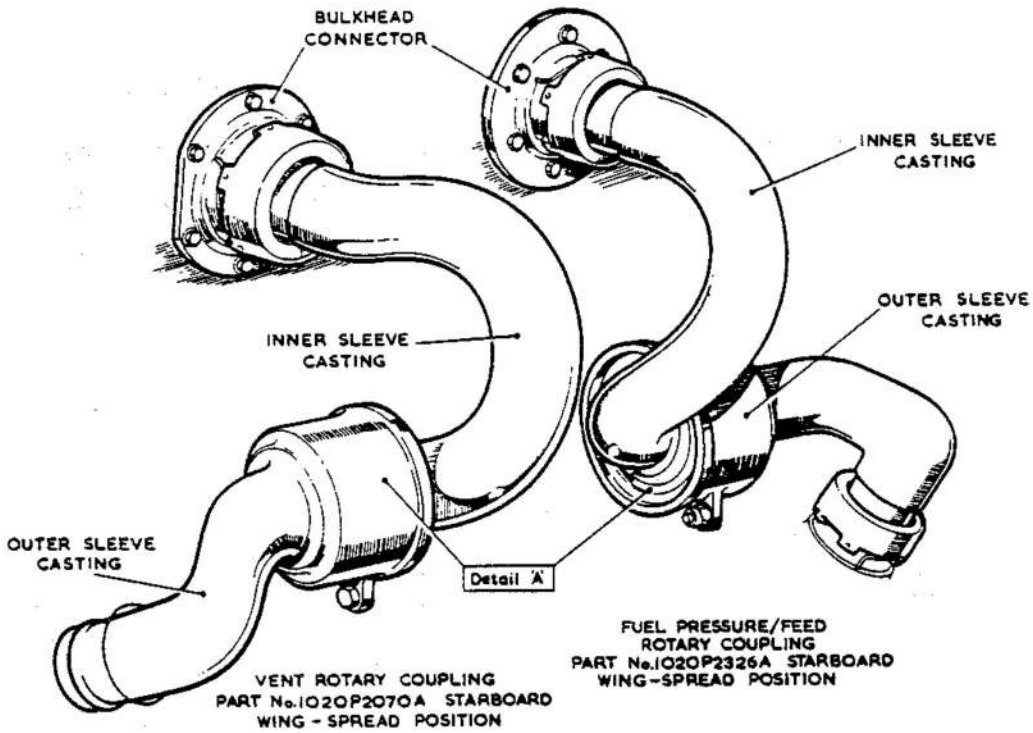
Fig.		Page
1	Fuel pressure/feed and vent rotary couplings	2
2	Torque testing	4
3	Fuel recirculation rotary coupling, Part No.10-20P 3357A(Port)	5

Introduction

1. Rotary couplings are provided in the fuel system of an aircraft, at the wing fold, to ensure a positive means of supplying and feeding fuel to and from the outer wing tanks; similar couplings are used in the vent and recirculation systems. The part numbers for the couplings are allocated as follows:-

System	Part Nos.	
	Port wing	Starboard wing
Fuel pressure feed pipe couplings	10-20P 2325A	10-20P 2326A
Vent pipe couplings	10-20P 2069A	10-20P 2070A
Recirculation pipe couplings	10-20P 3357A	10-20P 3352A

2. The vent pipe couplings are similar to those for fuel pressure feed with a Flexibox mechanical seal fitted in the drum of each coupling. The recirculation couplings are more simply constructed. Instructions for the disconnection of rotary couplings from their associated pipe-lines are contained in AP 4647A, Vol.1.



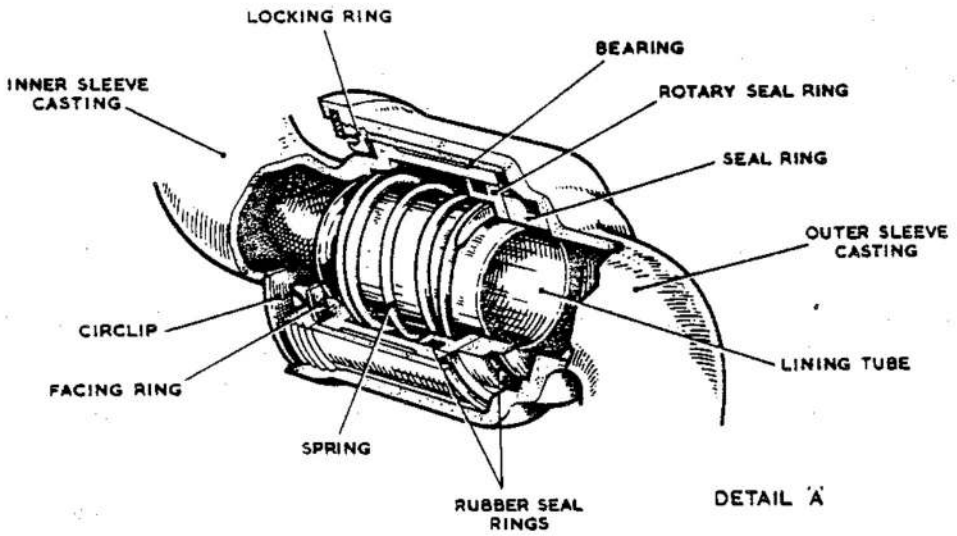


Fig.1 Fuel pressure/feed and vent rotary couplings

DESCRIPTION

General (fig. 1 and 3)

3. Rotary couplings for fuel pressure feed and vent pipe-lines consist of two main components, the inner and outer sleeve castings; the castings of the fuel system couplings differ in shape from those of the vent system and each system is provided with port and starboard versions. At the joint of these components the outer sleeve casting, the static member, is formed into a drum in which the boss of the inner sleeve casting, the rotary member, is retained by a locking ring and locked by a circlip. In order to effect a leakproof

joint under rotary conditions a mechanical seal, consisting of a spring-loaded rotary seal ring, is housed within the boss. The face of this seal ring is driven by the spring against the face of a compounded carbon sealing ring housed in the drum. Close contact between these true faces prevents leakage. The boss is aligned within the drum by two raised bearing surfaces on the interior of the boss, which is a push fit inside a bearing sleeve. This sleeve, in turn, is a drive fit inside the wall of the drum. Leakage is further prevented by the fitting of synthetic rubber seal rings, one in a groove around the skirt of the rotary seal ring is in contact with the bearing sleeve, whilst a static ring resiliently supports the carbon seal within the drum. A PTFE facing ring makes a leakproof joint between the locking ring and a shoulder on the boss. To assist in the speedy transfer of fuel, the interior of the boss is fitted with a lining tube belled at one end. The belled end is housed in a recess at the inner end of the boss.

4. Rotary couplings for the recirculation pipe-line consist of a pipe and spindle assembly contained within an outer casting. The pipe and spindle assembly sections are welded together at right angles, and the spindle is provided with four slotted ports to allow the necessary fuel circulation. An inner and outer bush are housed in the drum of the outer casting to align the spindle assembly. To ensure a leakproof joint one synthetic rubber seal ring is used, fitted in a groove on the spindle. This ring is in close contact with the interior machined surface of the outer casting drum. When assembled, the spindle is retained in the outer casting drum by a circlip secured in a groove on the outer bush.

SERVICING

Dismantling

5. Dismantle the couplings as follows:

Fuel and vent system rotary couplings

(1) Remove the circlip and unscrew the locking ring.

(2) Extract the inner sleeve casting, complete with the lining tube and rotary seal ring assembly. The end of the spring is an interference fit in the inner end of the boss.

(3) Lift out the carbon seal ring and the rubber seal ring from the drum.

Recirculation rotary coupling

(4) Remove the circlip.

(5) Extract the pipe and spindle assembly complete.

Examination

6. Examine all the parts for wear and tear, and the mechanical seal for the penetration of grease. This condition may be found on earlier types, where the drums have been fitted with a grease nipple, and is caused by over-lubrication. The mechanical seal must be free from grease. Excessive greasing in detrimental to the satisfactory operation of the couplings, possibly resulting in a fuel leak. Clean the parts thoroughly before assembling and renew the rubber seals.

Assembly

7. Assemble or reassemble couplings as follows:-

Fuel and vent system rotary couplings

(1) Replace the rubber seal on the recess of the bottom face of the carbon seal ring and insert the assembly in the bottom end of the drum, with the true face of the seal ring upwards.

(2) Replace the rubber seal in the groove of the rotary seal ring. Smear the bearing surfaces of the boss and the bearing sleeve in the drum with grease Nato symbol G-287 (Ref.No.34B/2241973).

(3) Fit the boss assembly within the drum and compress the spring. Engage the locking ring, ascertaining that the facing ring is seating properly. Tighten the locking ring and replace the circlip. Check that the torque required to swivel the coupling does not exceed 3·8 lb/in. when tested on a rig similar to that shown in fig.2. Adjust the tightness of the locking ring as necessary.

Recirculation rotary coupling

(4) Replace the rubber seal ring on the groove of the spindle.

(5) Smear the bearing surfaces with grease Nato symbol G-287 (Ref.No. 34B/2241973).

(6) Fit the spindle within the drum of the outer casting and replace the circlip.

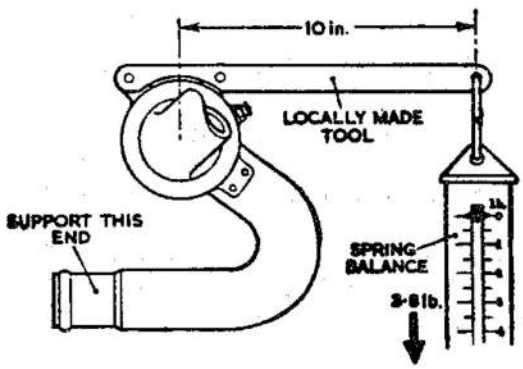


Fig.2 Torque testing

Testing

8. The following test must be applied before a rotary coupling is installed in an aircraft fuel system, or at any time when the serviceability of the unit is in doubt. The test pressures to be used are as follows:-

Fuel feed coupling	112 lb/in^2
Vent coupling	12 lb/in^2
Recirculation coupling	50 lb/in^2

Pressure test

► (1) Blank off the end of one casting and fill the assembly with OM-15. ◄

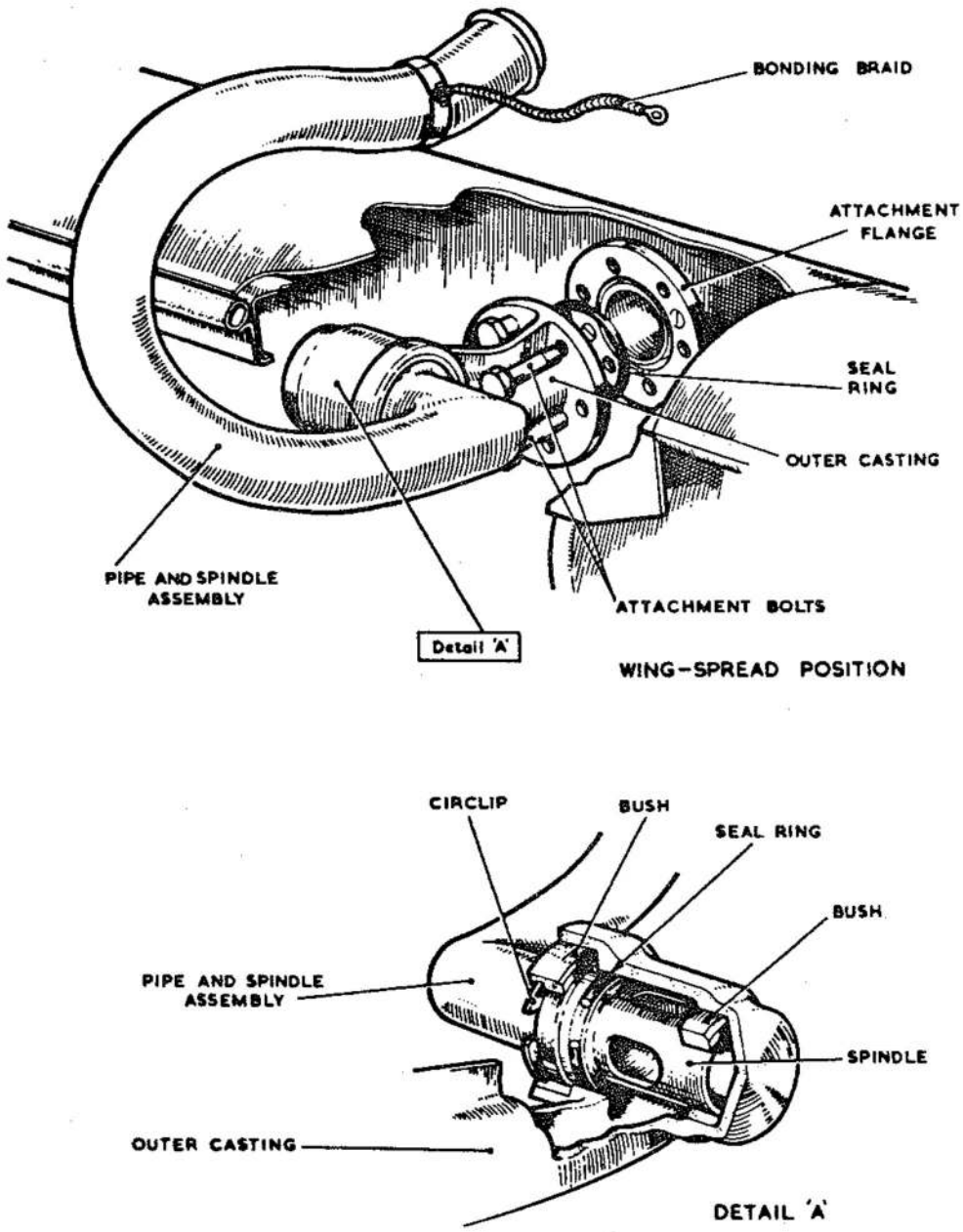


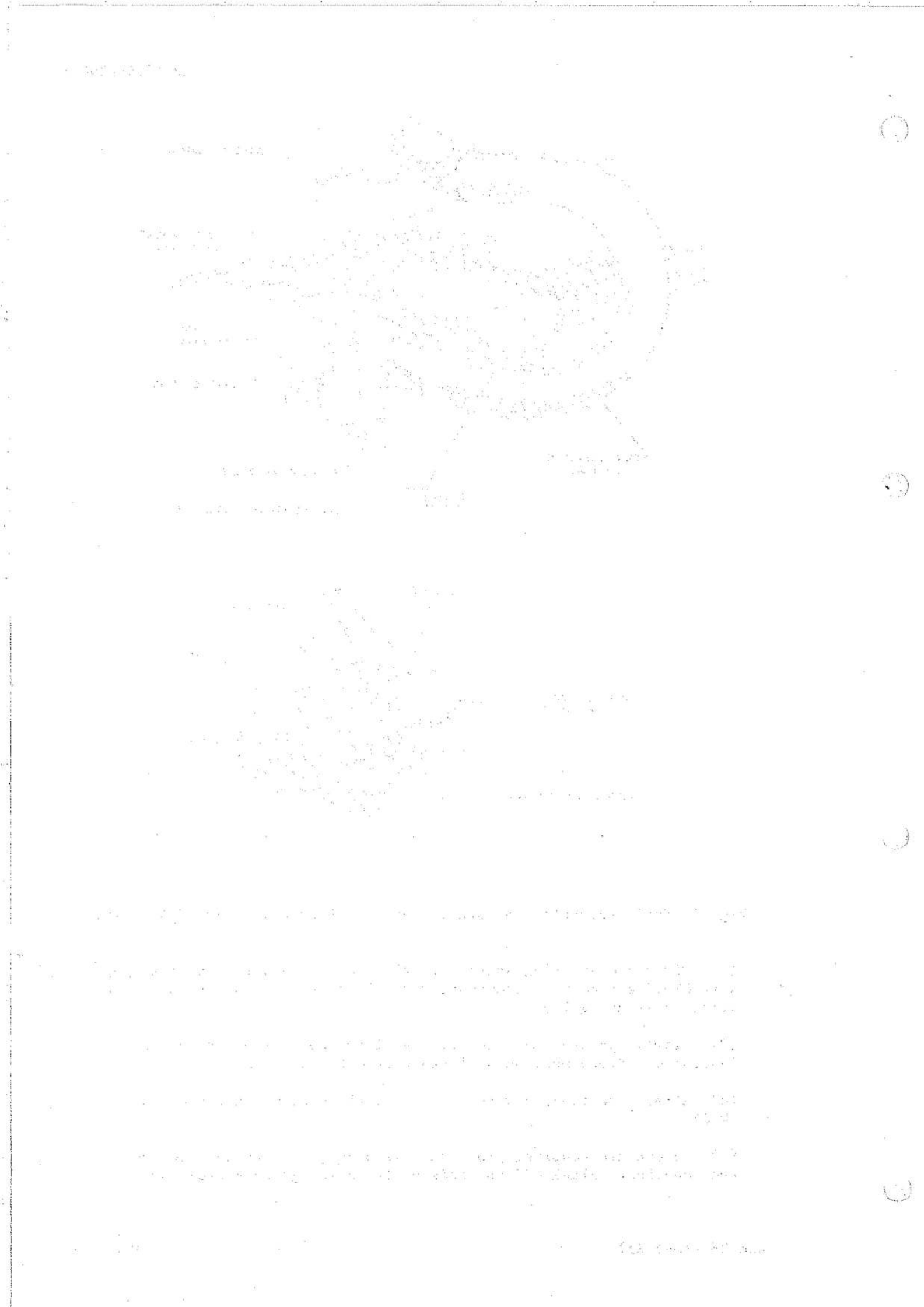
Fig. 3 Fuel recirculation rotary coupling, Part No. 10-20P 3357A (Port)

(2) Fit a pressurising adapter to the end of the other casting, top up ► with OM-15 and connect the adapter to the test panel of the test rig ◄ static pressure gallery.

(3) Slowly operate the hand pump until the specified test pressure is indicated. There must be no leakage from the coupling.

(4) After a satisfactory test, release the pressure and drain away the ► OM-15. ◄

(5) Remove the coupling from the test panel, and the test equipment from the coupling. Blank off the ends of the castings to exclude dust.



Chapter 7

BRITISH METRIC SWAGED PIPE COUPLINGS

CONTENTS

Para

1 Introduction

Description

2 Types and construction

5 Coupling combinations

10 Pipe coupling and fitting standards

11 Tightening standard fittings

12 Tightening thrust wire fittings

13 Precautions

15 Coupling assembly

17 Tube materials

18 Protection and blanking plugs

19 Part numbering

Swaging procedure

20 Introduction

23 Swaging machine

Wicksteed Type 1000 Mk 2A swaging machine

24 Description

28 Setting up the Type 1000 machine for swaging

29 Pipe expander, setting effective expansion length

30 Calibration of torque limiter (Torquemaster unit)

31 Preparation of pipe ends and fittings

34 Preparing 5 and 6 mm diameter tubing for swaging

35 Swaging procedure

36 The swaging operation

37 Completing the swaging by hand

38 Completing the swaging with power drive

39 Completion checks and curing Loctite

41 Torquemaster adjustment

Quality assurance

44 Checking operation of swaging machine and tooling

46 Criteria for effective swaging

Post swaging operations

47 Inspection

49 Cleaning

Pressure testing

50 Pressure test requirements

51 Test procedure for oil and fuel system parts

Maintenance

53 General

54 Tube expanders

55 Swaging machine and other tools

Installation of replacement pipes in aircraft

56 Preparation

57 Procedure, short pipes

58 Procedure, long pipes

60 Post installation checks

61 Pipe adjustment

62 Pipe re-swaging

CONTENTS (continued)

Table		Page
1	BMSP coupling data	4
2	Cross reference list for AS/EAG/PAN standard pipe couplings	7
3	Approved tube materials for use with BMSP couplings	12
4	Tube sizes and swaging information	19
5	Pipe bend limitations	21
6	Fault diagnosis	26
7	Minimum clearances for installation	35

Fig		Page
1	Pipe to pipe coupling	3
2	Pipe to component coupling	3
3	Coupling combinations	5
4	Male nut, thrust wire fitting	11
5	Female nut, thrust wire fitting	11
6	Pressure blank fittings	13
7	Protection blank fittings	14
8	Swaging machine, Type 1000 (Wicksteed)	16
9	Setting position of bearing block	17
10	Pipe expander	20
11	Pipe bend limitations	21
12	Position of pipe in fitting	24
13	Torque calibration unit	27
14	Measurement of test specimen	28
15	Tube section thinning and penetration	29

Introduction

1 The British Metric Swaged Pipe Couplings (BMSPC) replace the AGS series for all metric size pipes from 5 to 28 mm diameter, both for repairs and for new equipment. A range of associated pipe adaptors to ground equipment systems is included in the range. The couplings are secured to the pipe by a swaging operation which is carried out by a small machine which can be clamped in a vice. The fittings conform with SBAC AS4302 and AS43090 specifications and the threads are to ISO metric series standards.

DESCRIPTION

Types and construction (fig 1 and 2)

2 The coupling uses the configuration of a spherical nipple and a mating 60° cone to form the seal and the nipple is secured to the pipe by a swaging operation which expands the pipe into internal grooves in the nipple or coupling.

3 The high pressure system has couplings in sizes 5, 6, 10, 14 and 16 mm which are approved for pressures up to:

3.1 Steel couplings, 272 bar (4 000 lbf/in²). Temperature range -60°C to +200°C.

3.2 Aluminium alloy, 204 bar (3 000 lbf/in²). Temperature range -60°C to +130°C.

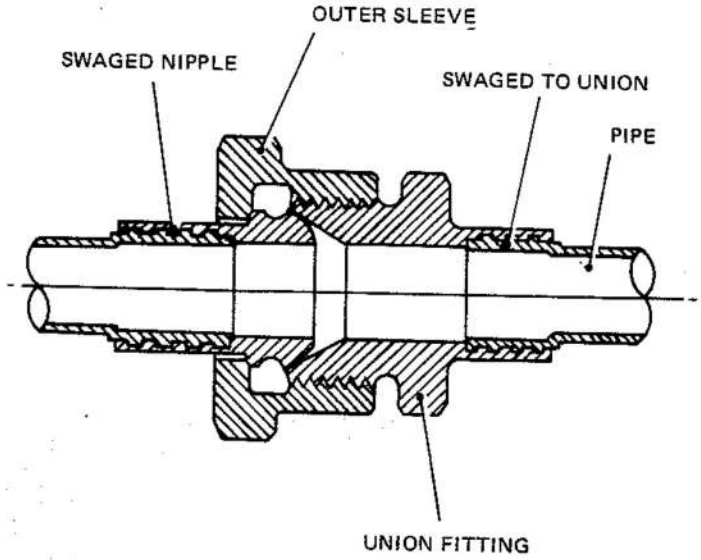


Fig 1 Pipe to pipe coupling

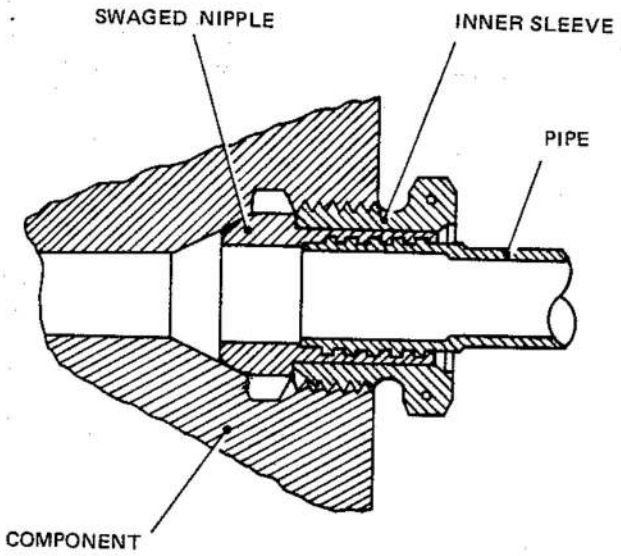


Fig 2 Pipe to component coupling

4 The low pressure system has couplings in sizes 8, 12, 15, 18, 22 and 28 mm for up to 68 bar (1 000 lbf/in²) for both steel and aluminium fittings. The temperature range is as given in para 3.1 and 3.2.

TABLE 1 BMSP COUPLING DATA

Pipe size (mm)	High or low pressure	Maximum working pressure (bar)ϕ		Thread size	Hexagon A/F size (mm spanner size)			
		Steel	Al alloy		Male nuts and adaptors	Female nuts	Tee pieces and elbows	Hex bulkhead adaptors
05	H.P.	272	204	M 12 x 1,0	14	14(16*)	12	17
06	H.P.	272	204	M 14 x 1,5	17	17	12	19
08	L.P.	68	68	M 16 x 1,5	17	19	14	22
10	H.P.	272	204	M 18 x 1,5	19	22	17	24
12	L.P.	68	68	M 20 x 1,5	22	24	19	27
14	H.P.	272	204	M 22 x 1,5	24	27	22	30
15	L.P.	68	68	M 24 x 2,0	27	27	22	32
16	H.P.	272	204	M 25 x 2,0	27	30	22	36
18	L.P.	68	68	M 27 x 2,0	30	30	24	36
20	H.P.	272	204	M 30 x 2,0	32	36	27	41
22	L.P.	68	68	M 32 x 2,0	36	36	30	41
28	L.P.	68	68	M 39 x 2,0	41	46	36	50

Note ...

*16 mm A/F for aluminium alloy female nuts.

Note ...

ϕ 272 bar = 4 000 lbf/in²
204 bar = 3 000 lbf/in²
68 bar = 1 000 lbf/in²

Coupling combinations

5 The range of couplings and fittings is shown in Table 1. The pipe is mechanically swaged into the internal rectangular grooves in either a nipple (1), or union pipe fitting (3) (fig 3). Couplings from 5 to 8 mm outside diameter have five internal grooves. The addition of an internally threaded outer sleeve (2) completes the basic three piece pipe to coupling combinations.

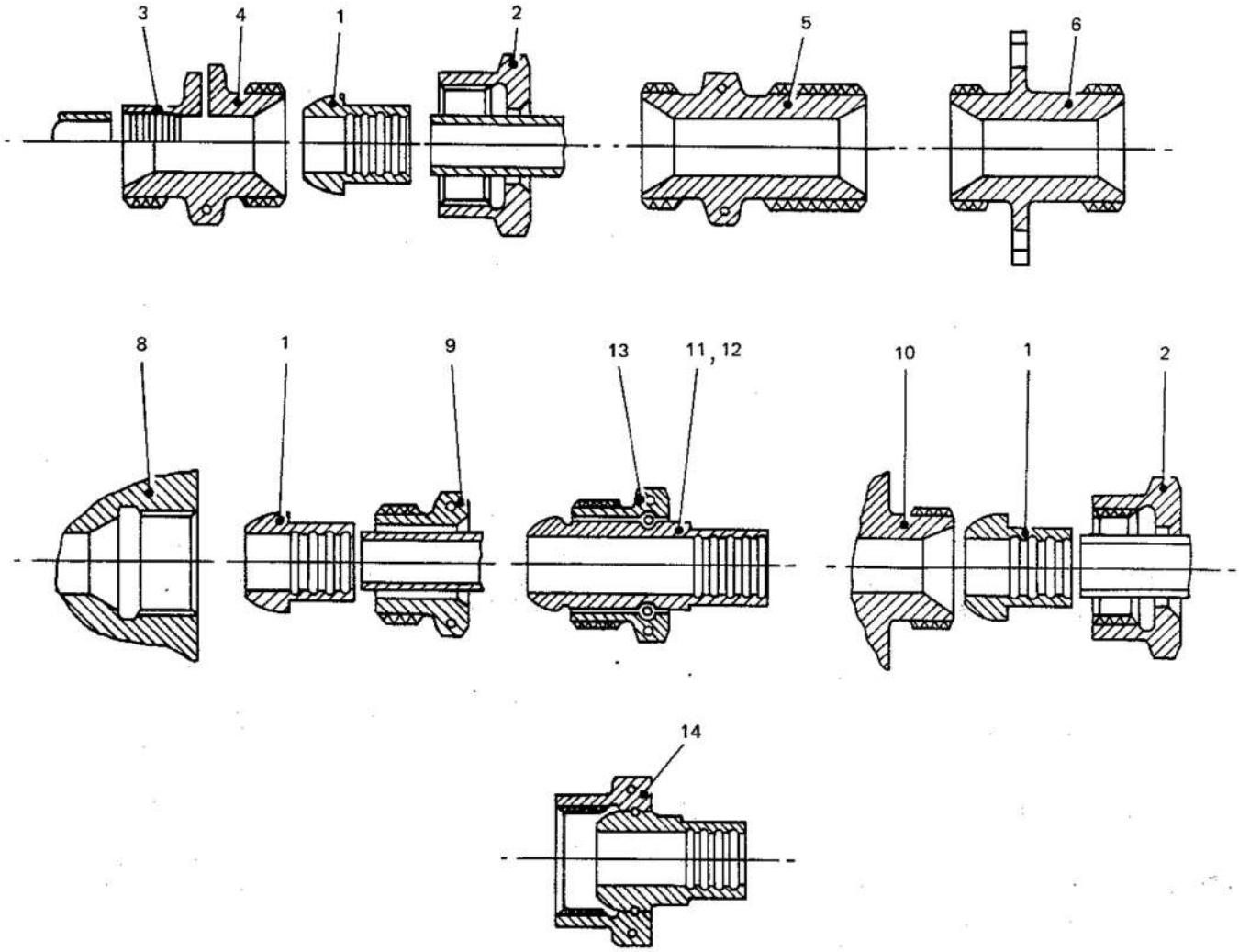


Fig 3 Coupling combinations

Item	Description	Pt No	Item	Description	Pt No
1	Nipple (swaged)	AS 43022	9	Internal sleeve	
2	Outer sleeve (nut)	AS 43021	10	External sleeve (thread)	
3	Union pipe fitting	AS 43024			
4	Union body	AS 43023	11	Inner sleeve	AS 46730
5	Hexagon bulkhead	AS 43027	12	Outer sleeve	
6	3 bolt flanged bulkhead union	AS 43032	13	Thrust wire (male nut)	AS 46732
7	6 bolt flanged bulkhead union	AS 43034	14	Thrust wire (female nut)	AS 43045
8	Housing (female thread)	NA			

6 Pipe to pipe joints are made up from alternative combinations of the nipple (1) and the outer sleeve (2) to union body (4), hexagon bulkhead union (5), a three bolt flanged bulkhead union (6), or six bolt flanged bulkhead union (7). All these items have external threads and union ends which form a sealing surface with the nipple (1) and outer sleeve (2).

7 Sealing to components is obtained by using a swaged nipple (1) either:

7.1 With an internal sleeve (9) for an internal tapping (specification ref RS 735) or

7.2 With an outer sleeve (2) for an external thread (10).

8 Alternative sealing to components may also be made by replacing items (1) and (9) by an adaptor assembly which may incorporate:

8.1 An inner sleeve (11) attached by a thrust wire.

8.2 An outer sleeve (12) attached by a thrust wire.

Notes ...

(1) Thrust wires are also used in male and female nuts (13 and 14) and in alternative fittings to connectors.

(2) Components must have a bore machined to specification RS 735.

9 Apart from the swaged fittings, items (1 and 3) and the assemblies incorporating thrust wires, all other fittings are available in both steel and light alloy versions which are physically interchangeable (Table 2) but the system pressure must be taken into consideration.

Note ...

The pressure rating of light alloy fittings is limited to 204 bar (3 000 lbf/in^2).

Pipe coupling and fitting standards

10 To ensure a perfect fit between the coupling and mating components or for pipe to pipe joints, a perfectly aligned and tension free pipe run must be achieved. This is to ensure correct contact of the nipple to cone seating which is essential to prevent seeping or leakage from the coupling.

Tightening standard fittings

11 The coupling nuts shall be capable of being run up finger tight to seat the coupling nipple on to the cone seating before application of the final tightening torque. A further angular movement of 30° (half one spanner flat) by set spanner is adequate tightening torque for standard fittings.

Tightening thrust wire fittings (figs 4 and 5)

12 The coupling nuts shall be capable of being run up finger tight to seat the coupling nipple on to the cone seating before application of the final tightening torque. A further angular movement of 60° (one spanner flat) by set spanner is adequate tightening torque at first assembly. All subsequent reassemblies being from finger tight plus a turn of up to 30° max (half one spanner flat).

TABLE 2 CROSS REFERENCE LIST FOR AS/EAG/PAN STANDARD PIPE COUPLINGS

SBAC No	New SBAC No	EAG No	PAN No	Description
AS 43021	-	EAG 5591/1	PAN 4011	Nut union, steel
43022	-	5591/2	4010	Nipple swaged, carbon steel
43023	-	5591/3	4013	Union, steel
43024	-	5591/4	4012	Union swaged, carbon steel
43025	-	5591/5	4057	Nut union - male, steel
43026	-	5591/6	4056	Nipple - blanking short, steel
43027	-	5591/7	4014	Union - hexagon bulkhead, steel
AS 43030	-	5591/10	4055	Plug - blanking, steel
43031	-	5591/11	4016	Reducer, steel
43032	-	5591/12	4017	Union - bulkhead triangular flange, steel
43034	-	5591/14	4015	Union - bulkhead sealed flange, steel
43036	-	5591/16	4032	Elbow - 90°, steel
43037	-	5591/17	4018	Tee - equal, steel
43038	-	5591/18	4019	Tee - reduced branch, steel
43039	-	5591/19	4020	Tee - increased branch, steel
AS 43040	-	5591/20	4021	Tee - reduced end, steel
43041	-	5591/21	4022	Tee - increased end, steel
43042	-	5591/22	4033	Elbow assy - 90° nipple end female nut union, steel
43043	-	5591/23	4034	Elbow - 90° nipple end female nut union, steel
43044	-	5591/24	4046	Nut union - thrust wire female, steel
43045	-	5591/25	4048	Thrust wire - nut union female, steel
43046	-	5591/26	4023	Tee assy - nipple branch female nut union, steel
43047	-	5591/27	4024	Tee - nipple branch female nut union
43048	-	5591/28	4025	Tee assy - nipple end female nut union
43049	-	5591/29	4026	Tee - nipple end female nut union, steel
AS 43051*	AS 46733	5591/31	4053	Union adaptor assy - nipple end male union, steel
43052*	46734	5591/32	4052	Union adaptor - nipple end male nut, steel
43053*	46730 46731	5591/33	4047	Nut union - thrust wire male, steel
43054*	46732	5591/34	4049	Thrust wire - nut union male, steel

Note ...

Where a new AS No is shown the old part is superceded by the new component.

(continued)

TABLE 2 CROSS REFERENCE LIST FOR AS/EAG/PAN STANDARD PIPE COUPLINGS (continued)

SBAC No	New SBAC No	EAG No	PAN No	Description
AS 43055*	AS 46739	EAG 5591/35	PAN 4035	Elbow assy 90° nipple end male nut union, steel
43056*	46740	5591/36	4036	Elbow 90° nipple end male nut union, steel
43057*	46735	5591/37	4027	Tee assy nipple branch male nut union, steel
43058*	46736	5591/38	4028	Tee - nipple branch male nut union, steel
43059*	46737	5591/39	4029	Tee assy - nipple end male nut union, steel
AS 43060*	46738	5591/40	4030	Tee nipple end male nut union, steel
43061	-	5591/41	4042	Cross - equal branches, steel
43062	-	5591/42	4043	Cross - equal branches, steel
43063	-	5591/43	4037	Elbow - 135°, steel
43064	-	5591/44	4038	Elbow assy - 135° nipple end female nut union, steel
43065	-	5591/45	4039	Elbow - 135° nipple end female nut union, steel
43066*	AS 46741	5591/46	4040	Elbow assy - 135° nipple end male nut union, steel
43067*	46742	5591/47	4041	Elbow - 135° nipple end male nut union, steel
43068	-	5591/48	4054	Nipple - blanking long, steel
43069	-	5591/49	4100	Elbow - 90° bulkhead, steel
AS 43070	-	5591/50	4102	Tee - branch bulkhead, steel
43071	-	5591/51	4103	Tee - end bulkhead, steel
43072	-	5591/52	4101	Elbow - 135° bulkhead, steel
AS 43091	-	5592/1	4060	Nut union - female, al alloy
43093	-	5592/3	4061	Union, al alloy
43095	-	5592/5	4076	Nut union, al alloy
43097	-	5592/7	4062	Union - hexagon bulkhead, al alloy
43098	-	5592/8	4077	Washer plate, al alloy
43099	-	5592/9	4080	Nut thin, al alloy
AS 43100	-	5592/10	4075	Plug - blanking, al alloy
43101	-	5502/11	4066	Reducer, al alloy
43102	-	5592/12	4065	Union bulkhead triangular flange, al alloy
43103	-	5592/13	4079	Washer plate triangular (al alloy)
43104	-	5592/14	4064	Union bulkhead sealed flange, al alloy
43105	-	5592/15	4078	Washer plate, al alloy
43106*	AS 43180	5592/16	4071	Elbow - 90° (al alloy)

(continued)

TABLE 2 CROSS REFERENCE LIST FOR AS/EAG/PAN STANDARD PIPE COUPLINGS (continued)

SBAC No	New SBAC No	EAG No	PAN No	Description
AS 43107*	AS 43181	EAG 5592/17	PAN 4063	Tee - equal, al alloy
43108*	43187	5592/18	4067	Tee - reduced branch, al alloy
43109*	43188	5592/19	4068	Tee - increased branch, al alloy
AS 43110*	43189	5592/20	4069	Tee - reduced end, al alloy
43111*	43190	5592/21	4070	Tee - increased end, al alloy
43131*	43182	5592/41	4073	Cross - equal branches, al alloy
43132*	43183	5592/42	4074	Cross - reduced branches, al alloy
43133	-	5592/43	4072	Elbow - 135°, al alloy
43139*	43184	5592/49	4104	Elbow - 90° bulkhead, al alloy
43140*	43185	5592/50	4106	Tee - branch bulkhead, al alloy
43141*	43186	5592/51	4107	Tee - end bulkhead, al alloy
43142	-	5592/52	4105	Elbow - 135° bulkhead, al alloy
AS 43180	-	-	T B A	Elbow - 90°, al alloy
43181	-	-	T B A	Tee - equal, al alloy
43182	-	-	T B A	Cross equal branches, al alloy
43183	-	-	T B A	Cross reduced branches, al alloy
43184	-	-	T B A	Elbow - 90° bulkhead, al alloy
43185	-	-	T B A	Tee branch bulkhead, al alloy
43186	-	-	T B A	Tee end bulkhead, al alloy
43187	-	-	T B A	Tee reduced branch, al alloy
43188	-	-	T B A	Tee decreased branch, al alloy
43189	-	-	T B A	Tee reduced end, al alloy
AS 43190	-	-	T B A	Tee decreased end, al alloy
43191	-	-	PAN 4135	Reduced adaptor assy - nipple end male nut union, steel
43192	-	-	4138	Reduced adaptor - nipple end male nut union, steel
43193	-	-	4133	Cone blank, steel
43194	-	-	4132	Nut union - cone blank, steel

(continued)

TABLE 2 CROSS REFERENCE LIST FOR AS/EAG/PAN STANDARD PIPE COUPLINGS (continued)

SBAC No	New SBAC No	EAG No	PAN No	Description
AS 46730	-	-	PAN 4050	Nut union - thrust wire - male, steel
46731	-	-	4051	Nut union - thrust wire - male 5,0 mm sizes, steel
46732	-	-	4045	Thrust wire - nut union - male, steel
46733	-	-	4084	Union adaptor assy - nipple end
46734	-	-	4083	Union adaptor - nipple end - male nut union, steel
46735	-	-	4148	Tee assy - nipple branch - male nut union, steel
46736	-	-	4149	Tee - nipple branch male union, steel
46737	-	-	4143	Tee assy - nipple end male nut union, steel
46738	-	-	4144	Tee - nipple end - male nut union, steel
46739	-	-	4141	Elbow assy - 90° nipple end male nut union, steel
AS 46740	-	-	4142	Elbow 90° - nipple end male nut union, steel
46741	-	-	4085	Elbow assy - 135° nipple end male nut union, steel
46742	-	-	4086	Elbow 135° nipple end male nut union, steel

Precautions

13 Finger tightness should ensure contact of the nipple to cone seating in both standard and thrust wire fittings. If this is not achieved or resistance is not felt during the 30° tightening movement check for:

13.1 Tight threads.

13.2 Distortion or mal-adjustment of pipe assembly.

13.3 Distortion or pull up of structure.

14 The code of practice illustrated in Air Diagram 105B-1172-D1 (Sheets 1, 2 and 3) must be strictly followed to ensure a high standard of coupling maintenance and handling.

Coupling assembly

15 The use of two spanners for tightening and releasing of fittings is mandatory, except when tightening or releasing the standard male or female nut onto a major component or a locked bulkhead fitting.

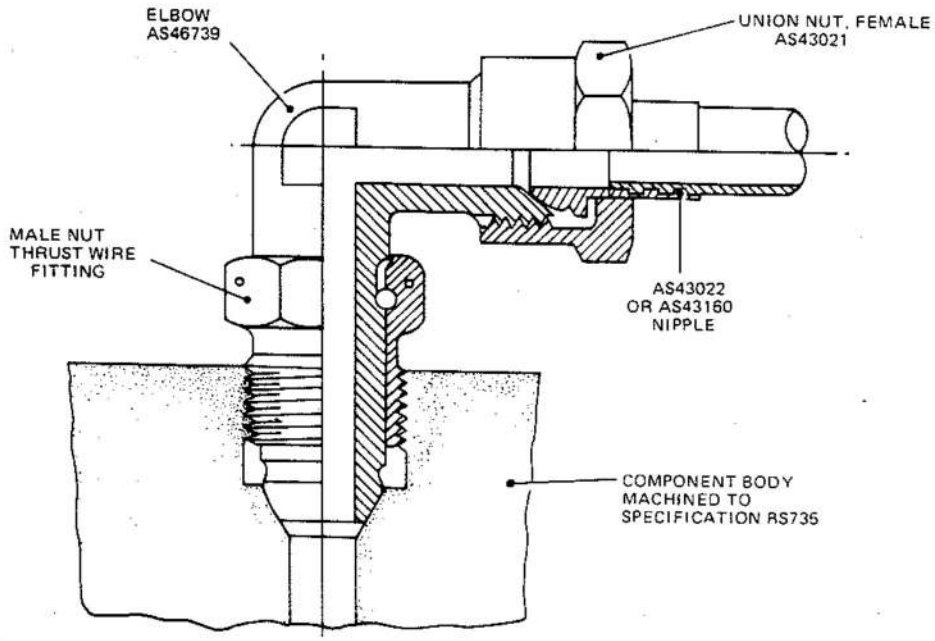


Fig 4 Male nut, thrust wire fitting

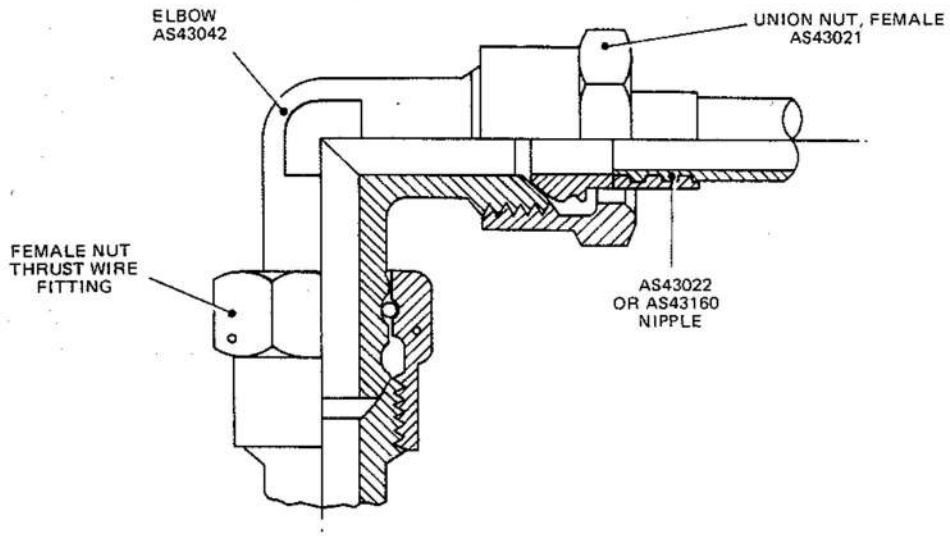


Fig 5 Female nut, thrust wire fitting

16 When tightening or releasing a standard pipe to pipe coupling only the spanner on the loose male or female nut should be rotated through the required angular movement, the second spanner being held stationary and used to react the tightening torque, thus preventing any torque being induced into the pipe assemblies. Similarly when attaching or removing a pipe assembly from a thrust wire fitting, a second spanner shall be used on the nipple hexagon to react the tightening torque being induced into the fitting.

Tube materials

17 Five tube materials, Nimonic 75, DTD5016, T72, T73 and 6061 T4 are approved for use with BMSP Couplings. The relevant sizes are listed in Table 3.

Notes ...

(1) It is design policy that Nimonic 75 is specified in a different diameter to DTD5016, T72 and T73 to prevent possible use of a low pressure tubing in a high pressure system. This can result in high pressure Nimonic 75 tubing being used for low pressure ancillary system lines.

(2) DTD5016 tubing is being replaced by T72 and T73.

(3) All coupling and tube sizes up to 10 mm diameter are cleared for use with gaseous nitrogen up to normal approved working pressures.

TABLE 3 APPROVED TUBE MATERIALS FOR USE WITH BMSP COUPLINGS

Hydraulic system pressure		Tube material	Tube sizes	
bar	lbf/in²		(mm wall)	
272	3944	Nimonic 75 (BACM 116)	5 x 0.5	14 x 1.0
			6 x 0.5	16 x 1.2
			10 x 0.8	20 x 1.5
68	986	DTD 5016 T72 and T73	8 x 0.5	18 x 0.6
			12 x 0.5	22 x 0.8
			15 x 0.5	28 x 1.0
Ancillary system pressure				
68	986	6061 T4 (BACM 123)	6 x 0.6	10 x 0.8
			8 x 0.6	12 x 0.8
			10 x 0.6	14 x 0.8

Protection and blanking plugs

18 The full range of pressure blanking fittings is illustrated in fig 6 and protection blanks are illustrated in fig 7. It is essential that full use is made of these items when dismantling.

Part numbering

19 The part numbers used initially on various aircraft were EAG 5591 series for steel fittings and EAG 5592 series for aluminium alloy fittings. The Panavia 4000 series part numbers originally used for Tornado aircraft are now superceded by AS series part number. Cross referenced lists for AS/PAN/EAG to BMSPC are given (Table 2).

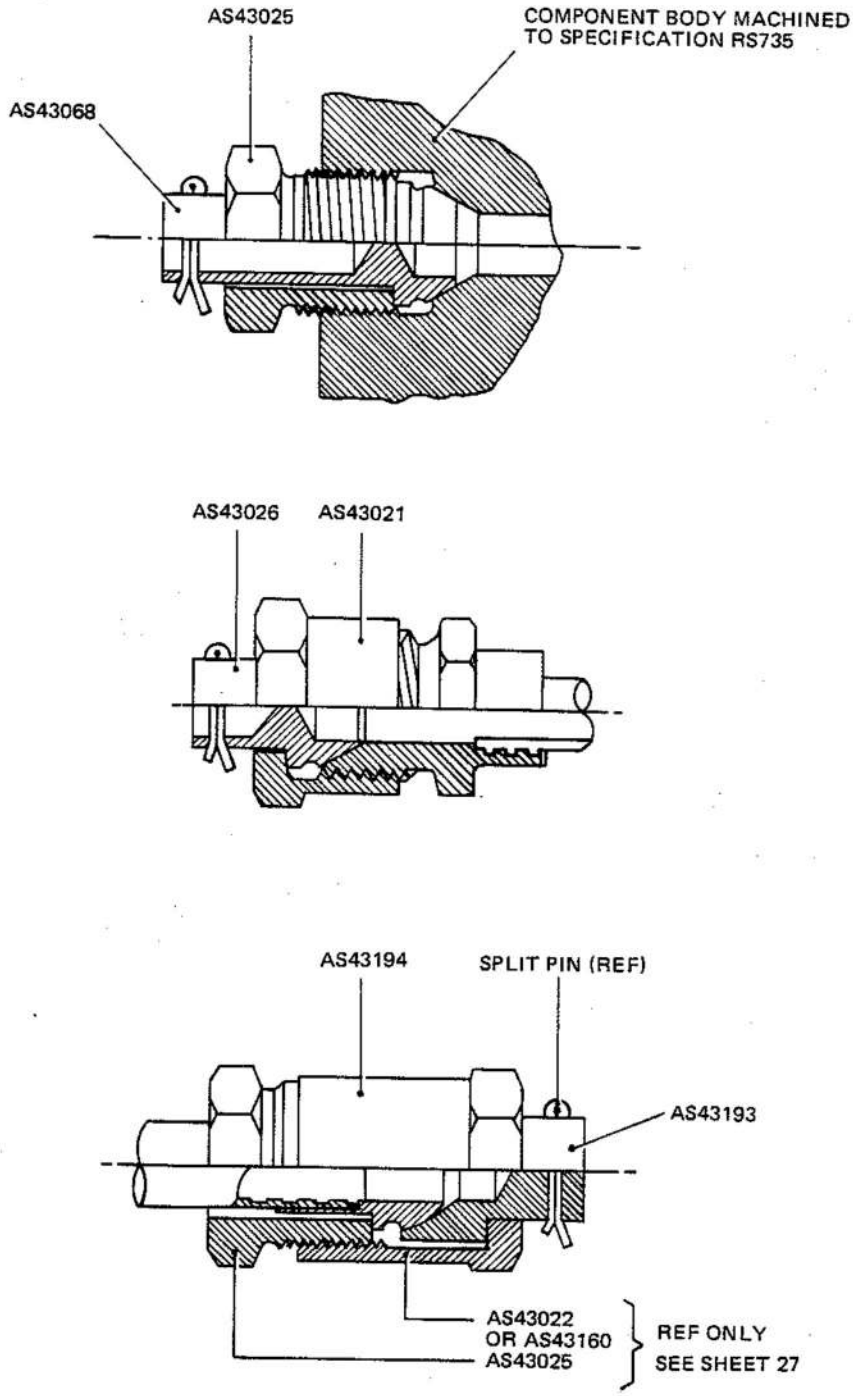


Fig 6 Pressure blank fittings

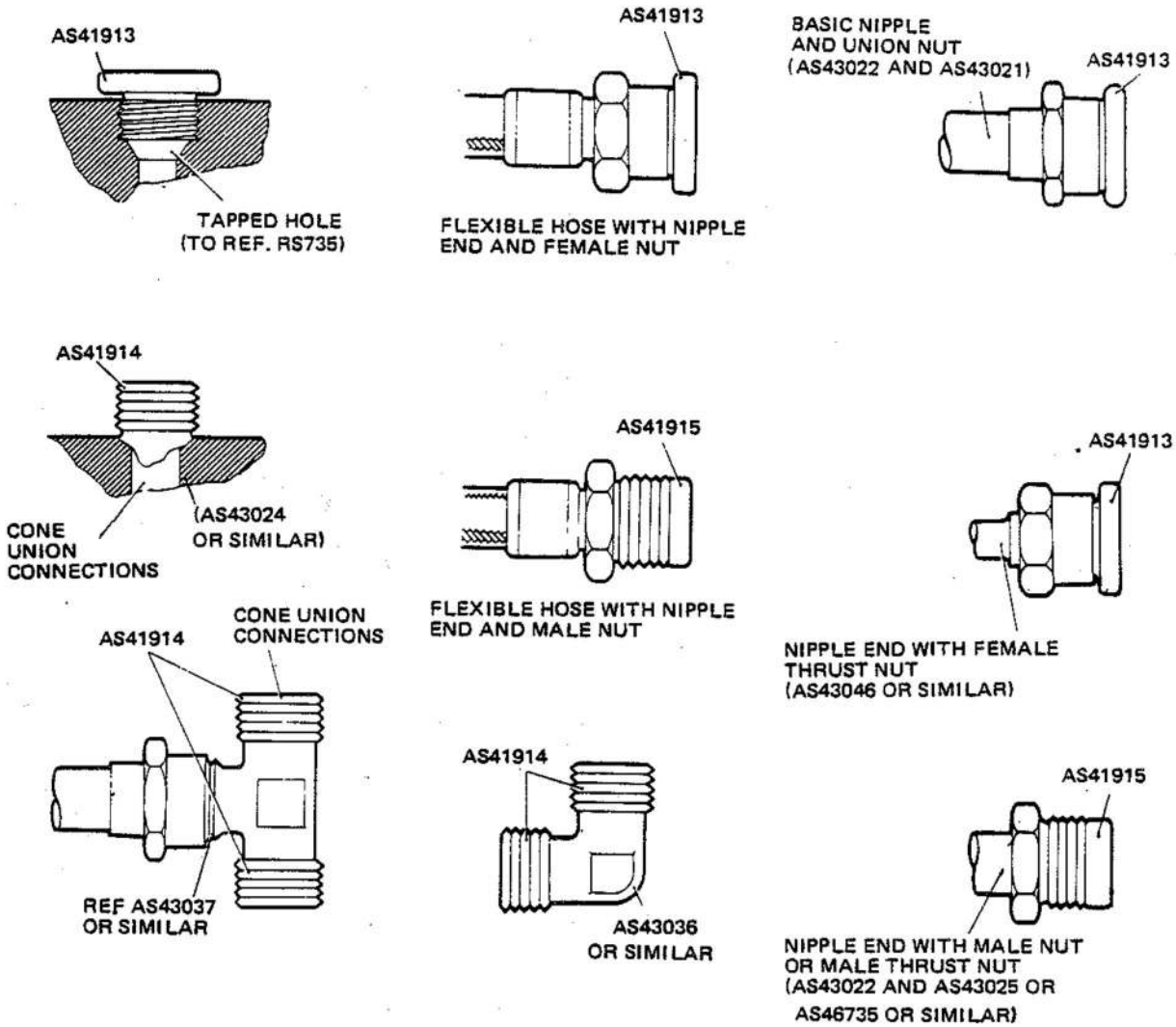


Fig 7 Protection blank fittings

Item No	Description	Pt Number	Blank with Pt
1	Tapped hole (to ref RS735)		AS 41913
2	Flexible hose with nipple end and female nut	AS 43022 AS 43021	AS 41013
3	Basic nipple and union nut	AS 43022 AS 43021	AS 41913
4	Cone union connection	AS 43024	AS 41914
5	Flexible hose with nipple end and male nut	NA	AS 41915
6	Nipple with female thrust nut	AS 43046 or similar	
7	Tee, equal	AS 43037	AS 41914
8	Elbow, male, 90°	AS 43036	AS 41914
9	Nipple with male nut	AS 43022 AS 43025 AS 46735	AS 41915

SWAGING PROCEDURE

Introduction

20 The attachment of the nipple (AS 43022) or union fitting (AS 43024) to the relevant tubing is performed by swaging the pipe outwards into rectangular circumferential grooves machined into the tail of the fitting.

21 The swaging operation is performed by means of a pipe expander (fig 10), which is inserted into the nipple or union, having an internal mandrel which is rotated in a clockwise direction. Parallel expansion of the tube is obtained over the full length of the tail fitting by means of a caged set of three tapered rollers rotating on the inversely tapered mandrel. The action is self-feeding once the rollers have engaged the bore of the tubing, since the rollers are retained at an angle of two degrees to the axis of the mandrel. Upon reaching a preset torque the drive and self-feeding action is reversed and the expander is withdrawn. Split collets clamp the tail of the fitting and contain the high radial loads induced during the swaging operation.

22 For each particular tube material, diameter and wall thickness there is a relevent swaging torque which controls the depth of pipe penetration into the swaging grooves in the tail of the fitting and also the degree of pipe thinning (Table 4).

Swaging machine (fig 8)

23 The swaging operation is performed on a Wicksteed Type 1000 machine equipped with the appropriate tools according to the size and material of the pipe (Table 4). The machine can be hand operated or powered by a reversible electric tool having $^{3}/_{8}$in. square drive socket.

Wicksteed Type 1000 Mk 2A swaging machine (fig 8)

Description

24 The machine consists of a channel section baseplate, having a raised keyway to align the collet holder assembly (1) with the bearing block (6). The collet holder (1) retains the swaging collet (14) which is opened and closed by screws (16) to clamp swaged fitting (2). The tube expander (3) is connected to the Torque master unit (9) by adaptor (4). A loose distance piece (13) fits over the expander stem when swaging the shorter length nipple fitting, so that the effective swaging length setting for the tube expander is the same for both a swaged nipple or a union fitting. One distance piece is required for each particular tube size. The tube expander is driven through a special MHH Torquemaster unit which has a steel outer sleeve to suit the bearing block (6). The baseplate (10) has a small steel block (11) welded on underneath which can be gripped in a bench vice.

25 The Torquemaster unit is rotated clockwise either by hand using a spanner or by a reversible power tool having a $^{3}/_{8}$in. square drive socket. Upon reaching a predetermined torque for the particular tube material and size (Table 5) the direction of drive is reversed.

26 The Torquemaster unit has a visual indicator (5) to clearly indicate when the preset torque setting is reached.

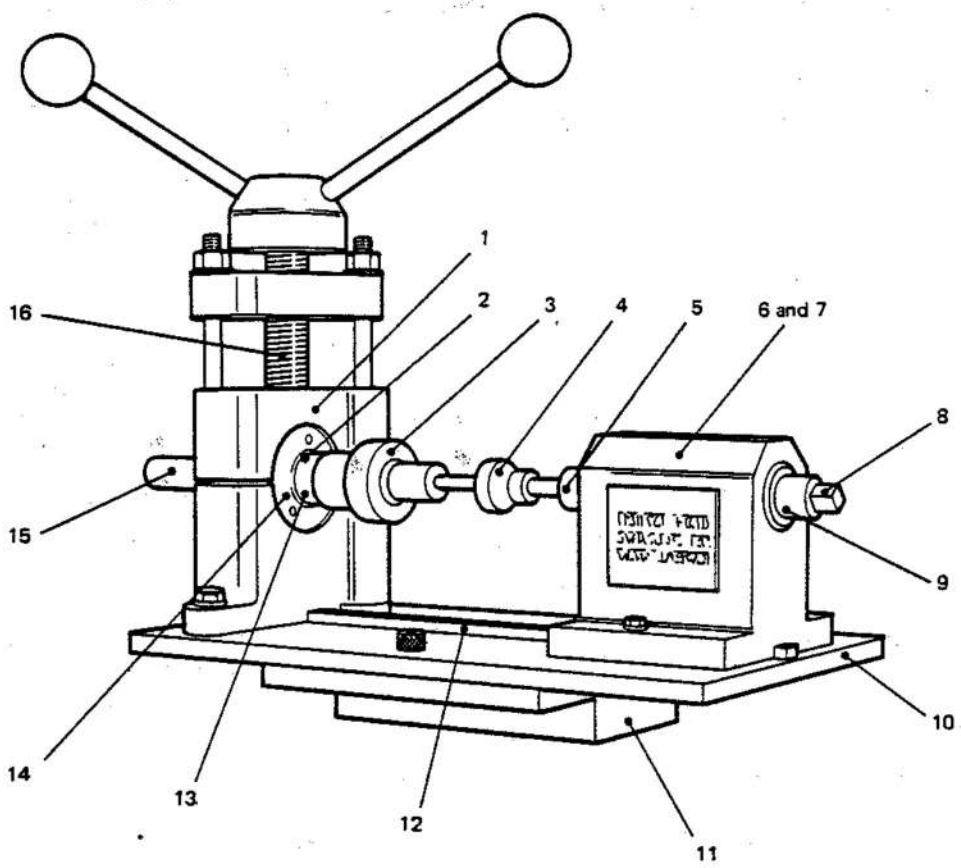


Fig 8 Swaging machine, Type 1000 (Wicksteed) BAE FTF 49196

Item	Description	Part No
1	Collet holder assembly	2650
2	Swaged fitting	NA
3	Tube expanders	2650/1 etc
4	Adaptor $\frac{1}{4}$in. x $\frac{3}{8}$in.	2151
	$\frac{1}{4}$in. x $\frac{1}{4}$in.	2152
5	Visual indicator	1254
6	Bearing block assembly (with 7)	1150
7	Bushes	1152 and 1153
8	Square drive, $\frac{3}{8}$in.	1253
9	Torquemaster unit	1251 and 1252
10	Baseplate assembly (with 11)	1050
11	Clamping bar	1056
12	Alignment keyway	1052C
13	Distance piece	2600/5 etc
14	Swaging collets	2550/05 etc
15	Tube	NA
16	Screw, clamp	NA

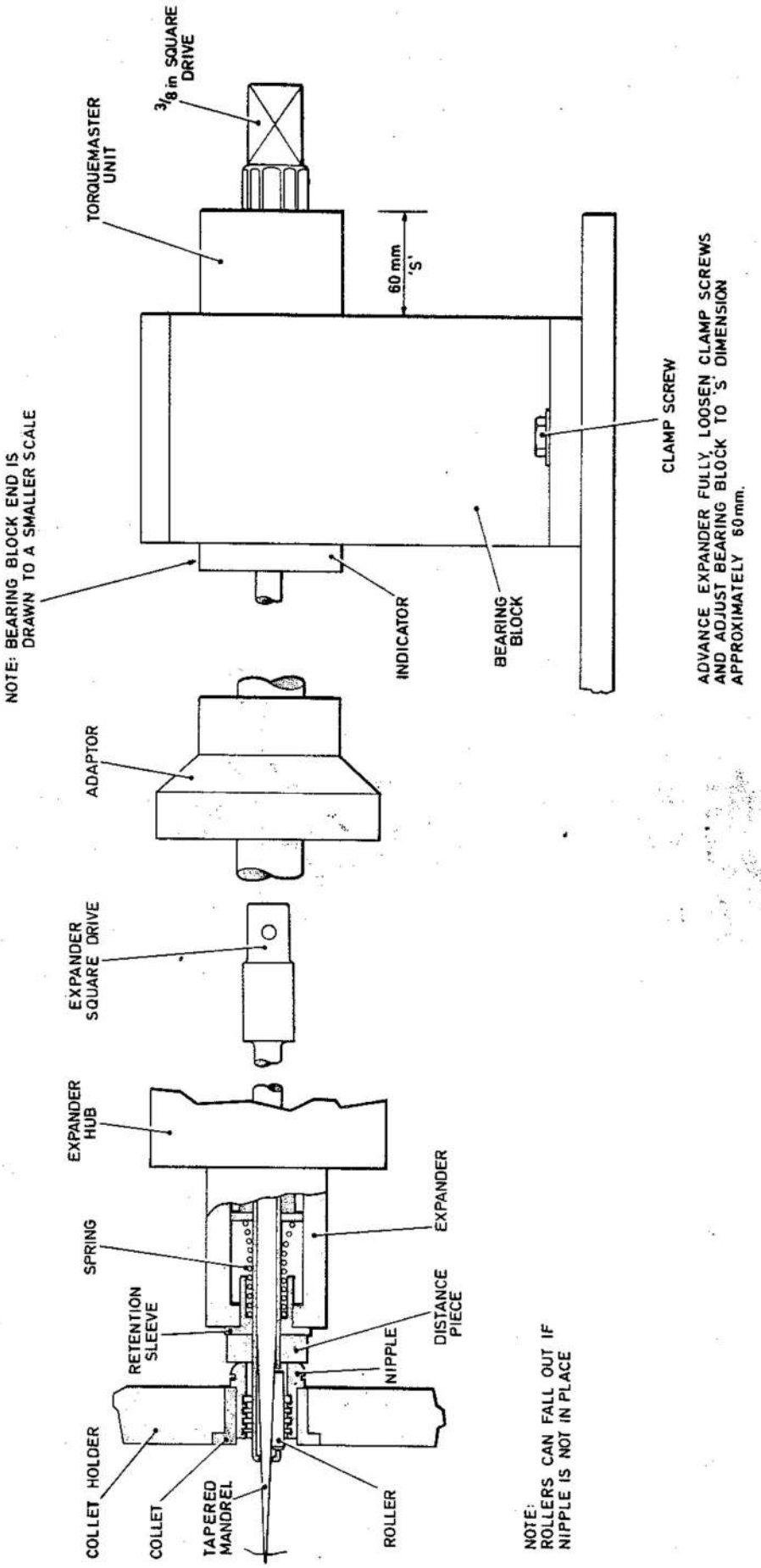


Fig 9 Setting position of bearing block

27 Two torque limiters cover the range required:

27.1 Torquemaster standard, Part No 1250/1 being used for torque settings up to and including 3 Nm.

27.2 Torquemaster major, Part No 1250/2 being used for torque settings over 3 Nm.

Notes ...

(1) These Torquemasters are fitted with special outer sleeves (para 24).

(2) Torque settings are given in Table 4.

Setting up the Type 1000 machine for swaging

Note ...

If the machine or tooling is new it is essential to carry out a Quality Assurance check (para 44).

28 The operations and tools needed to set up the machine are as follows:

28.1 Refer to Table 4 and select against tube size and material:

28.1.1 Collet split bore to suit outside diameter of tube.

28.1.2 Distance piece.

28.1.3 Expander (para 29).

28.1.4 Torquemaster size and torque setting.

28.2 Check the effective expansion length of expander (para 29).

28.3 Set the Torquemaster to the median of min and max figures in Table 4.

28.4 Fit the collet into the holder with the boss on the side into which the tube enters (that is opposite side to the bearing block).

28.5 Check the position of the bearing block, with an unswaged nipple, (Pt No AS 43022) clamped in the collet (fig 9) and adjust so that 'S' dimension is approximately 60 mm.

Notes ...

(1) The machine is designed to be clamped in a bench vice when in use.

(2) Collet size is indicated by the pipe outside diameter added to the collet Pt No, for example 2550/06 is for 6 mm pipe.

Pipe expander, setting effective expansion length (fig 10)

29 A different expander is used for each size of tube (Table 5) and the effective expansion length should not need alteration once set correctly, but when using an expander for the first time check as follows:

29.1 Note the correct expansion length from Table 5.

29.2 Push the expander body fully forward towards the rollers to take up any play in the bearing and push the rollers in the same direction.

TABLE 4 TUBE SIZES AND SWAGING INFORMATION

Tube size od x wall mm	Torquemaster Setting Nm min	max	Part No	Expander Part No	*Effective expansion length mm	Expansion range mm min	max
Sizing							
5 x 0,5	0,30	0,34	1250/1	CM.0505/S	20,0	3.71	4.3
6 x 0,5	0,30	0,34	1250/1	CM.0605/S	20,0	4.53	5.35
Swaging							
5 x 0,5	0,66	0,70	1250/1	CM.0505	27,0	3.94	4.6
6 x 0,5	0,66	0,70	1250/1	CM.0605	28,0	4.83	5.6
10 x 0,8	2,1	2,3	1250/1	CM.1008	29,0	7.9	9.2
14 x 1,0	5,2	5,6	1250/2	CM.1410	32,5	11.5	12.75
16 x 1,2	6,0	6,4	1250/2	CM.1612	33,5	13.1	14.2
20 x 1,5	8,4	8,8	1250/2	CM.2015	34,5	16.5	17.7
8 x 0,5	0,8	0,9	1250/1	CM.0805	28,5	6.6	7.5
12 x 0,5	1,9	2,1	1250/1	CM.1205	31,0	10.6	11.5
15 x 0,5	2,9	3,1	1250/1	CM.1505	32,5	13.2	14.5
18 x 0,6	3,6	3,8	1250/2	CM.1806	33,5	16.5	17.3
22 x 0,8	4,8	5,2	1250/2	CM.2208	34,5	20.0	20.9
28 x 1,0	7,6	8,0	1250/2	CM.2810	36,0	25.6	26.5
6 x 0,6	0,22	0,24	1250/1	CM.0606	28,0	4.5	5.35
8 x 0,6	0,52	0,56	1250/1	CM.0806	28,5	6.4	7.3
10 x 0,6	0,52	0,56	1250/1	CM.1006	29,0	8.5	9.4
10 x 0,8	0,8	0,9	1250/1	CM.1008	29,0	7.9	9.2
12 x 0,8	0,8	0,9	1250/1	CM.1208	31,0	10.15	11.2
14 x 0,8	1,0	1,2	1250/1	CM.1408	32,5	11.9	13.0

Note ...

Tolerance on effective expansion length is +0, -½ turn of expander hub (para 29).

29.3 If the length (fig 10) is incorrect adjust as follows:

29.3.1 Loosen the grubscrews in the expander hub and turn the hub relative to the threaded expander body until the length is correct.

29.3.2 If the locking screw does not now line up with one of the axial flats on the expander body, turn the body so as to reduce the effective expansion length, until the next flat lines up.

29.3.3 Tighten the locking screw.

Note ...

On 5 mm and 6 mm expanders removal of the spring protection cap will facilitate measurement.

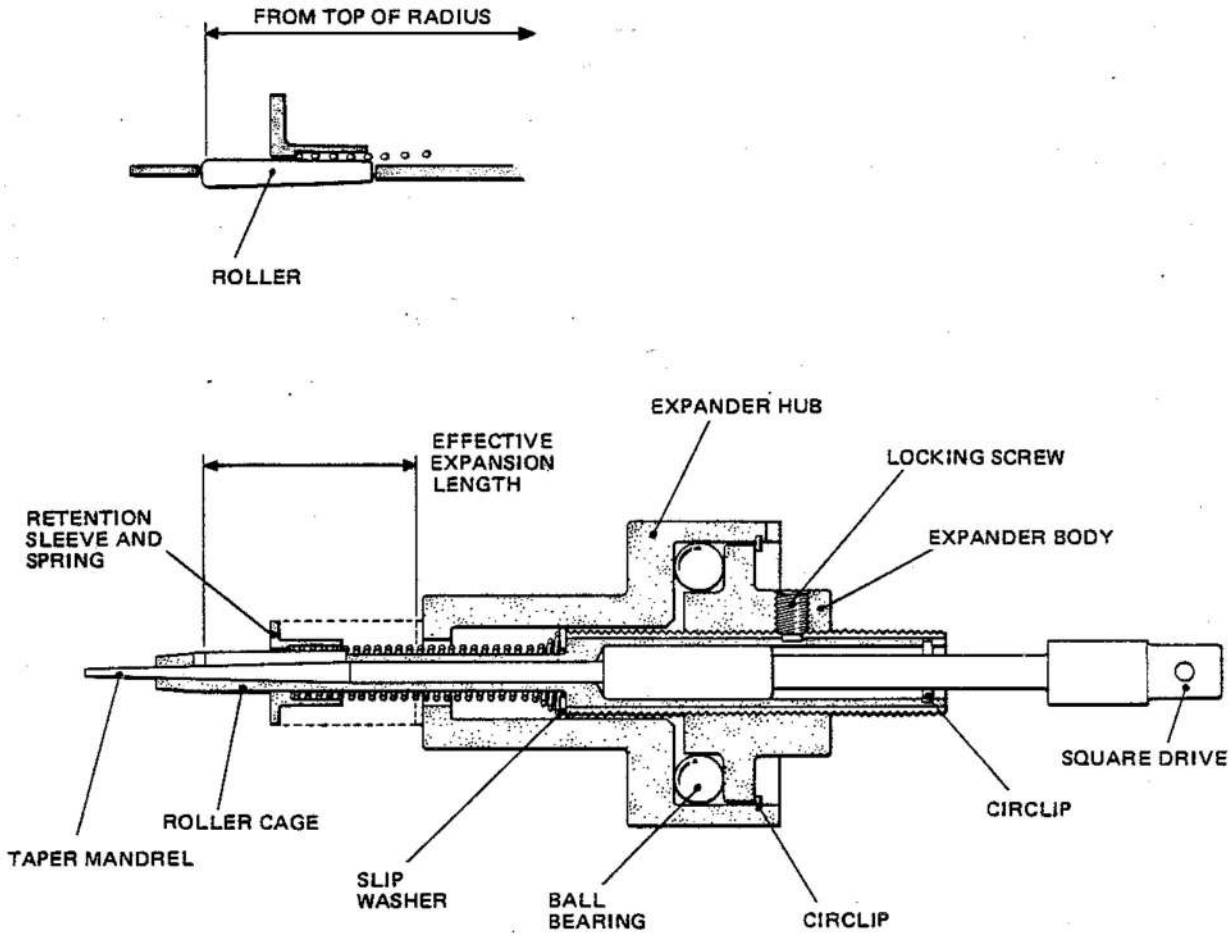


Fig 10 Pipe expander

TABLE 5 PIPE BEND LIMITATIONS

Tube outside diameter (mm)	Minimum length of straight 'L' (mm)	
	For 3½D bend	For 5D bend
5	25	27
6	28	27
8	18	16
10	18	16
12	19	16
14	20	16
15	20	15
16	20	15
18	21	15
20	21	15
22	22	15
28	22	13

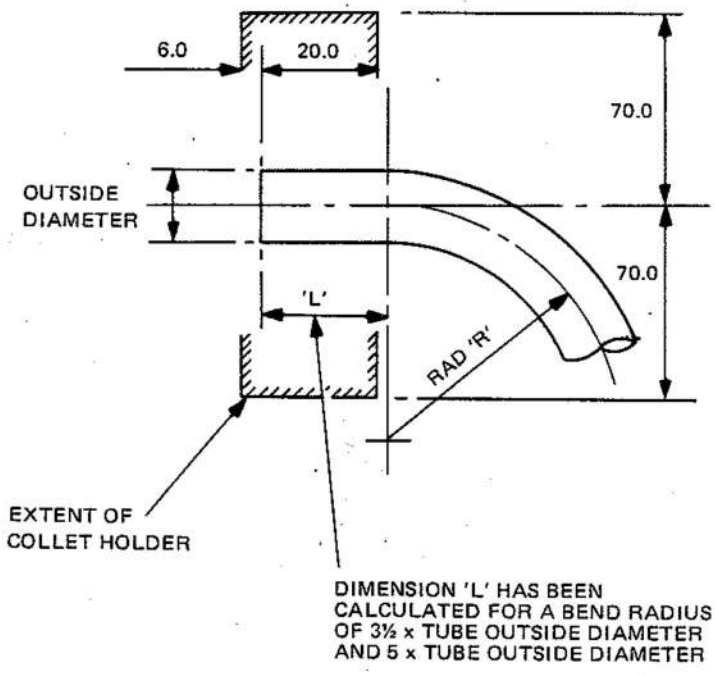


Fig 11 Pipe bend limitations

Calibration of torque limiter (Torquemaster unit)

30 Select either the Standard or Major Torquemaster (para 27) according to the torque value required and fit it into the torque calibration indicator (fig 13).

30.1 Rotate the Torquemaster clockwise by the square drive end and note the reading at which it 'breaks'.

30.2 If adjustment is needed insert setting key (Pt No 1351) through the hole in the square drive end. Turn mechanism clockwise to increase torque or counter-clockwise to reduce torque.

Preparation of pipe ends and fittings

31 Requirements to make the pipe ready for the swaging operation:

31.1 The lengths of straight pipe beyond the end of an adjacent bend must not be less than that shown in Table 5 (fig 9) and must clear the collet holder.

31.2 Light alloy pipes which are painted must be cleaned so as to be free of paint for a minimum of 15 mm from each end to be swaged. The paint finish must be restored after swaging.

31.3 The end faces of the pipe must be square to the straight portion with ½ a degree, and deburred both internally and externally to remove sharp corners only, without a distinct chamfer.

Notes ...

(1) Avoid letting any debris or swarf drop into the tube or remain on it, since this will damage the tube during swaging.

(2) 5 x 0.5 wall and 6 x 0.5 wall tubing may need a pre-sizing operation before swaging (para 34).

(3) Examine the tube to ensure that there are no pits or scores in the area to be swaged or adjacent to it.

32 Clean the end of the pipe with a lint free cloth moistened with trichloroethane and allow to dry.

33 Examine the fitting to ensure that no contaminent is present in the swaging grooves. Clean thoroughly by soaking in trichloroethane for 2 minutes and allow to dry.

Preparing 5 and 6 mm diameter tube for swaging

34 Prior to swaging union nipples or fittings onto 5 x 0.5 mm wall and 6.05 mm wall tubing check that the relevant tube expander bodies will fully and freely enter the tubing. If not a pre-sizing operation is needed using special expanders and sizing collets (Table 4) as follows:

34.1 5 x 0.5 mm wall use expander CM0505/S and collet 2550/05/S.

34.2 6 x 0.5 mm wall use expander CM0605/S and collet 2550/06/S.

34.3 Clamp the selected sizing collet in the collet holder and insert the tube into the rear of the collet making sure the tube butts against the internal stop.

34.4 Lubricate the expander mandrel and rollers copiously with lubricating oil OX-38 (Nato O-149), ensure that the tapered mandrel (fig 9) is fully back, and enter the end of the expander into the tube.

34.5 Slide the expander mandrel forward by hand until it makes contact with the rollers and rotate clockwise until the rollers are felt to be gripping the tube.

Note ...

This will be the point at which the torque required to rotate the mandrel becomes appreciably greater and results in the mandrel becoming self-feeding, signified by rotation of the expander hub.

34.6 Check that Torquemaster unit is correctly set (Table 4, para 41).

34.7 Make connection between expander mandrel and Torquemaster using the adaptor.

34.8 Complete the pre-sizing operation either by hand (para 37) or by power drive (para 38).

34.9 Remove the pipe from the sizing collet and clean (para 32) before swaging on a nipple or fitting.

Swaging procedure

WARNING ...

DO NOT USE LOCTITE ON PIPES FOR OXYGEN SYSTEMS.

35 The pipe and the fitting must be prepared as detailed (para 31) and the swaging machine set up for the pipe size concerned (para 41). A supply of Loctite is required, except for oxygen pipes, namely:

35.1 Locquic primer 'T' for application to the pipe end.

35.2 Loctite 35 or 635.

Notes ...

(1) A small supply of lubricating oil OX-38 (Nato O-149) is also required.

(2) Only small quantities of primer should be used at a time. Keep in a container with an airtight lid. Fresh clean supplies must be obtained every 4 hours.

(3) Pipes coated with primer must be re-coated if more than 4 hours has elapsed before swaging.

The swaging operation

36 To swage a nipple or union onto a pipe proceed as follows:

36.1 Apply Locquic primer 'T' to the end of the pipe over a minimum length of 15 mm and to the internal bore of the tail of the fitting. Shake off any excess and allow to dry.

36.2 Fit tail of fitting (nipple or union end) into collet with nipple end or union body facing expander, and clamp it firmly without using excessive force (fig 12).

36.3 Fit the distance piece onto expander stem if a nipple is to be swaged. If the pipe already has a fitting on the other end, now fit the union nut (fig 3) over the pipe.

36.4 Apply a continuous bead of Loctite 35 or 635 to the outer circumference of the pipe end to be swaged at a distance of 1 to 2 mm from the end. Use Loctite Model 50 hand gun. Ensure that no Loctite enters the pipe end.

Caution ...

Do not use Loctite on oxygen system pipes.

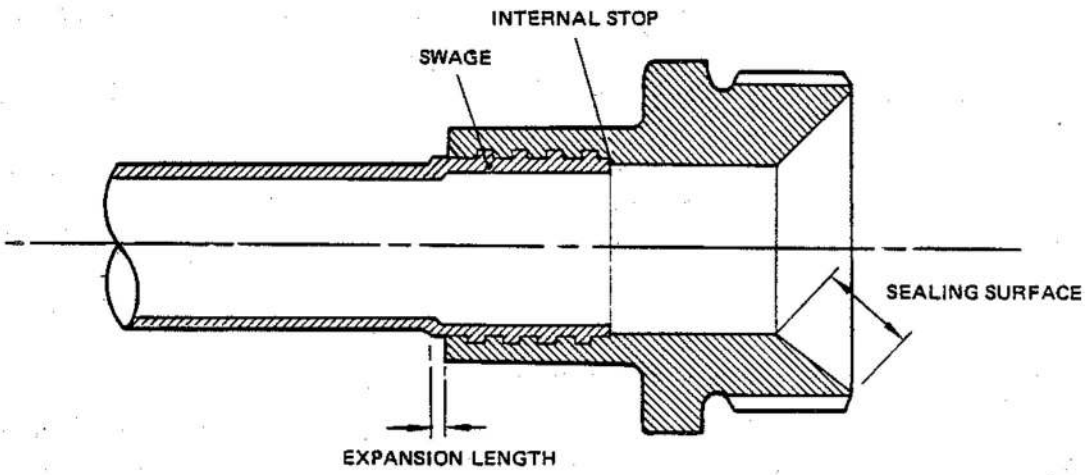


Fig 12 Position of pipe in fitting

36.5 Insert pipe into fitting making sure that the pipe end abuts the internal stop in the tail of the nipple or fitting (fig 12) and hold the pipe, at a point near the collet, firmly against the internal stop in the fitting, with the pipe maintained square to the collet, so that any misalignment of the pipe to the fitting during swaging is avoided.

Notes ...

(1) Unless the pipe is short additional supports may be required, especially for pipe assemblies.

(2) If a nipple is being swaged the distance piece must now be in position on the expander stem.

36.6 Lubricate the expander mandrel and roller copiously with lubricating oil OX-38 (Nato O-149) and ensure that the tapered mandrel (fig 9) is fully back, and enter the end of the expander into the tube.

36.7 Slide the expander mandrel forward by hand until it makes contact with the rollers and rotate clockwise until the rollers are felt to be gripping the tube.

Note ...

This will be the point at which the torque required to rotate the mandrel becomes appreciably greater and results in the mandrel becoming self-feeding, signified by rotation of the expander hub.

36.8 Check that the Torquemaster unit is correctly set (Table 4 para 41).

36.9 Make connection between the expander mandrel and the Torquemaster using the adaptor, size 1/4in. x 1/4in. (Pt No 2152).

Completing the swaging by hand

37 Fit a spanner 3/8in. A/F or socket wrench on to the square drive end of the Torquemaster and rotate clockwise until the indicator shows or the Torquemaster has broken at least three times.

37.1 Reverse direction of rotation and remove expander.

37.2 Loosen collet which holds the fitting and remove the pipe assembly.

Completing the swaging with power drive

38 Fit square drive socket(3/8in. A/F Pt No 1307E) of reversible drill or nutrunner on to Torquemaster and start tool using only minimal axial loading until the expander hub starts rotating. The mandrel is now self-feeding and it is sufficient to maintain engagement of the drive with no further axial load being applied.

38.1 Observe the indicator on the Torquemaster which shows when the preset torque is reached at break, then reverse the tool to back out the expander.

38.2 Remove expander.

38.3 Loosen collet which holds the fitting and remove the pipe assembly.

Completion checks and curing Loctite

39 Remove any excess Loctite from the outside of the pipe assembly and from the pipe bore.

Notes ...

(1) Use clean lint free cloth to clean the pipe assembly.

(2) It is also essential to clean all Loctite off the pipe expander and holding collets.

40 The Loctite requires 16 hours to cure at room temperatures not below 15°C (60°F). If the pipe assembly is required urgently proceed as follows:

40.1 Inspect the pipe assembly as detailed in para 47.

40.2 Check that excess Loctite has been removed from the bore of the pipe and from the outside around the nipple or fitting.

40.3 High temperature cure the pipe ends at 120°C ± 5°C for 30 minutes in an air circulating type oven.

Caution ...

All pipe assemblies must be cleaned, inspected and where appplicable, pressure tested before use or putting into storage.

TABLE 6 FAULT DIAGNOSIS

Fault	Possible cause	Corrective action
Expander hub does not rotate during swaging.	1. Rollers or taper mandrel worn or damaged.	Replace worn or damaged parts.
	2. Incorrect expander being used for size of pipe.	Check expander size with Table 4.
	3. Incorrect holding collet in use.	Fit correct size collet.
	4. Rollers and mandrel are dirty.	Clean and relubricate.
Expander bottoms without the Torquemaster breaking.	1. Rollers or taper mandrel worn or damaged.	Replace worn or damaged parts.
	2. Incorrect expander being used for size of pipe.	Check with Table 4.
	3. Torquemaster set to incorrect torque.	Reset torque to correct value (Table 4).
	4. Incorrect rollers fitted to expander.	Fit correct rollers.
Nipple or fitting misaligned on pipe.	1. Pipe not against internal stop in union before swaging.	Ensure that pipe abutts internal stop.
	2. Incorrect collet used.	Check collet size for tube.
	3. Pipe not supported in line with collet.	Provide support for pipe.

Torquemaster adjustment (fig 13)

41 The torque calibration unit is provided in three ranges, and the unit may be bench or wall mounted:

41.1 Part 1401 0 to 0.7 Nm
Part 1402 0.7 to 4 Nm
Part 1403 4 to 10 Nm

42 Select the appropriate Torquemaster unit (para 27) and note the setting value against the three variables, tube material, tube diameter and tube wall (Table 4).

42.1 Rotate Torquemaster clockwise after inserting the square end into the socket on the appropriate calibration unit, and note the reading at which it 'breaks'.

42.2 If this reading is not correct adjust it to the required figure by inserting setting screwdriver (Pt No 1351) through the hole in the square end and turn clockwise to increase torque, or counter-clockwise, to reduce torque.

43 After setting check again with Table 4 and recheck the torque setting.

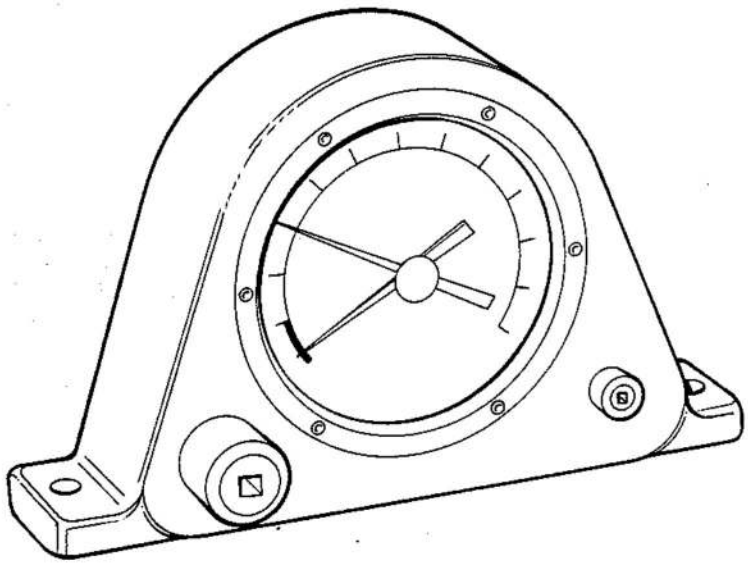


Fig 13 Torque calibration unit

QUALITY ASSURANCE

Checking operation of swaging machine and tooling

44 When the equipment is new or a swaged nipple or fitting has failed to pass inspection or pressure test, it is essential to carry out a quality assurance check. A specimen swaged in accordance with para 35 to 38 shall be sectioned so that both the groove penetration and the wall thinning of the pipe can be measured (fig 14 and 15).

45 The test equipment consists of a dial test indicator reading to 0.01 mm, mounted on a vertical stand with a base. A support pillar mounted on the base has interchangeable tips of 0.5 mm radius for 5 mm pipes and 1.5 mm radius for 6 mm and bigger pipes. The dial indicator stem has a tip with 0.5 mm radius (fig 14).

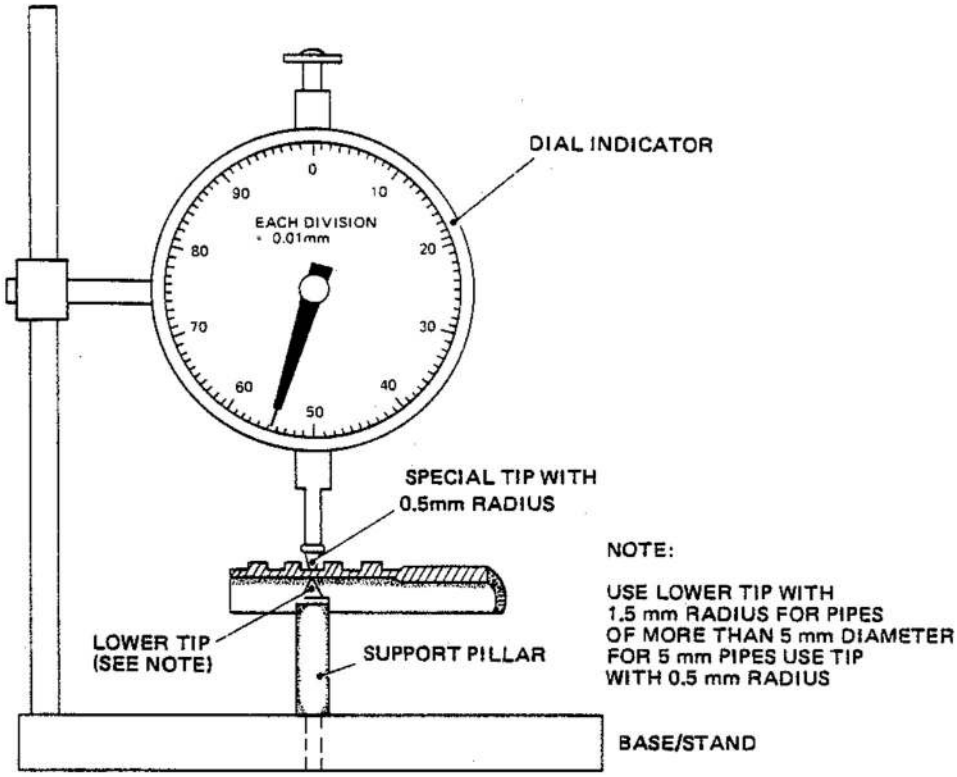


Fig 14 Measurement of test specimen

Criteria for effective swaging

46 In all swaging operations the following requirements must be met:

46.1 The correct expander, collets and torque limiter must be used.

46.2 Contaminated expanders, or those having damaged mandrels or rollers shall not be used.

46.3 The expander shall be adequately lubricated.

46.4 The expander hub shall rotate during the swaging operation.

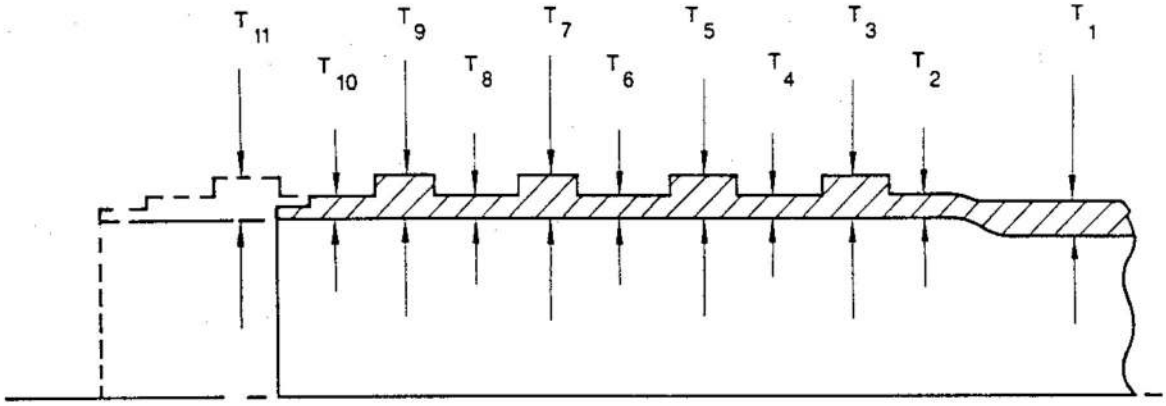
Note ...

If it does not rotate, reverse the drive, remove the expander and check as para 46.1 and 46.2.

46.5 The correct preset swaging torque shall be reached for every swage. If the expander bottoms without the Torquemaster breaking, reverse the drive, remove the expander and check as para 46.1 and 46.2.

Note ...

If the fitting is not damaged it may be reswaged, but this may only be done once.



WALL THINNING

Maximum permissible thinning is defined as a 25% mean measured diametrally on opposite walls with 30% maximum allowed at a single point.

$$\text{Percentage of wall thinning} = \frac{(T_1 - T_2}{T1} \times 100$$

GROOVE PENETRATION

Minimum permissible penetration is defined as an average of 0.05 mm measured over all the grooves.

Penetration:

1st groove = $P_1 = T_3 - T_4$

2nd groove = $P_2 = T_5 - T_6$

3rd groove = $P_3 = T_7 - T_8$

4th groove = $P_4 = T_9 - T_8$

or $P_4 = T9 - T_{10}$

5th groove = $P_5 = T_{11} - T_{10}$

5 groove fitting

Fig 15 Tube section thinning and groove penetration

46.6 Mandrels and rollers are not interchanged between expanders for different pipe sizes and gauges.

46.7 No excessive end loads may be applied to the expander during swaging.

46.8 The pipe shall be held firmly and squarely in the fitting during the swaging operation.

▶ WARNING ...

DO NOT USE LOCTITE ON OXYGEN SYSTEM PIPES, REFER TO CHAPTER 16. ◀

46.9 Fresh Locquic primer Type T shall be used for each nominal 4 hour period and shall be free of contaminant or suspension.

46.10 The Locquic primer T shall be dry before application of the Loctite adhesive 35 or 635. The primer normally dries within 5 minutes.

46.11 Pipe assemblies left for more than 4 hours after priming shall be recoated with primer.

Post swaging operations

Inspection

47 The following procedure is to be adhered to before a pipe is finally cleaned and pressure tested. A light is to be used for internal inspection. Check as follows:

47.1 The pipe has not been pushed away from the internal step in the tail of the fitting.

47.2 A definite change in the internal diameter of the pipe shall be visible in the area of the swage.

Note ...

On 5 and 6 mm diameter pipes where they have been pre-sized, an additional step in the bore may be visible.

47.3 The bore shall be free of surface defects.

47.4 The pipe is free from visible cracks or damage.

47.5 The fitting shall be swaged as far as the end of the fitting to a tolerance of -0.5 to +1.0 mm.

47.6 The fitting must be swaged squarely to the pipe to a tolerance of ± 1 degree.

47.7 The sealing surface of the fitting shall be free from damage.

Note ...

The pressure of Loctite 35 between the pipe and the tail of the fitting can be confirmed by using an ultra-violet light focussed on the swaged fitting.

48 If the pipes pass visual inspection they are to be cleaned before testing or storage.

Cleaning

WARNING ...

IT IS IMPORTANT THAT THE CLEANING PROCEDURES FOR LIQUID AND GASEOUS OXYGEN PIPES ARE STRICTLY ADHERED TO: (REFER TO AP 107D-0001-1, CHAP 4.) MANY MATERIALS, PARTICULARLY OIL AND GREASE, ARE SUBJECT TO SPONTANEOUS COMBUSTION WHEN EXPOSED TO UNDILUTED OXYGEN UNDER PRESSURE.

49 Prior to testing, storage or fitting to an aircraft, pipe assemblies must be cleaned as detailed in Chap 15.

Pressure testing

50 Before attaching the pipework to the test rig check the following requirements:

50.1 That the pipework is externally and internally clean in accordance with Chap 15.

50.2 The pipework is free from visible cracks or damage.

50.3 The pipework is free of any noticeable odours of trichloroethane.

50.4 Whether the pipe is for oil or fuel system or part of the gaseous or water system.

50.5 The working pressure of the system.

► 50.6 The test pressure is 1.5 times working pressure for a duration of five minutes. ◄

Test procedure, oil and fuel system parts

51 To pressure test a pipe assembly proceed as follows:

51.1 Assemble nipple end of pipe to pressure rig and tighten by hand only (para 11).

51.2 Refer to fig 6 and select a suitable pressure blank fitting.

51.3 Loosely assemble the blanking fitting on to the union end and bleed the pipe until the test fluid only issues from the loosely blanked end. Tighten outer sleeve of blanking fitting, using two spanners (para 15 and 16) and finally tighten the outer sleeve, by 30° movement only, at connection to test rig.

► 51.4 The pressure test is to be carried out in accordance with Chap 17 of this publication. ◄

51.5 If the test is satisfactory submit the pipe for final cleaning (Chap 15).

Test procedure, gaseous and water system parts

52 Test mediums shall be limited to be following:

52.1 Clean, dry oil free air, see note (2).

52.2 Nitrogen.

52.3 Demineralized clean cold water.

Notes ...

(1) When the selected medium is 52.1 and 52.2 the test shall be carried out with the pipe submerged in water.

(2) It is unlikely that air from an air line is suitable for this test.

52.4 Connect the pipe to the test rig as detailed in para 51, 51.1, 51.2 and 51.3.

52.5 Apply a test pressure equivalent to 1.5 times working pressure.

52.6 Maintain this pressure for 3 minutes and look for leaks around the swaged coupling.

Note ...

If leakage occurs at either end of the pipe, release pressure, disconnect pipe and examine coupling for foreign matter or damage to sealing faces. If satisfactory, reconnect and tighten up to a maximum of 30° from the new finger tight position.

52.8 Apply test pressure as para 52.6, and if leakage is visible from the swage, that is between the pipe and the fitting, a reswage is possible as detailed in para 62. If leakage persists or leakage is detected from the seating faces, the pipe assembly is to be scrapped, but see note (2).

Notes ...

(1) If the leakage is from the swage investigate the swaging procedure (para 35 to 38).

(2) If it is difficult to replace the pipe assembly it may be possible to repair it using Permaswage unions (Chap 9).

52.9 If the test is satisfactory submit the pipe for final cleaning (Chap 15).

52.10 Blank off pipe ends using blanking caps, plugs, or clean polythene film and elastic bands, immediately after cleaning (fig 7).

Maintenance

General

53 The swaging machine and especially the tooling equipment must be kept clean and undamaged so that the criteria for effective swaging are met (para 46). The main item needing attention, due to the heavy loads it has to carry during swaging, is the expander, and all those sizes provided must be regularly serviced at the same time as the whole equipment is checked.

Tube expanders (fig 10)

54 Although the expanders are cleaned externally after each swage the following routine maintenance is essential:

54.1 Remove the spring circlip in the expander body and withdraw the mandrel. This will release the three tapered rollers.

54.2 Thoroughly clean the mandrel, expander stem and rollers and closely examine them for:

54.2.1 Pits or flats on rollers and mandrel.

54.2.2 Worn slots and burrs on edges of slots in expander stem (body).

Notes ...

(1) All three rollers in a set must be the same length and diameter; check using a micrometer, and when fitting a new set also check that the end profiles are identical at the large end.

(2) Burrs may be removed by using a fine file or if internal by an appropriately sized drill.

54.3 Reassemble the expander and very lightly lubricate with oil OX-38 (Nato O-149), ensure that the mandrel moves freely to and fro to expand and contract the rollers.

54.4 Check the maximum and minimum expansion (Table 6), using a 'V' anvil micrometer, over the three rollers, and if satisfactory check that the expansion length (Table 4) can be met, adjusting if necessary (para 29).

54.5 If either of these dimensions cannot be achieved the expander body and possibly the set of rollers require replacement. Also check the mandrel for wear.

Swaging machine and other tools

55 These items are not subjected to so much stress and wear as the expander but should be cleaned and examined for wear and damage, then lightly oiled.

55.1 The set of collets

55.2 Collet holder and clamp screw

55.3 Distance pieces

55.4 Torquemaster units and adaptor

55.5 Bearing block

55.6 Machine slides and aligning key

55.6.1 The alignment of the collet holder and expander holder must be checked using the setting piece provided.

INSTALLATION OF REPLACEMENT PIPES IN AIRCRAFT

Preparation

56 The pipework should be clean. Check that the protective caps are undamaged and if ingress or dirt seems possible, reclean the pipe (Chap 15). Then proceed as follows:

56.1 Remove the protective caps and examine seating and mating surfaces for scratches or other defects likely to provide leakage paths.

56.2 Clean pipe and coupling mating surfaces using a lint free cloth. Use clean white spirit, where necessary, to remove any PX24 protective coating on steel fittings.

Procedure, short pipes

57 The procedure for installing a short pipe run is as follows:

57.1 Loosen one end coupling, and if possible one fairlead or clamp each side of the end couplings.

57.2 Clean the couplings to which the pipe is to be attached using a lint free cloth and check mating surfaces for scratches or other defects (para 56.1).

57.3 Loosely assemble the pipe to match the fairlead positions, ensuring that the critical clearances are maintained (Table 7).

57.4 Lightly tighten all couplings until the mating sealing surfaces are felt to engage.

57.5 Lightly tighten fairleads, brackets or clamps, and carry out post installation checks (para 60).

Procedure, long pipes

58 To install a long pipe run first choose two fixed datum points from any of those given:

58.1 A fixed component

58.2 A bulkhead fitting

58.3 A tee, cross or similar type of fitting which is already in place.

59 Taking care not to disturb previously set pipe runs, slacken off the datum points and fairlead clamp positions, as far as possible, to achieve optimum alignments during the initial assembly of the pipe run. However, a tee fitting in an established run may be rotated to provide better alignment with the pipe being fitted. Then proceed as follows:

59.1 Loosely assemble all pipes in the run from fixed datum to fixed datum so that the best run to match fairlead positions, fixed datums and critical clearances is achieved (Table 7).

Notes ...

(1) During this stage make full use of adjustable fairlead brackets and angulation of tee pieces.

(2) Unless controlled by fixed components, pipes should pass centrally through holes in the structure to give the maximum clearance.

TABLE 7 MINIMUM CLEARANCES FOR INSTALLATION

Pipe run position	Minimum clearances mm	inch approx
Pipes in close proximity to moving parts	12	0.5
Pipes and other pipes	5	0.2
Pipes and structure or static parts	6	0.25
Pipes in the same run	* 1.5	* 0.06
Pipes and static parts	* 1.5	* 0.06

Note ...

* Measured within 25.4 mm (1in.) of clamp blocks.

59.2 Lightly tighten all intermediate couplings until the mating sealing faces are felt to engage.

59.3 Lightly tighten end couplings to fixed datums until the mating sealing faces are felt to engage.

59.4 Lightly tighten fairlead brackets and clamps and intermediate supports.

Notes ...

(1) Limited straining of pipes to achieve correct fitment is allowed for mating the sealing faces at a pipe end fitting or to centralise a pipe in a fairlead.

(2) Correct alignment of mating couplings is essential to avoid high induced stress levels upon mating the coupling.

(3) If these requirements cannot be met the pipe may be adjusted (para 61).

Post installation checks

60 Prior to final tightening of the couplings it is essential to check that the initial installation is correct. Proceed as follows:

60.1 Fully loosen one end coupling at a fixed datum, back off the fitting and visually check for alignment of the joint (axial and angular). Feel for centralisation of the pipe and initial contact of the sealing faces. If satisfactory retighten the coupling.

60.2 Repeat the operations described in 60.1 for the opposite end of the same pipe assembly.

60.3 If a pipe has been refitted or replaced continue the run within the chosen datums checking each pipe assembly in sequence by loosening, backing off the nuts as detailed in para 60.1.

60.4 If a pipe has been disturbed, slacken one fairlead or clamp which is adjacent to a fixed end and visually check for alignment. Feel for centralisation of the pipe in the fairlead and ensure that the pipe is not being put under strain (para 59.4 notes (1) and (2)).

60.5 Repeat this procedure for other fairleads or clamps which are adjacent to fixed datums.

60.6 Repeat the procedure of para 60.4 for all remaining fairleads and clamps.

Caution ...

Two spanners must be used to tighten the halves of a union. One spanner to turn the union nut and the other to prevent any movement of the composite unit (elbow, tee, cross or pipe) (para 15).

60.7 Using two spanners tighten the unions in sequence observing:

60.7.1 That from the finger tight position only 30° rotation, half a spanner flat, is required (para 11).

60.7.2 Requirements regarding straining and alignment (para 59.4 notes (1) and (2)) must be met.

Note ...

Air diagram 105B-1172-D1 Sheet 3 illustrates this procedure.

60.8 Check that no existing pipe has been misplaced by the work, for example, side by side bulkhead fittings, common fairleads or clamps are concerned, and that the minimum clearances in Table 7 are maintained.

60.9 If any pipe cannot be correctly aligned as defined in para 60.8 check that all previous assemblies are correctly aligned, and make corrections where required (para 61).

60.10 Complete any work needed to conform to bonding requirements.

60.11 Wirelock the fittings where required.

Pipe adjustment

61 In order that a pipe may be assembled in the aircraft without strain and with correct alignment of the couplings while maintaining minimum clearances, adjustment is permissible provided the following requirements are observed:

61.1 The pipe shall have been fitted as detailed up to para 60.8.

61.2 The error in position shall not exceed 6 mm measured between the pipe outside diameter and the position it should occupy at a fixed datum.

61.3 Adjustment is limited to alteration of existing bends.

61.4 Two mating pipes are not altered to eliminate a single erro.

61.5 Reinstallation to conform to para 56.

Pipe re-swaging

62 If a leakage occurs at the swaged portion of a pipe assembly after installation in the aircraft, and where no replacement pipe assembly is available, then the original pipe assembly may be re-swaged provided the following conditions are observed:

62.1 The leaking union shall be re-swaged to the appropriate torque for the particular tube material, pipe diameter and wall thickness.

62.2 Only one re-swage is permitted.

62.3 After re-swaging the pipe shall satisfy the pressure test requirements (para 50, 51 and 52). Failure to meet these or inspection (para 47), means that the assembly shall be scrapeed.

Note ...

It may be possible to replace the defective union by using Permaswage fittings (Chap 9).

Chapter 8

SELF-SEALING COUPLINGS FOR AIRCRAFT METAL PIPE-LINES

LIST OF SUB-CHAPTERS

8-1. Self-sealing couplings Lockheed Avery Type

8-2. Quick-release self-sealing couplings types BSCV,BSCS,HSCV and HSCS

8-3 Self-sealing coupling units Part Nos. C17316 and C17317

Chapter 8-1

SELF-SEALING COUPLINGS LOCKHEED AVERY TYPE

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
General	2
Types and sizes	5
Blanking caps	8
SERVICING	
Minor repairs	9

TABLES

No.		Page
1	Self-sealing couplings and blanking caps	5
2	Rubber seals and associated fitting tools	6

ILLUSTRATIONS

Fig.		Page
1	Flanged self-sealing coupling	2
2	Sectioned coupling (valves partially open)	2
3	Flanged self-sealing couplings installed	3
4	Studded half-coupling	3
5	Blanking caps	4

Introduction

1. The Lockheed Avery Type of self-sealing couplings are used in aircraft to allow fuel, oil, hydraulic, and other fluid pipelines to be disconnected and reconnected without loss of fluid, and without introducing air into the system. They make it unnecessary to drain the system prior to disconnecting pipelines, irrespective of whether the system is pressurised or not. The couplings also eliminate the necessity of bleeding a system of air when a joint is uncoupled, or of having to prime a system after an engine change.

DESCRIPTION

General (Figs.1 and 2)

2. The Avery self-sealing coupling (fig.1) comprises three main component parts, a fixed half-coupling, a union half-coupling and a tube nut. Each half-coupling contains a valve and a valve spring, the valve preventing the escape of any liquid or the ingress of air when the two halves of the coupling are separated. When the tube nut is screwed on to the fixed half-coupling,

the union half-coupling is drawn towards the fixed half, and the two valve heads press against each other. The component parts of the self-sealing coupling are illustrated in fig.2.

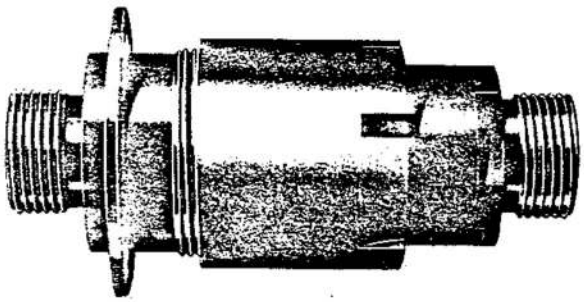


Fig.1 Flanged self-sealing coupling

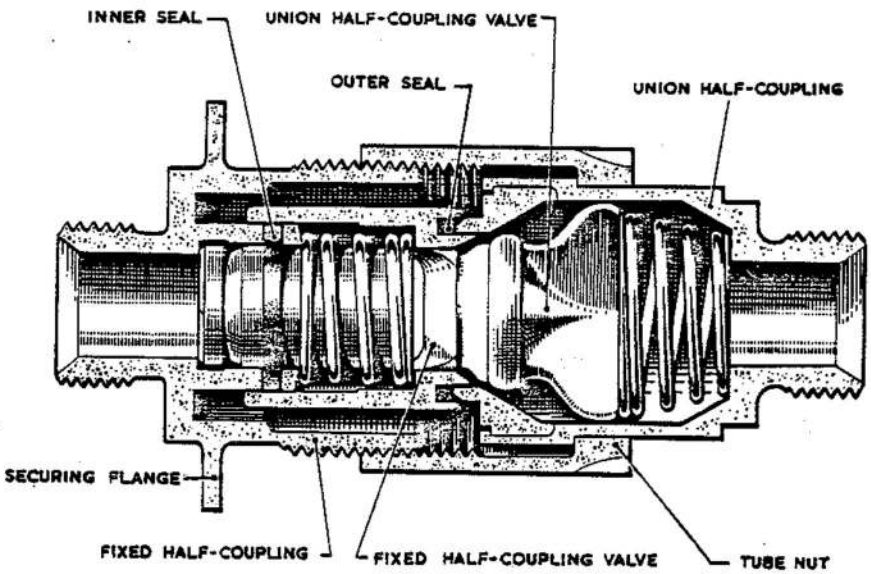


Fig.2 Sectioned coupling (valves partially open)

3. The valve in the fixed half-coupling does not move, but the pressure exerted by the tube nut forces the valve seating away from the valve head and compresses the spring. At the same time the head of the valve exerts an increasing pressure against the opposite valve head which is forced away from its seating and contracts its spring. In the completely coupled position both valves are open to the maximum extent, and the two valve springs are fully compressed. In this position there is a free passage around the valve heads equivalent to the full cross-sectional area of the pipe. The tube nut has external castellations at one end for 'C' type spanner manipulation.

4. When unscrewing the tube nuts, the pressure against the two valve heads is gradually released, and the valve spring in the union half-coupling forces the valve head against its seating, and the valve seating in the fixed half-coupling is forced against the valve head. This ensures a complete fluid and air seal of both half-couplings. Further unscrewing of the tube nut separates the two halves of the coupling.

WARNING...

WHEN MAKING OR BREAKING THE JOINT OF A SELF-SEALING COUPLING, GREAT CARE MUST BE TAKEN TO AVOID ROTARY MOVEMENT BETWEEN THE TWO HALVES, OTHERWISE THE SEATING FOR THE VALVE IN THE UNION HALF-COUPLING MAY DAMAGE THE SEAL IN THE FIXED HALF-COUPLING AND PREVENT AN OIL-TIGHT JOINT BEING OBTAINED.

Types and sizes (figs.3 and 4)

5. The fixed half-coupling is either flanged or studded according to installation requirements. The flanged type can be secured to a bulkhead or to a bracket as illustrated in fig.3, and the studded half-coupling (fig.4) can be screwed on to a rigid supporting body such as a pump casting or similar component.

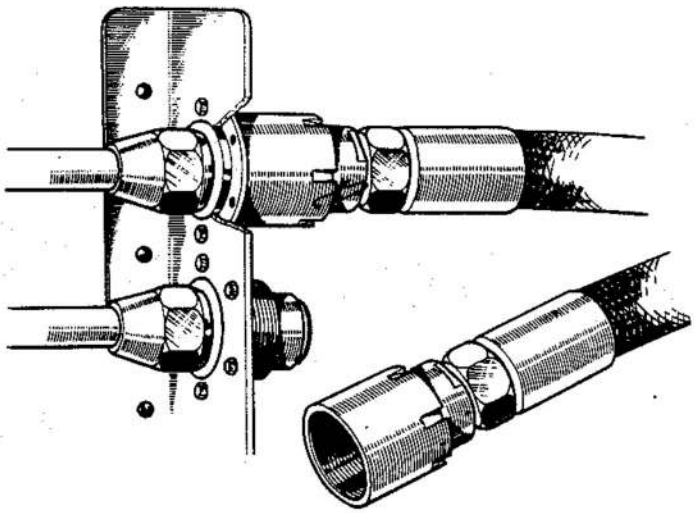


Fig.3 Flanged self-sealing couplings installed

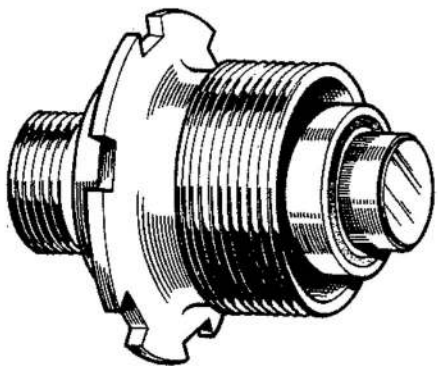


Fig.4 Studded half-coupling

6. Union half-couplings are made in one type only for each size coupling, and will connect to either a flanged or studded half-coupling. The inlet ends of couplings can be connected to hose or rigid pipeline unions fitted with standard AGS pipe or hose nipples. The screw threads of the end portions conform to the BSP gauge for each size of coupling, i.e. a 3/8in. thread connection is used for a 3/8in. coupling. Couplings are supplied in two grades,

one for low-pressure and one for medium-pressure fluid systems. The diameters, working pressures, gradings and other data for self-sealing couplings are contained in Table 1.

7. Self-sealing couplings are manufactured mainly from light-alloy metal. The two springs and the valve in the fixed half-coupling are the only component parts made from steel.

Blanking caps (fig.5)

8. When the two halves of an installed coupling have been separated, making a break in the aircraft pipeline system, blanking caps (fig.5) must be fitted to each half-coupling. The caps will protect the threads and the valve heads from accidental damage, prevent the deposition of dust and other foreign matter, and form an independent pressure seal.

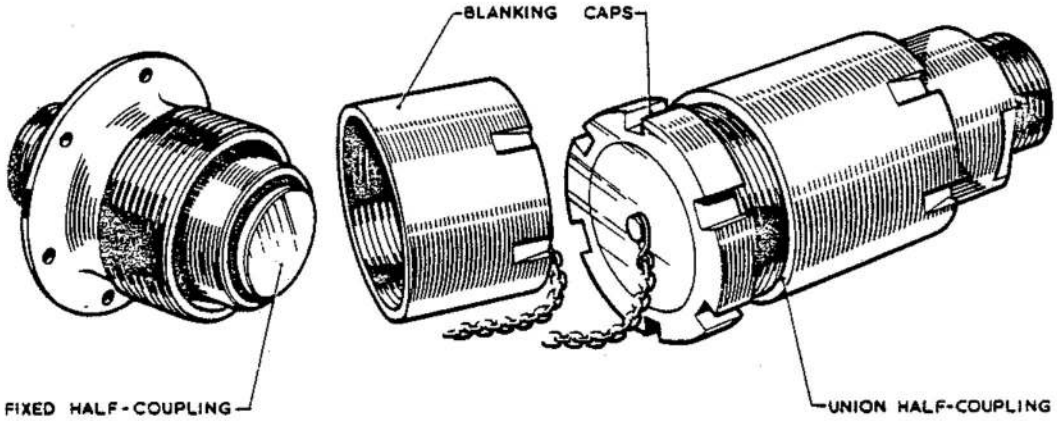


Fig.5 Blanking caps

SERVICING

Minor repairs

9. Normally the self-sealing couplings are not repairable as the valve housing of each half-coupling is swaged during assembly and cannot be dismantled. Any sign of fluid leakage which persists after the pipe or hose unions and the tube nut have been checked for tightness may necessitate fitting a new half or a complete coupling. The leakage will probably be due to a faulty valve spring or a defective outer seal in the fixed half-coupling (fig.2).

10. If renewal of the outer seal should be necessary the rubber seal must be removed from the groove in the fixed half-coupling and a new seal pressed into position, using the appropriate assembly tool. Refer to Table 2 for the size of the faulty coupling to ascertain the correct seal and tool required for the renewal.

11. Leakage is also possible if the head of the union half-coupling, which mates with the seal, becomes defaced. In this case a new half-coupling must be fitted.

TABLE 1

Self-sealing couplings and blanking caps

Size of coupling BSP(in)	Pressure grade	Max. working pressure	Flanged half-coupling		Stud half-coupling		Union half-coupling			
			Half-coupling Part No.	Blanking cap Part No.	Half-coupling Part No.	Blanking cap Part No.	Half-coupling Part No.	Blanking cap Part No.	Alloy Part No.	Steel Part No.
1/8	Medium	3000	AVA1150A	AVA64-7A	AVA1151A	AVA64-7A	AVA57A	AVA63A	AVA62A	AVA65A
1/4	Medium	3000 4000	AVA1150B AVA551B	AVA64-7B AVA552B	AVA1151B	AVA64-7B	AVA57B	AVA63B	AVA62B	AVA65B
3/8	Medium	3000 4000	AVA1150C AVA551C	AVA64-7C AVA552C	AVA1151C	AVA64-7C	AVA57C	AVA63C	AVA62C	AVA65C
1/2	Medium	3000 4000 4000	AVA1150D AVA551D AVX3393*	AVA64-7D AVA552D AVA64-7D	AVA1151D	AVA64-7D	AVA57D	AVA63D	AVA62D	AVA65D
5/8	Low	1200	AVA1152E	AVA64-7E	AVA1151E	AVA64-7E	AVA57E	AVA63E	AVA62E	AVA65E
3/4	Low	1200	AVA1152F	AVA64-7F	AVA1151F	AVA64-7F	AVA57F	AVA63F	AVA62F	AVA65F
1	Low	1200	AVA1152H	AVA64-7H	AVA1151H	AVA64-7H	AVA57H	AVA63H	AVA62H	AVA65H
$1^1/_4$	Low	500	AVA1152J	AVA64-7J	AVA1151J	AVA64-7J	AVA57J	AVA63J	AVA62J	
$1^1/_2$	Low	250	AVA1152K	AVA64-7K	AVA1151K	AVA64-7K	AVA57K	AVA63K	AVA62K	

* Note...

Similar to AVA1150D except made of steel instead of light-alloy.

TABLE 2

Rubber seals and associated fitting tools

Size of coupling BSP(in)	Sect.27M Ref.No.	Seals AVA	Tools ARD
1/8	9815	1146A	1742A
1/4	9816	1146B	1742B
3/8	9817	1146C	1742C
1/2	9818	1146D	1742D
5/8	9819	1146E	1742E
3/4	9820	1146F	1742F
1	9821	1146H	1742H
$1^1/_4$	9822	1146J	1742J
$1^1/_2$	9823	1146K	1742K

12. The tube nut is wire-locked to the union half-coupling when the coupling is assembled. Component parts, blanking caps, and 'C' spanners for each size of coupling are referenced in AP4515F, Vol.3.

Chapter 8-2

QUICK-RELEASE SELF-SEALING COUPLINGS TYPES BSCV,BSCS,HSCV and HSCV

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
Bulkhead couplings (BSC types)	4
Hose end couplings (HSC types)	8
Protective covers (SPC Series)	10
OPERATION	
General	12
Vented types	14
Non-vented types	15
Protective covers	16
INSTALLATION AND SERVICING	
All types	19

ILLUSTRATIONS

Fig.		Page
1	Typical quick-release self-sealing couplings	2
2	Typical coupling with bulkhead attachment flange	2
3	Schematic diagram (vented type)	3
4	Schematic diagram (non-vented type)...	3
5	Protective cover (SPC Series)	4
6	Schematic diagram protective cover	5

Introduction (fig. 1, 2 and 5)

1. The BSC and HSC Series of quick-release, self-sealing couplings (fig. 1 and 2) are designed for use on aircraft hydraulic, fuel and oil systems. When connected, these couplings permit a free flow of system fluid; on separation, the open ends close automatically to prevent loss of fluid. A series of protective covers, the SPC Series (fig.5), is also provided to prevent damage to the sealing face of any coupling not in use.

2. Each complete coupling comprises a bulkhead assembly, which may incorporate a bulkhead attachment flange, and a hose assembly, types BSC and HSC respectively. The BSCS and HSCS Series are normal couplings, whilst the BSCV and HSCV Series are especially designed to reduce the trapping of air during mating operations to a minimum. The 'V' (vented) Series of couplings are for use where it is important to have an air free system. The SPC Series protective covers are all similar in construction to each other, the only difference being the size of the bore.

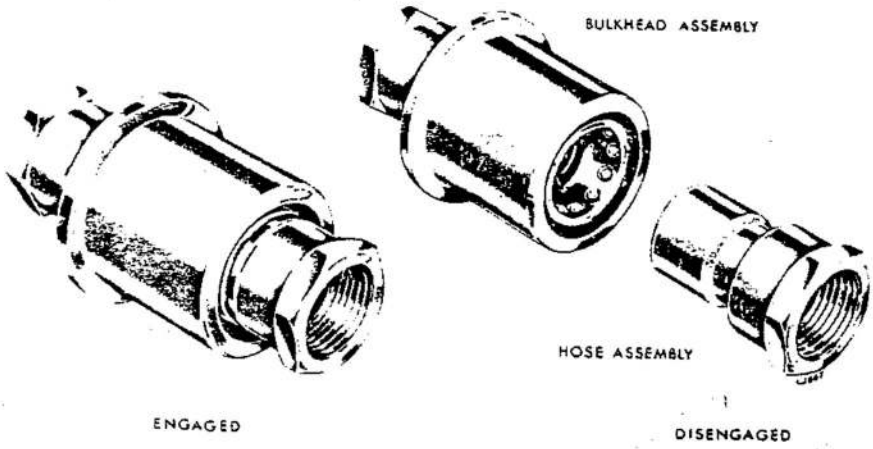


Fig.1 Typical quick-release self-sealing couplings

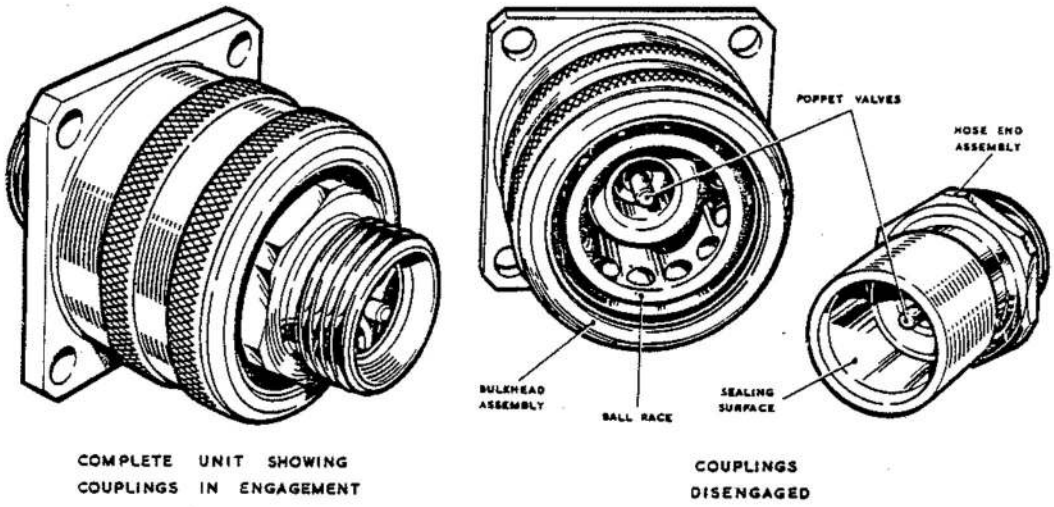


Fig.2 Typical coupling with bulkhead attachment flange

3. The type and number of the unit, e.g BSCS 108, identifies the specific installation and the calibration code to which the unit must be tested. The couplings cover a range of sizes to suit the various sizes of hose.

DESCRIPTION

Bulkhead couplings (BSC types) (figs.3 and 4)

4. The BSCV, Vented, type of bulkhead assembly (fig.3) consists of a collet housing a spring-loaded sliding cage retainer into which a coupling is screwed, coupling and cage retainer being held in the collet by a jump ring. The coupling is spring-loaded against a sliding cage assembly, one end of which is flanged and housed in the cage retainer whilst the other end accommodates a ring of ball bearings.

5. A spring-loaded sliding valve seat is accommodated in the bore of the coupling and rests upon a valve screwed into the coupling. A leakproof seal is formed by a rubber seal on the valve seat contacting the face of the valve. Holes formed in the valve stem provide an outlet for the liquid.

6. The BSCS, non-vented, type of bulkhead assembly (fig.4) is similar in construction to the BSCV type, the main difference being in the arrangement of the valve.

7. The valve seat in the BSCS type is formed in the bore of the coupling. The spring-loaded valve operates in a guide which is retained in the bore by a jump ring. An extension pin is formed on the end of this valve. Sealing is achieved by means of a rubber seal on the face of the valve mating on the valve seat.

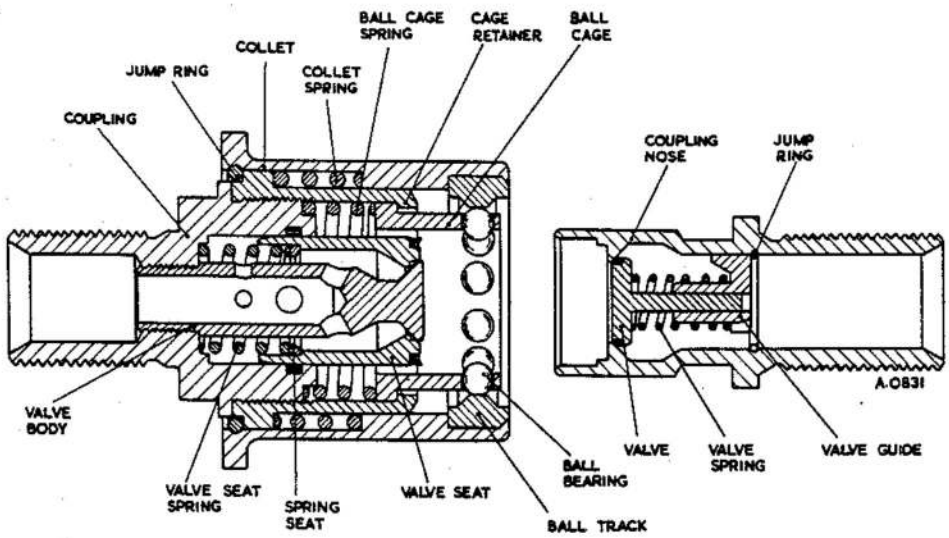


Fig.3 Schematic diagram (vented type)

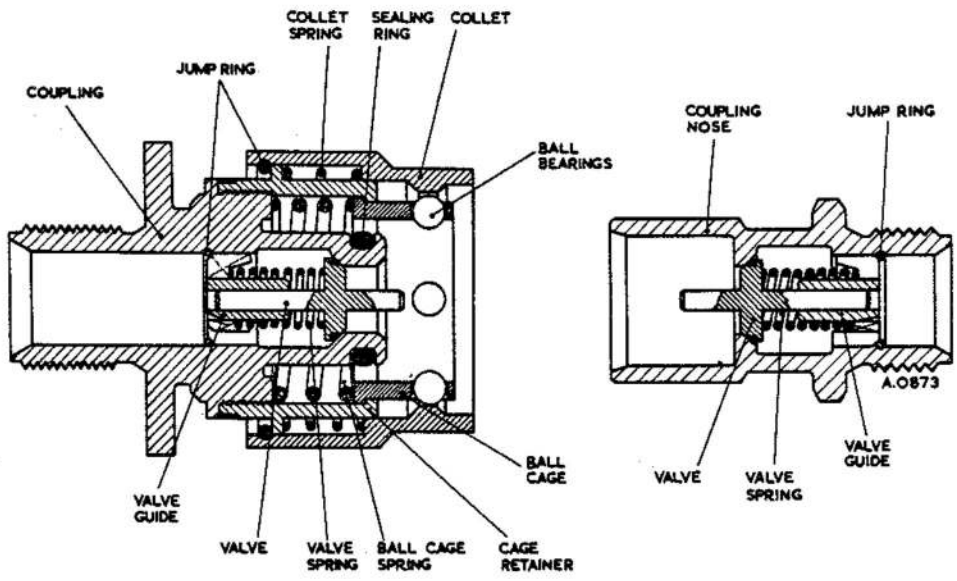


Fig.4 Schematic diagram (non-vented type)

Hose end couplings (HSC types) (figs.3 and 4)

8. The hose end assemblies, HSCV and HSCS Series (figs.3 and 4) are both similar in construction, consisting of a coupling nose bored to house a spring-loaded sliding valve the face of which accommodates a rubber seal. A leak-proof seal is effected by the valve being retained upon a valve seat

formed in the coupling nose.

9. The coupling may be threaded at its outer end, or provision made to accept an adapter for the attachment of the hose. The valves of these assemblies are similar to the bulkhead assembly valves, the non-vented type (fig.4) being formed with an extension pin. The hose of the coupling is suitably machined to mate into the bulkhead assembly to form a seal.

Quick-release protective covers SPC Series (fig.6)

10. Each quick-release protective cover (fig.6) consists of a spring-loaded sliding sleeve one end of which is sealed. The spring is accommodated between the sleeve and the body, and held in position by a retaining ring and a jump ring.

11. The length of travel of the sliding sleeve is limited by the retaining ring contacting a stop formed in the body. The bore of the sleeve is grooved circumferentially to accommodate a sealing ring which provides a cushion between the coupling and the protective cover in the event of shock. Four steel balls are located in recesses formed in the entry of the sleeve to provide the mechanism for retaining the cover on the coupling.

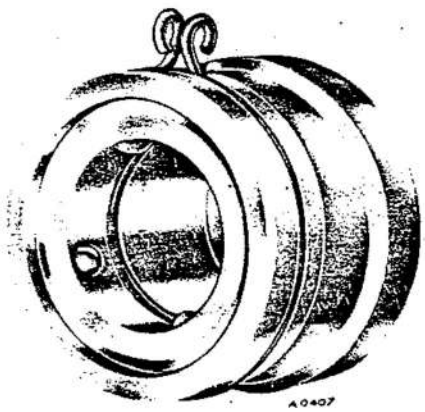


Fig.5 Protective cover (SPC Series)

OPERATION

General

12. A correctly mated coupling is locked automatically by the action of the balls of the spring-loaded ball cage locating in the machined stop of the hose end assembly.

13. To uncouple the assembly an axial movement aft is required, and this can be carried out under pressure. The springs beneath the valve and the valve seat return them to their respective mating surfaces, thereby preventing loss of fluid from the pipeline.

Vented types (fig.3)

14. When the assemblies are engaged, the coupling nose encases the end of the assembly. At the same time the valves come into contact and the hose end assembly valve is lifted from its seat to form a free-flowing passage through the coupling.

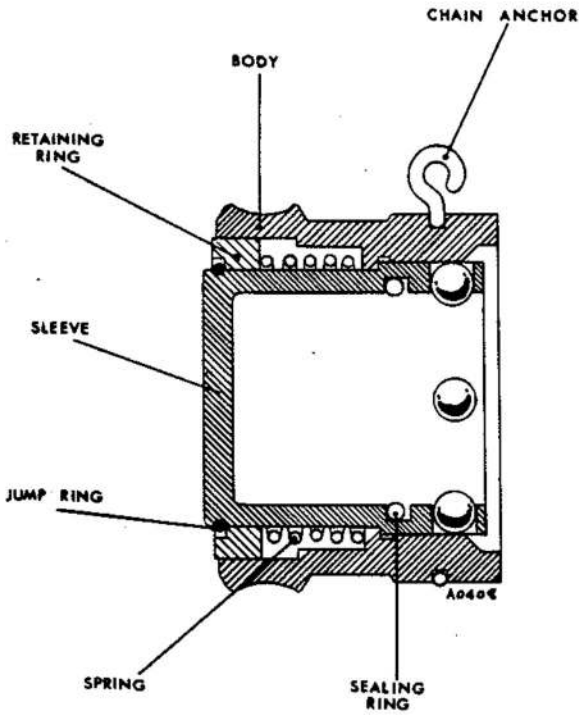


Fig.6 Schematic diagram protective cover

Non-vented types (fig.4)

15. On mating this type of coupling, the coupling nose encases the end of the assembly. At the same time the extension pins of the two valves come into contact so that the valves are lifted from their seats and a free-flowing passage is formed.

Protective covers (fig.6)

16. Hand pressure, applied to the sealed end of the cover sleeve, will overcome the loading of the spring and allow the sleeve to move forward until the balls are fully floating in their recess between the sleeve and the body. The length of travel of the sleeve prevents the balls from coming out.

17. In this attitude the cover can be placed over the hose assembly, and release of pressure on the sleeve will cause the spring to position the sleeve so as to enable the balls to grip in the stop formed on the hose assembly.

18. To release the cover an axial movement aft is required, as for uncoupling, and an anchor is provided on the cover for the attachment of a chain to retain the cover in an accessible position.

INSTALLATION AND SERVICING

All types

19. Installation details are contained in the relevant Air Publication.

Once the couplings are installed, no servicing is necessary normally except for routine examination for leaks in accordance with the relevant schedules. When necessary, inhibiting is to be carried out in accordance with the instructions contained in AP4471A using oil Nato symbol O-135 (Ref.no. 34B/9105055), or oil Nato symbol O-134 (Ref.no. 34D/9431324).

Chapter 8-3

SELF-SEALING COUPLING UNITS PART NUMBERS C17316 and C17317

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
Identification	3
Special features	4
Stud type coupling unit	5
Flanged type coupling unit	7
Union half-coupling	9
Construction	10
Principle of operation	11
Protective caps	12

ILLUSTRATIONS

Fig.		Page
1	Coupling unit, Part No. C17316	2
2	Coupling unit, Part No. C17317	2
3	Stud half-coupling	3
4	Union half-coupling	4
5	Flanged half-coupling	4
6	Pressure sealing cap	5

Introduction (figs.1 and 2)

1. The Coupling Units Part Nos. C17316 and C17317 have been designed to provide self-sealing couplings for aircraft hydraulic pipelines which can be connected or disconnected by hand whilst under pressure.

2. When properly connected they provide for a flow of fluid, when disconnected the open ends are automatically sealed to prevent loss of the system fluid. The two halves of each coupling unit are designed to reduce the trapping of air to a minimum whilst they are being connected or disconnected.

DESCRIPTION

Identification

3. Each coupling is identified by its basic part number followed by a numeral after a stroke, e.g. Part No. C17316/6. The numeral following the stroke indicates the size of the coupling and represents multiples of 1/16in. Hence the range "/6,/8,/10" corresponds to the 3/8in, 1/2in, and 5/8in. range of couplings.

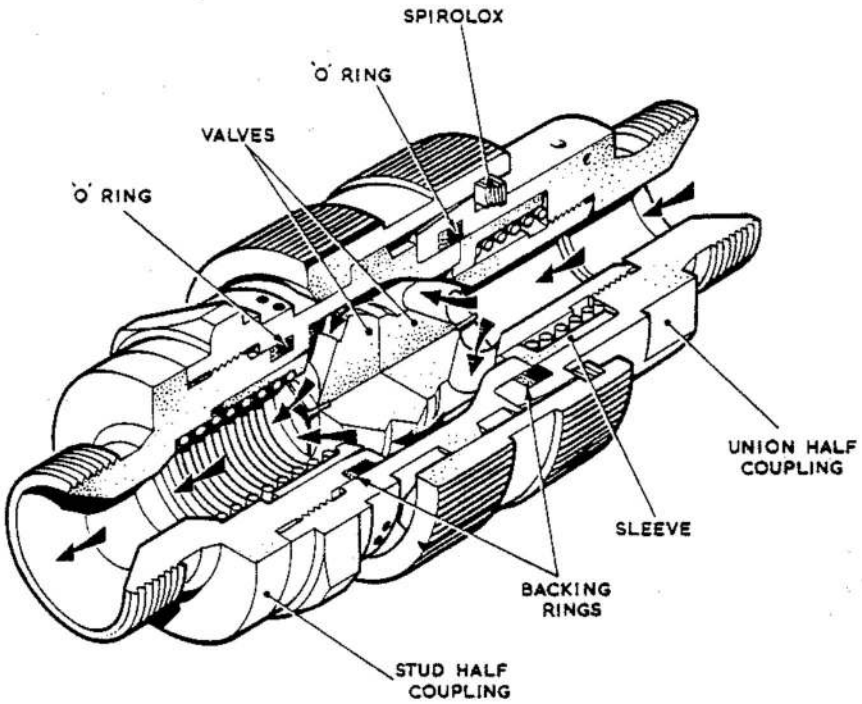


Fig.1 Coupling unit, Part No. C17316

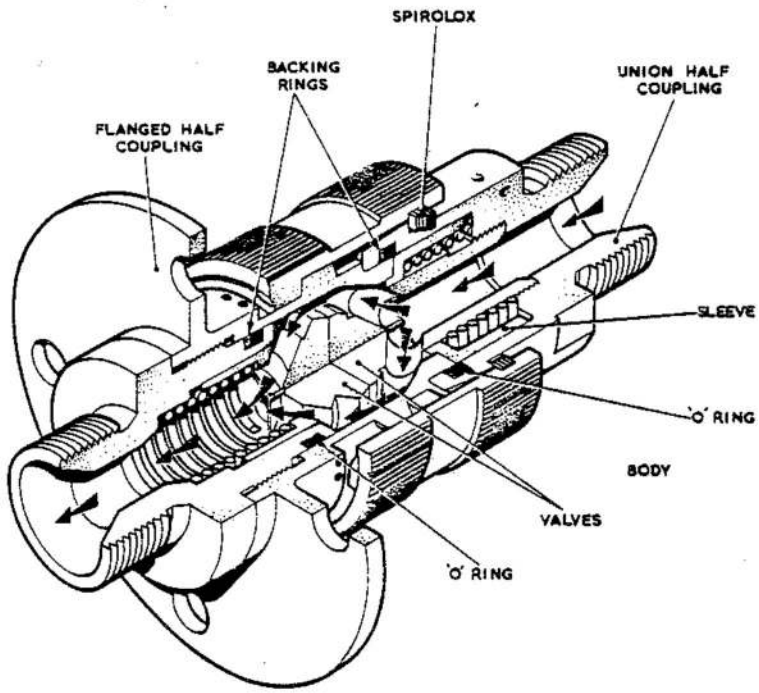


Fig.2 Coupling unit, Part No. C17317

Special features

4. The coupling units have a number of special features which are as follows:-

(1) When connected, the lock is engaged automatically.

(2) There is no intermediate position so, when connected, the coupling cannot be partially opened with consequent loss of system fluid or pressure.

(3) Positive visual indications are provided for checking that connection is complete and the lock engaged.

(4) Accidental disconnection is impossible.

(5) Each assembly carries clear instructions for connection and disconnection.

(6) The seals cannot be damaged whilst the two halves are being rotated during connection or disconnection.

Stud type coupling unit (figs.1, 3 and 4)

5. The stud type coupling unit (fig.1), Part No. C17316, consists of a stud half-coupling (fig.3), Part no. C17318, and a union half-coupling (fig.4), Part No. C17319, which is common to both stud and flanged types.

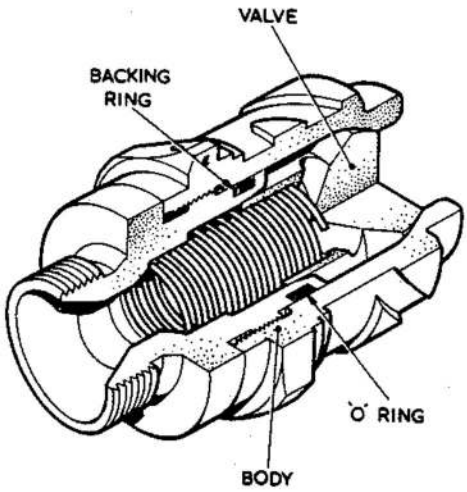


Fig.3 Stud half-coupling

6. The stud half-coupling consists of a body into which is screwed an adapter. A spring-loaded valve is fitted inside the adapter and the coupling end of the body is machined to form a three-start quick lead thread.

Flanged type coupling unit (figs.2, 4 and 5)

7. The flanged type coupling unit (fig.2), Part No. C17317, consists of a flanged half-coupling (fig.5), Part No. C17320, and a union half-coupling.

8. The flanged half-coupling is for bulkhead mounting by means of holes drilled in the integral flange round the body. Except for this it is basically the same as the stud half-coupling and the end of the body is machined to form a three-start quick lead thread.

Union half-coupling (fig.4)

9. The union half-coupling (fig.4), Part No. C17319, is used with both the other types of half-coupling. It comprises a body, a sleeve, and a tubular valve; a union nut is secured to the body by a Spirolox circlip. The tubular

valve fits inside the sleeve and is screwed inside the body. The sleeve is spring operated so as to cover the ports in the tubular valve whilst the half-coupling remains disconnected.

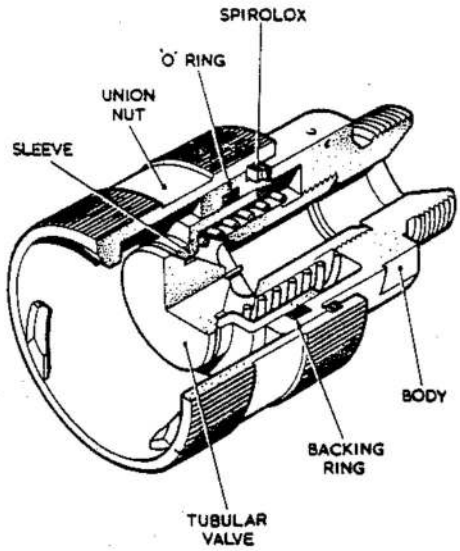


Fig.4 Union half-coupling

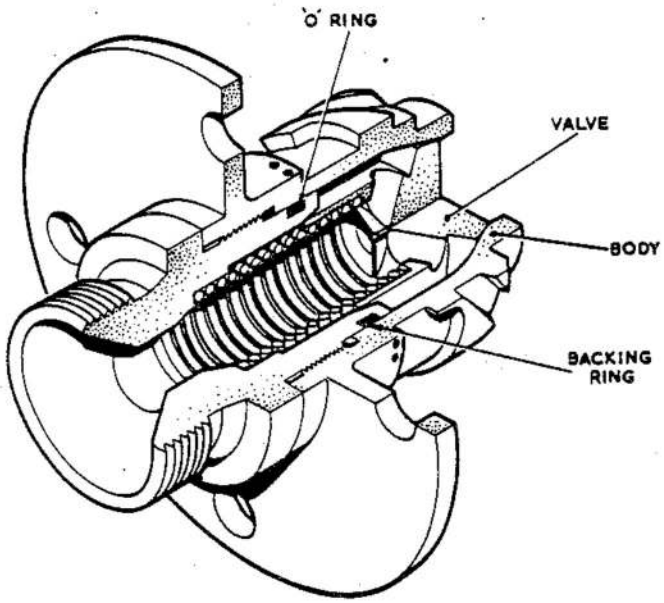


Fig.5 Flanged half-coupling

Construction

10. The valves and bodies of the half-couplings are lapped to reduce to a minimum leakage or intake of air whilst the unit is being connected or disconnected under pressure. In addition the faces of the valves of both the union and the stud half-couplings, together with the mating faces of the bodies of all three types of half-coupling, are also lapped to reduce leakage under similar conditions. Sealing of the couplings in use is achieved by means of 'O' rings fitted in each of the half-couplings.

Principle of operation

11. The two halves of a coupling are brought together by rotation of the union nut. The body of the stud or the flanged half-coupling (as appropriate) forces back the sleeve of the union half-coupling to expose the ports in the tubular valve. As the rotation continues, the tubular valve face comes into contact with the face of the valve of the stud or flanged half-coupling, which is then pushed back against its spring to uncover its valve ports. Thus, when the coupling is completely made, there is a free passage through the valves (fig. 1 and 2) for the flow of hydraulic fluid.

Protective caps (fig.6)

12. Standard AGS protective caps are provided to prevent damage to the external male threads of the half-couplings, and to prevent the ingress of dust or other foreign matter when the couplings are not in use.

13. In addition, pressure sealing caps, Part No. C17321, are provided as a further precaution. They are fitted to the stud and flanged half-couplings which, although installed in an aircraft, may not be in use. They safeguard against the loss of pressure and fluid in the event of valve failure in the coupling.

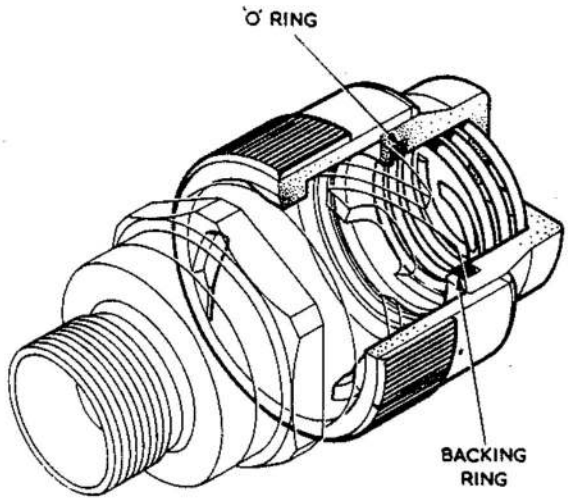


Fig.6 Pressure sealing cap

14. A pressure sealing cap (fig.6) consists of a cover and body with an internal three-start quick lead thread and a sleeve. To the end of the cover body an end piece is fitted inside which is a synthetic rubber 'O' ring and a spring. The pressure sealing cap is screwed to the stud or flanged half-coupling when the assembly is disconnected whilst under pressure and is held firmly in position by the action of its internal spring.

Chapter 9

PERMASWAGE PIPE FITTINGS

(Completely revised)

CONTENTS

Para

1 Introduction

Description

2 Permaswage unions

3 Swaging tools

4 Permaswage tool kits

5 Portable hydraulic power supply unit

7 Tube repair kits

9 Permaswage repair methods

10 Types of repair using PE 60000 series (metric) fittings

11 Type A repair: pin hole or circumferential crack in tubing

12 Type B repair: longitudinal crack in tubing in excess of 7.60 mm (0.30 in)

13 Type C repair: leaking end fitting, male or female

14 Type D repair: leaking male or female end-fitting, direct replacement

15 Type E repair: leaking PAN boss fitting

16 Types of repair using PE 40000 series (imperial) fittings

17 Type 1 repair: pin hole or circumferential crack in tubing

18 Type 2 repair: longitudinal crack in tubing in excess of 7.60 mm (0.30 in)

19 Type 3 repair: leaking tee or elbow fitting

20 Type 4 repair: leaking end-fitting, flared tube (brazed or welded) and flareless tube

23 Types of repair using Standard (D9000, D10000 and D11000 series fittings (lipseal)

24 Type 1: pin hole or circumferential crack in tubing

25 Type 2: longitudinal crack in tubing in excess of 7.60 mm (0.30 in)

26 Type 3: replacement of Dynatube swivel fitting, butt-welded or swaged

27 Type 4: replacement of damaged Permaswage female assemblies D11200 in all sizes, and butt-welded and swaged Dynatube fittings size -20 and -24

28 Type 5: replacement of Dynatube R44277PT butt-welded reducer female assembly

29 Type 6: replacement of Dynatube butt-welded or Permaswage male threaded connectors MR54100, MR44100P or D11007

30 Minimum straight tube length to a bend, Standard fittings

31 Repairs to pipes with bends and curves

32 Permaswage pipe manufacture or repair procedure

33 Preparation

34 Preliminary pipe marking

35 Cutting damaged tube

36 Cutter wheel replacement

37 Deburring the cut tube

38 Deburring tool cutter head replacement

39 Tube end preparation and marking

41 Swaging operation

42 Air bleed procedure

43 Inspection of swaged joint

Para

► 44 Pipe testing ◄
45 Handling and fitting
46 Standard fittings

Table Page

1 Tube material approved for repair and manufacture by the Permaswage technique using PE 40000 and PE 60000 series fittings 5
2 Tube material approved for repair and manufacture using CRES (corrosion resistant steel) standard Permaswage fittings 5
3 Permaswage tool kits and applicable tube and fitting types 7
4 Cutting measurement (dimension 'L' fig 9) for removal of faulty PAN end-fittings 12
5 Cutting measurement for the removal of faulty AN flared and MS flareless end fittings 15
6 Minimum straight tube length for swaging standard fittings 22
7 Spare cutter wheel part numbers 26
8 Deburring tools for imperial size tubes 29
9 Deburring tools for metric size tubes 29
10 Minimum straight tube length for swaging 31
11 Swage head dimensions 32
12 Fault diagnosis 40
13 List of Permaswage replacement fittings for imperial, MS and AN fittings 41
14 List of Permaswage replacement fittings for metric fittings (short tail) 42
15 List of Permaswage replacement fittings for metric fittings (long tail) 43
16 Standard fittings, separable, lipseal 45
17 Standard fittings, permanent union 47
18 Standard fittings, reducer union, permanent, D10045 48
19 Standard fittings, elbows 90° permanent 49
20 Standard fittings, tees, permanent 50
21 Standard fittings, adapter, male 51
22 Standard fittings, adapter, bulkhead 51

Fig

1 Sectional view of completed repair 4
2 Typical tool kit and hydraulic power supply 6
3 Metric tube with damaged length less than 7.6 mm (0.30 in) 9
4 Completed repair to metric tube (single swaged fitting) 9
5 Metric tube with longitudinal crack in excess of 7.6 mm (0.30 in) 9
6 Completed repair with replacement section of tubing ... 10
7 Leaking male or female end-fitting 10
8 Completed repair with new combined tube lengths and end-fitting 10
9 Leaking male or female end-fitting, direct replacement 11
10 Completed repair with replacement swaged end-fitting ... 11
11 Imperial tube with damaged length less than 7.6 mm (0.30 in) 13
12 Completed repair to imperial tube (single swaged fitting) 13
13 Imperial tube with longitudinal crack in excess of 7.6 mm (0.30 in) 13
14 Completed repair with replacement section of tubing ... 14
15 Leaking or damaged tee-piece 14
16 Completed repair with replacement tee-piece 14

		Page
17	Leaking end-fittings with flared tube (brazed or welded) or MS flareless tube	15
18	Cut off length for flared and flareless separable end replacement ...	15
19	Completed repair with replacement flared or flareless end fitting ...	16
20	Completed repair to a pipe with a welded nipple end-fitting	16
21	Imperial tube with damaged length less than 7.6 mm (0.30 in)	17
22	Completed repair to imperial tube/single swaged fitting) ...	17
23	Imperial tube with longitudinal crack in excess of 7.6 mm (0.30 in)	17
24	Completed repair with replacement section of tubing	18
25	Cut-off dimensions, damaged Dynatube swivel fitting	18
26	Completed repair with DD00200A fitting	19
27	Damaged Permaswage D11200 and Dynatube female fittings	19
28	Completed repair with DD00200A fitting	19
29	Cut-off dimensions, damaged Dynatube RR442775 fitting	20
30	Completed repair with DD00300A or D11300 reducer fitting	20
31	Damaged male threaded connector	21
32	Completed repair using D10036 union and D11007 adapter	21
33	Cut-off dimensions at tube bends, standard fittings	21
34	Pipe marking for shape retention	23
35	Chipless cutter	24
36	Deburring tool operation	26
37	Deburring tool (Part Nos D9850 and D9851) components	28
38	Deburring tool (Part Nos D9849) components	28
39	Tube insertion witness marking	30
40	Tube end-fitting limits	32
41	Swaging tool	34
42	Hydraulic power supply unit	36
43	Go/no go gauge inspection criteria	38
44	Tube insertion limits	39
45	Standard fittings, separable, lipseal	46
46	Standard fittings, permanent unions	46
47	Part numbering system	47
48	Standard fittings, elbow 90°, permanent	49
49	Standard fittings, tee, permanent	50
50	Standard fittings, adapters, male and bulkhead	51

Introduction

1 This chapter contains repair and operating procedures for installing Permaswage unions and fittings using D12000 series tool kits. Included in this chapter are illustrations of typical repairs to pipework. The tooling and repair procedures described enable 'in situ' repairs to be carried out on imperial and metric pipes.

Note ...

This repair system is approved for use on hydraulic system pipes up to the pressure rating of the pipe material.

DESCRIPTION

Permaswage unions (fig 1)

2 The Permaswage technique produces a permanent in-line repair by swaging a metal union (fitting) on to the adjoining ends of a rigid pipe, using an hydraulic swaging tool. Male and female screwed end-fitting replacements are also possible. The basic element of the repair technique is the Permaswage union which is swaged on to the pipe by means of hydraulic pressure applied through a pair of specially shaped dies located in a swage head. The resulting deformation of the fitting and the pipe achieve a metal-to-metal joint. Two internal back-up seals incorporated in the fitting compensate for any imperfections in the rigid pipe surfaces. A sectional illustration of the completed repair is illustrated in fig 1. A list of tubing material specifications approved for swaging joints is given in Table 1 and 2 .

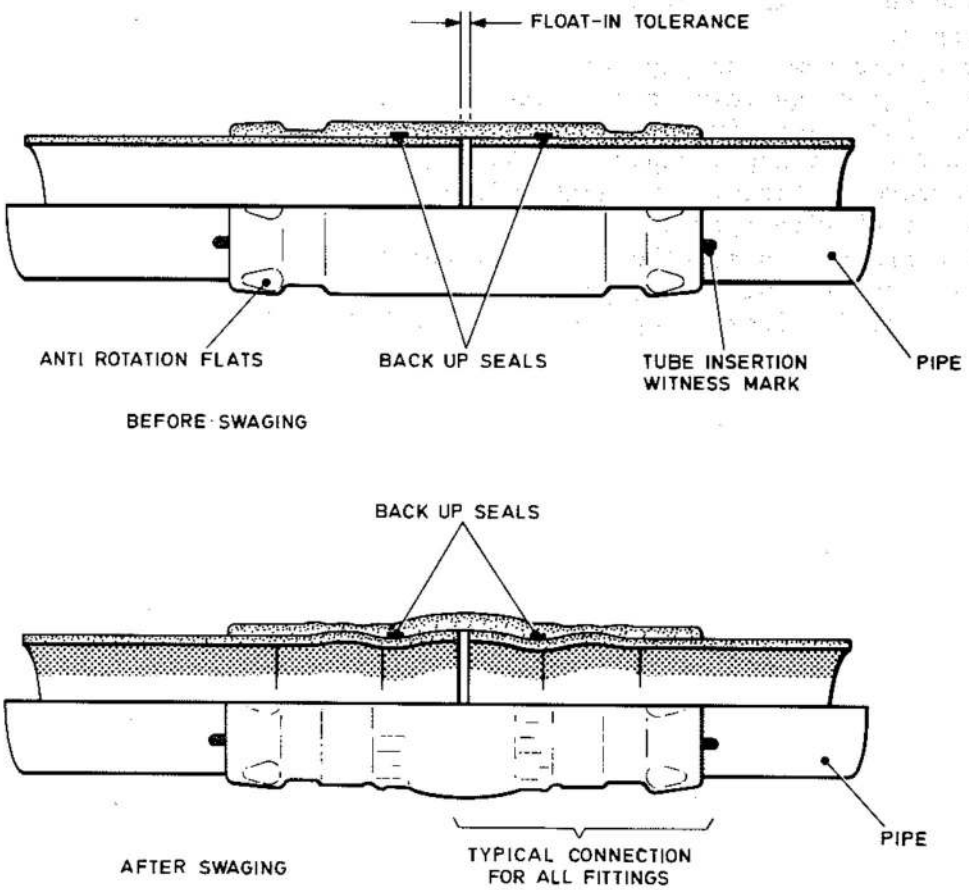


Fig 1 Sectioned view of completed repair

TABLE 1 TUBING MATERIAL APPROVED FOR REPAIR AND MANUFACTURE BY THE PERMASWAGE TECHNIQUE USING PE 40000 AND PE 60000 SERIES FITTINGS

Material	Specification
Corrosion resistant steel (CRES)	21-6-9 (MMS 229)
Corrosion resistant steel (CRES)	304 1/8 Hard
Corrosion resistant steel (CRES)	304
Corrosion resistant steel (CRES)	321 1/8 Hard
Annealed steel (DTD 5016)	T72, T73
Titanium	3AL-2.5
Nimonic 75	BAC M116
Aluminium alloy	6061-T6

TABLE 2 TUBE MATERIAL APPROVED FOR REPAIR AND MANUFACTURE USING CRES(CORROSION RESISTANT STEEL) STANDARD PERMASWAGE FITTINGS)

Material	Specification
Corrosion resistant steel (CRES)	304 1/8 Hard
Corrosion resistant steel (CRES)	21-6-9 (MMS 229)
Corrosion resistant steel (CRES)	221 1/8 Hard
Titanium	3Al-2.5V CWSR
Titanium	3AL-2.5V annealed
Aluminium alloy	6061-T6

Note ...

The types of tubing materials permissible for swaged joints are restricted to those listed above.

Swaging tools (fig 2)

3 The basic equipment is a swaging tool comprising a swage head, with detachable power unit and upper and lower die blocks. These three parts interlock to ensure easy assembly around the pipe fitting to be secured. A different pair of die blocks is needed for each size of pipe but the swage heads cover a range of pipe sizes.

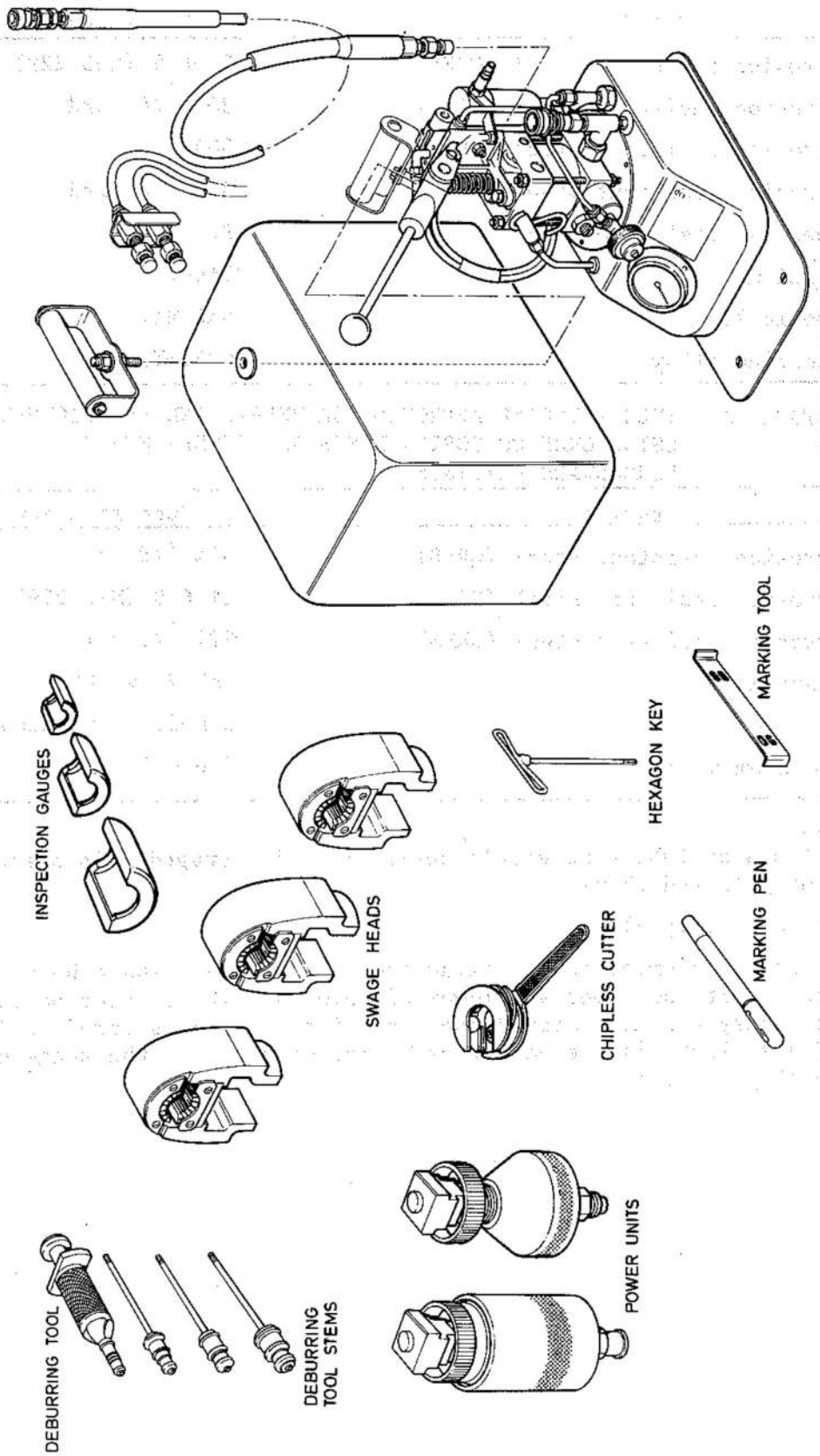


Fig 2 Typical tool kit and hydraulic power supply

Permaswage tool kits

4 The Permaswage tube repair equipment consists of a standard portable hydraulic power supply (Part No D12025-001) and a tube repair kit containing equipment relative to the outside diameter of the tube to be repaired. Eight different tube repair kits are available for different tube sizes (Table 2).

Portable hydraulic power supply unit (fig 2)

5 The portable hydraulic power supply unit (D12025-001) generates the pressure required to operate the swaging tool, either by hand or by compressed air. The unit consists of a hydraulic oil pump with associated pressure relief valve, a hydraulic oil reservoir, a control valve, a pressure gauge and an air pressure regulator. Fittings and components are mounted on a flat base and a cover and a carrying handle are provided for protection and portability. A hydraulic hose, 3.65 m (12 ft.) long together with a twin air hose terminated with a pushbutton control, in all 4.57 m (15 ft.) long, which is permanently attached to the hydraulic supply unit, provides remote control to the hydraulic supply unit when used in the air powered mode. The Part No D12025-001 hydraulic supply unit can be used in conjunction with all sizes of imperial and metric swage heads.

6 Hydraulic fluid is fed to the swage tool through a $^{1}/_{4}$ inch quick-disconnect high pressure hose. A swaging pressure of 379 bar (5500 lbf/in^2 is used for all tubing sizes and materials and may be attained either by manual operation of the hand pump or air-to-fluid intensification from a 5.5 to 6.8 bar (80 to 100 lbf/in^2) compressed air source. Upon completion of swaging, pressure is reduced to zero to release the swage dies.

Tube repair kits (fig 2)

7 There are eight variations of the tube repair kit and each kit set is contained within a separate tool box. The repair kits differ only in the range of fittings and tube sizes that the swage heads can accommodate. All tube repair kits are utilised in association with portable hydraulic power supply D12025-001.

8 Table 2 provides a list of the repair kits numbered 1,2,3,4,5,7,8 and 9 with the range of tube sizes and the series of fittings for which the kit must only be used. Tables 3 to 10 give a list of equipment provided with each kit and the Permaswage part number for each item.

TABLE 3 PERMASWAGE TOOL KITS AND APPLICABLE FITTING TYPES

Kit No	Permaswage Pt No	Pipe sizes	Applicable fitting types	Tables
1	D12109C60-01	5,6,8,10 mm	PE 60000 series	Table 1
2	D12179C02-02	12,14,15,16 and 18 mm	PE 60000 series	Table 1
3	D12108C03-01	1/4, 3/8 in	PE 40000 series	Table 1
4	D121707C06-06	1/2, 5/8, 3/4 in	PE 40000 series	Table 1
5	D12108C02-01	1/4, 5/16, 3/8 in	PE 40000 series	Table 1
7	D12108C01-01	3/16, 1/4, 5/16,3/8 in	PE 40000 series	Table 1

(continued)

TABLE 3 PERMASWAGE TOOL KITS AND APPLICABLE TUBE SIZES(Cont'd)

Kit No	Permaswage Pt No	Pipe sizes	Applicable fitting types	Tables
8	D12102C03-01	1/4,3/8 in	Standard series	Table 2
9	D12102C06-26A00	1/2,5/8, 3/4 in	Standard series	Table 2

Note ...

For tool kit break down and Sec/Ref No cross refer to AP 119G-0601-135F

PERMASWAGE REPAIR METHODS

9 The Permaswage technique for tubing repair involves: cutting, deburring, tube-end preparation, swaging and gauging operations. This repair technique is suitable for the repair and manufacture of both metric and imperial size tubing. It is vital to select the correct fitting approved for use with the material of the tube. (Notes 1 to 3).

CAUTION:

Operators are to ensure that pipe materials used for repair/manufacture are as specified in the relevant Topic 6 and furthermore are authorised for repair/manufacture by the Permaswage method

Notes ...

(1) The standard series of Permaswage fittings, identified by their D10000 or D11000 series part numbers are used for the manufacture and repair of imperial size tubing of the material types detailed in Table 2 . They are swaged using the kits containing the D12200 series of swage heads.

(2) Permaswage PE 60000 series fittings are an annealed form of fitting and are used for the manufacture and repair of metric size tubing of the material types detailed in Table 1. They are swaged using kits containing D12900 series of swage heads.

(3) Permaswage PE 40000 series fittings are an annealed form of imperial size fitting suitable for the repair and manufacture of imperial size pipes of the material types detailed in Table 1. They are swaged using kits containing the D12800 series swage heads.

Types of repair using PE 60000 series (metric) fittings

10 Four basic types of metric tube assembly failures lend themselves to repair using Permaswage techniques. The failure modes and the recommended repair method for each type are described in para 11 to 15.

Type A repair: pin hole or circumferential crack in tubing (fig 3 and 4)

11 Make one or two cuts as necessary to remove the damaged section. If two cuts are required, the distance between them shall not exceed 7.60 mm (0.30 in.). If this measurement is exceeded refer to repair method Type B (para 12).

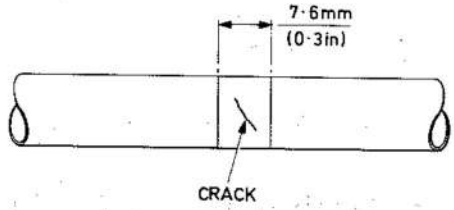


Fig 3 Metric tube with damaged length less than 7.6 mm (0.30 in.)

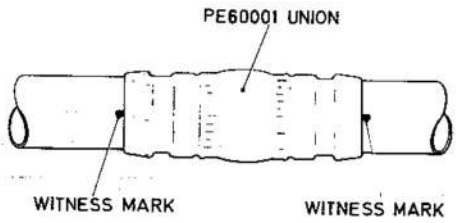


Fig 4 Completed repair to metric tube (single swaged fitting)

Type B repair: longitudinal crack in tubing in excess of 7.60 mm (0.30 in.) (fig 5 and 6)

12 Make two cuts to remove the damaged section. The cuts should be made only after a fit check has been made to assure swaging tool accessibility in the area to be swaged. Remove the damaged section and use it as a pattern to duplicate the new section. Swage the replacement section on to the original pipeline under repair using two tube-to-tube permanent unions PE 60001 (fig 6).

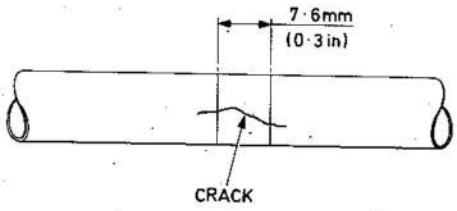


Fig 5 Metric tube with longitudinal crack in excess of 7.6 mm (0.30 in.)

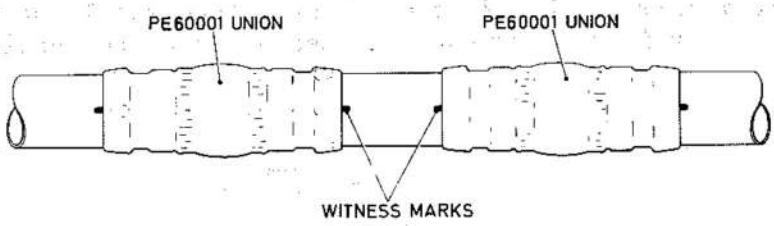


Fig 6 Completed repair with replacement section of tubing

Type C repair: leaking end-fitting, male or female (fig 7 and 8)

13 Cut off damaged end-fitting at a point convenient for swage tool access. Make repair using tube splice with a PE 60001 union and the relevant replacement Permaswage end-fitting PE 60801 or PE 60807.

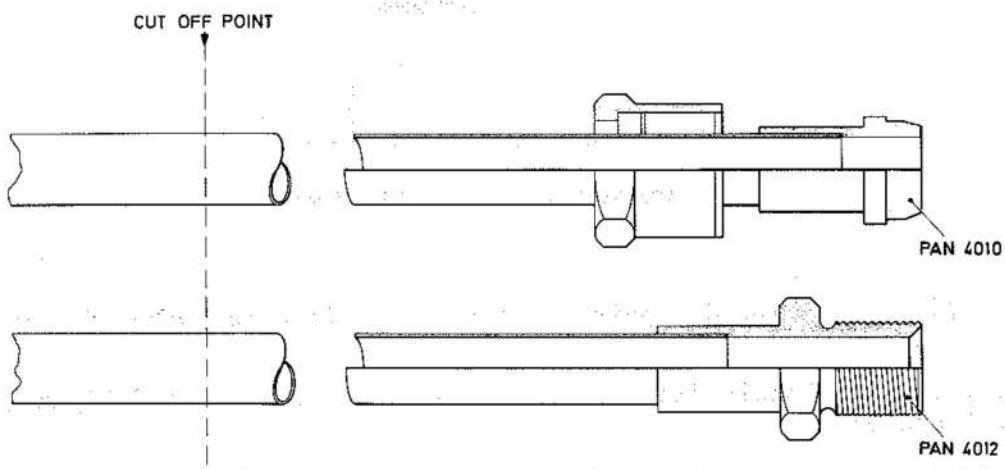


Fig 7 Leaking male or female end-fitting

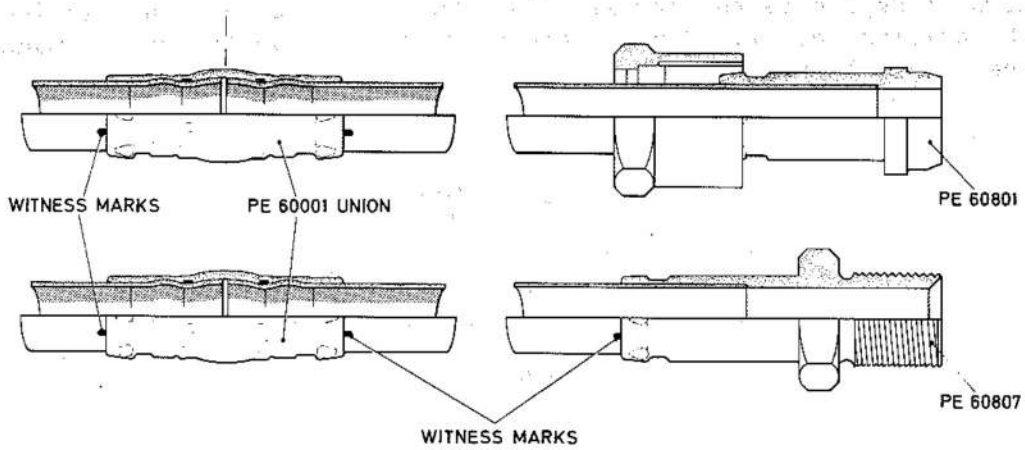


Fig 8 Completed repair with new combined tube length and end-fitting

Type D repair: leaking male or female end-fitting, direct replacement (fig 9 and 10)

14 Cut off the leaking or damaged PAN end-fitting at distance 'L' (Table 4). After deburring, introduce the tubing into the replacement Permaswage end-fitting and duplicate the overall length of the tube assembly by making use of the ± 3.8 mm (± 0.15 in.) float-in tolerance. Wherever possible finger-tighten the sleeve nut to its interface before swaging.

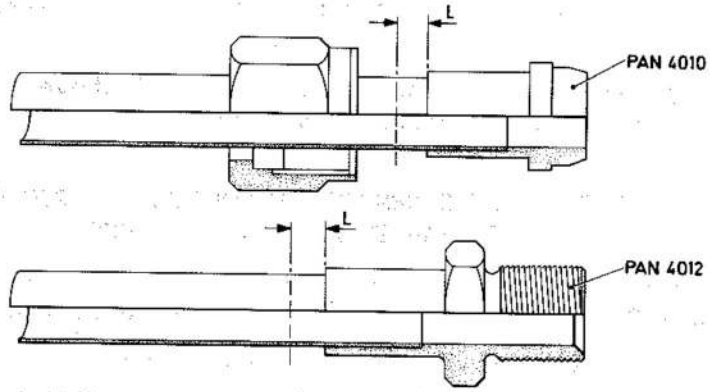


Fig 9 Leaking male or female end-fitting, direct replacement

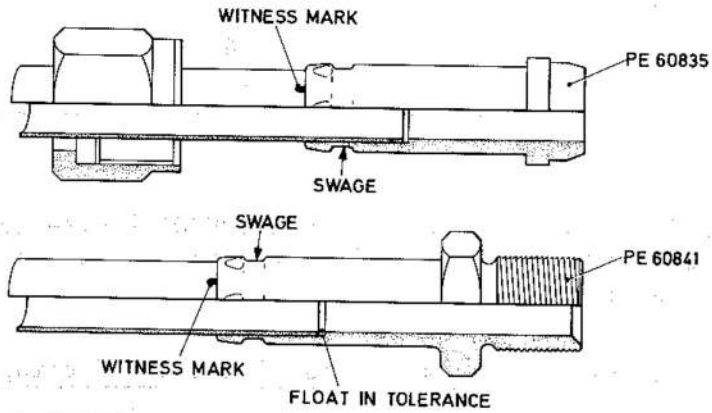


Fig 10 Completed repair with replacement swaged end-fitting

Type E repair: leaking PAN boss fitting

15 The boss fitting consists of a PAN sleeve 4010 and a male nut PAN 4057. This end-fitting can be replaced by either repair type C or repair type D given in sub-para 15.1 and 15.2 respectively.

15.1 Repair type C. Select the correct replacement Permaswage boss fitting PE 60829-05, 06, 08 and 10. Each of these boss fittings consists of short (Permaswage) end-fitting PE 60802 and male nut PE 60866.

15.2 Repair type D:

15.2.1 For sizes 5, 6, 8 and 10 mm, use replacement Permaswage boss end-fitting PE 60844. Each of these end-fittings consists of long Permaswage insert PE 60836 and male nut PE 60856.

15.2.2 For sizes 12, 14, 16, 18, 20, 22 and 28 mm, use replacement Permaswage boss end-fitting PE 60829. Each of these end-fittings consists of long Permaswage insert PE 60830 and male nut PE 60831.

Notes ...

(1) All Permaswage end-fittings size 5 to 10 mm consist of separate sleeves and nuts (issued as assemblies).

(2) All Permaswage end-fittings size 12 mm and above consist of sleeves with pinned-on nuts (issued as assemblies).

TABLE 4 CUTTING MEASUREMENT (DIMENSION 'L' FIG 9) FOR REMOVAL OF FAULTY PAN END-FITTINGS

Nipple PAN 4010		Male fitting PAN 4012	
Size (mm)	Dimension 'L' (mm)	Size (mm)	Dimension 'L' (mm)
5	5	5	5
6	5	6	5
8	5	8	5
10	5	10	5
12	5	12	5
14	5	14	5
16	5	16	5
18	5	18	5

Note ...

Where provided, cut-off marking tool OPE001-1 size (PAN 4010 nipple) or OPE001-2 size (PAN 4012 male fitting) can be used as an alternative method of marking distance 'L' in Table 5.

Types of repair using PE 40000 series (imperial) fittings

16 Four basic types of imperial tube assembly failures lend themselves to repair using Permaswage techniques. The failure modes and the recommended repair methods for each type are described in para 17 to 20.

Type 1 repair: pin hole or circumferential crack in tubing (fig 11 and 12)

17 Make one or two cuts as necessary to remove the damaged section. If two cuts are required, the distance between them shall not exceed 7.60 mm (0.30 in.). If this measurement is exceeded refer to repair method Type 2 (para 18).

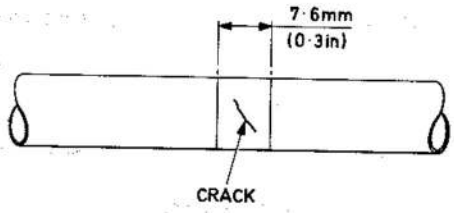


Fig 11 Imperial tube with damaged length less than 7.6 mm (0.30 in.)

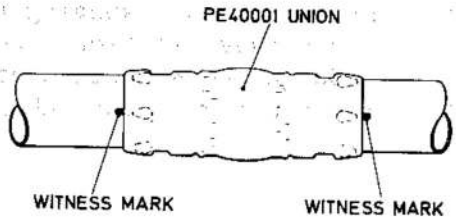


Fig 12 Completed repair to imperial tube (single swaged fitting)

Type 2 repair: longitudinal crack in tubing in excess of 7.60 mm (0.30 in.) (fig 13 and 14)

18 Make two cuts to remove the damaged section. The cuts should be made only after a fit-check has been made to assure swaging tool accessibility in the area to be swaged. Remove the damaged section and use it as a pattern to duplicate the new section. Swage the replacement section on to the original pipeline under repair using two tube-to-tube unions PE 40001.

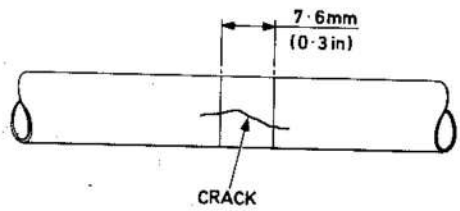


Fig 13 Imperial tube with longitudinal crack in excess of 7.6 mm (0.30 in.)

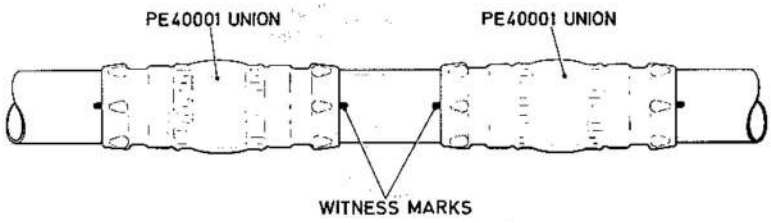


Fig 14 Completed repair with replacement section of tubing

Type 3 repair: leaking tee or elbow fitting (fig 15 and 16)

19 Cut out defective tee or elbow fitting. The cuts should be made only after a fit-check has been made to assure swaging tool accessibility in the area to be swaged. Remove the damaged sections and use them as a pattern to duplicate the new sections. Swage the spliced sections to tee or elbow fittings. Connect each splice section to the tubing under repair, using a tube-to-tube union.

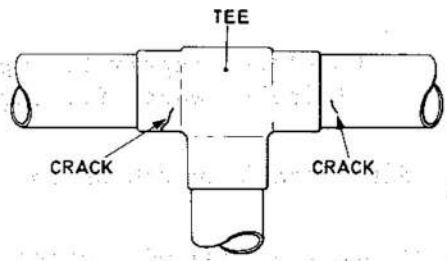


Fig 15 Leaking or damaged tee-piece

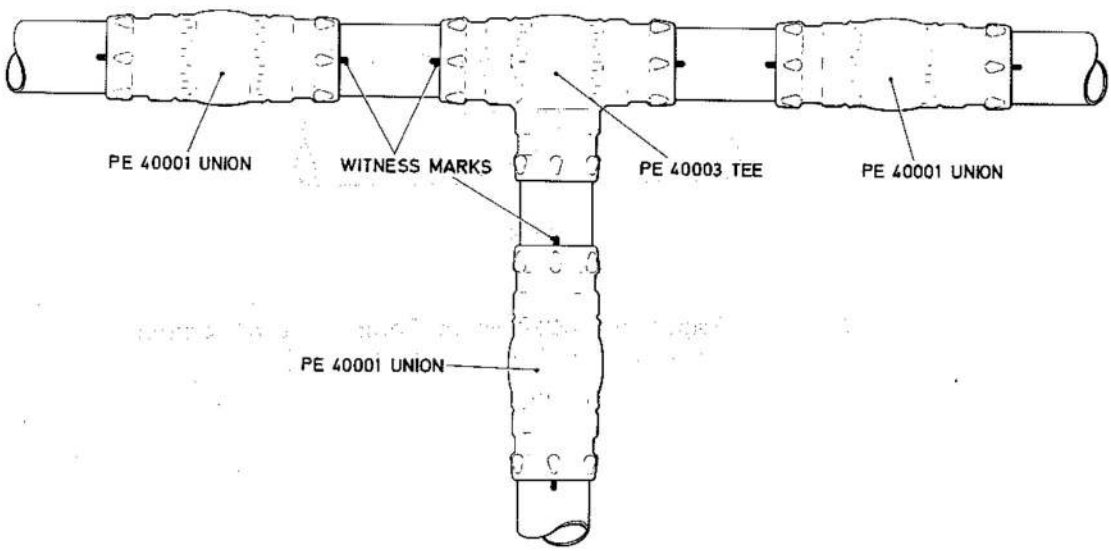


Fig 16 Completed repair with replacement tee-piece

Type 4 repair: leaking end-fitting, flared tube (brazed or welded) and flareless tube (fig 17, 18, 19 and 20).

20 Refer to Table 5 to determine the cut-off length for the flared and flareless separable end replacement. Mark a line over the tube at distance 'L' measured from the end-fitting (refer to Table 5). The 'bottoming' of a Permaswage sleeve on to the cut tube end duplicates the original overall length of the assembly.

Note ...

If distance 'L' is correctly marked on the pipe as per the measurements given in Table 5, pipeline repair can be completed without the need for splicing new tubing into the line.

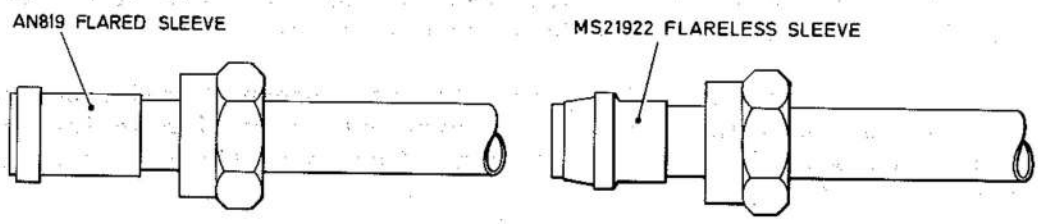


Fig 17 Leaking end-fittings with flared tube (brazed or welded) or MS flareless tube

TABLE 5 CUTTING MEASUREMENT FOR REMOVAL OF FAULTY AN FLARED AND MS FLARELESS END-FITTINGS

MS/AN pipe size	Dimension 'L' ± 0.010 in	
	AN (in)	MS (in)
- 3	0.724	1.125
- 4	0.622	1.127
- 5	0.687	1.148
- 6	0.696	1.154
- 8	0.827	1.208
-10	1.106	1.477
-12	0.974	1.515
-16	1.280	1.746

Note ...

Pipe sizes are in increments of 1/16in, for example size 3 is 3/16in outside diameter.

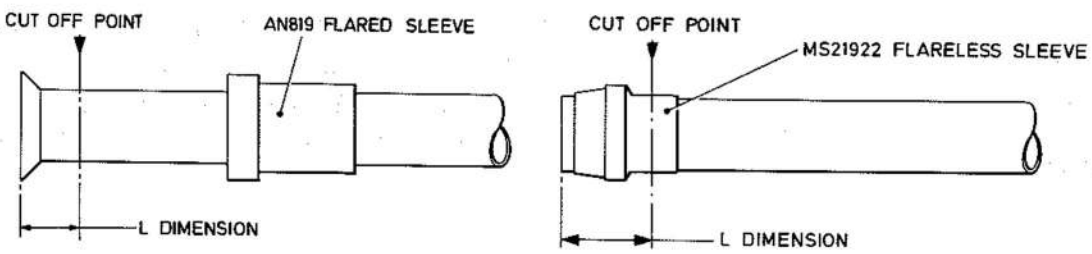


Fig 18 Cut-off length for flared and flareless separable end replacement

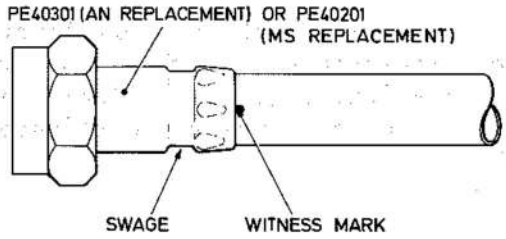


Fig 19 Completed repair with replacement flared or flareless end-fitting

21 If the end-fitting to be fabricated is a simple flare with a Vickers nipple inserted, this can be made up at unit level.

22 For a pipe with a welded nipple, utilise a pre-prepared stub-end pipe with a welded replacement nipple and carry out an in-line splice to the original tube with a Permaswage PE 40001-K union of the relevant size (refer to Fig 20).

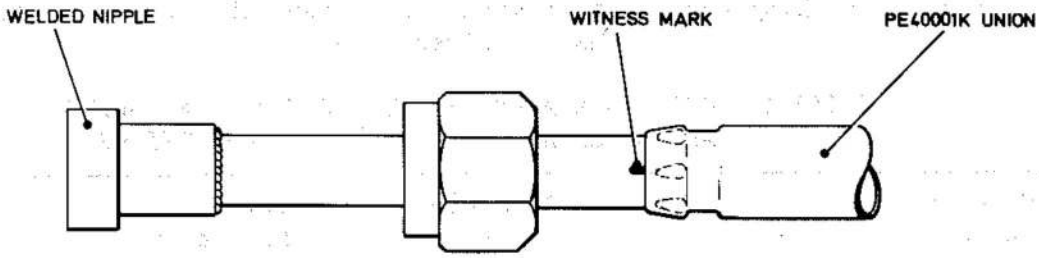


Fig 20 Completed repair to a pipe with a welded nipple end-fitting

Types of repair using Standard, D9000, D10000 and D11000 series fittings, (lipseal)

23 Six basic types of tube assembly failures lend themselves to repair using Permaswage 'Standard' fitting to replace lipseal (Dynatube) fittings. The failure modes and the recommended repair method for each type are described in para 24 to 29.

Note ...

It can be advantageous to use a Permaswage repair length fitting in cases where axial access for the Dynatube swaging tool, is limited.

Type 1 repair: pin hole or circumferential crack in tubing (fig 21 and 22)

24 Make one or two cuts as necessary to remove the damaged section. If two cuts are required, the distance between them shall not exceed 7.60 mm (0.30 in). If this measurement is exceeded refer to repair method Type 2 (para 25).

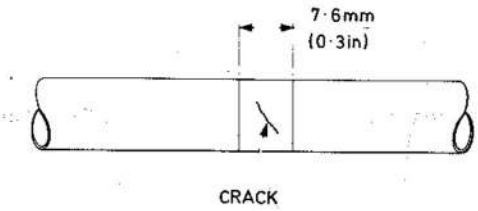


Fig 21 Imperial tube with damaged length less than 7.6 mm (0.30 in)

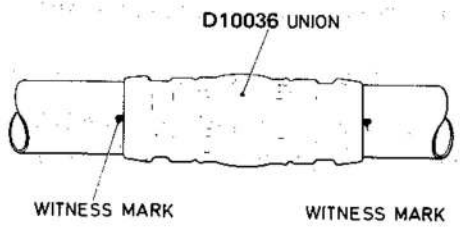


Fig 22 Completed repair to imperial tube (single swaged fitting)

Type 2 repair: longitudinal crack in tubing in excess of 7.60 mm (0.30 in) (fig 23 and 24)

25 Make two cuts to remove the damaged section. The cuts should be made only after a fit-check has been to assure swaging tool accessibility in the area to be swaged. Remove the damaged section and use it as a pattern to duplicate the new section. Swage the replacement section on to the original pipeline under repair using two tube-to-tube unions D10036.

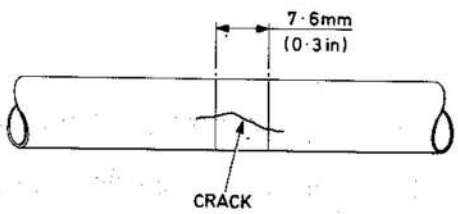


Fig 23 Imperial tube with longitudinal crack in excess of 7.6 mm (0.30 in)

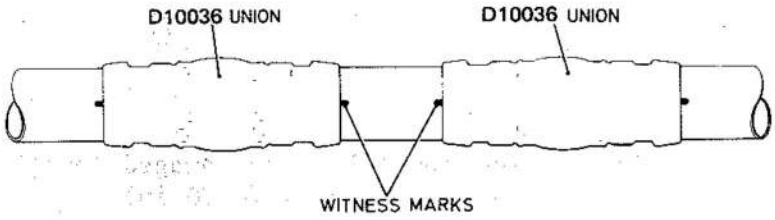
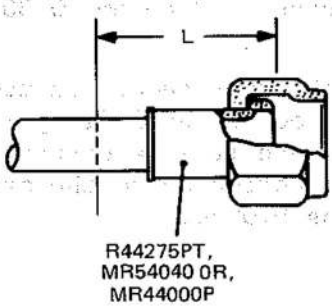


Fig 24 Completed repair with replacement section of tubing

Type 3 repair: Replacement of Dynatube swivel fitting butt-welded or swaged

26 This procedure is for the replacement of R44275PT butt-welded and MR 54040 and MR 44000P swaged lipseal assemblies in sizes -3 to -16. Proceed as follows.

26.1 Cut off the damaged fitting at a distance 'L' from the sealing surface as shown in fig 25 and prepare the end of the tube (para 32)



TUBE Size	L in. ±0.010
-3	.940
-4	.970
-6	.995
-8	1.075
-10	1.120
-12	1.120
-16	1.120

Fig 25 Cut-off dimensions, damaged Dynatube swivel fitting

26.2 Select the correct size Permaswage DD00200A fitting assembly.

26.3 Slide the fitting onto the tube until it butts against the internal shoulder. Mark the position of the end using a fibre tip marker.

26.4 Swage to assemble to fitting to the tube.

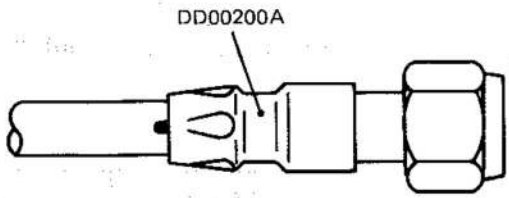


Fig 26 Completed repair with DD00200A fitting

Type 4 repair: Replacement of damaged Permaswage female assemblies DD11200, in all sizes and butt-welded and swaged Dynatube fittings size -20 and -24

27 This procedure is for the replacement of female assemblies Permaswage D11200, in all sizes and Dynatube MR 54040 and MR 44000P swaged and R 44275PT butt-welded fittings in sizes -20 and -24. Proceed as follows:

27.1 Cut-off the damaged fitting making the cut at a point convenient for swage tool access.

27.2 Make the repair using a tubing splice with D10036 or D10136 permanent union and an replacement fitting DD00200A or D11200.

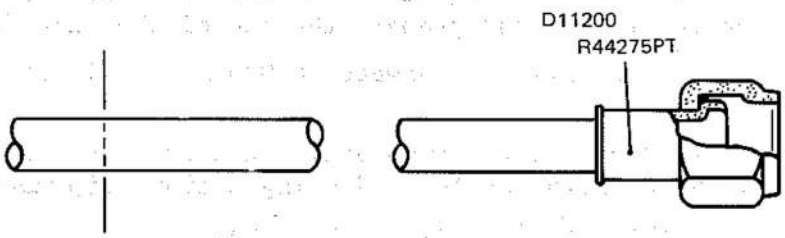


Fig 27 Damaged Permaswage D11200 and Dynatube female fittings

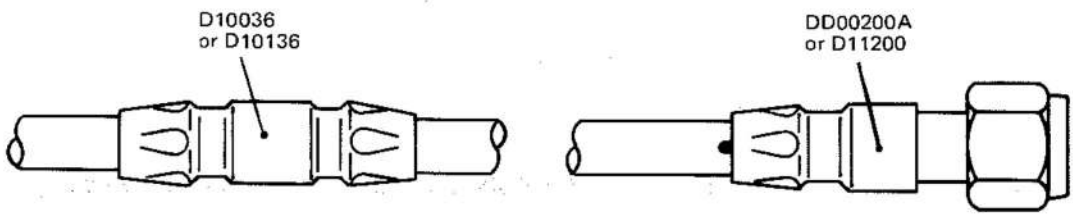
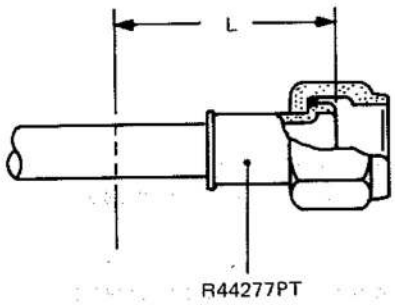


Fig 28 Completed repair with DD00200A fitting

Type 5 repair: Replacement of Dynatube R 44277PT butt-welded reducer female assembly

28 This procedure is for the replacement of damaged Dynatube swivel fittings R 44277PT, butt-welded.



End 1 Dash size	End 2 Dash size	L in = ±0.010
04	03	.850
05	04	.857
06	04	.857
08	04	.857
08	06	.872
10	06	.887
10	08	.943
12	06	1.007
12	10	1.008
16	08	1.073
16	10	1.103
16	12	1.033

Fig 29 Cut-off dimensions, damaged Dynatube R 442775 fitting

28.1 Cut-off the damaged fitting at a distance 'L' from the sealing surface as shown in Fig 29, and prepare the end of the tube (para 32).

28.2 Select the correct size Permaswage DD00300A, or D11300 reducer fitting.

28.3 Slide the fitting onto the tube until it butts against the internal shoulder. Mark the position of the end using a fibre tip marker.

28.4 Swage to assemble the fitting to the tube.

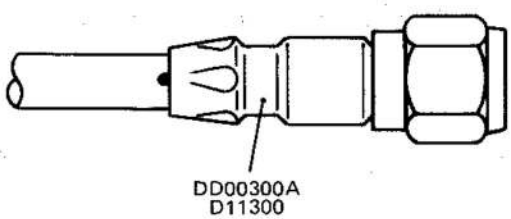


Fig 30 Completed repair with DD00300A or D11300 reducer fitting

Type 6 repair: Replacement of Dynatube butt-welded or Permaswage male threaded connectors, MR 54100, MR 44100P or D11007

29 This procedure is for the replacement of male threaded connectors, of Dynatube and Permaswage types. The procedure is as follows:

29.1 Make the repair using a tubing splice joined by permanent connector D10036 and assemble male threaded adapter, D11007 (up to -16 size).

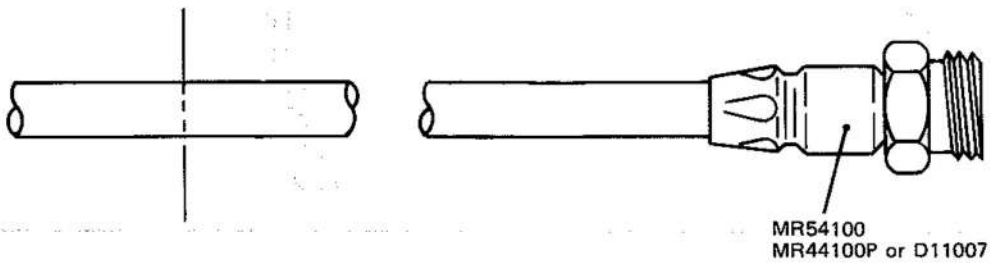


Fig 31 Damaged male threaded connector

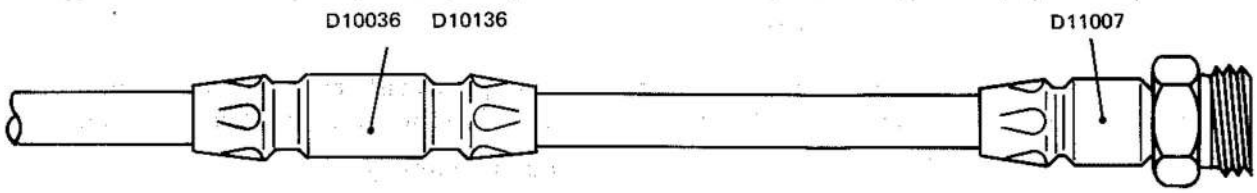


Fig 32 Completed repair using D10036 union and D11007 adapter

Minimum straight tube length to a bend, Standard fittings

30 It is important to ensure that there is an adequate length of straight tube to accept the fitting and to ensure that the swaging operation is effective. The applicable dimensions are given in Table 6 (fig 33).

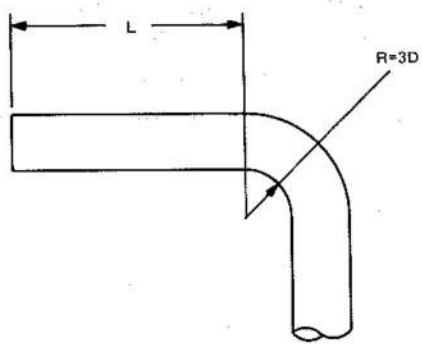


Fig 33 Cut-off dimensions at tube bends, standard fittings

TABLE 6 MINIMUM STRAIGHT TUBE LENGTH FOR SWAGING STANDARD FITTINGS

Tube diameter inches	'L' dimension inches
3/16	0.600
1/4	0.740
5/16	0.780
3/8	0.816
1/2	1.318
5/8	1.358
3/4	1.428
1	1.573
1.1/4	1.675
1.1/2	1.800

CAUTION...

Do not carry out the swaging operation if the straight tube length available is less than the minimum.

Repairs to pipes with bends and curves (fig 34)

31 To ensure that a pipe retains its original shape after repair operations are completed proceed as follows:

31.1 Prior to cutting the tube, draw a line parallel to the tube run, across the section to the cut, using the marking pen and a straight edge.

31.2 Cut the tubing and deburr the ends as necessary.

31.3 If a tube end is to be replaced, make sure that the line is placed in the same location on the new tube as the tube section that has been removed.

CAUTION...

Ensure that a tube insertion witness mark is placed upon all tube ends (refer to para 31).

31.4 Draw a line across the Permaswage fitting.

31.5 Install the pipe run with the Permaswage fitting loosely positioned. Finger tighten any end-fitting. (One end-fitting may be swaged on the bench if possible).

31.6 Place the swage tool on the first end being swaged, lining-up the line on the tube end being swaged with the line on the fitting. Repeat this step with the other ends to be swaged.

31.7 Tighten any end-fittings to their specified torque value.

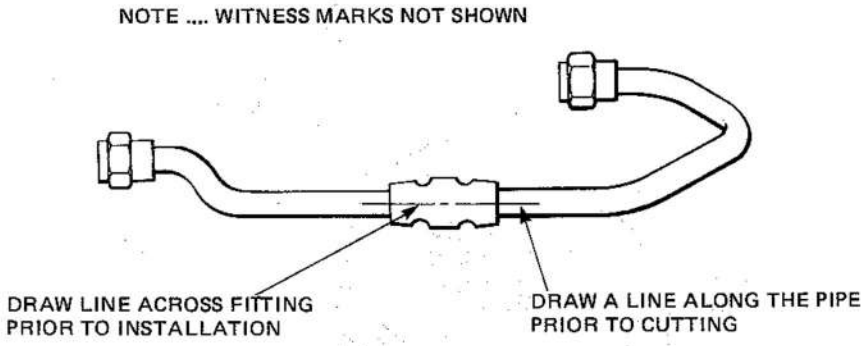


Fig 34 Pipe marking for shape retention

PERMASWAGE PIPE MANUFACTURE OR REPAIR PROCEDURE

32 Permaswage manufacture or repair methods for both imperial and metric size tubes are described in para 9 to 30. Permaswage manufacture or repair procedures are described in para 32 to 44. Repairs can be carried out either on the bench or 'in situ'.

CAUTION...

Before carrying out 'in situ' repairs ensure that all safety precautions are observed, ie system pressure released and that all necessary reservoirs and pipelines are drained.

Preparation

33 Before commencing any repair work proceed as follows:

33.1 Ensure that the material of the pipe to be repaired is listed in Table 1, or Table 2.

33.2 Determine the type of repair to be performed by reference to the repair types described in para 10, 16 and 23.

33.3 Read the CAUTION in para 32 and the WARNINGS in sub-paras 33.4 and 33.7.

33.4 Obtain the following equipment:

33.4.1 Relevant Permaswage repair kit (refer to Table 2) for the tube size.

33.4.2 Portable hydraulic power supply, Part No D12025-001.

33.4.3 Refer to the appropriate Table and obtain the correct replacement Permaswage PE 40000 series imperial fittings, PE 60000 series metric fittings, or standard fittings.

33.4.4 Lubricating oil can containing OX-14 (NATO O-147) oil.

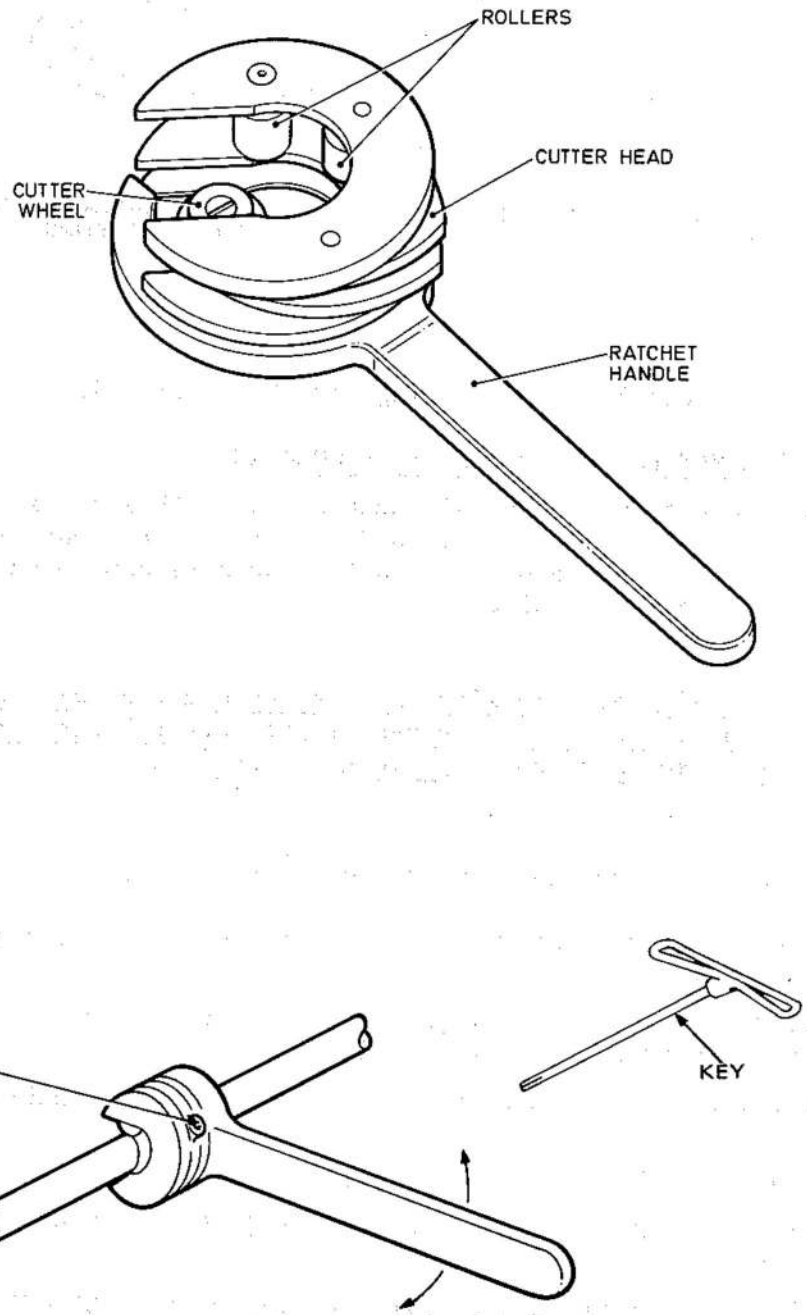


Fig 35 Chipless cutter

Preliminary pipe marking

34 To ensure that the pipe retains its original shape after repair is completed, carry out the marking procedures given in para 31 before attempting any cutting operation (refer to fig 34).

Cutting damaged tube (fig 35)

35 To cut away the damaged part of a tube proceed as follows:

35.1 Select the appropriate chipless cutter for the tube size.

35.2 Inspect the cutter for serviceability. Ensure that the ratchet operates freely. Make sure the cutter is clean and properly lubricated with oil OX-14.

35.3 Position the cutter wheel clear of the cutter head opening.

35.4 Rotate the cutter head to accept the tubing and locate the cutter in cutting position on the tube. When properly located, the tube will be centred on the two rollers and the cutting wheel.

CAUTION ...

Do not overtorque. On soft tubing a large burr will result. On hard tubing the cutter wheel will wear prematurely or break.

35.5 Using the hexagon key provided, torque the drive screw until light contact is made by the cutter wheel on the tube. Then tighten the screw an additional 1/8 to 1/4 turn.

35.6 Rotate the ratchet handle through the arc of clearance until there is a noticeable ease of rotation.

35.7 Torque the drive screw an additional 1/8 to 1/4 turn.

35.8 Repeat steps in sub-para 35.6 and 35.7 until the cut is completed.

Notes ...

(1) Lubricate ratchet, rollers and cutter wheel regularly with oil OX-14 (NATO O-147) to ensure ease of operation.

(2) In the event that the chipless cutter does not function correctly, renew the cutter wheel (para 36).

Cutter wheel replacement

36 Using the spare provided in the repair kit, renew a faulty cutter wheel as follows:

36.1 Turn the drive screw (fig 35) clockwise until the cutter pivot pin becomes accessible.

36.2 Remove the cutter pivot pin and the cutter wheel will easily slide out.

36.3 Slide new cutter wheel (Table 13) into position and secure with the pivot pin.

36.4 Turn the drive screw counter-clockwise to the original position.

36.5 Lubricate the chipless cutter moving parts with oil OX-14 (NATO O-147).

TABLE 7 SPARE CUTTER WHEEL PART NUMBERS

Chipless cutter Part No	Replacement cutter wheel Part No
D12530-001	D12530-109
D12531-001	D12531-109
D12532-001	D12532-109

Note ...

For Sec/Ref No cross refer to AP 119G-0601-123F.

Deburring the cut tube (fig 36 and 37)

CAUTION ...

Do not place a fitting over the tube-end until the tube-end is properly deburred since damage to the fitting may result.

37 Carry out deburring of the end tube as follows:

37.1 Select the appropriate deburring tool and sub-assembly for the tube being repaired. Refer to Tables 8 and 9 .

Note ...

Use solid spiral flute deburring tool Part No D10210 for tubing with an inside diameter less than 3.8 mm or 0.15 in.

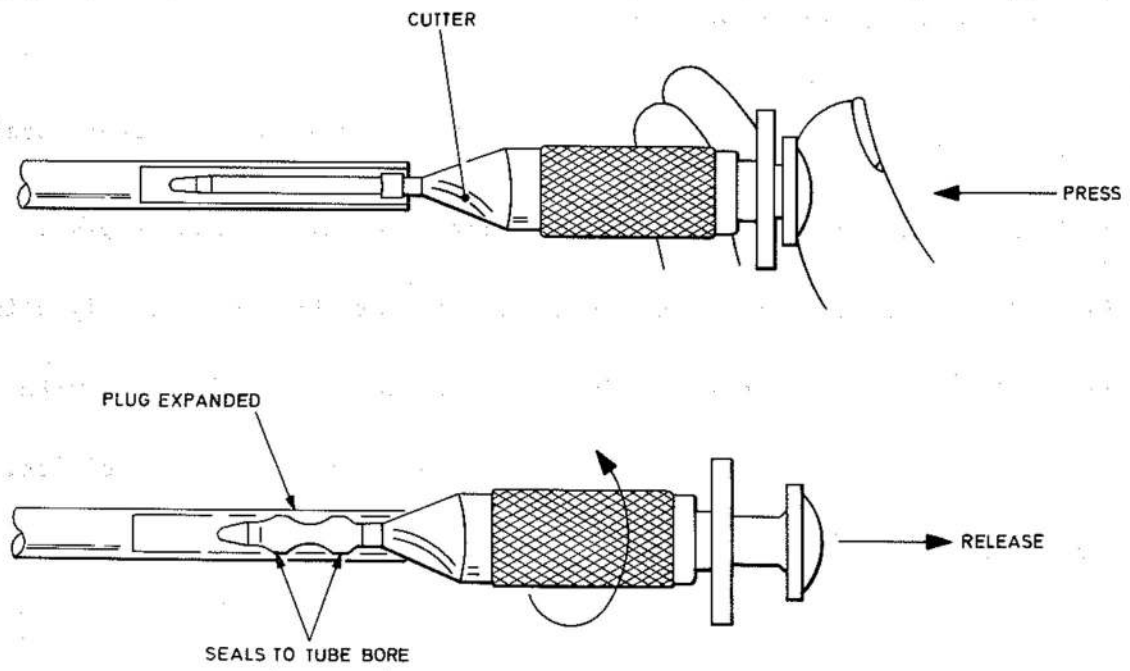


Fig 36 Deburring tool operation

37.2 Lubricate the stem with common system lubricant, where applicable. Insert the stem assembly into the cutter end of the tool. With the plunger depressed, screw the stem into the plunger until it is 'bottomed' and torque finger tight.

37.3 Release and depress the plunger several times to ensure that the elastic plug expands correctly (fig 36).

37.4 Hold the tube with one hand, depress the plunger of the deburring tool and insert the elastic plug into the tube end. Release the plunger to allow the elastic plug to expand and seal the tube.

37.5 Retain the tube in position with one hand and rotate the knurled body of the deburring tool in a clockwise direction whilst applying slight pressure on the cutter. Continue to rotate the knurled body until the tube end is deburred.

CAUTION ...

Excessive deburring will cause too deep a chamfer on the tube inside diameter and is to be avoided. Chamfer width should generally not exceed 1/2 of the wall thickness of the tubing.

37.6 Without depressing the plunger, ease the tool from the tube until the first ridge of the plug is exposed. Wipe off the end of the tube and plug to remove any metal particles.

37.7 Examine the tube end and if deburring is not completed push the tool back into the tubing. Repeat the operation in sub-para 37.5.

37.8 If the tube end has been properly deburred, without depressing the plunger, pull the tool completely free of the tubing.

CAUTIONS ...

(1) If the elastic plug has been in contact with Skydrol hydraulic fluid, it should be thoroughly cleaned with methyl ethyl keytone (MEK) or acetone and immediately dried after use.

(2) Do not use air pressure to remove swarf. Pressurized air can blow swarf into existing hydraulic lines.

Note ...

Immediately after the completion of deburring operations, return the stem sub-assembly and the cutter body to the fitted tool kit box for protective storage. This action is essential to prolong the life of the stem assembly.

Deburring tool cutter head replacement

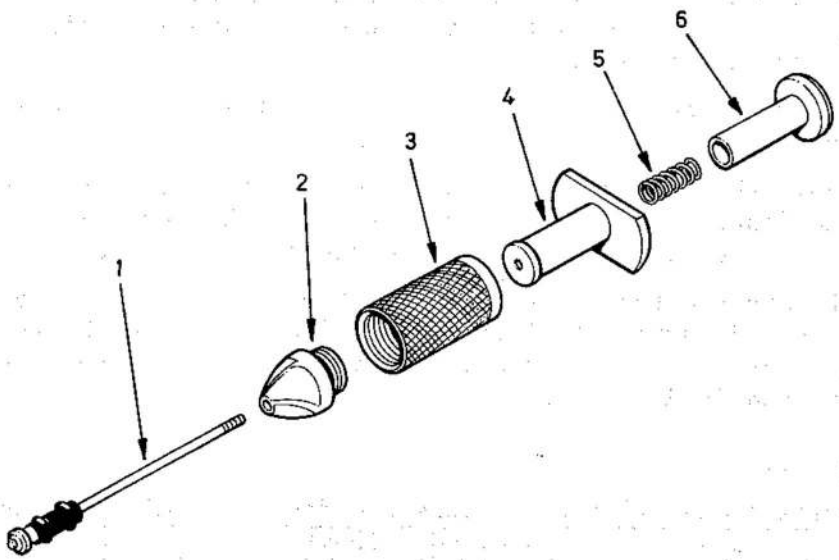
38 To renew a worn or damaged cutter head proceed as follows:

38.1 Deburring tools Part No D9850 and D9851 (fig 37).

38.1.1 Remove stem assembly (1) from the deburring tool.

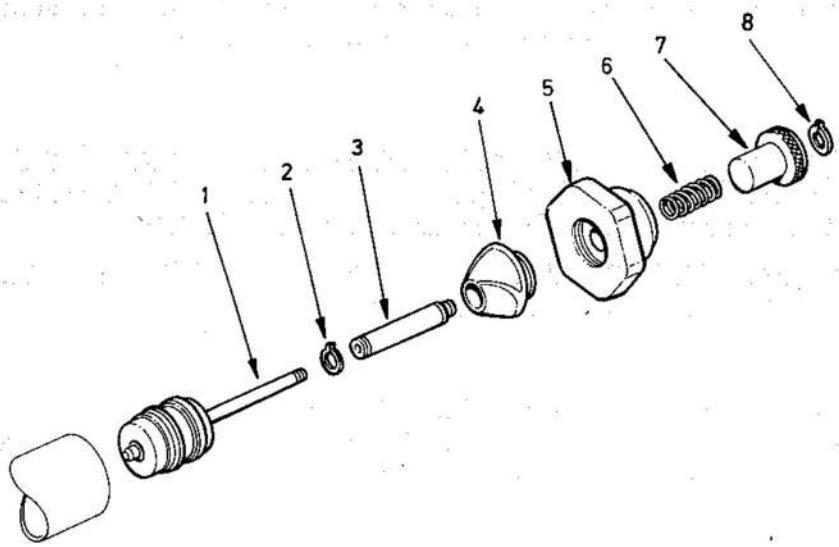
38.1.2 Using a pair of pipe grips, or similar, remove the worn or damaged cutter head (2).

38.1.3 Thread the new cutter head Part No D9800-3 or D9851-3 (as appropriate) into the deburring tool body until it is bottomed and torque the cutter finger tight.



1 Stem assembly
2 Cutter head
3 Body
4 Locator
5 Spring
6 Pressbutton plunger

Fig 37 Deburring tool components (Part No D9850 and D9851)



1 Stem assembly
2 Retaining ring
3 Bushing
4 Cutter head
5 Handle
6 Spring
7 Press button
8 Retaining ring

Fig 38 Deburring tool components (Part No D9849)

38.1.4 Insert the stem assembly into the cutter end of the tool. With the press button (6) depressed, screw the stem assembly (1) into the plunger until it is bottomed and torque finger tight.

38.2 Deburring tool Part No D9849 (fig 25)

38.2.1 Remove stem assembly (1) from the deburring tool.

38.2.2 Depress button (7) and remove retaining ring (2). Unscrew cutter head (4).

38.2.3 Thread the new cutter head (Part No D9849-3) into handle (5) and torque the cutter head finger tight.

38.2.4 Depress button (7) and refit retaining ring (2) to bushing (3).

38.2.5 Insert stem assembly (1) into the cutter end of the tool and torque the stem assembly finger tight.

TABLE 8 DEBURRING TOOLS FOR IMPERIAL SIZE TUBES

Tube od (in.)	Tube wall thickness (in.)	Stem sub-assembly Part No	Deburring tool Part No	Replacement cutter head Part No
1/4	0.016 - 0.028	D9851-13-04	D9851-14	D9851-3
	0.028 - 0.050	D9851-13-03	D9851-14	D9851-3
3/8	0.016 - 0.035	D9851-13-06	D9851-14	D9851-3
	0.035 - 0.058	D9851-13-07	D9851-14	D9851-3
1/2	0.016 - 0.042	D9850-13-08	D9850-14	D9850-3
	0.042 - 0.065	D9850-13-09	D9850-14	D9850-3
5/8	0.016 - 0.058	D9850-13-10	D9850-14	D9850-3
3/4	0.016 - 0.065	D9850-13-12	D9850-14	D9850-3

TABLE 9 DEBURRING TOOLS FOR METRIC SIZE TUBES

Tube id (mm)	Stem sub-assembly Part No	Deburring tool Part No	Replacement cutter head Part No
3.81 - 4.92	D9581-13-03	D9851-14	D9851-3
4.92 - 5.53	D9851-13-04	D9851-14	D9851-3
6.17 - 7.13	D9851-13-05	D9851-14	D9851-3
7.74 - 8.71	D9851-13-06	D9851-14	D9851-3
6.57 - 7.74	D9851-13-07	D9851-14	D9851-3
10.56 - 11.88	D9850-13-08	D9850-14	D9850-3
9.39 - 10.56	D9850-13-09	D9850-14	D9850-3
12.92 - 15.06	D9850-13-10	D9850-14	D9850-3
15.74 - 18.23	D9850-13-12	D9850-14	D9850-3
21.18 - 24.38	D9849-13-16	D9849-14	D9849-3

Note ...

(1) The solid spiral flute deburring tool D1020 must be used on tubing with an internal diameter (id) less than 3.80 mm (0.15 in).

(2) For Sec/Ref No cross refer to AP 119G-0601-135F

Tube end preparation and marking (fig 39)

Note ...

The tube end to be swaged should be deburred and squared to within 1/2° of square to the tube centre line. Deburring forms a slight chamfer on the inner edges of the cut tube. The chamfer may be a maximum of half the tube wall thickness at an angle no greater than 45°.

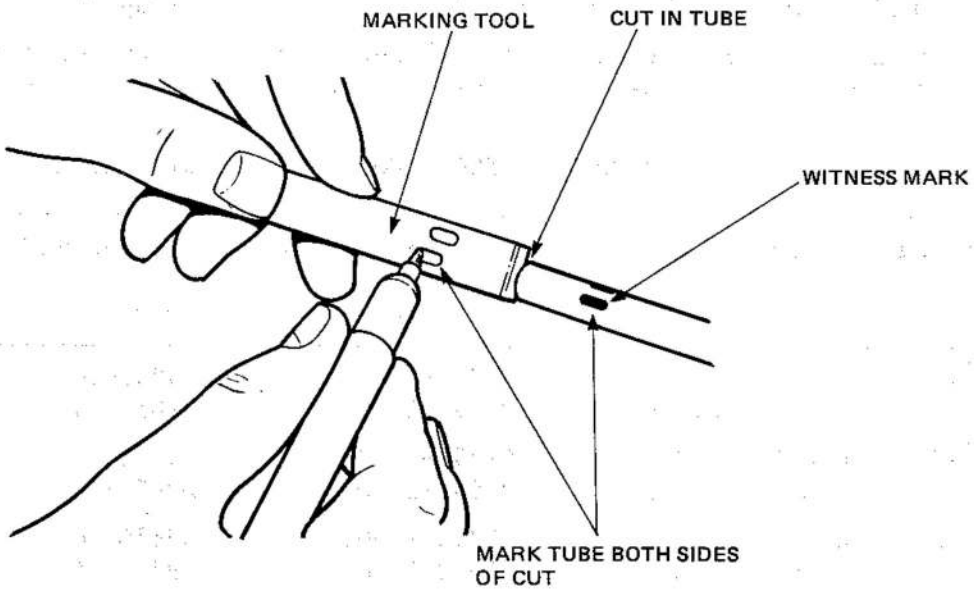


Fig 39 Tube insertion witness marking

39 To mark the tube end prior to swaging proceed as follows: (fig 31)

39.1 Select the appropriate marking tool Part No D9862 for the size of tubing to be swaged.

39.2 Position the lip stop of the marking tool hard up against the tube end.

39.3 Using marking pen D10058, mark the tube through the correct slot in the marking tool relative to the tube size. This mark is referred to as the tube insertion witness mark, the length of which is 7.6 mm (0.30 in).

40 If there are bends in the tube length to be swaged refer to Table 16 in order to determine the minimum straight tube length to a bend. Swaging operations should not be performed if the straight tube length available is less than the prescribed minimum.

TABLE 10 MINIMUM STRAIGHT TUBE LENGTH FOR SWAGING

Metric tubes		Imperial tubes	
od size (mm)	Dimension 'L' (mm)	od size (in)	Dimension 'L' (in)
5	15.05	1/4	0.89
6	18.67	3/8	0.97
8	19.68	1/2	1.47
10	20.57	5/8	1.51
12	33.35	3/4	1.58
14	33.35	-	-
15	34.37	-	-
16	36.14	-	-
18	36.14	-	-

Note ...

Refer to fig 40 for illustration of dimension 'L' in Table 10

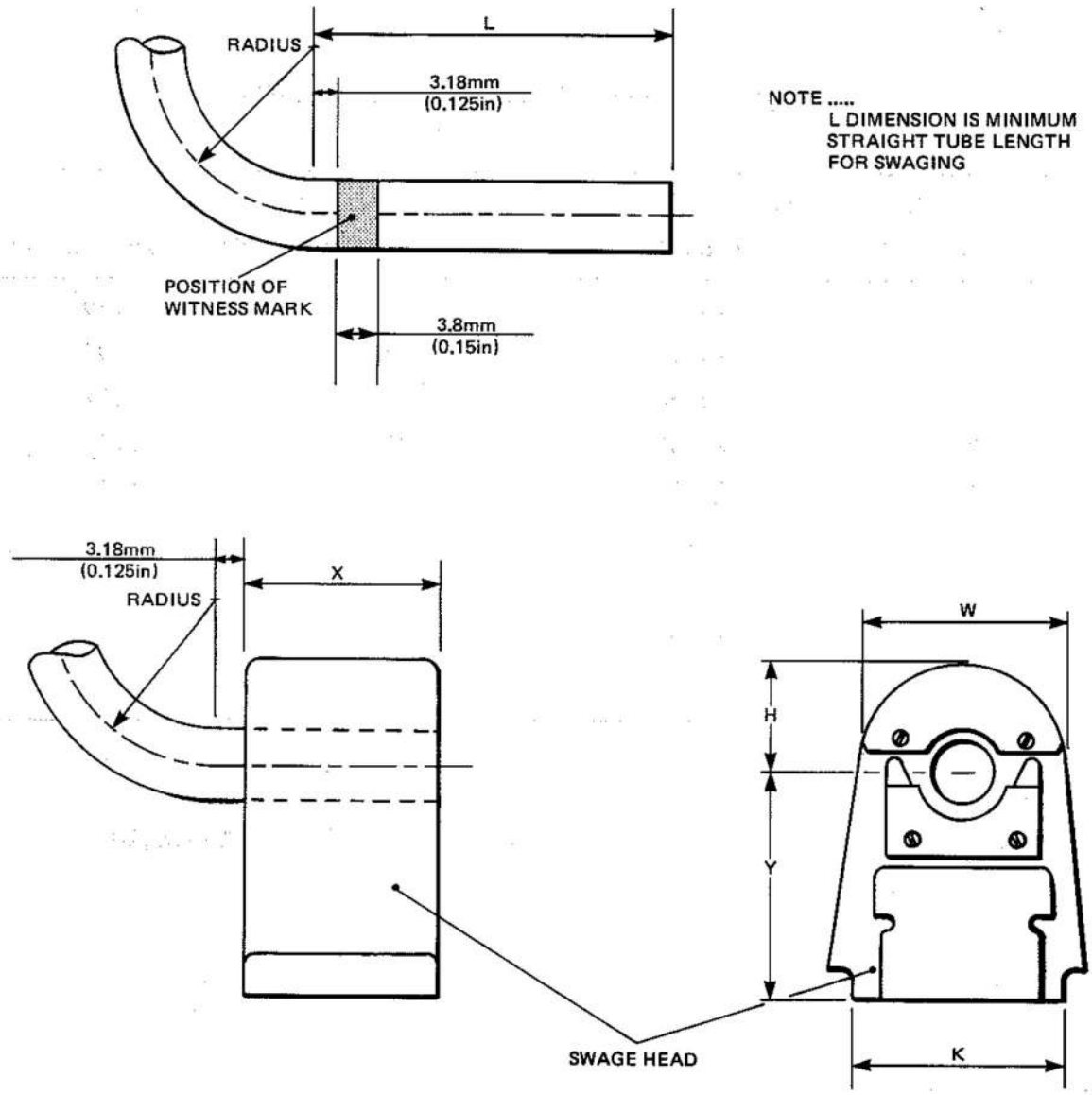


Fig 40 Tube end fitting limits

TABLE 11 SWAGE HEAD DIMENSIONS

Imperial size od	Swage dimensions (fig 40)									
	W		X		H		K		Y	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
1/4	40.6	1.60	24.1	0.95	15.7	.62	31.5	1.24	47.2	1.86
3/8	40.6	1.60	24.1	0.95	15.7	.62	31.5	1.24	47.2	1.86
1/2	53.8	2.12	38.6	1.52	22.8	.90	52.1	2.05	64.5	2.54
5/8	53.8	2.12	38.6	1.52	22.8	.90	52.1	2.05	64.5	2.54
3/4	61.2	2.41	38.6	1.52	22.8	.96	56.9	2.24	66.8	2.63

Swaging operation (fig 41)

Note ...

Before putting a new or overhauled swage tool into service, or if the high pressure hose from the hydraulic power supply to the swage tool is replaced, it is essential to bleed the tool in accordance with the air bleed procedure given in para 42.

41 Carry out swaging procedures as follows:

41.1 Select the desired size of swage tool. Connect the hydraulic hose from the hydraulic power supply to the base of the tool at the hydraulic coupling. Match the swage tool to the Permaswage fitting size. Too small a tool will not accept a larger fitting. Too large a tool will result in insufficient swaging.

WARNING ...

ON NO ACCOUNT ARE SWAGE HEADS TO BE MODIFIED IN ANY WAY. REMOVAL OF MATERIAL FROM THE HEAD WILL RESULT IN A REDUCTION OF THE HEADS ABILITY TO WITHSTAND THE LOADS PRODUCED BY THE SWAGING OPERATION, RESULTING IN POSSIBLE TOOL FAILURE AND HARM TO THE OPERATOR.

41.2 Slide the yoke over the fitting to be swaged with the silver side of the yoke assembly closest to the end of the fitting to be swaged (fig 41). The silver side of the yoke must mate with the end of the fitting to be swaged. If this is not so, an unsatisfactory swage will result.

41.3 Insert the die holder into the yoke assembly so that the silver face of the die holder assembly corresponds with the silver side of the yoke. The silver side of the yoke and the die holder must mate with the end of the fitting to be swaged. If the silver side of the die holder and yoke do not mate, an unsatisfactory joint will result.

41.3 Install the square strut portion of the power unit into the swage head assembly. Tighten the knurled nut (finger tight) making sure it is snug against the yoke. Check to ensure that any clearance between the lower angle of the yoke and the strut has been taken up. Any clearance is to be removed by lifting up on the yoke and retightening the knurled nut.

THIS IS CRITICAL CHECK TWICE

WARNING ...

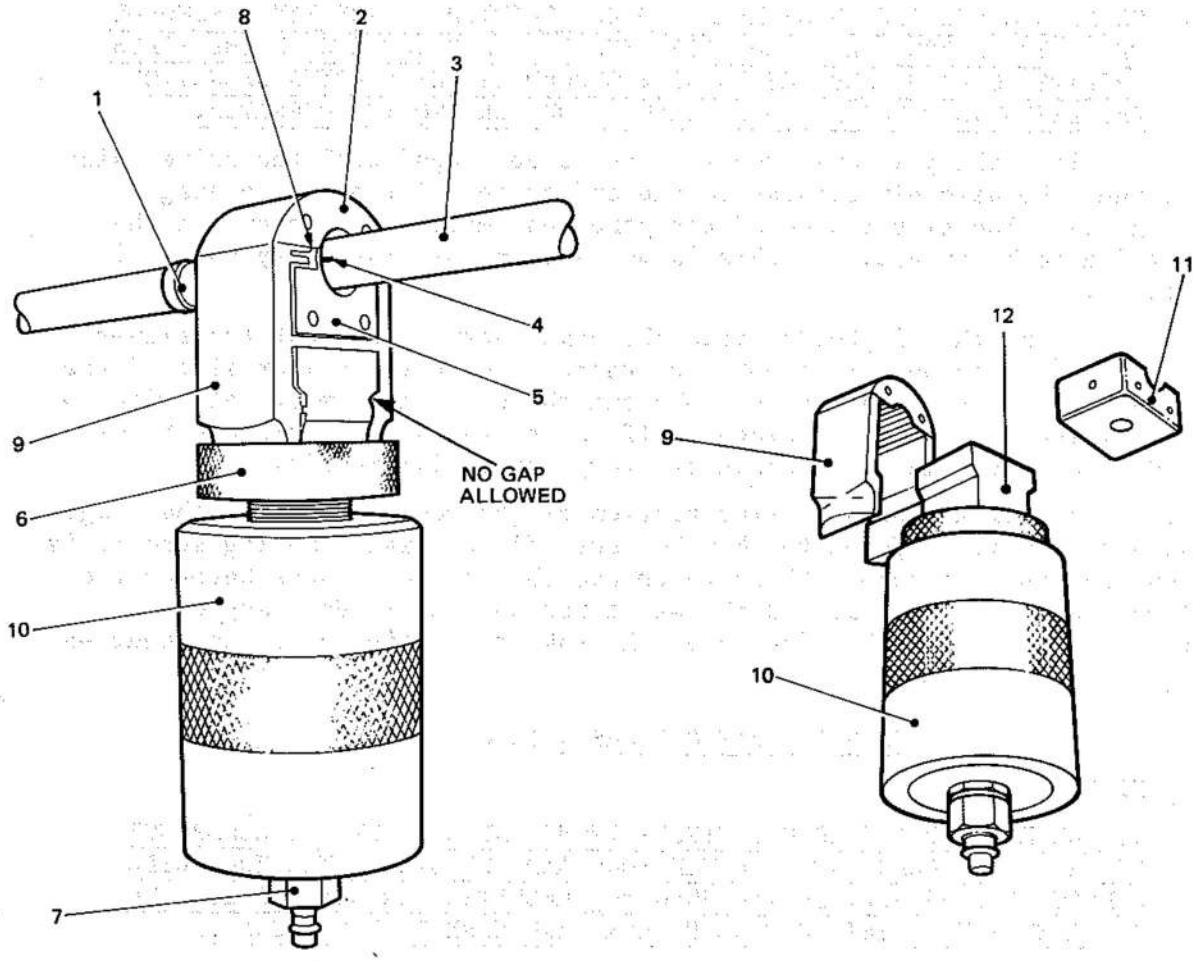
IF THE KNURLED NUT IS NOT FINGER TIGHT AND/OR THERE IS CLEARANCE BETWEEN THE LOWER ANGLE OF THE YOKE AND THE STRUT, THE YOKE WILL DEFLECT EXCESSIVELY DURING SWAGING, RESULTING IN DESTRUCTIVE STRESS DISTRIBUTION, POSSIBLE TOOL FAILURE AND HARM TO THE OPERATOR.

41.5 Position the Permaswage fitting over the tube insertion witness mark so that some portion of the mark is visible. The tube must be positioned properly within the fitting. Insufficient or excessive tube insertion will result in rejection of the joint (fig 44).

41.6 Move the tool along the tubing towards the centre of the fitting until the bright polished end stop (fig 41) makes light contact with the end of the fitting. Back off the tool slightly until the end stop is approximately 0.76 mm (0.03 in) from the fitting end. Visually re-verify that some portion of the tube insertion witness mark is visible (para 41.5). Maintain the tool in this position until hydraulic pressure is applied.

Note ...

If the end stop is not near to the end of the fitting, it may result in an insufficient swage length and a defective joint. Backing off the tool to separate the end-stop from the fitting end prevents possible interference between the end-stop and the fitting during the swaging action.



1 Swaged fitting
2 Bright polished end plate of yoke
3 Hydraulic pipe
4 Tube insertion witness mark
5 Bright polished end stop plate
6 Knurled nut
7 Hydraulic coupling
8 End of fitting
9 Yoke body
10 Power unit
11 Lower die block
12 Strut

Fig 41 Swaging tool

41.7 Using the hydraulic power supply unit Part No D12025-001 (fig 29) apply a pressure of 5,500 to 5,750 lbf/in² (379 to 396 bar) as registered on the pressure gauge as follows:

WARNING ...

KEEP HANDS AND HEAD AWAY FROM THE DIRECTION OF DRIVING FORCE OF THE TOOL WHILE PRESSURE IS BEING APPLIED.

CAUTION ...

Do not over-pressurise. Do not under pressurise. Over-pressurisation will put undue stress on the swaging tool. Under-pressurisation may result in only partial closure of the dies and hence inadequate reduction of the fitting diameter.

Manual operation

41.7.1 Close the knurled hand-operated selector valve (adjacent to the pressure gauge) by turning it fully clockwise.

41.7.2 Operate the hand pump until the pressure indicates approximately 379 bar (5500 lbf/in²). Further cycling of the hand pump will not increase the system pressure since an internal relief valve allows excess pressure to relieve into the reservoir.

41.7.3 When swaging is completed turn the knurled hand-operated selector valve fully counter-clockwise to the open position to release the hydraulic pressure. Ensure that the pressure gauge indication falls to zero.

Automatic operation

41.7.4 Connect the compressed air at an inlet pressure of 5.5 to 6.89 bar (80 to 100 lbf/in²). Turn the knurled hand-operated selector valve fully counter-clockwise to the open position.

41.7.5 Press the ON pushbutton attached to the end of the flexible air control line assembly (fig 42). Hold the button pressed and observe the pressure gauge until the pressure indicates approximately 379 bar (5500 lbf/in²) indicating that the relief valve has opened. Release the ON pushbutton.

41.7.6 When swaging is completed, press the OFF pushbutton attached to the end of the control line assembly and verify that the hydraulic pressure gauge drops to zero. Release the OFF pushbutton.

41.8 Release all hydraulic pressure. If pressure is not released the dies remain closed, making it impossible to remove the tool from the fitting.

Caution ...

Before loosening the knurled nut ensure that all hydraulic pressure has been released.

41.9 Loosen the knurled nut and remove the power unit from the yoke assembly. Disconnect the hydraulic hose from the base of the power unit.

41.10 Remove the die holder and yoke assembly.

41.11 Carry out the inspection and checks detailed in para 35.

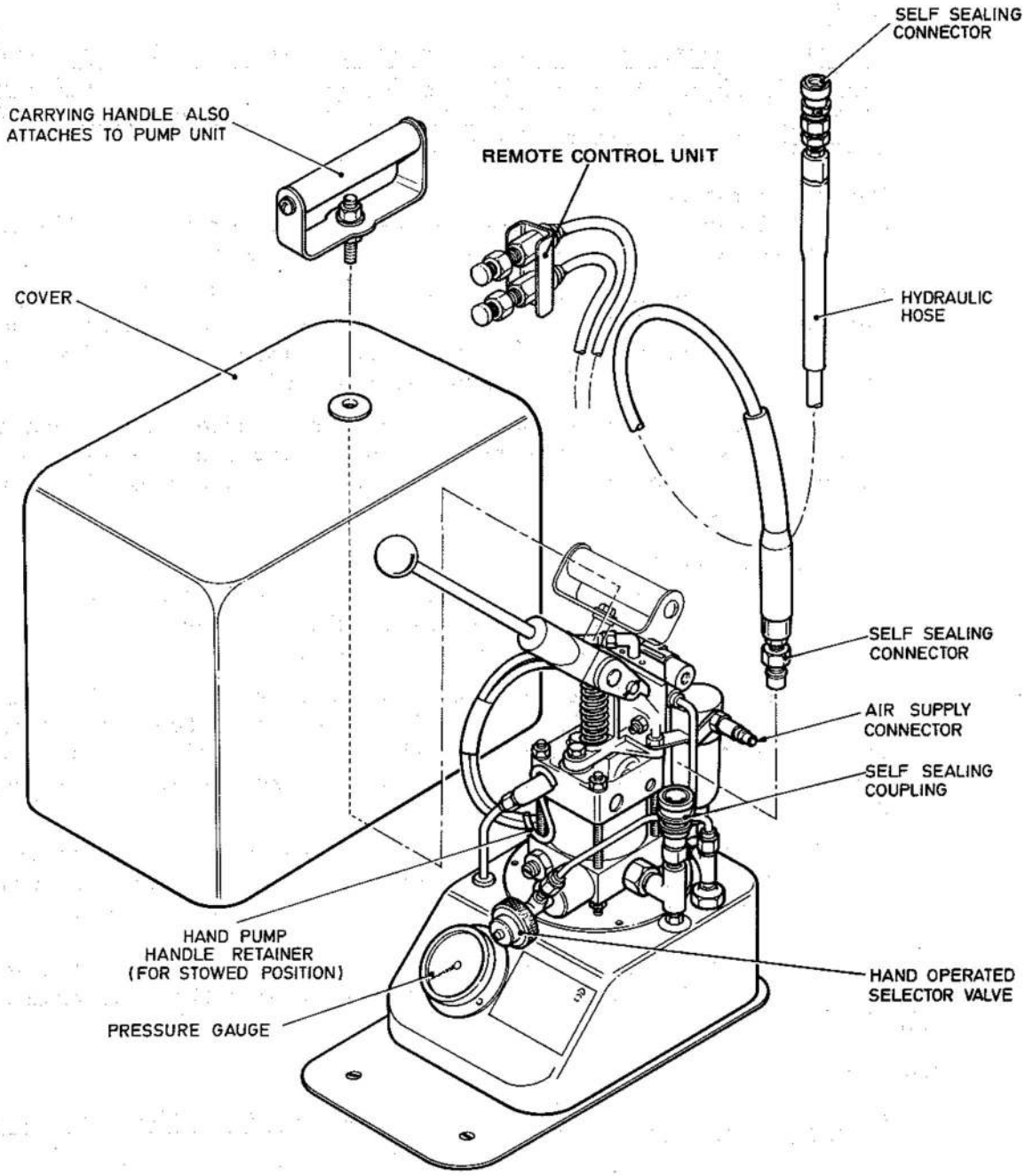


Fig 42 Hydraulic power supply unit

Air bleed procedure

42 Before putting a new or overhauled swage tool into service, or if the high pressure hose from the hydraulic power supply to the tool is replaced, it is essential to bleed the tool as follows:

42.1 Select the hydraulic power supply and the swage head with die retainer to be used.

42.2 Ensure that the die is properly installed in the yoke and die holder. The tapered end of the dies must be on the side of the yoke and die holder which is fitted with black plates. Improperly installed dies will produce an unsatisfactory swage, requiring the fitting to be cut off the tube.

42.3 Insert the die holder into the yoke assembly (fig 41). The die holder must be inserted so that the black face and the silver face match those on the yoke (ie silver to silver and black to black). If the die holder is incorrectly installed it will produce an unsatisfactory swage, requiring the fitting to be cut out.

42.4 Install the square strut portion of the power unit into the swage head assembly. Tighten the knurled nut (finger tight) making sure it is snug against the yoke. Check to ensure that any clearance between the lower angle of the yoke and the strut has been taken up. Any clearance is to be removed by lifting up on the yoke and retightening the knurled nut.

THIS IS CRITICAL CHECK TWICE

WARNING ...

IF THE KNURLED NUT IS NOT FINGER TIGHT AND/OR THERE IS CLEARANCE BETWEEN THE LOWER ANGLE OF THE YOKE AND THE STRUT, THE YOKE WILL DEFLECT EXCESSIVELY DURING SWAGING, RESULTING IN DESTRUCTIVE STRESS DISTRIBUTION, POSSIBLE TOOL FAILURE AND HARM TO THE OPERATOR.

42.5 Connect the pressure source by means of the self-sealing hose coupling to the hydraulic coupling at the base of the tool.

42.6 Set the swaging tool at a point lower than the pressure source. This ensures an air bleed during operation.

42.7 On the power supply, close the knurled hand-operated selector valve (turn fully clockwise) and using the hand pump, raise the hydraulic pressure to between 1000 and 1500 lbf/in^2 (68.9 to 103 bar) to actuate the swaging tool.

42.8 Release the hydraulic pressure to zero by opening (turn fully counter-clockwise) the knurled hand-operated selector valve.

42.9 Repeat the operations in sub-para 34.7 and 34.8 at least three times. This cycling procedure ensures an air bleed.

42.10 With all hydraulic pressure released slacken the knurled nut and remove the power unit from the yoke assembly. Disconnect the hydraulic hose from the base of the power unit.

Inspection of swaged joint (fig 43 and 44)

43 Inspection and checking of the completed swaged joint is accomplished visually and with the aid of the appropriate go/no-go inspection gauge for the tube size. Position the gauge (fig 43) over the swaged joint with the gauge shoulder hard up against the end fitting. With the gauge in position check the following:

43.1 Outside diameter of swaged fitting to seat of go-no/go gauge.

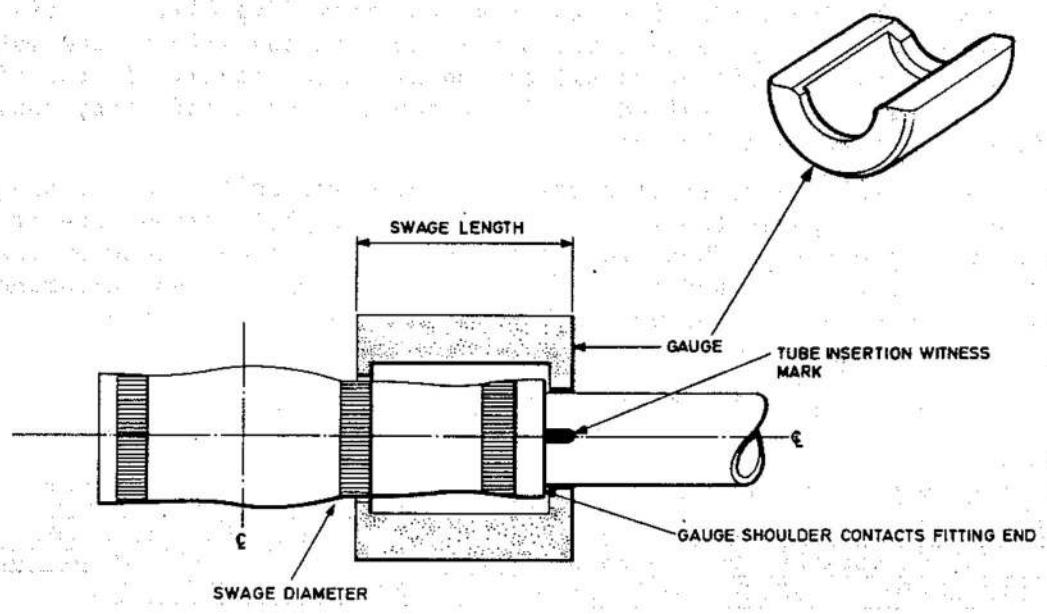


Fig 43 Go/no go gauge inspection criteria

43.2 Length of tube to fitting engagement. With the gauge shoulder hard up against the fitting, the end of the gauge must be within tube insertion witness marks (refer to fig 44).

43.3 Length of the swaged portion of the fitting.

Notes...

(1) The use of the segments produces longitudinal ridges ('flash marks') on the swaged fittings. To obtain true od measurements, rotate the gauge off the flash marks.

(2) For possible causes of faulty swaged joints refer to Table 12.

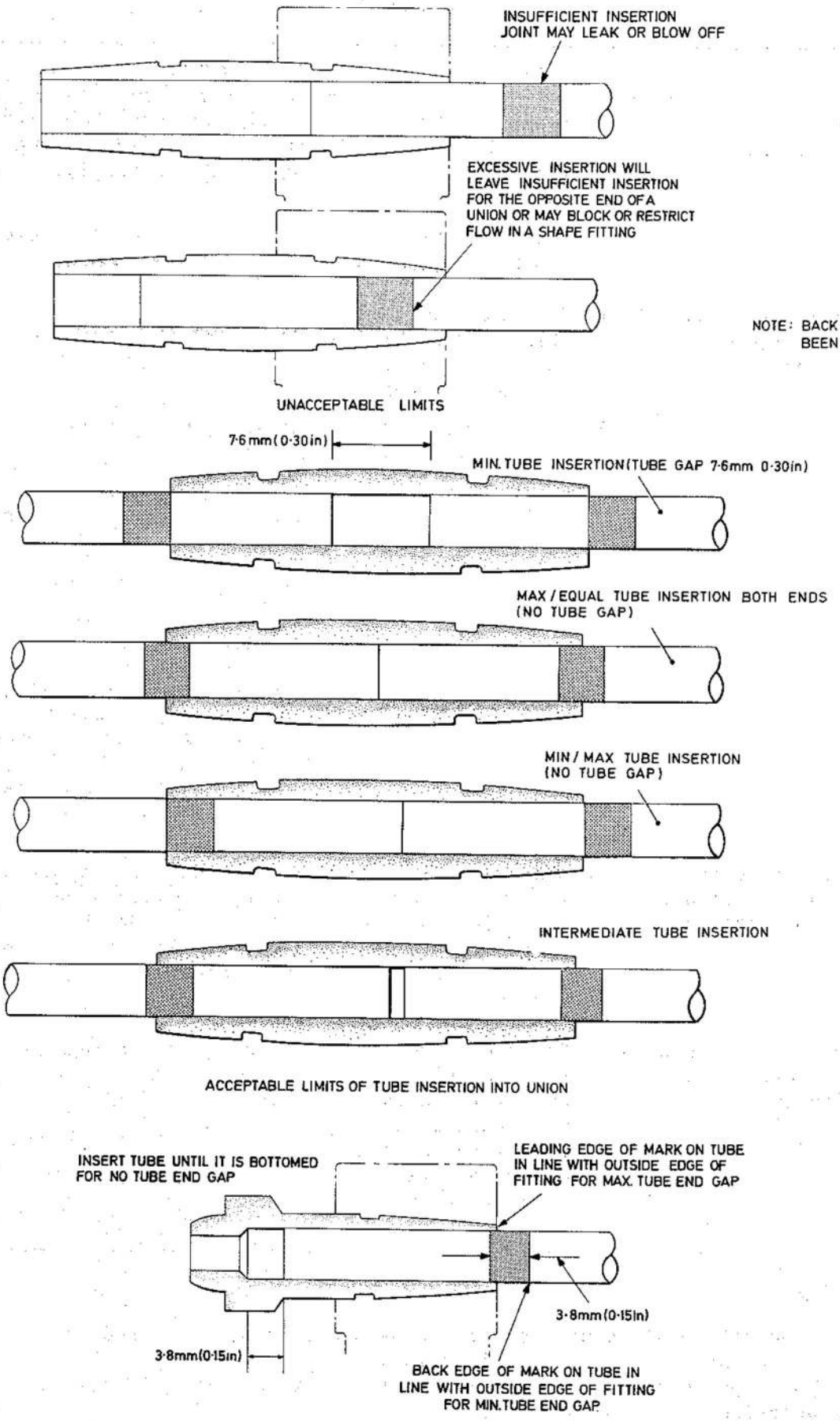


Fig 44 Tube insertion limits

TABLE 12 FAULT DIAGNOSIS

Item	Fault	Possible cause	Corrective action
1	Fitting does not swage properly.	1. Swaging with less than 5250 to 5750 lbf/in² (362 to 396 bar) to tool.	Check the serviceability and correct functioning of the power supply.
		2. Improper size die blocks.	Install correct size die blocks.
2	Gauge will not fit over-swaged fitting od.	1. Swaging with less than 5250 to 5750 lbf/in² (362 to 396 bar) to tool.	Reswage.
		2. Attempting to read over flash marks.	Rotate gauge off flash marks.
		3. Die segments and walls of the segments not clean.	Carefully remove die segments from die blocks and: 1. Clean between die segments. 2. Clean and lubricate die block side surfaces in contact with die segments with a light film of oil OX14 (NATO O-147). Do not use lubricant between the segments.
3	Gauge shoulder does not contact end of fitting.	1. End of fitting not within 0.76 mm (0.03 in.) of end stop before pressure is applied to the tool.	Reswage in correct position. Locator and stops on swaging tool may be damaged. Renew end stops if necessary.
4	End of fitting does not make contact with tube insertion witness mark.	1. Failure to verify that the fitting end is in contact with tube insertion witness marks before applying pressure to the tool.	Cut out the fitting.

Pipe testing

► 44 After manufacture all pipelines are to be proof pressure tested in accordance with Chap. 17 of this publication.

44.1 The pipe is to be pressure tested to 1½ times working pressure for a duration of five minutes. ◄

CAUTION ...

Do not proof pressure test an 'in situ' repair to 1½ times system pressure.

Handling and fitting

45 During the handling and fitting of pipelines incorporating Permaswage fittings to aircraft systems, care must be taken to prevent rotation between the swage and the pipeline caused by torsional forces. However, minimal rotation is acceptable provided that the fitting does not leak.

TABLE 13 LIST OF PERMASWAGE REPLACEMENT FITTINGS FOR IMPERIAL, MS AND AN FITTINGS

Permaswage Part No	Applicability	Size (in.)
PE 40001K03	Swage pipe-to-pipe	3/16
PE 40001K04	Swage pipe-to-pipe	1/4
PE 40001K05	Swage pipe-to-pipe	5/16
PE 40001K06	Swage pipe-to-pipe	3/8
PE 40001K08	Swage pipe-to-pipe	1/2
PE 40001K10	Swage pipe-to-pipe	5/8
PE 40001K12	Swage pipe-to-pipe	3/4
PE 40201K03	Replaces MS flareless end fitting	3/16
PE 40201K04	Replaces MS flareless end fitting	1/4
PE 40201K05	Replaces MS flareless end fitting	5/16
PE 40201K06	Replaces MS flareless end fitting	3/8
PE 40201K08	Replaces MS flareless end fitting	1/2
PE 40201K10	Replaces MS flareless end fitting	5/8
PE 40201K12	Replaces MS flareless end fitting	3/4
PE 40301K03	Replaces AN flare end fitting	3/16
PE 40301K04	Replaces AN flare end fitting	1/4
PE 40301K05	Replaces AN flare end fitting	5/16
PE 40301K06	Replaces AN flare end fitting	3/8
PE 40301K08	Replaces AN flare end fitting	1/2
PE 40301K10	Replaces AN flare end fitting	5/8
PE 40301K12	Replaces AN flare end fitting	3/4

TABLE 14 LIST OF PERMASWAGE REPLACEMENT FITTINGS FOR METRIC FITTINGS (SHORT TAIL)

Permaswage Part No	Applicability	Size (mm)	AS No
PE 60001K05	Swage pipe-to-pipe	5	NA
PE 60001K06	Swage pipe-to-pipe	6	NA
PE 60001K08	Swage pipe-to-pipe	8	NA
PE 60001K10	Swage pipe-to-pipe	10	NA
PE 60001K12	Swage pipe-to-pipe	12	NA
PE 60001K14	Swage pipe-to-pipe	14	NA
PE 60001K15	Swage pipe-to-pipe	15	NA
PE 60001K16	Swage pipe-to-pipe	16	NA
PE 60001K18	Swage pipe-to-pipe	18	NA
PE 60802K05	Replaces PAN 4010 nipple	5	AS43021
PE 60802K06	Replaces PAN 4010 nipple	6	AS43021
PE 60802K08	Replaces PAN 4010 nipple	8	AS43021
PE 60802K10	Replaces PAN 4010 nipple	10	AS43021
PE 60843K05	Replaces PAN 4011 nut	5	AS43022
PE 60843K06	Replaces PAN 4011 nut	6	AS43022
PE 60843K08	Replaces PAN 4011 nut	8	AS43022
PE 60843K10	Replaces PAN 4011 nut	10	AS43022
PE 60801H05	Replaces PAN 4010 nipple PAN 4011 nut	5	AS43021 AS43022
PE 60801H06	Replaces PAN 4010 nipple PAN 4011 nut	6	AS43021 AS43022
PE 60801H08	Replaces PAN 4010 nipple PAN 4011 nut	8	AS43021 AS43022
PE 60801H10	Replaces PAN 4010 nipple PAN 4011 nut	10	AS43021 AS43022
PE 60801H12	Replaces PAN 4010 nipple PAN 4011 nut	12	AS43021 AS43022
PE 60801H14	Replaces PAN 4010 nipple PAN 4011 nut	14	AS43021 AS43022
PE 60801H15	Replaces PAN 4010 nipple PAN 4011 nut	15	AS43021 AS43022
PE 60801H16	Replaces PAN 4010 nipple PAN 4011 nut	16	AS43021 AS43022
PE 60801H18	Replaces PAN 4010 nipple PAN 4011 nut	18	AS43021 AS43022
PE 60829H05	Replaces PAN 4010 nipple PAN 4057 nut	5	AS43021 AS43025

continued...

TABLE 14 LIST OF PERMASWAGE REPLACEMENT FITTINGS FOR METRIC FITTINGS (SHORT TAIL) (continued)

Permaswage Part No	Applicability	Size (mm)	AS No
PE 60829H06	Replaces PAN 4010 nipple PAN 4057 nut	6	AS43021 AS43025
PE 60829H08	Replaces PAN 4010 nipple PAN 4057 nut	8	AS43021 AS43025
PE 60829H10	Replaces PAN 4010 nipple PAN 4057 nut	10	AS43021 AS43025
PE 60807H05	Replaces PAN 4012 female union	5	AS43024
PE 60807H06	Replaces PAN 4012 female union	6	AS43024
PE 60807H08	Replaces PAN 4012 female union	8	AS43024
PE 60807H10	Replaces PAN 4012 female union	10	AS43024
PE 60807H12	Replaces PAN 4012 female union	12	AS43024
PE 60807H14	Replaces PAN 4012 female union	14	AS43024
PE 60807H15	Replaces PAN 4012 female union	15	AS43024
PE 60807H16	Replaces PAN 4012 female union	16	AS43024
PE 60807H18	Replaces PAN 4012 female union	18	AS43024

TABLE 15 LIST OF PERMASWAGE REPLACEMENT FITTINGS FOR METRIC FITTINGS (LONG TAIL)

Permaswage Part No	Applicability	Size (mm)	AS No
PE 60844H05	Replaces PAN 4010 nipple PAN 4057 nut	5	AS43021 AS43025
PE 60844H06	Replaces PAN 4010 nipple PAN 4057 nut	6	AS43021 AS43025
PE 60844H08	Replaces PAN 4010 nipple PAN 4057 nut	8	AS43021 AS43025
PE 60844H10	Replaces PAN 4010 nipple PAN 4057 nut	10	AS43021 AS43025
PE 60829H12	Replaces PAN 4010 nipple PAN 4057 nut	12	AS43021 AS43025
PE 60829H14	Replaces PAN 4010 nipple PAN 4057 nut	14	AS43021 AS43025
PE 60829H16	Replaces PAN 4010 nipple PAN 4057 nut	16	AS43021 AS43025
PE 60835H05	Replaces PAN 4010 nipple PAN 4011 nut	5	AS43021 AS43025

continued...

TABLE 15 LIST OF PERMASWAGE REPLACEMENT FITTINGS FOR METRIC FITTINGS (LONG TAIL) (continued)

Permaswage Part No	Applicability	Size (mm)	AS No
PE 60835H06	Replaces PAN 4010 nipple PAN 4011 nut	6	AS43021 AS43022
PE 60835H08	Replaces PAN 4010 nipple PAN 4011 nut	8	AS43021 AS43022
PE 60835H10	Replaces PAN 4010 nipple PAN 4011 nut	10	AS43021 AS43022
PE 60835H12	Replaces PAN 4010 nipple PAN 4011 nut	12	AS43021 AS43022
PE 60835H14	Replaces PAN 4010 nipple PAN 4011 nut	14	AS43021 AS43022
PE 60835H15	Replaces PAN 4010 nipple PAN 4011 nut	15	AS43021 AS43022
PE 60835H16	Replaces PAN 4010 nipple PAN 4011 nut	16	AS43021 AS43022
*PE 60835H18 or PE 60801H18	Replaces PAN 4010 nipple PAN 4011 nut	18	AS43021 AS43022
PE 60841H05	Replaces PAN 4012	5	AS43024
PE 60841H06	Replaces PAN 4012	6	AS43024
PE 60841H08	Replaces PAN 4012	8	AS43024
PE 60841H10	Replaces PAN 4012	10	AS43024
PE 60841H12	Replaces PAN 4012	12	AS43024
PE 60841H14	Replaces PAN 4012	14	AS43024
PE 60841H15	Replaces PAN 4012	15	AS43024
PE 60841H16	Replaces PAN 4012	16	AS43024
PE 60841H18	Replaces PAN 4012	18	AS43024

*Note ...

Permaswage Part No PE 60801H18 can be used as a duplicate item for Permaswage Part No PE 60835H18.

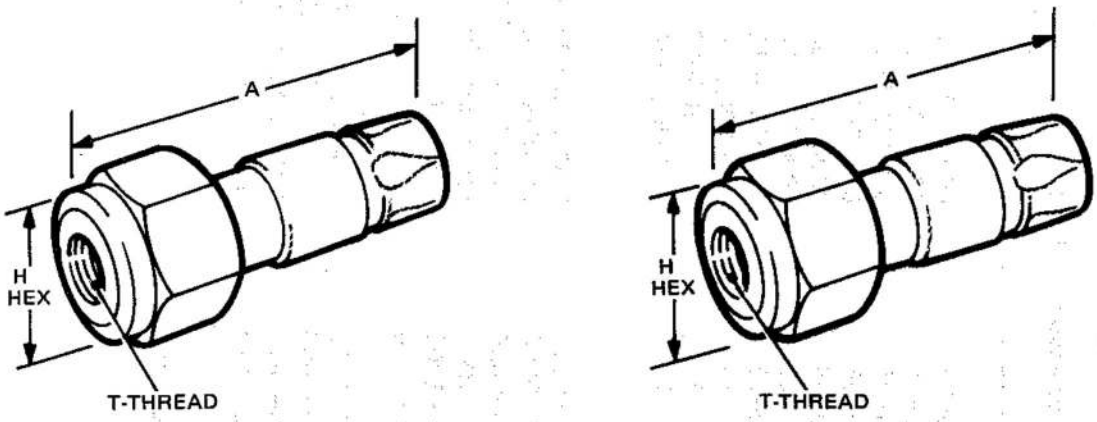
Standard fittings

46 An extensive range of fittings is used in the aircraft and these are detailed in the applicable Topic 3 of the aircraft publication, (Illustrated parts catalogue). The general range of fittings are listed in Table 16, and the part number system is illustrated in fig 47.

TABLE 16 STANDARD FITTINGS, SEPARABLE, LIPSEAL

Description	Size	Dimensions, inch Normal A	Repair A	Hexagon A/F H	* Permaswage Pt No Normal	Repair length
Adapter assembly, swivel	3/16	1.219	1.610	0.500	D11200-03	DD00200A-03
	1/4	1.414	1.801	0.562	D11200-04	DD00200A-04
	5/16	1.490	1.836	0.625	D11200-05	DD00200A-05
	3/8	1.569	1.925	0.688	D11200-06	DD00200A-06
	1/2	2.153	2.507	0.875	D11200-08	DD00200A-08
	5/8	2.391	2.645	1.000	D11200-10	DD00200A-10
	3/4	2.462	2.713	1.125	D11200-12	DD00200A-12
	1	2.755	3.038	1.500	D11200-16	DD00200A-16
	1-1/4	2.804	-	1.875	D11200-20	use D11200-20
	1-1/2	3.323	3.322	2.125	D11200-24	DD00200A-24
Adapter assembly, swivel reducer	3/8-1/4	1.435	1.835	0.687	D11300-0604	DD00300A-0604
	1/2-1/4	1.452	1.852	0.875	D11300-0804	DD00300A-0804
	1/2-3/8	1.544	1.942	0.875	D11300-0806	DD00300A-0806
	5/8-3/8	1.657	2.015	1.000	D11300-1006	DD00300A-1006
	5/8-1/2	2.101	2.575	1.000	D11300-1008	DD00300A-1008
	3/4-3/8	1.767	2.168	1.125	D11300-1206	DD00300A-1206
	3/4-1/2	2.212	2.643	1.125	D11300-1208	DD00300A-1208
	3/4-5/8	2.257	2.713	1.125	D11300-1210	DD00300A-1210
	1-1/2	2.398	2.738	1.500	D11300-1608	DD00300A-1608
	1-5/8	2.398	2.808	1.500	D11300-1610	DD00300A-1610
	1-3/4	2.398	2.808	1.500	D11300-1612	DD00300A-1612

*Add suffix to Pt No to indicate material - CRES, corrosion resistant steel; Ti-Titanium.



Normal length

Repair length

Fig 45 Standard fittings, separable, lipseal

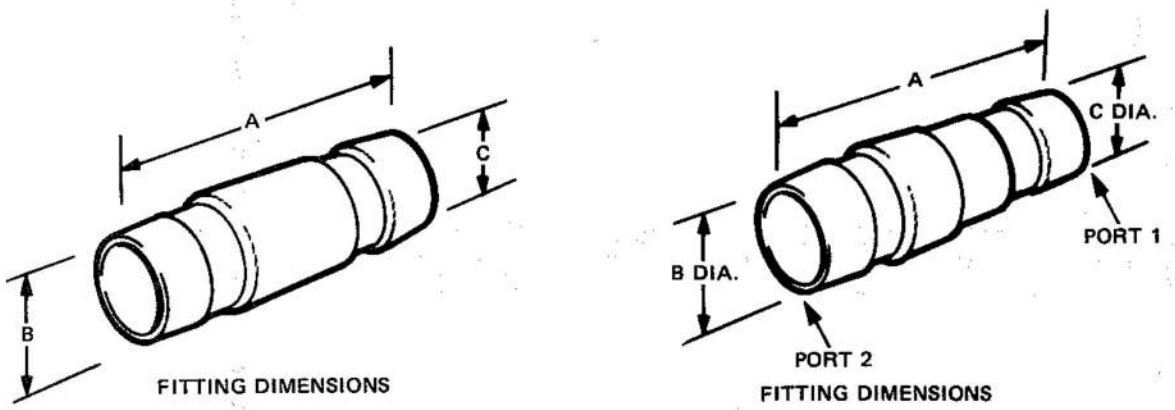


Fig 46 Standard fittings, permanent unions

TABLE 17 STANDARD FITTINGS, PERMANENT UNION

Description	A Dimension, inch Size, inch	Normal	Permaswage Pt No
Union, permanent	3/16	1.255	D10036-03
	1/4	1.540	D10036-04
	5/16	1.620	D10036-05
	3/8	1.690	D10036-06
	1/2	2.700	D10036-08
	5/8	2.780	D10036-10
	3/4	2.920	D10036-12
	1	3.209	D10036-16
	1-1/4	3.414	D10136-20
	1-1/2	3.664	D10136-24

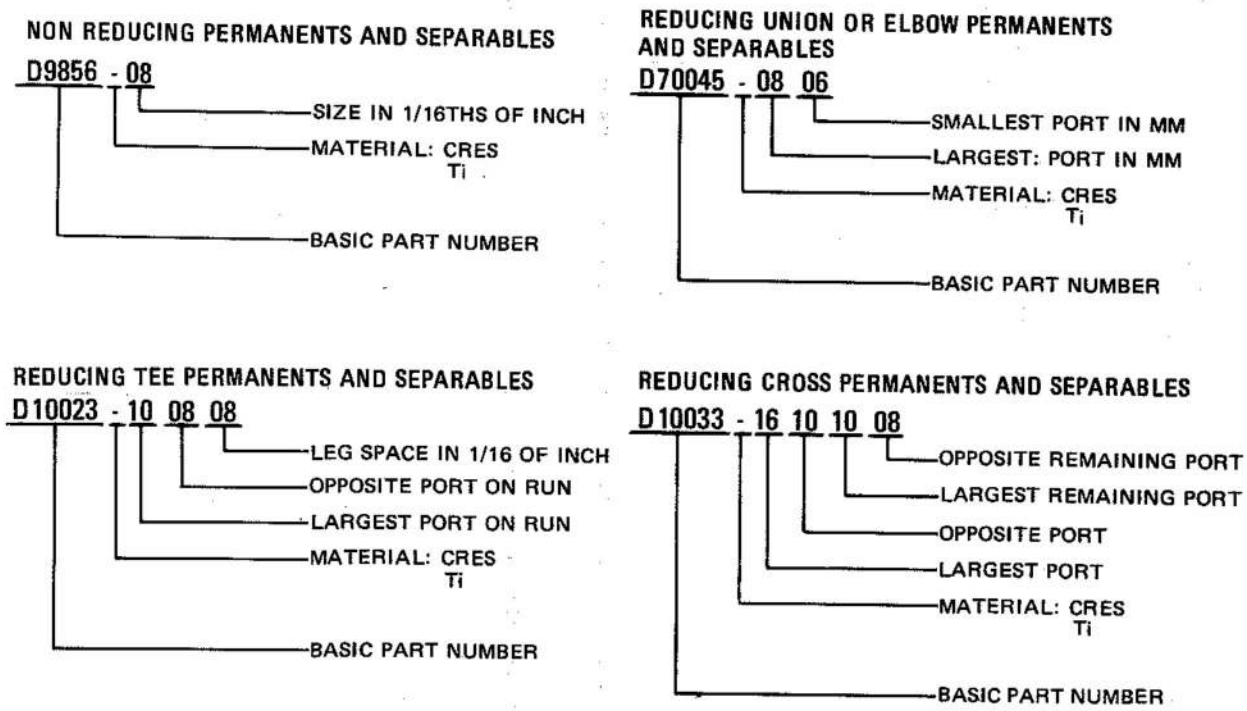


Fig 47 Part numbering system

TABLE 18 STANDARD FITTINGS, REDUCER UNION, PERMANENT, D10045

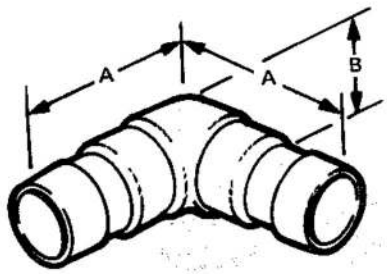
Port 1 B size		3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1-1/4	1-1/2
Port 2 C size	3/16	-	1.640	1.688	1.790	2.375	2.500	2.570	2.985	-	-
	1/4		-	1.765	1.850	2.415	2.550	2.620	3.070	3.425	
	5/16			-	1.875	2.425	2.575	2.630	3.150	3.475	3.710
	3/8				-	2.425	2.590	2.640	3.340	3.688	3.915
	1/2					-	2.953	3.030	3.420	3.796	3.984
	5/8						-	3.030	3.375	3.770	3.955
	3/4							-	3.375	3.770	3.955
	1								-	3.850	4.040
	1-1/4									-	4.148

Dimension A, length overall, is found at the intersection of Port 1 and Port 2 sizes

Note ...
Material designation letters to be added to Pt No as suffix. (CRES or Ti).

TABLE 19 STANDARD FITTINGS, ELBOW 90°, PERMANENT

Pipe size	Dimension A	Dimension B	Permaswage Pt No
3/16	0.860	0.325	D9856-03
1/4	1.050	0.390	D9856-04
5/16	1.120	0.465	D9856-05
3/8	1.190	0.550	D9856-06
1/2	1.755	0.705	D9856-08
5/8	1.860	0.866	D9856-10
3/4	1.990	1.041	D9856-12
1	2.344	1.385	D9856-16
1-1/4	2.535	1.697	D10256-20
1-1/2	2.683	1.885	D10256-24

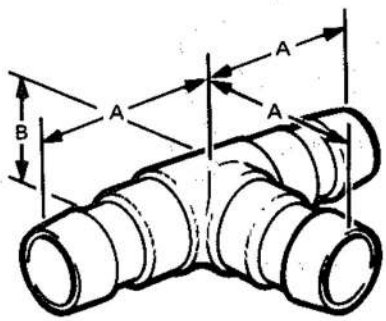


FITTING DIMENSIONS

Fig 48 Standard fitting, elbow 90°, permanent

TABLE 20 STANDARD FITTINGS, TEES, PERMANENT

Pipe size	Dimension A	Dimension B	Permaswage Pt No
3/16	0.860	0.325	D9855-03
1/4	1.050	0.390	D9855-04
5/16	1.120	0.465	D9855-05
3/8	1.190	0.550	D9855-06
1/2	1.755	0.705	D9855-08
5/8	1.860	0.866	D9855-10
3/4	1.990	1.041	D9855-12
1	2.344	1.385	D9855-16
1-1/4	2.535	1.697	D10255-20
1-1/2	2.683	1.885	D10255-24



FITTING DIMENSIONS

Fig 49 Standard fitting, tee, permanent

TABLE 21 STANDARD FITTINGS, ADAPTER, MALE

Pipe size	Dimension A	Dimension B Hexagon	Permaswage Pt No
3/16	1.129	0.375	D11007-03
1/4	1.306	0.437	D11007-04
5/16	1.349	0.500	D11007-05
3/8	1.356	0.562	D11007-06
1/2	2.078	0.750	D11007-08
5/8	2.104	0.875	D11007-10
3/4	2.184	1.062	D11007-12
1	2.630	1.500	D11007-16
1-1/4	2.819	1.625	D11007-20
1-1/2	2.759	2.125	D11007-24

TABLE 22 STANDARD FITTINGS, ADAPTER, BULKHEAD

Pipe size	Dimension A	Dimension B Hexagon	Permaswage Pt No
1/4	1.747	0.688	D11019-04
5/16	1.797	0.750	D11019-05
3/8	1.868	0.813	D11019-06
1/2	2.442	1.000	D11019-08
5/8	2.581	1.125	D11019-10
3/4	2.728	1.250	D11019-12
1	3.146	1.500	D11019-16

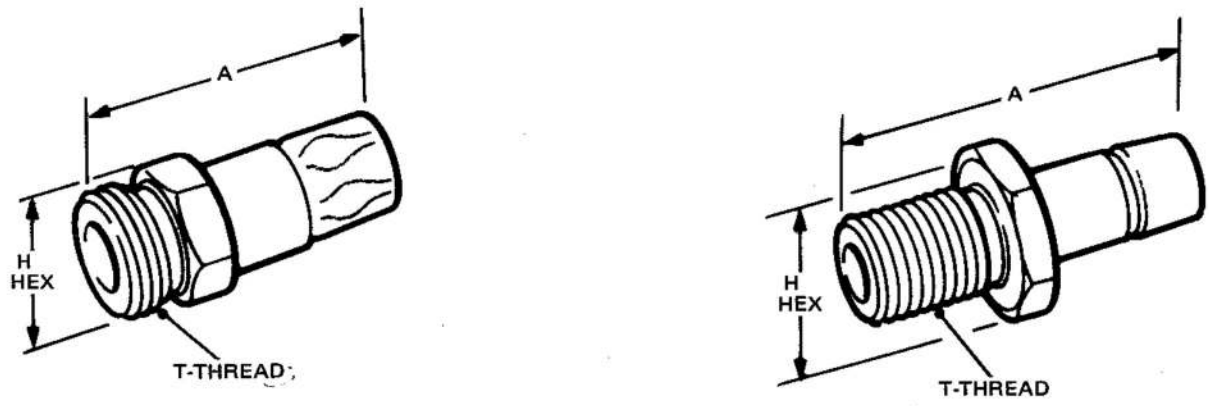


Fig 50 Standard fittings, adapters, male and bulkhead



Chapter 10

FLEXIBLE COUPLINGS FOR AIRCRAFT METAL PIPE-LINES

LIST OF SUB-CHAPTERS

10-1 High-pressure semi-flexible couplings Avimo type

10-2 Flexible couplings Miflex AC4030 Series

Chapter 10-1

HIGH-PRESSURE SEMI-FLEXIBLE COUPLINGS AVIMO TYPE

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
General	2
Dismantling	4
Assembly	5
SERVICING	
Leakages	6

ILLUSTRATIONS

Fig.		Page
1	Avimo coupling (standard version)	2

Introduction

1. The Avimo Coupling is designed for incorporation in aero-engine installations, where it is used to connect high-pressure pipe-lines in a semi-flexible manner. It is available in a range of sizes suitable for connecting pipes of between ½in. and 3 1/4in. outside diameter. The coupling is used in engine service pipe-lines carrying water, glycol or oil at pressures of up to 60 lb/in^2 and at temperatures of up to 130 deg.C.

DESCRIPTION

General (fig.1)

2. The standard version of the coupling consists of the following parts

(1) Two sleeves, corrugated at one end, made of material suitable for welding or sweating on to the ends of the tubes which are to be connected.

(2) A neoprene (synthetic rubber) collar which fits over the adjacent ends of the two sleeves, covering their corrugations.

(3) Two semi-circular flanged and ribbed packing pieces which encase the neoprene collar, lip over the outer shoulders of the two sleeves, and distribute radial pressure evenly around the coupling.

(4) A worm drive hose-clip, usually of the "Jubilee" or "Supergrip" type which encircles the whole assembly, clamping the packing pieces together and causing the corrugations of the sleeves to bed down into the neoprene collar.

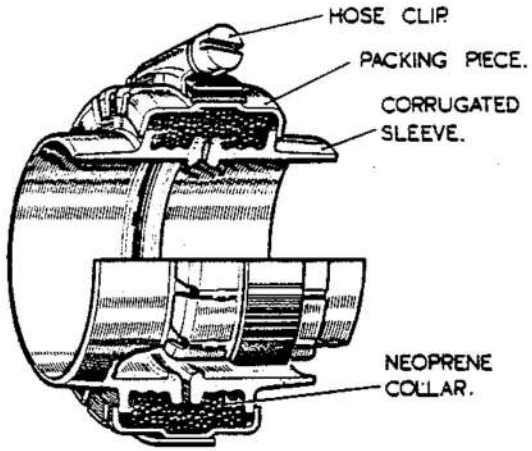


Fig.1 Avimo coupling (standard version)

3. This chapter deals only with the standard or basic model of the coupling but it should be noted that special applications of the Avimo principle exist where, for example, the pipe passes through a bulkhead and a connection is required at each side, or where the corrugated sleeve is incorporated in the design of another part. In all instances however, the principle of the coupling remains unchanged.

Dismantling

4. The sequence of operations for dismantling the Avimo coupling is as follows:-

(1) Remove the hose clip and clip and packing pieces.

(2) Exert a firm pull at each side of the coupling simultaneously. This will cause the neoprene collar to slip off one of the sleeves, it can then be prised off the other sleeve with the fingers. Difficulty will sometimes be experienced however in removing the collar where the coupling is used in pipe-lines which work at high temperatures, as it may adhere to the sleeves quite firmly due to a slight vulcanisation between the surfaces. It may then be necessary to ease away the collar from the metal by running a thin tool, such as a small screwdriver, around under it. Great care must be taken in the operation to avoid cutting the collar or bruising the sleeve corrugations.

Assembly

5. The coupling is assembled or re-assembled as follows:-

(1) Place the neoprene collar over one of the sleeves, then ease it on to the other when the two are butted together.

(2) Next place the packing pieces over the collar in positions diametrically opposite each other, so that the clearance at each side between their ends is equal. The amount of this clearance must be between 1/32in. and 3/16in. before tightening up the hose clip.

(3) Position the hose clip centrally around the packing pieces. Where the jubilee type clip is used in conjunction with packing pieces which have the raised ribs running uninterrupted across their widths, care must be taken to ensure that the screw box of the clip rests across two of them when tightened; otherwise the tabs which hold the screw box in position on the band, will be pulled from their locating holes and failure of the clip may result. As the efficiency of the coupling rests largely upon the effectiveness of the clip, it is essential that this be screwed up tightly, taking care not to strip either the thread of the screw or the nut, screw box or band slots in which it actuates.

SERVICING

Leakages

6. Where leakages occur they will usually be found to be of a major nature, due to the hose clip bursting and a consequent blowing out of the neoprene collar. Bleed leaks normally occur only through some small cut or split in the neoprene collar itself. In all cases the faulty or damaged item must be renewed.

Chapter 10-2

MIFLEX COUPLINGS AC4030 SERIES

CONTENTS

	Para.
Introduction	1
DESCRIPTION	
General	2
Operation	3
Seal identification	6
SERVICING	
Dismantling of couplings and renewal of 'O' rings	7
Assembly	8
Fault-finding	9

TABLES

No.		Page
1	Allocation of seals for systems use	3
2	Fault finding	6

ILLUSTRATIONS

Fig.		Page
1	Pipe and coupling components	2
2	Coupling and position of pipes	2
3	Standard pipe coupling	4
4	Elbow pipe coupling	4
5	Termination pipe coupling	5
6	Boss coupling	5

Introduction (fig. 1, 3, 4 and 5)

1. Miflex Couplings Type AC4030 Series are used to provide a flexible connection between two pipe-lines, or between a pipe-line and an end fitting of a component. The pipe ends must be beaded for use with these couplings (fig.1). Pipe sizes from 1/4in.o.d. to 3½in.o.d. and a range of coupling types are covered by the Series (fig. 3-5). These may vary to suit the medium for which the pipe-line is used (see para.6).

DESCRIPTION

General (fig. 1 and 2)

2. Each coupling consists of a body, two split gland washers, two 'O' rings, a centre split retaining sleeve, a nut and a circlip locking ring (fig.1). This engages in slots on the body and the nut, to lock them together when the coupling is assembled on the pipe and/or component. The 4BA tapped hole in

the nut is for bonding purposes, to link the pipe held in the nut assembly to the pipe held in the body assembly, via the nearest of the 4BA tapped holes in the projections round the body.

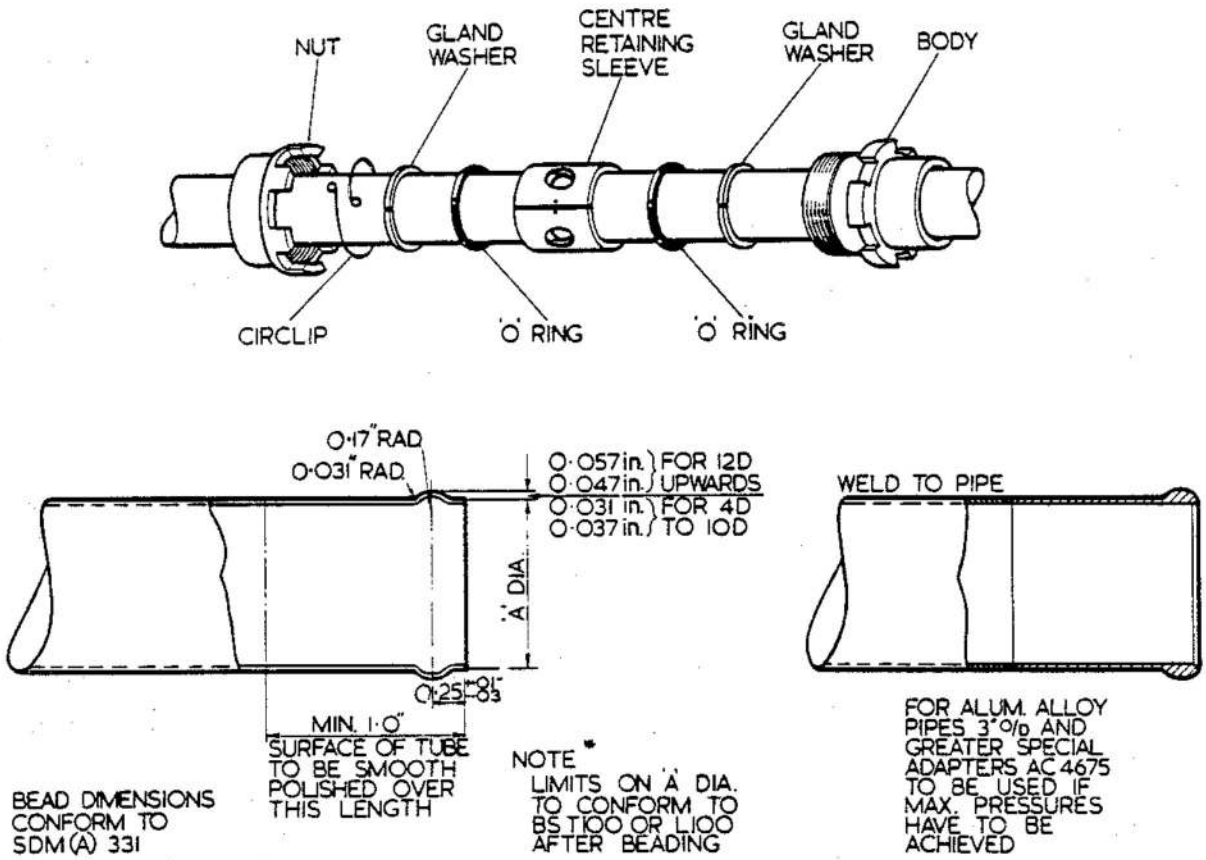


Fig.1 Pipe and coupling components

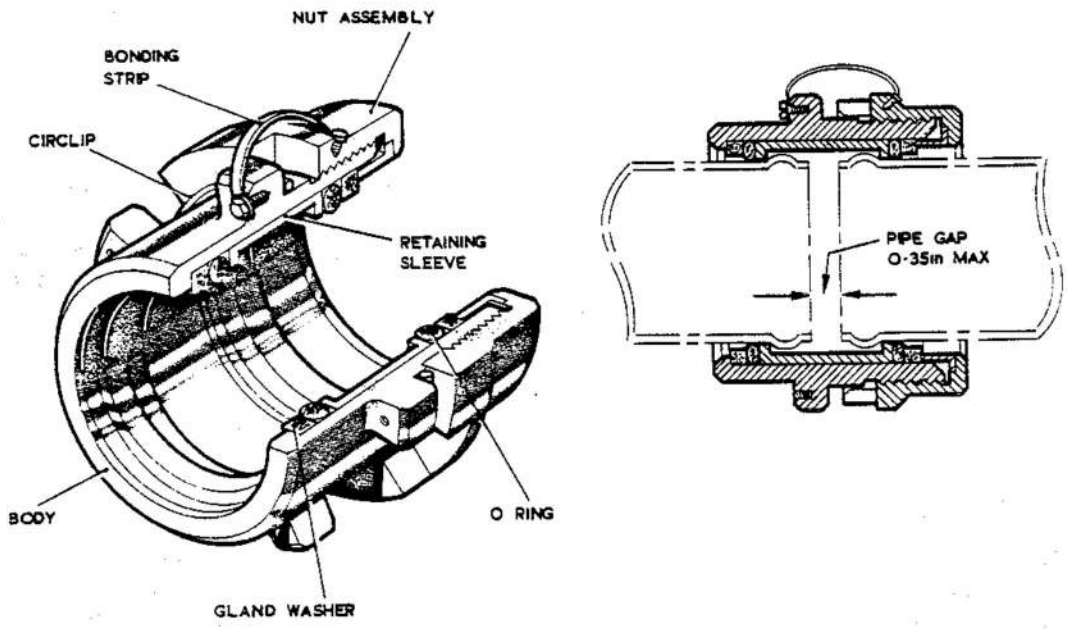


Fig.2 Coupling and position of pipes

Operation (fig.2)

3. As the nut is tightened on the body it compresses the 'O' rings between the gland washers and the centre retaining sleeve. The 'O' rings expand and form a seal between the outer surface of the pipe and the bore of the body, as shown in fig.2. Fig.2 also shows the maximum permissible gap, of 0.35in, between the ends of the pipes.

4. The coupling is leak-proof under static conditions with an internal working pressure of -11 lb/in^2 to +125 lb/in^2 for fuels, and from 0 lb/in^2 to 100 lb/in^2 for air, with a maximum angular misalignment of four degrees.

5. The coupling is leakproof under dynamic conditions with an internal working pressure of -4 lb/in^2 to +15 lb/in^2, a maximum misalignment of two degrees, and an axial movement of 0.35in. It will operate through a temperature range of -50 deg.C to +70 deg.C for most uses but with air the upper temperature range may be extended to 280 deg.C.

Seal identification

6. Details of the seals used in the various pipe systems are given in Table 1.

TABLE 1

Allocation of seals for systems use

Seal No.	System use
AC/B/4038	AVTAG DERD2454 (Nato symbol F-40)
	AVTAG DERD2486 (Nato symbol F-45)
	Oil DERD2487 (Nato symbol O-149)
	AVTUR50 DERD2494 (Nato symbol F-35)
	AVCAT48 DERD2498 (Nato symbol F-44)
	Oil DTD585 (Nato symbol H-515)
	Hydraulic fluid SKYDROL 500
	Nitrogen and oxygen
AC/B/4047	Hot air (max.temp.280 deg.C)

SERVICING

Dismantling of couplings and renewal of 'O' rings

7. Dismantle the coupling as follows:-

(1) Remove the bonding strip.

(2) Spring the circlip locking ring free from its slots.

(3) Unscrew the nut from the body, then slide the nut and body along the pipe clear of the retaining sleeve.

(4) Using circlip pliers if necessary, spring the centre retaining sleeve over the beads and slide it along the pipe. Remove the 'O' ring.

(5) Spring the centre retaining sleeve over the beads to the other pipe, then remove the other 'O' ring.

(6) If it is necessary to renew any of the metal components of the coupling, the whole pipe section must be uncoupled so that a small length of the pipe may be removed to allow the renewal of the faulty component. If the pipe is too short for cutting, then it will be necessary to make up a complete new section with new couplings.

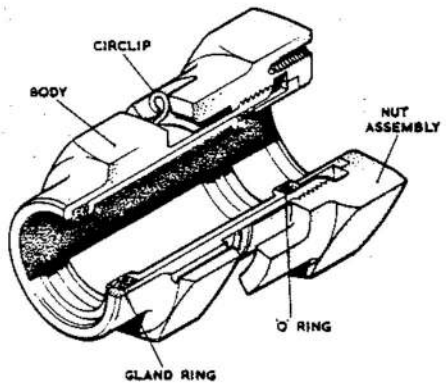


Fig.3 Standard pipe coupling

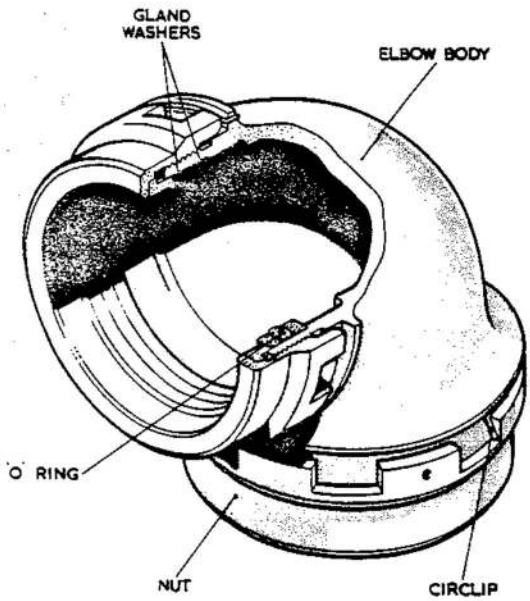


Fig.4 Elbow pipe coupling

Assembly (fig.1)

8. Assemble the coupling on a pipe-line as follows:-

(1) Slide the coupling body on one pipe end.

(2) Slide the coupling nut on the other pipe end.

(3) Fit a gland washer to each pipe, using circlip pliers if necessary.

(4) Lubricate the 'O' rings with the fluid in the system to be sealed and fit one on to each pipe.

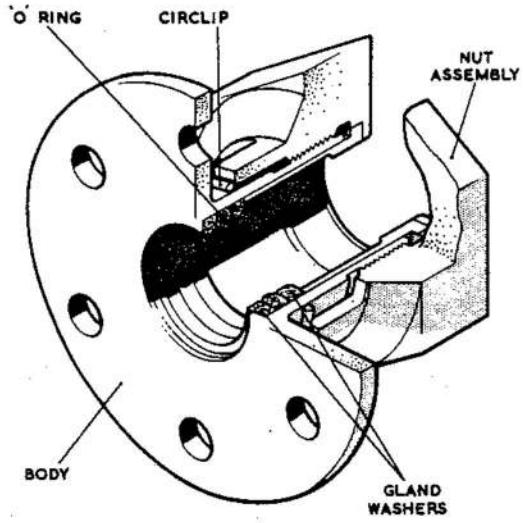


Fig.5 Termination pipe coupling

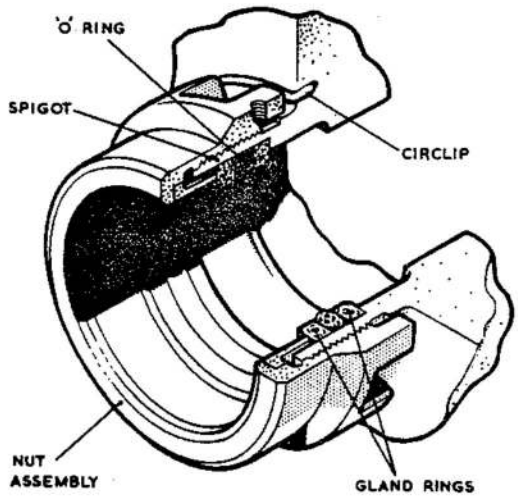


Fig.6 Boss coupling

(5) Shape the ends of the two pipes (fig.1) as detailed in SDM(A)331, so that the beads are formed to fit against the shoulders of the coupling nut and body.

(6) Using circlip pliers if necessary, fit the centre retaining sleeve over the beads on both the pipe ends as shown in fig.1.

(7) Lightly smear the threads on the body and nut with graphited grease Ref.No. 34B/9100528 (Nato symbol S-720).

(8) Slide the coupling body and nut together and engage the threads carefully. Screw the nut on to the body by hand until, by feel, the compression of the 'O' ring begins. Apply a further half-turn to tighten.

(9) Lock the coupling by allowing the circlip lugs to spring into the nearest locking slots on the nut and body. A slight unscrewing movement is then necessary to establish the correct locking position.

(10) Replace the bonding strip to link the nut and body (see para.2).

Fault finding

9. After assembly or reassembly, and as detailed in the aircraft schedule, all couplings in a system must be checked for leaks and security. Table 2 is given as a guide to fault-finding.

TABLE 2

Fault finding

Fault	Cause	Rectification
Fluid leaks	(1) Scored, trapped or distorted 'O' rings	(1) Renew 'O' rings
	(2) Perished 'O' rings due to contamination by incorrect fluid from external or internal sources	(2) Renew 'O' rings. Check metal parts for corrosion or damage
	(3) Scored, dented or distorted pipe end	(3) Renew pipe

Chapter 11

DYNATUBE PIPE FITTINGS

CONTENTS

Para

1 Introduction

Description

3 Types and construction

5 Design features

6 Tightening action

11 Pipe coupling and fitting standards

12 Tightening fittings

14 Precautions

15 Coupling assembly

17 Tube materials

18 Protection and blanking plugs

19 Part numbering

21 Reducer fittings

22 Repair techniques

23 Tooling

Procedure to assemble a Dynatube fitting

28 General

32 Tube preparation

35 Pipe bend limitations

37 Tool selection

39 Selection procedure

40 Checks before assembling fittings

41 Swaging procedure

Maintenance

42 General

43 Expander setting

44 Measuring expander setting

45 Using a V-anvil micrometer

48 Using a set ring gauge

50 Adjustment of expander setting

51 Adjustment procedure

Expander care and inspection

52 General

53 Precautions before use

Replacement of expander mandrels and rollers

54 Disassembly of tool

55 Visual inspection

56 Reassembly of tool

Replacement of expander cages

57 Disassembly

58 Reassembly, with replacement cage

59 Measurement of expander insertion depth, 'E'

Special repair techniques

62 Male connector resurfacing

63 Resurfacing procedure

64 Dynaring washers

► 65 Testing procedure ◄

CONTENTS (continued)

Table		Page
1	Lubricants for couplings and threads	8
2	Installation torque values for CRES and titanium fittings	8
3	Part numbers of Dynatube fittings	9
4	Dimensions of internal tube chamfer	17
5	Pipe bend limitation dimensions	18
6	Longitudinal growth allowances	19
7	Dynatube tool selection	20
8	Contents of tool kits	21
9	Tube insertion depths	24
10	Swage internal diameter	27
11	Fault diagnosis	29
12	Expander setting values (C-3)	30
13	Dimensions of 'E' dimension checking fixture	35
▶ 14	Dynaring washers ◀	38

Fig		Page
1	Dynatube coupling compared with MS coupling	3
2	Method of attaching fittings	4
3	Typical male threaded fittings	4
4	Typical female threaded fittings	4
5	Typical Dynatube fittings	5
6	Section of sealing area	6
7	Seal details	7
8	Part numbering system, fittings	10
9	Part numbering system, tees	11
10	Part numbering system, reducers	11
11	A typical tool kit	12
12	A typical expander, die set and collar	13
13	Male/female fitting cut-off points	14
14	Splice tube repairs	15
15	Dimensions of internal tube chamfer	17
16	Pipe bend limitations	18
17	Typical holding dies and corresponding fittings	23
18	Damaged expander rollers	23
19	Expander inserted into tubing	25
20	Die halves positioned	25
21	Collar positioned	25
22	Dial gauge for measuring swaged inside diameter	26
23	Identification of tooling components	28
24	Expander components	31
25	Expander internal components	32
26	Expander insertion depth fixture	34
27	Resurfacing tool components	37
▶ 28	Dynaring washer assembly and size ◀	38

Introduction

1 The Dynatube range of pipe fittings provides a pressure tight coupling between two rigid lengths of piping or between the various elements of a hydraulic system and the flexible or rigid piping and its elements. Connections to rigidly mounted component bodies are made using Rosan fittings (Chap 11-1) on the appropriate end of the pipe assembly.

2 The coupling comprises of three components and is attached to the end of the pipe by a swaging operation for which the appropriate tool kits are provided.

Note ...

Metric conversions are not normally given in this publication since all components are basically measured in inches.

DESCRIPTION

Types and construction

3 The coupling is smaller than the corresponding size of MS coupling (Chap 13) as a result of the tubing being swaged on to the tube end fitting, which incorporates a combined disc spring and diaphragm. Only three components are needed to form a coupling (fig 1) and these are:

3.1 Main connector male fitting.

3.2 Coupling female nut.

3.3 Tube end fitting.

4 In addition to the normal fittings longer repair length fittings are provided. These are used to retain the length of the pipe assembly when the original fitting must be cut off due to it being unserviceable.

Note ...

Permaswage fittings of 'Standard' type in the D10000 or D11000 series may also be used to effect repairs (Chap 9).

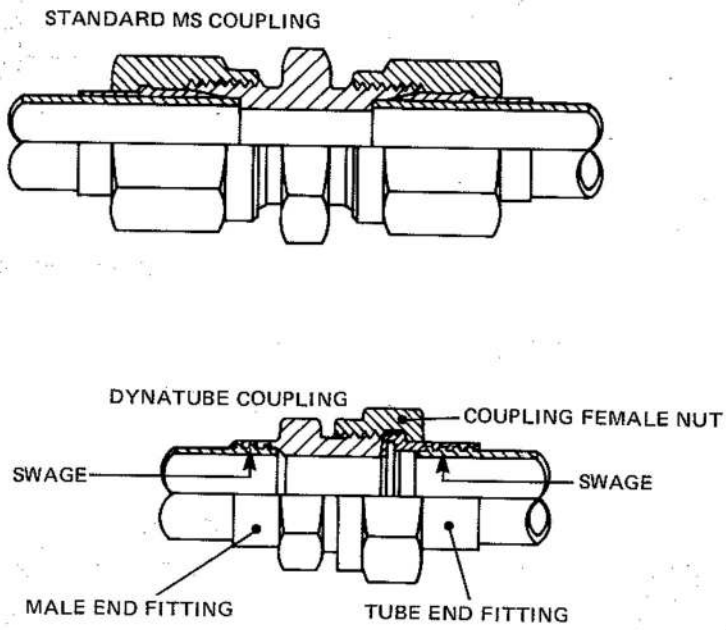


Fig 1 Dynatube coupling compared with MS coupling

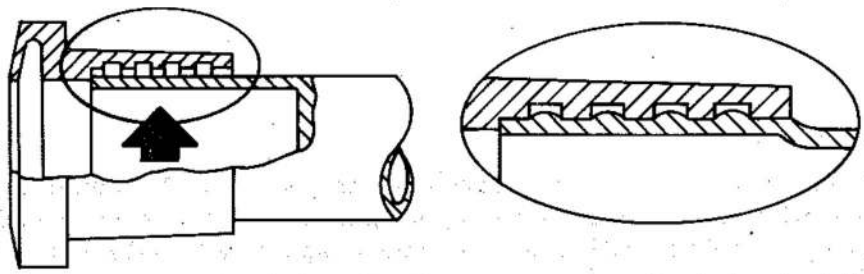


Fig 2 Method of attaching fittings



Standard Repair length

Fig 3 Typical male threaded fittings



Standard Repair length

Fig 4 Typical female threaded fittings

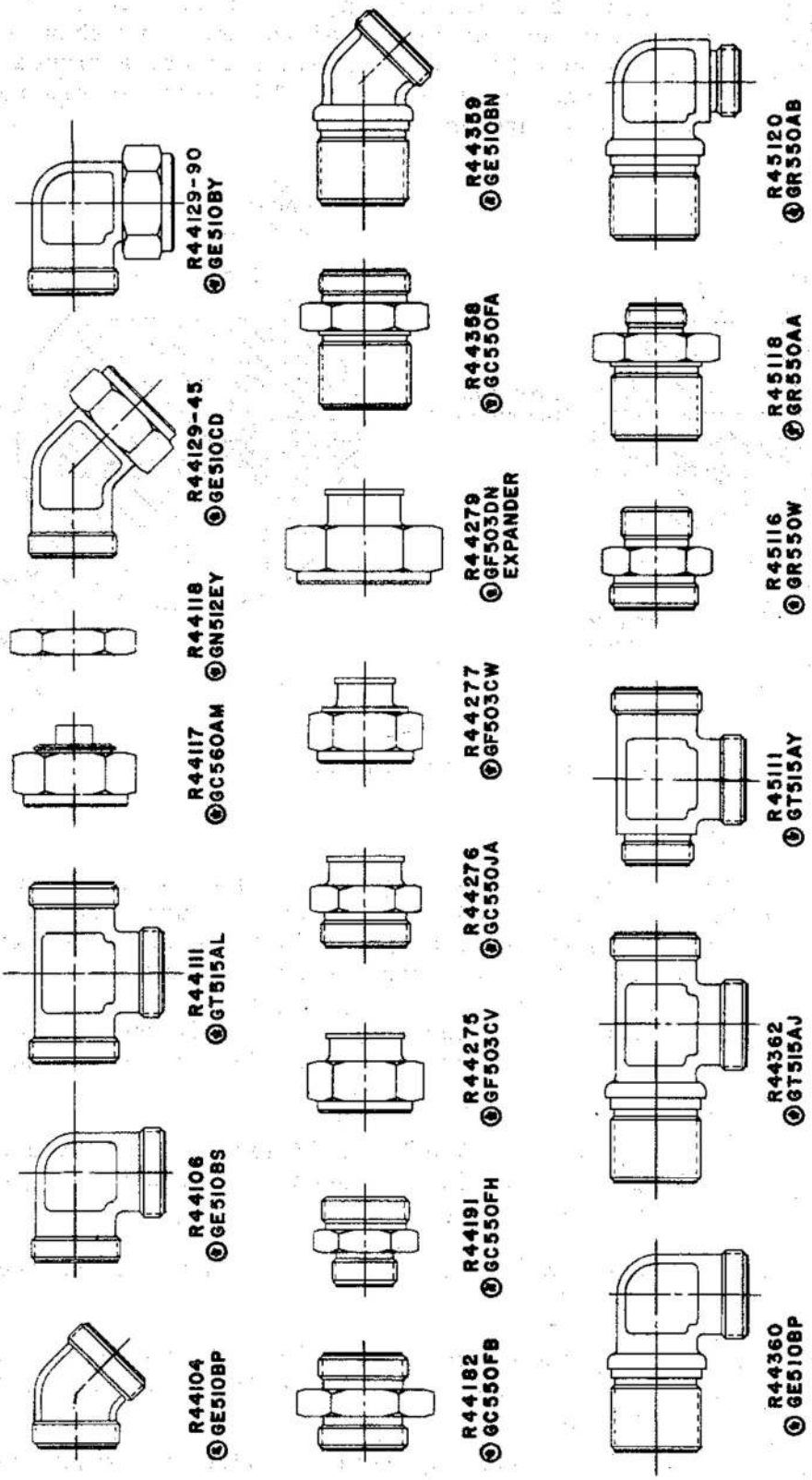


Fig 5 Typical Dynatube fittings

Design features

5 The sealing surface of a fitting is concave and the corresponding convex sealing surface is in the form of a disc spring, the outer edge of which is shaped to form both an abutment for the flange of the nut, and then to accept the end of the tubing (fig 6A and 6B). The top diameter has a truncated thread so that the nut can be unscrewed over it. This gives access to the sealing surface for corrective maintenance.

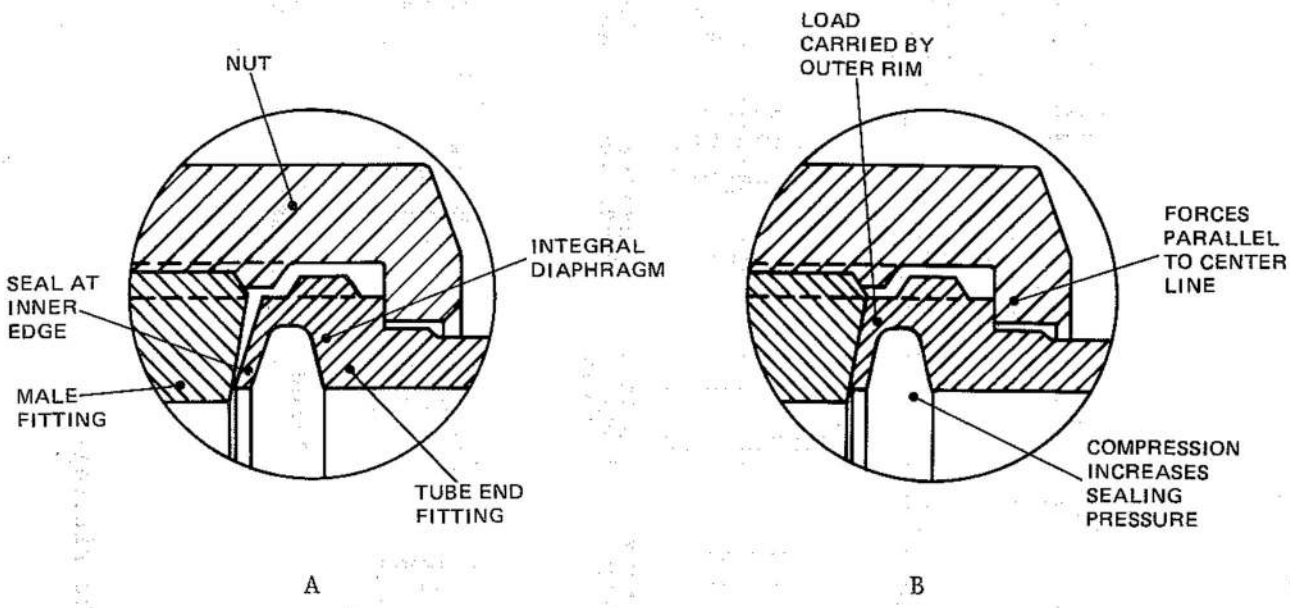


Fig 6 Section of sealing area

Tightening action

6 The position of the sealing surfaces when finger tightening of the nut (fig 6A) shows the pressure seal formed at the inner circumference of disc. As the torque on the nut is increased the spring in the disc allows it to deflect thus bringing the whole surface into contact (fig 6B).

7 The disc spring action maintains a force against the flange of the nut, parallel to the centre line and this serves as lock for the entire union by preventing loosening.

8 Excessive tightening pressure is taken by solid metal between the shoulder and sealing face but will deform the nut or spanner. Excessive tightening will not deform the seal or affect its efficiency.

9 The fittings incorporate two other features which contribute to their serviceability:

9.1 The nut is prevented from sliding back to expose the seal to damage by a short length of truncated thread, but can still be withdrawn from the seal if required (fig 7).

9.2 The inside face of the sprung disc seal is under system pressure which increases seal contact pressure,(fig 7) shows the pressure boost area of the seal arising from this feature.

10 Since the fittings are less susceptible to overtorquing, provided a solid film lubricant is applied to all sliding surfaces, they may be assembled and disassembled at least fifty times.

Pipe coupling and fitting standards

11 To ensure a perfect fit between the coupling and mating components or to the male connector for pipe-to-pipe joints, a perfectly aligned and tension free pipe run must be achieved. This is to ensure correct contact of the tube end fitting seal with the male connector fitting (fig 7), which is essential to avoid leakage or seeping from the coupling. The swaging operation must have been carried out correctly and checked as described.

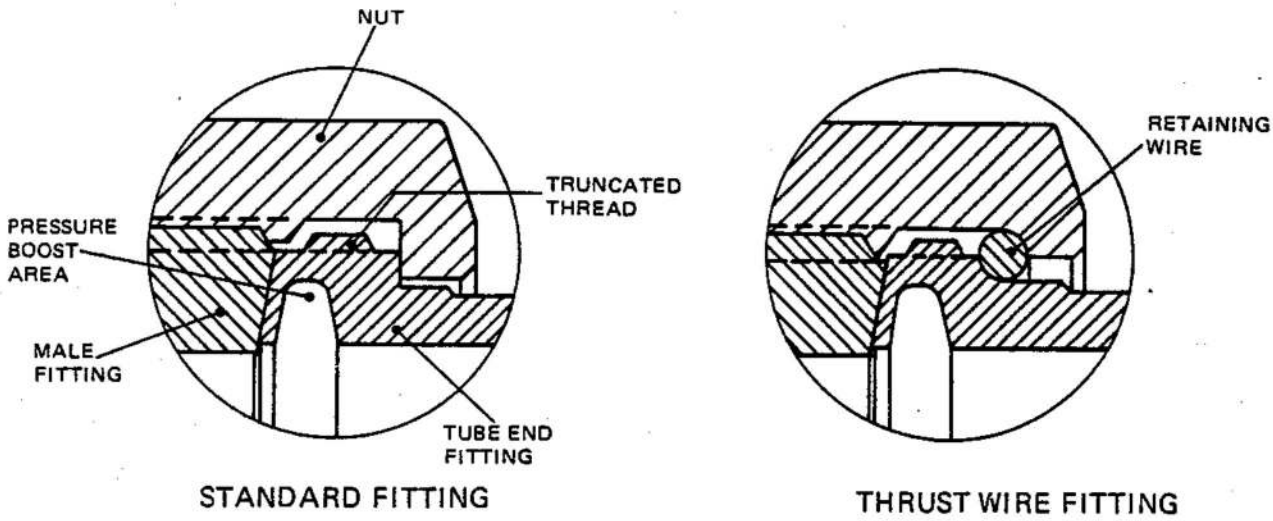


Fig 7 Seal details

Tightening fittings

12 The coupling nuts and mating threads must be coated with the appropriate lubricant before assembly (Table 1). Tighten the nut by hand until a resistance to turning is encountered. If it is impossible to run the nut down with the fingers, a set spanner may be used to bottom the connection. At this point final torquing should be applied. Use a set spanner to prevent the male connection or fitting being twisted and a torque spanner to tighten the coupling nut to the values specified in the publication relating to the aircraft or engine.

13 Torque values are also given in Table 2, but these are for use only in the absence of information in the relevant aircraft/engine publication.

WARNING ...

▶ DO NOT USE OIL ON OXYGEN SYSTEM PIPING. SEE PROCEDURES IN CHAPTER 16. ◀

TABLE 1 LUBRICANTS FOR COUPLINGS AND THREADS

System	Specification of lubricant US	UK	Nato
Hydraulic	MIL-H-5006	OM15	H515
Fuel	MIL-H-5006	OM15	H515
Oil	MIL-O-6032	OX27	O-156
Freon	MIL-L-6085A	OX14	O-147
Pneumatic	MIL-G-4343	XG269	-

Precautions

14 Finger tightness should ensure contact of the tube end seal with the fitting or male connection. If this is not achieved or resistance is not felt during the tightening movenent check for:

14.1 Tight threads.

14.2 Incorrect swaging of tube end fitting.

14.3 Distortion or maladjustment of pipe assembly.

14.4 Distortion or pull up of structure.

Coupling assembly

15 The use of two spanners for tightening and releasing fittings is mandatory, except when tightening or releasing nuts on to a major component or locked bulkhead fitting.

16 When tightening or releasing a standard pipe-to-pipe coupling only the spanner on the loose nut should be rotated, the second spanner behind held stationary and used to react to the tightening torque thus preventing any torque being induced into pipe assemblies.

TABLE 2 INSTALLATION TORQUE VALUES FOR CRES AND TITANIUM FITTINGS

Fitting size	Torque range lbf/ft			kgf/cm		
inch	min	nominal	max	min	nominal	max
3/4	5	7	9	69.2	96.8	124.5
1/4	10	12	14	138	166	194
3/8	15	20	25	207	277	346
1/2	30	35	40	415	484	553
5/8	41	48	55	567	664	761
3/4	50	60	70	692	830	968
1	70	82	94	968	1134	1300
1.1/4	108	124	140	1494	1715	1936
1.1/2	125	145	165	1728	2005	2282

Notes ...

(1) kgf/cm ÷ 100 = kgf/m.

Notes (continued) ...

(2) Torque values are in accordance with RES 228.

(3) The torque values listed above are recommended for high strength stainless steel and titanium fittings.

(4) Bulkhead fitting jam nuts should be torqued to a value between the minimum and nominal values.

TABLE 3 PART NUMBERS OF DYNATUBE FITTINGS

Tube size inch	Part No Basic fitting	Part No Repair fitting
3/16	MR54040T-03 MR54100T-03	MR54035T-03 MR54225T-03
1/4 (female fitting) (male fitting)	MR54040T-04 MR54100T-04	MR54035T-04 MR54225T-04
3/8	MR54040T-06 MR54100T-06	MR54035T-06 MR54225T-06
1/2	MR54040T-08 MR54100T-08	MR54035T-08 MR54225T-08
5/8	MR54040T-10 MR54100T-10	MR54035T-10 MR54225T-10
3/4	MR54040T-12 MR54100T-12	MR54035T-12 MR54225T-12
1	MR54042T-16 MR54200T-16	MR54035T-16 MR54225T-16
1.1/4	MR54040T-2120 MR54100T-2120	MR54035T-2120 MR54225T-2120

Tube materials

17 Since the tube end fitting is attached to the tube by an internal swaging operation the range of materials is limited to as follows:

17.1 Tubing as specified in the publication relating to the aircraft or engine.

17.2 The following tubing materials:

17.2.1 Titanium tubing, 3AL-2-1/2 V Ti

17.2.2 Stainless steel tubing, 304-1/8 hard SS

Protection and blanking plugs

18 The available cap and plug are used to blank off the male and female couplings respectively. It is essential that full use is made of these items when dismantling pipework.

Part numbering

19 The part numbers of basic and repair fittings are given in Table 3, and the part numbering system for fittings is illustrated in fig 6 and 7. It is laid out as follows:

19.1 Basic part number.

19.2 Shoulder material.

19.3 Nut material.

19.4 Finish.

19.5 Dash size - two digits.

19.6 Letter to replace hyphen when wire holes are required:

19.6.1 W indicates two wire holes.

19.6.2 U indicates three wire holes.

19.7 Last two digits of tube wall thickness.

Notes ...

(1) Only one letter is inserted when shoulder material (para 19.2) and nut material (para 19.3) are the same.

(2) All fitting part numbers in this chapter include the suffix T to indicate that the material is titanium.

20 For tees the numbering system is as follows:

20.1 Dash size of left run - two digits

20.2 Dash size of right run - two digits

20.3 Dash size of side - two digits

20.4 Code letter - W

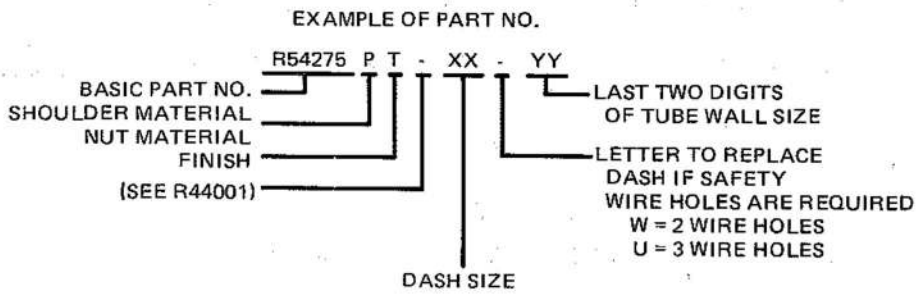


Fig 8 Part numbering system, fittings

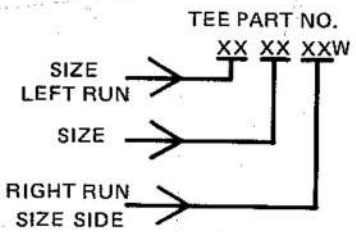


Fig 9 Part numbering system, tees

Reducer fittings

21 Reducer fittings for attachment by swaging are provided but in only two tube size reductions, and are specified as in fig 10.

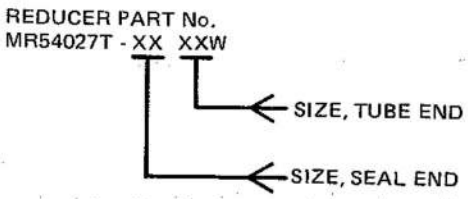


Fig 10 Part numbering system, reducers

Repair techniques

22 Dynatube fittings are assembled by use of the appropriate tooling for the following applications using the tool kits provided:

22.1 Fabricate new pipe assemblies.

22.2 Assemble repair length fittings to pipework in cases where the original fitting is unserviceable.

22.3 Repair localized damage to tubing by using a tube splice assembly.

22.4 Restoring the sealing surface of male connector fittings.

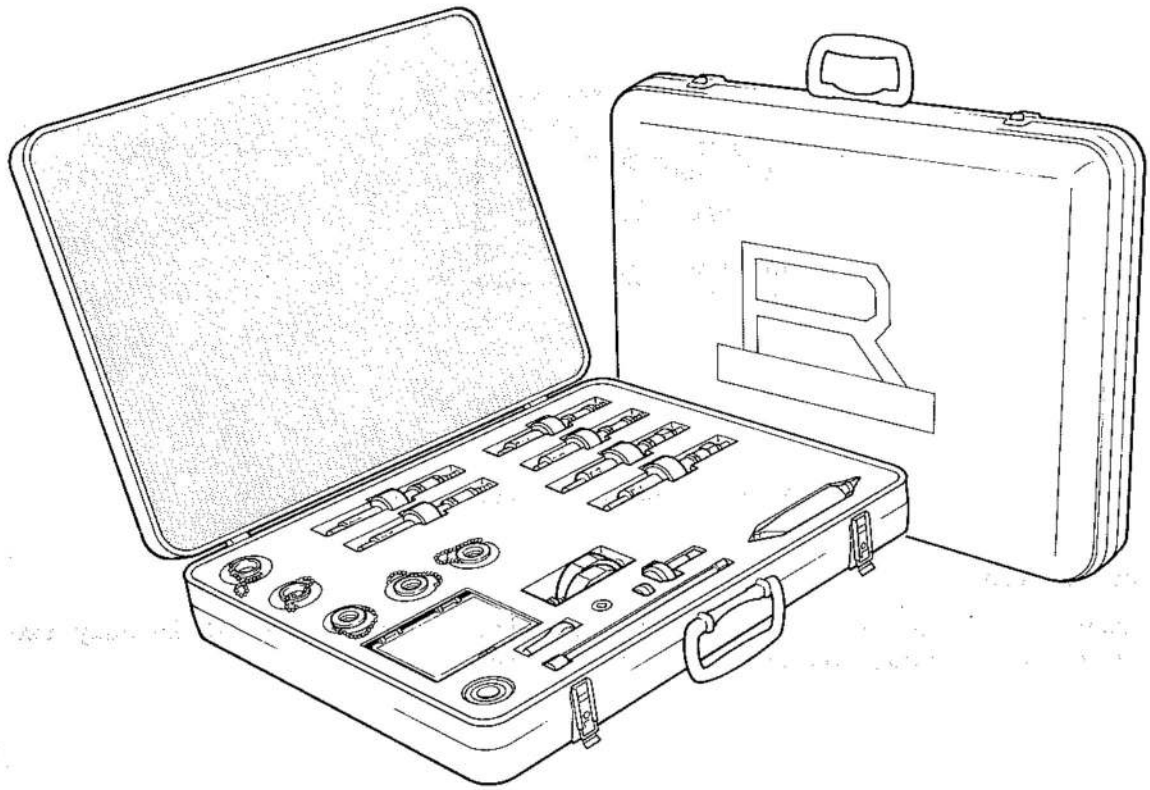


Fig 11 A typical tool kit

Tooling

23 The tool kit Pt No R27500MH provides all items needed to assemble Dynatube titanium fittings on to both titanium tubing and on to 304 1/8 hard stainless steel tubing (fig 11). The kit is contained in two cases one of which contains only the male resurfacing and lubricant repair tools, which are used to re-surface and reapply solid-film lubricanton to the sealing surface of all male fittings.

Note ...

For some sizes a different expander may be needed due to the differing elasticity of titanium and SS tubing.

24 The field installation and repair kits enables the operations given in para 21 to be carried out, including in situ repairs, but where axial access is limited; pipework removal may be necessary.

Note ...

To avoid the necessity of pipework removal due to limited axial access it may be possible to fit a standard Permaswage lipseal fitting (Chap 9).

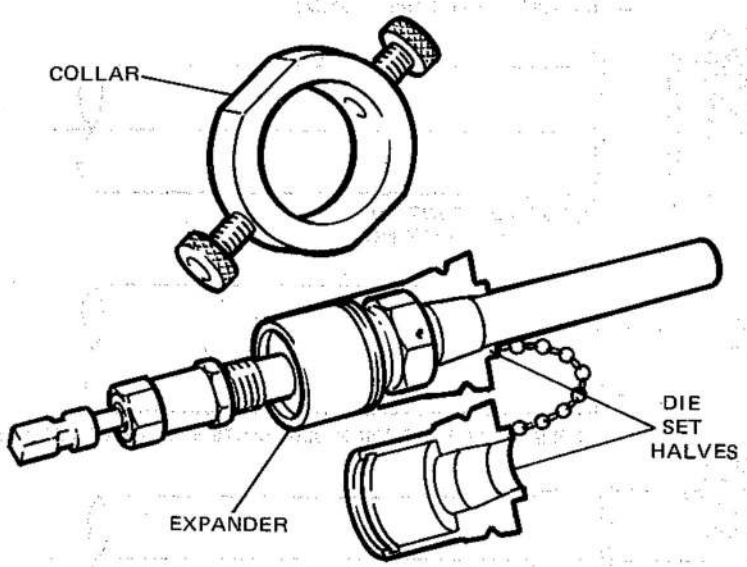


Fig 12 A typical expander, die set and collar

CAUTION ...

Permaswage standard lipseal fittings are not to be used for motion tubing above 1/4 in diameter.

25 The tooling to swage the tubing into the fitting comprises:

25.1 An expander, which can be rotated manually or by power drive.

25.2 A pair of die set halves which support both the fitting and the expander body.

25.3 A collar, with two thumbscrews, which serves to secure the die halves together during the swaging operation.

26 A plug gauge or internal dial indicator gauge is needed in addition,to check the bore of the swage so as to ensure that the operation has been carried out correctly. Setting rings are provided for the dial indicator gauge.

27 Lubricant for the expander is provided in the kit.

PROCEDURE TO ASSEMBLE A DYNATUBE FITTING

General

28 The assembly of the tube end fitting to the pipe can be made by welding or brazing at time of manufacture of the original equipment, but the following procedure describes the use of tools to swage the tubing outwards into radial grooves in the fitting for the repair of pipework.

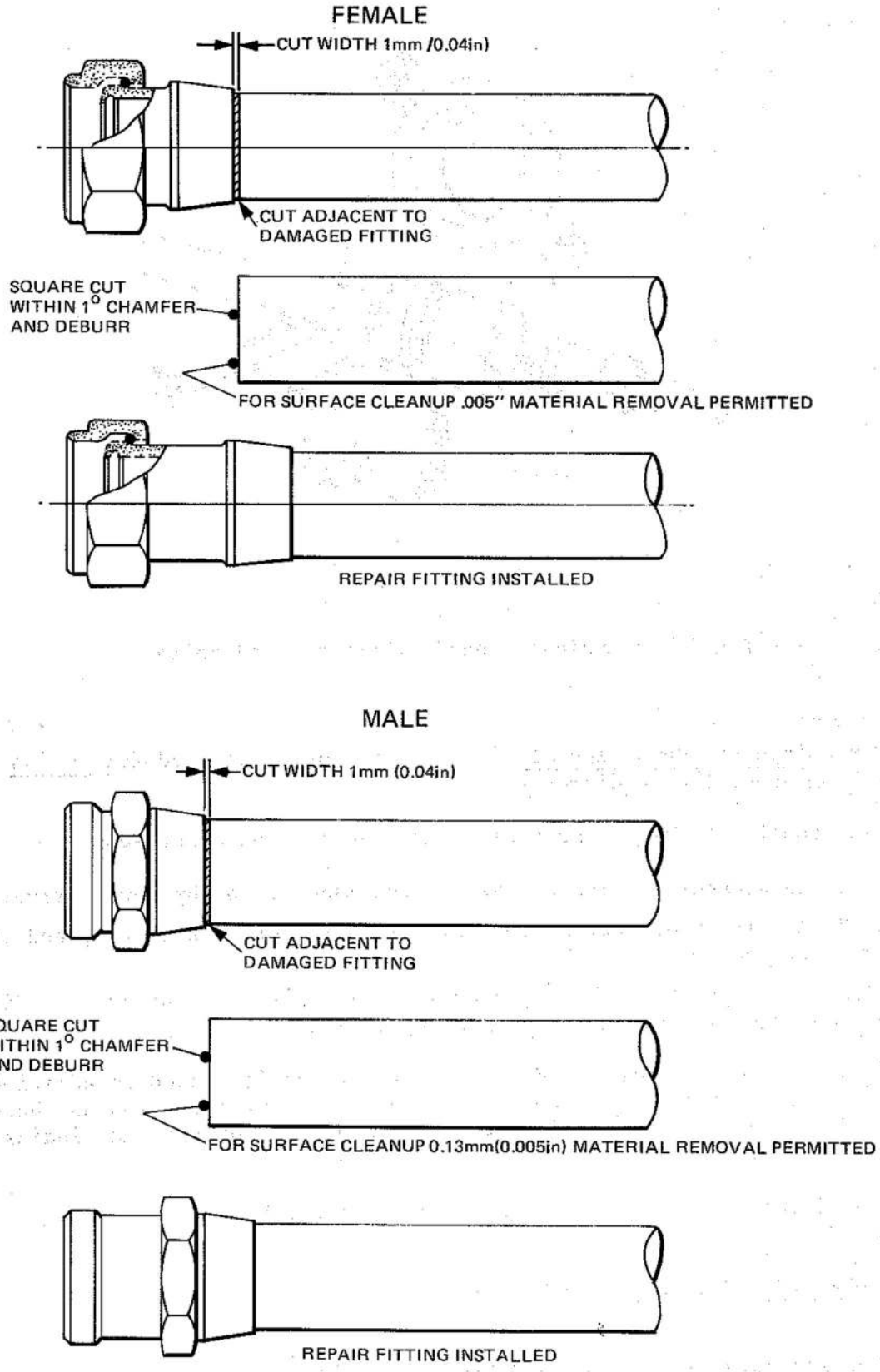
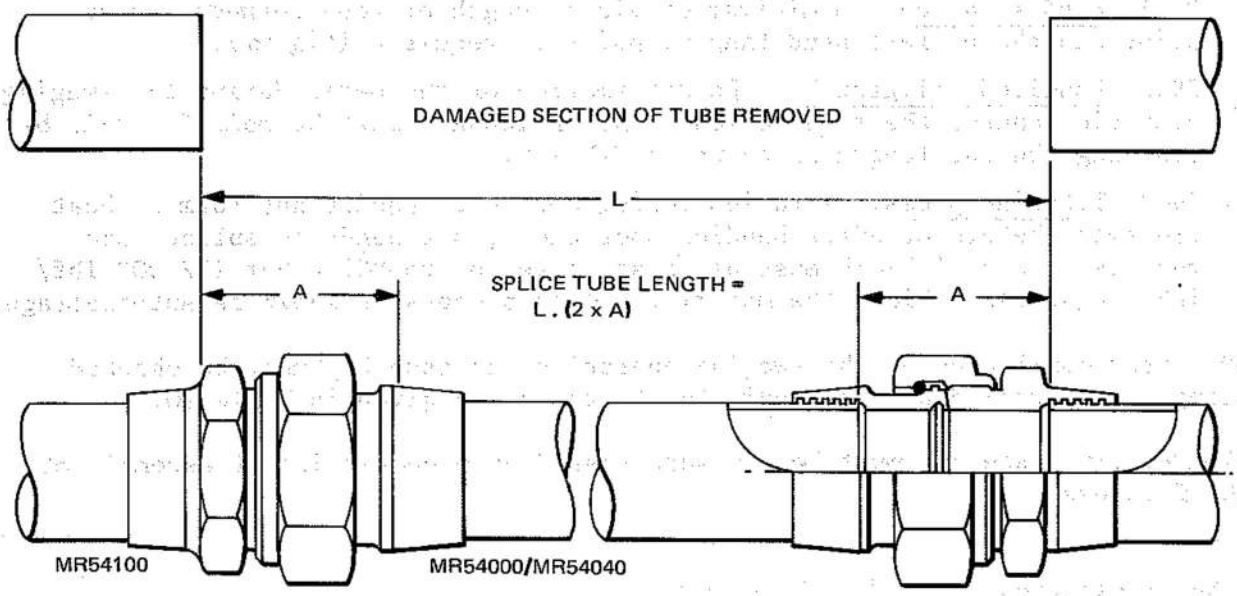


Fig 13 Male/female fitting, cut-off points



TUBE DIAMETER	*FACTOR FOR SPLICE TUBE LENGTH CALCULATION (2XA)
3/16	1.724
1/4	1.814
3/8	1.988
1/2	2.106
5/8	2.392
3/4	2.560
1	3.032

SAMPLE CALCULATION:
6.500" OF TUBE CUT OUT OF 1/2 DIAMETER TUBE. MR54000 AND MR54100 FITTINGS ARE TO BE USED. COMPUTE SPLICE LENGTH AS FOLLOWS:

SPLICE TUBE LENGTH =
6.500 - 2.106 = 4.394

*FACTOR IS ADJUSTED TO COMPENSATE FOR ANTICIPATED TUBE GROWTH PER TABLE 6.

Fig 14 Splice tube repairs

29 There are three factors which must be allowed for when assembling fittings or making replacement pipe assemblies using titanium or SS tubing, and these are:

29.1 Bend location. A minimum straight length of tube between the cut point and the nearest bend tangent point is required (fig 16).

29.2 Longitudinal growth. The deformation of the metal during the swaging operation causes the tube to lengthen. Allowance must be made for this by reducing the cut length as shown in Table 6.

29.3 Titanium pipes. Titanium tubing does not require any form of heat treatment before or after bending operations, but bends in splice tube repairs or new pipework must be pressure tested to 827.4 bar (12 000 lbf/in2) to stress relieve the material. This process is known as Autofrattage.

30 After completion of the swaging operation the assembly must be checked using an internal dial test indicator to the sizes given in Table 10.

31 The pipe assembly must be pressure tested upon completion of assembly of the fittings.

Tube preparation

32 Inspect the tube for roundness, cleanliness and freedom from marks and scratches.

Notes ...

(1) The tubing is to be rejected if any draw marks (longitudinal ridges of hollows are visible).

(2) The wall thickness of the tubing must be checked to ensure that it is not more than 10% under or oversize. Tubing outside tolerance is to be discarded.

33 Before cutting-off the tubing to length note from Table 6 that new pipework must be shortened to allow for longitudinal growth during swaging. No allowance is needed when assembling a repair fitting while allowances for splice tube repairs are given in fig 14. The cutting procedure is as follows:

33.1 Cut-off the tubing to the required length or in the case of damaged fitting close to the fitting (fig 13).

33.2 Use a fine tooth hacksaw with a cutting width of 1 mm (0.04 in) or less.

33.3 Correct any error in squareness to 1° or less using a fine file.

Note ...

It is not advisable to cut the tube with a roller cutter which can produce distortion.

34 Chamfer the bore of the tube at 60 degrees included angle (fig 15) to maintain a flat on the end of the tube to at least dimension 'A', Table 4.

Note ...

The outside corner of the cut end is to be square but free from roughness.

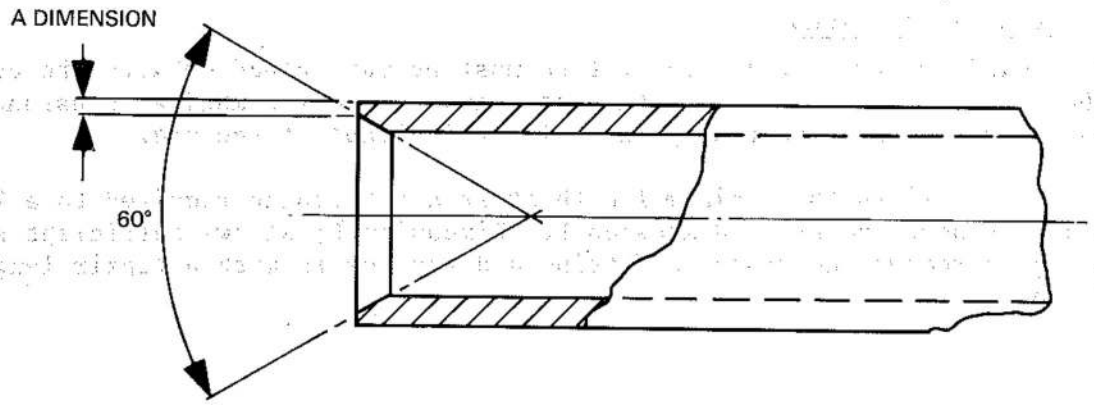


Fig 15 Dimensions of internal tube chamfer

TABLE 4 DIMENSIONS OF INTERNAL TUBE CHAMFER

Tube size		Tube material	'A' dimension (thickness)	
	inch		inch	mm
03020S	3/16	304-1/8 Hard SS	.005	0.13
03022S	3/16	304-1/8 Hard SS	.005	0.13
04016	1/4	3AL-2-1/2V Ti	.005	0.13
04020S	1/4	304-1/8 Hard SS	.005	0.13
04022S	1/4	304-1/8 Hard SS	.005	0.13
04022	1/4	3AL-2-1/2V Ti	.005	0.13
04028	1/4	3AL-2-1/2V Ti	.010	0.25
06019	3/8	3AL-2-1/2V Ti	.005	0.13
06022	3/8	3AL-2-1/2V Ti	.005	0.13
06028	3/8	3AL-2-1/2V Ti	.010	0.25
06028S	3/8	304-1/8 Hard SS	.010	0.25
08026	1/2	3AL-2-1/2V Ti	.010	0.25
08028	1/2	3AL-2-1/2V Ti	.010	0.25
08035S	1/2	304-1/8 Hard SS	.015	0.38
08036	1/2	3AL-2-1/2V Ti	.015	0.38
08049	1/2	3AL-2-1/2V Ti	.020	0.51
10032	5/8	3AL-2-1/2V Ti	.010	0.25
10049S	5/8	304-1/8 Hard SS	.020	0.51
12022	3/4	3AL-2-1/2V Ti	.005	0.13
12028	3/4	3AL-2-1/2V Ti	.010	0.25
12035	3/4	3AL-2-1/2V Ti	.015	0.38
12039	3/4	3AL-2-1/2V Ti	.015	0.38
12058S	3/4	304-1/8 Hard SS	.025	1.00
16022	1	3AL-2-1/2V Ti	.005	0.13
16028	1	3AL-2-1/2V Ti	.010	0.25
16065S	1	304-1/8 Hard SS	.030	0.76
20022	1.1/4	3AL-2-1/2V Ti	.005	0.13
20028	1.1/4	3AL-2-1/2V Ti	.010	0.25
20083S	1.1/4	304-1/8 Hard SS	.040	1.00

Note ...

The publication applicable to the aircraft/engine must be consulted regarding tube/material specifications applicable to a particular pipe assembly.

Pipe bend limitations

35 A minimum straight length of tube must be maintained between the cut tube end and the nearest bend tangent point to provide mandrel clearance, and to ensure that the tubing is truly cylindrical at the end.

36 Table 6 lists the minimum length of straight tubing required to a 25° or greater tangent point as dimension L. Dimension L_1 allows sufficient straight tubing to remove the standard fitting and replace it with a repair length fitting.

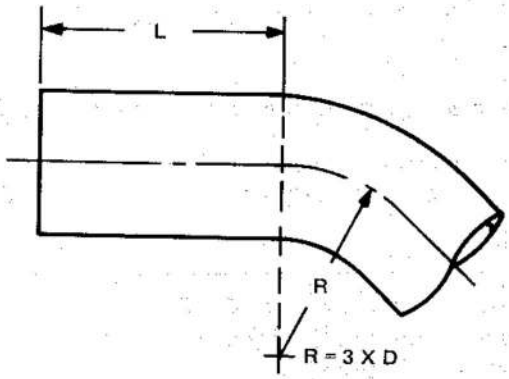


Fig 16 Pipe bend limitations

TABLE 5 PIPE BEND LIMITATION DIMENSIONS

od inch x wall	Dimension L minimum length mm	inch	Dimension L_1 minimum length - repair fitting mm	inch
3/16 x .020S	-		-	
3/16 x .022S	-		-	
1/4 x .016	25.4	1.000	35.9	1.415
1/4 x .020S	27.4	1.078	37.9	1.493
1/4 x .022S	25.4	1.000	35.9	1.415
1/4 x .022	25.4	1.000	35.9	1.415
1/4 x .028	25.4	1.000	35.9	1.415
3/8 x .019	25.4	1.000	35.9	1.415
3/8 x .022	25.4	1.000	35.9	1.415
3/8 x .028	26.2	1.032	36.7	1.447
1/3 x .028S	26.2	1.032	36.7	1.447
1/2 x .026	25.4	1.000	37.8	1.490
1/2 x .028	25.4	1.000	37.8	1.490
1/2 x .028	25.4	1.000	37.8	1.490
1/2 x .035S	25.0	.984	37.4	1.474

(continued)

TABLE 5 PIPE BEND LIMITATION DIMENSIONS (continued)

od inch x wall	Dimension L minimum length mm	Dimension L minimum length inch	Dimension L_1 minimum length - repair fitting mm	Dimension L_1 minimum length - repair fitting inch
1/2 x .036	25.4	1.000	37.8	1.490
1/2 x .049	25.4	1.000	37.8	1.490
5/8 x .032	25.4	1.000	39.7	1.565
5/8 x .049S	26.2	1.032	40.6	1.597
3/4 x .022	25.4	1.000	39.7	1.565
3/4 x .028	25.4	1.000	39.7	1.565
3/4 x .035	25.4	1.000	39.7	1.565
3/4 x .039	25.4	1.000	39.7	1.565
3/4 x .058S	28.6	1.125	42.9	1.690
1 x .022	27.8	1.093	44.1	1.738
1 x .028	27.8	1.093	44.1	1.738
1 x .065S	27.8	1.093	44.1	1.738
1.1/4 x .022	32.5	1.281	53.1	2.091
1.1/4 x .028	32.5	1.281	53.1	2.091
1.1/4 x .083S	32.5	1.281	53.1	2.091

TABLE 6 LONGITUDINAL GROWTH ALLOWANCES

Tube size	Growth per fitting inch	Tube size	Growth per fitting inch
03020S	-	08036	0.027
03022S	-	08049	0.032
04016	0.015	10032	0.034
04020S	0.018	10049S	0.039
04022S	0.020	12022	0.025
04022	0.019	12028	0.029
04028	0.014	12035	0.030
06019	0.016	12039	0.031
06022	0.015	12058S	0.047
06028	0.013	16022	0.047
06028S	0.017	16028	0.054
08026	0.027	16065S	0.050
08028	0.029	20022	0.057
08035S	0.025	20028	0.051

Notes ...

(1) Repair length fittings are dimensioned to include this allowance.

(2) New pipes must be shortened to allow for growth.

TABLE 7 DYNATUBE TOOL SELECTION

Tube dimensions (inches) dia x wall thickness inch	Expander ↓ = -size	Collars	Female die sets	Male die sets
0.250 x 0.016	R5170MHUK-04016	R24837-1-06	RF26826-2-04	RM26826-2-04
0.250 x 0.028	R5170MHUK-04028	R24837-1-06	RF26826-2-04	RM26826-2-04
0.375 x 0.019	R5170MHUK-06019	R24837-1-06	RF26826-2-06	RM26826-2-06
0.500 x 0.026	R5170MHUK-08026	R24837-1-12	RF26826-2-08	RM26826-2-08
0.625 x 0.032	R5170MHUK-10032	R24837-1-12	RF26826-2-10	RM26826-2-10
0.750 x 0.039	R5170MHUK-12039	R24837-1-12	RF26826-2-12	RM26826-2-12

Note ...

These tools are included in Kit Pt No R27500MHUK-01, Ref No 126VB/9827.

TABLE 8 CONTENTS OF TOOL KITS

Ref No/ Sect No	Manufacturers Part No	Description
TBD	R24837-16-07	Inside diameter gauge
TBD	R24837-16-20	V-anvil micrometer
126VB/9931	R29549-1	Chipless tube cutter -03 to -08
126VB/9932	R29549-2	Chipless tube cutter -08 to -20
126VB/9935	R29550-1	Facing/deburring tool -04 to -08
126VB/9936	R29550-2	Facing/deburring tool -10 to -20
1L/9106329	-	Ratchet wrench
1L/9106316	-	Wrench extension
1L/9106341	-	Universal drive
1L/1240790	-	Adapter 0.375 to 0.250 sq drive

Notes ...

(1) The repair and resurfacing kit is Pt No R24837-8-3, Ref No 126VB/9930.

(2) Lubricant Titanlube 1129 is Pt No R24837-8-3, Ref No 9150-00-0875088. Alternative is OX-38 (Nato O-149).

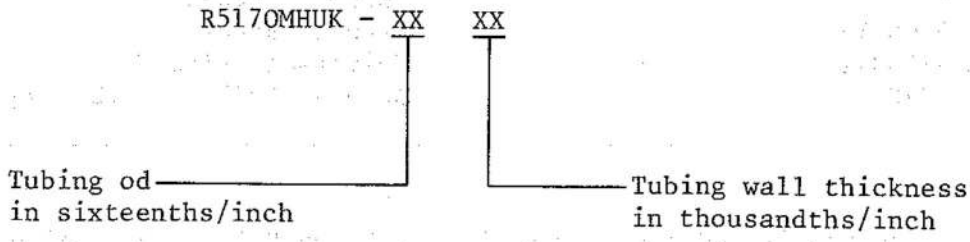
Tool selection (fig 12)

37 The tooling used for Dynatube fittings can be operated manually, but a reversible power tool (nut runner) with a speed not exceeding 300 rev/min is preferred as a means of rotating the expander.

CAUTION ...

The actual wall thickness of the tube should be measured before selecting the expander.

38 Each expander is set for a specific tube material and size which is marked on the expander sleeve as follows:



Selection procedure

39 The selection procedure is as follows:

39.1 Check the outside diameter/wall thickness and tube material specification.

39.2 Select the expander from Table 7 and check that the marking on it corresponds with the tube sizes.

CAUTION ...

Before using any expander visually check the condition of the mandrel and rollers for signs of pitting or spalling (fig 18).

Note ...

Expanders suitable for use with stainless steel tubing are identified by a green band on the stop collar.

39.3 Based on the fitting size and configuration, select the appropriate die set and collar. The collar has a tapered bore which engages the conical exterior of the die-sets.

39.4 Check that expander lubricant is available; that provided in the kit is Titanlube 1129 but lubricant OX38 (Nato O-149) is equally suitable.

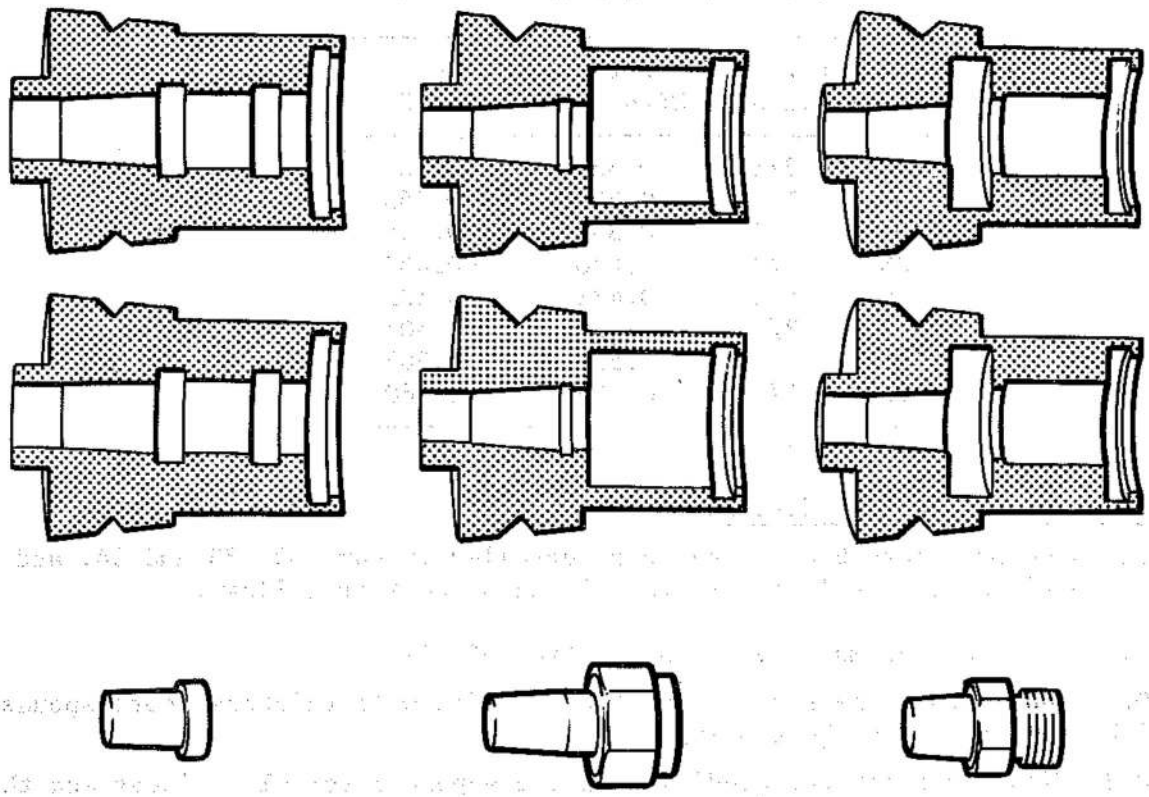


Fig 17 Typical holding dies and corresponding fittings

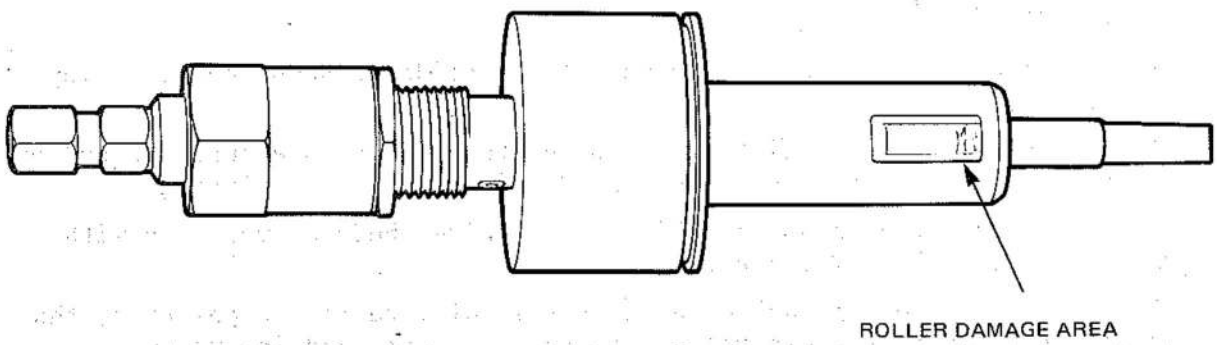


Fig 18 Damaged expander rollers

TABLE 9 TUBE INSERTION DEPTHS

Tube size dash	inch	Fittings series MR44 XXX	MR54 XXX
-03	3/16	0.325	0.325
-04	1/4	0.355	0.355
-06	3/8	0.355	0.355
-08	1/2	0.430	0.430
-10	5/8	0.430	0.505
-12	3/4	0.430	0.505
-16	1	0.505	0.585
-20	1.1/4	0.505	0.660

Checks before assembling fittings

40 The pipe must have been prepared as detailed in para 32, 33 and 34, and the appropriate tools selected (para 39); then check as follows:

40.1 The tube end must be clean and free of oil.

40.2 Ensure that the size of the tube and its wall thickness corresponds with that marked on the tooling.

40.3 Visually check the condition of the expander for cleanliness and the mandrel and rollers for signs of pitting or spalling.

40.4 Expanders suitable for use on stainless steel tubing are identified by a green band on the stop collar.

40.5 Check that the prepared tube end inserts cleanly into the fitting to the correct depth, Table 9.

40.6 A small quantity of lubricant OX38 (Nato O-149) is required.

40.7 Ensure that all traces of the cling film plastic packaging of the fitting are removed.

Swaging procedure

41 After carrying out the checks (para 40) and selecting the correct tooling the steps are as follows:

41.1 If the assembly includes a nut, first slide it down the tube away from the end.

41.2 Slip the tube end fitting on to the tube and ensure that the end of the tube contacts the stop on the inside diameter of the fitting.

41.3 Lubricate the expander rollers and mandrel before every use with OX38 (Nato O-149) or Titanlube 1129.

41.4 Position the expander mandrel in the fully retracted position, that is with the tip of the mandrel within the expander, and insert the expander into the fitting.

41.5 Position the expander/tube/fitting assembly in one die-set half by placing expander lip into slot of die and fitting while maintaining the correct position (fig 20).

41.6 Turn the square end of the mandrel clockwise until it is finger tight; all components will now hold together.

41.7 Assemble the second half of the die-set over the first half (fig 1). Holding the assembled halves together, slip holding collar over the assembly from the expander end (fig 21).

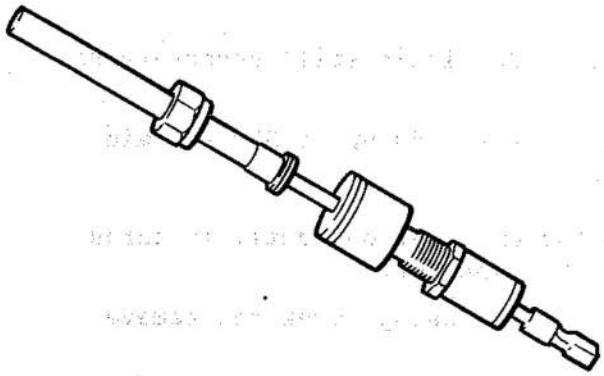


Fig 19 Expander inserted into tubing

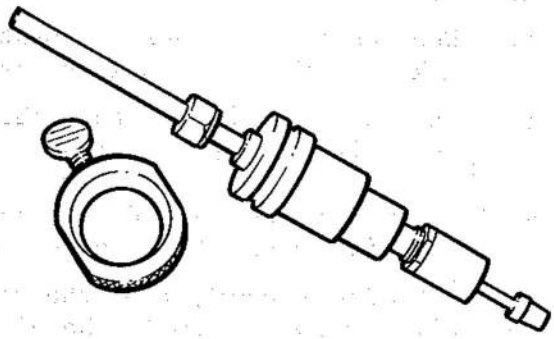


Fig 20 Die halves positioned

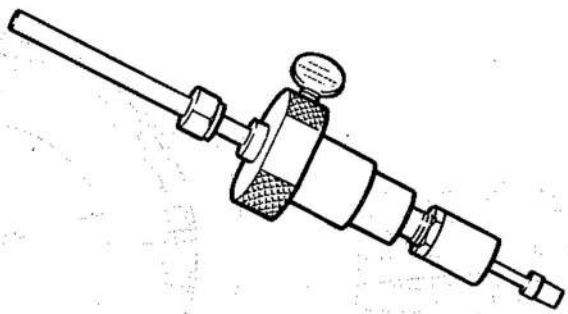


Fig 21 Collar positioned

41.8 Position the thumb screws at an angle approximately 15 to 45 degrees to the die joint line and tighten the thumb screws into the V groove in the die-set.

41.9 Secure the assembly in a bench vice by clamping on the flats of the collar; setting the position of the expander square drive so that the power driver can be attached, or a spanner used to rotate the expander.

Note ...

Expanders for 3/16 in and 1/4 in diameter tube have mandrel ends for 1/4 in square drive, expanders for 3/8 in to 1.1/4 in diameter tube, have 3/8 in square drive ends.

CAUTION ...

The mandrel will feed itself as it rotates. Do not apply pressure to force it into the fitting.

41.10 Ensure that the rotation of the power driver is to turn the expander clockwise, engage the tool and rotate the expander until the drive head contacts the stop collar and causes it to turn approximately ten additional turns.

Notes ...

(1) When using a spanner to rotate the expander it is still necessary to make the ten additional turns.

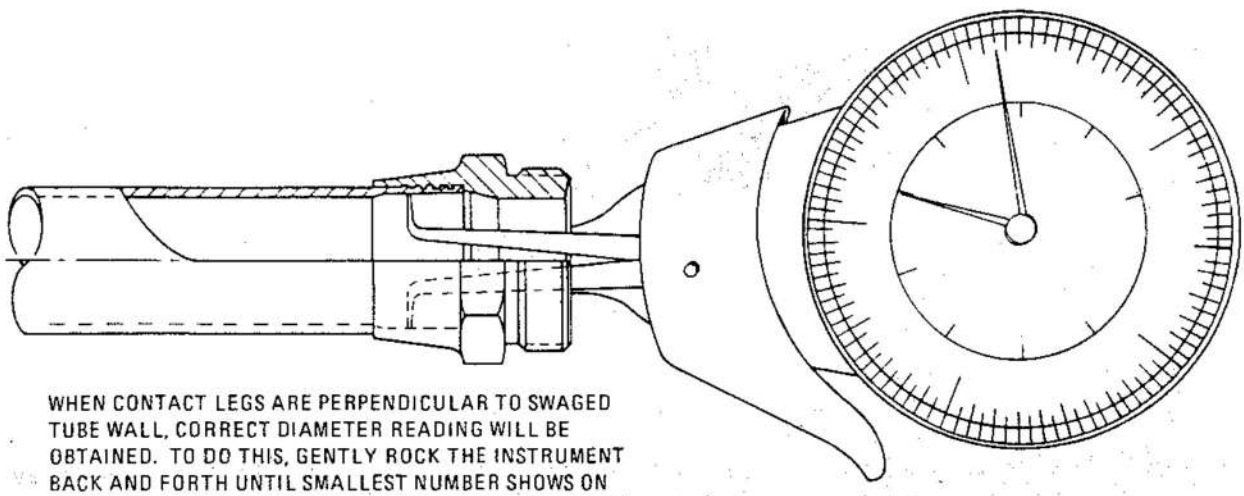
(2) The power driver may turn the expander at speeds up to 300 rev/min but this speed must not be exceeded.

41.11 Reverse the power driver and back the expander out until it turns freely. Disconnect the power drive from the expander.

41.12 Remove assembly from the vice, loosen the using screw and remove the collar and disassemble the die halves.

Note ...

If the expander does not come out freely, pull back the mandrel to release pressure on the rollers.



WHEN CONTACT LEGS ARE PERPENDICULAR TO SWAGED TUBE WALL, CORRECT DIAMETER READING WILL BE OBTAINED. TO DO THIS, GENTLY ROCK THE INSTRUMENT BACK AND FORTH UNTIL SMALLEST NUMBER SHOWS ON THE DIAL. THE SMALLEST READING IS THE TRUE DIAMETER OF THE PARTICULAR SWAGE.

Fig 22 Dial gauge for measuring swaged inside diameter

41.13 The assembly must now be checked to ensure that the swaging operation has been carried out correctly.

41.13.1 Clean the end of the pipe, the fitting and the bore using a lint free cloth moistened with trichloroethane and allow to dry.

41.13.2 Using the appropriate gauge (fig 22) check the bore of the swaged portion of the tubing (Table 10) to ensure that it lies between the maximum and minimum diameters given.

41.14 After checking the swage inside diameter the nut is to be screwed forward over the truncated thread into the final position (fig 4).

41.15 After the other fittings have been assembled to the pipe it is to be cleaned (Chap 15) before testing.

TABLE 10 SWAGE INTERNAL DIAMETER

Tube size dash x wall	Finished swage inside diameter inch Minimum	Nominal	Maximum
03020S	-	N/A	-
03022S	-	N/A	-
04016	0.230	0.232	0.234
04020S	0.224	0.226	0.228
04022S	0.221	0.223	0.225
04022	-	TBD	-
04028	0.209	0.211	0.213
06019	0.350	0.352	0.354
06022	0.346	0.348	0.350
06028	0.335	0.337	0.339
06028S	0.333	0.335	0.337
08026	0.464	0.466	0.468
08028	-	TBD	-
08035S	0.448	0.450	0.452
08036	0.448	0.450	0.452
08049	-	TBD	-
10032	0.578	0.580	0.582
10049S	0.551	0.553	0.555
12022	-	TBD	-
12028	-	TBD	-
12035	-	TBD	-
12039	0.690	0.692	0.694
12058S	0.665	0.667	0.669
16022	-	TBD	-
16028	0.961	0.963	0.965
16065S	0.898	0.900	0.902
20022	-	TBD	-
20028	-	TBD	-
20083S	1.121	1.123	1.125

Notes ...

(1) TBD - to be decided.

(2) 3/16 in size not repairable with kits.

(3) All dimensions are in inches.

(4) If inside diameter is incorrect refer to Table 11 fault diagnosis.

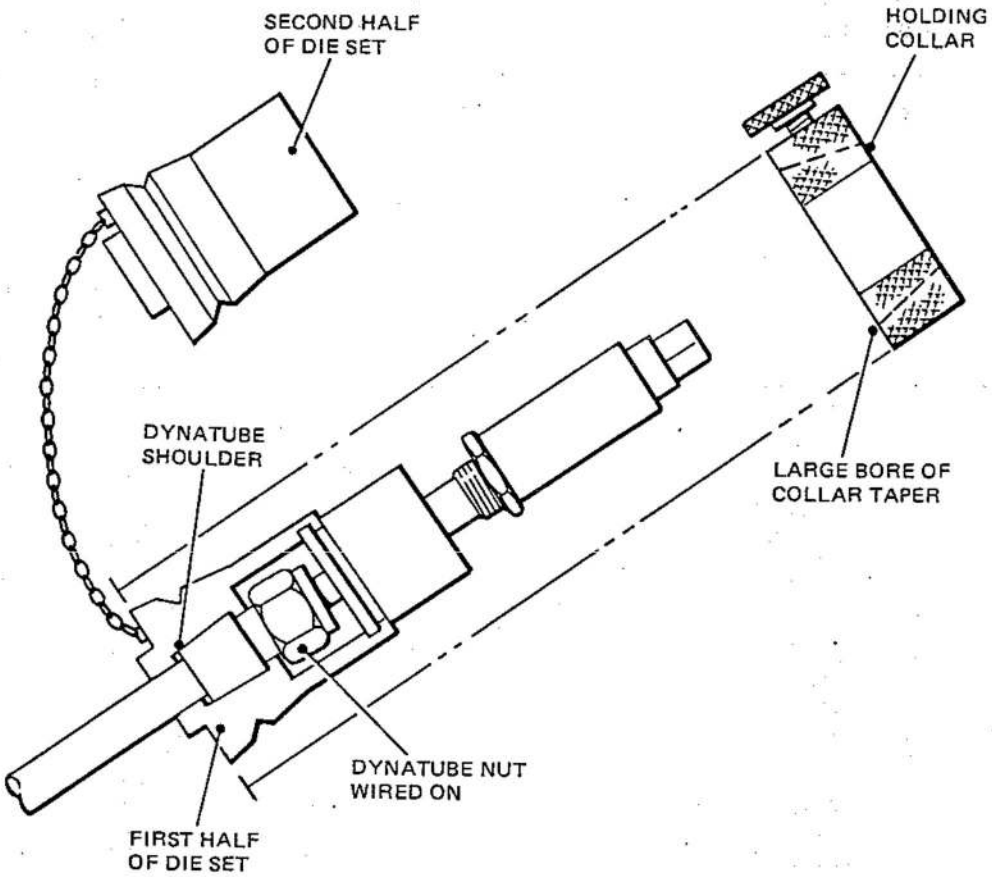
MINISTRY OF DEFENCE

Amdt No.26 to AP101A-0300-1

REMOVE and DESTROY Chap 11 pages 27 and 28 and SUBSTITUTE these new pages 27 and 28. RECORD the incorporation of this amendment.

CAUTION ...

All pipe assemblies must be cleaned, inspected, and where applicable, pressure tested before use or putting into storage.



TUBING AND FITTING POSITIONED IN DIE SET

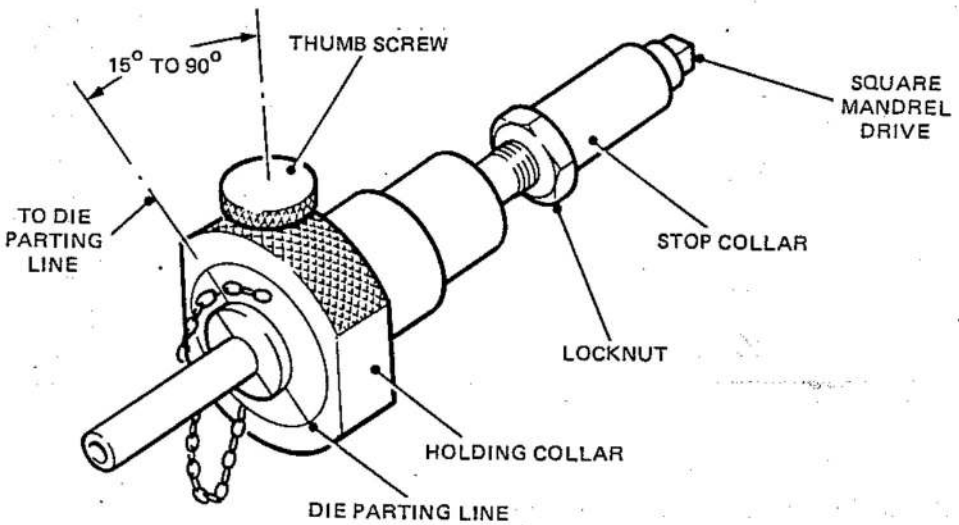


Fig 23 Identification of tooling components

TABLE 11 FAULT DIAGNOSIS

Fault	Possible cause	Corrective action
Measured id larger than maximum	1. Tube wall thickness outside tolerance.	Check wall thickness.
	2. Gauge is incorrect.	Check diameter; use correct size.
	3. Dial gauge wrongly set.	Reset.
Measured id smaller than minimum	1. Tube wall thickness outside tolerance.	Check wall thickness.
	2. Gauge is incorrect.	See 2 and 3 above.
	3. Damaged expander with spalled rollers.	Service expander.
Failure to ascertain cause of above faults	1. Expander wrongly set.	Check set specified diameters (para 43 and Table 12).

MAINTENANCE

General

42 This section describes the procedure for checking and resetting the expander size over the rollers, replacement of worn components, and checking the expander insertion depth. It is essential to use a V-anvil micrometer for measuring over the expander rollers, if the appropriate setting gauge is not available (Pt No R5167G-XXXX).

Expander setting

43 The expander setting is defined as the diameter over the rollers when the mandrel is in the full expansion position. The set value is a function of tube dimensions and material properties. It is referred to as the C-3 value.

Note ...

The expansion value shown on the tool identification band is the expanded internal diameter of the swaged tube. The tool setting, C-3, is always greater than this value to allow for the elasticity of the tube and the specified dimensional tolerances.

Measuring expander setting

44 Expanders up to 1 inch in size have three rollers, size 1.1/4 in and above have four rollers. It is advantageous to use a ring setting gauge when available otherwise use a V-anvil imperial scaled micrometer to measure over the three rollers.

45 Using a V-anvil micrometer. To measure using this type of micrometer hold the expander vertically with the roller/cage area upwards. Place the mandrel square drive end against a table top and maintain a downward pressure on the tool body to insure full depression of the mandrel.

46 Position the micrometer to read the maximum diameter defined by the three rollers. Take care that the micrometer anvil contacts the high point of the roller.

47 The C-3 value is to be taken from Table 12 and the maximum variation allowed is +0.001 in over the nominal size.

48 Using a set ring gauge. Hold the expander in one hand and the ring in the other. With the mandrel in a pull-back position insert the cage and rollers into the gauge. Slowly depress the mandrel until it contacts the stop collar.

49 If the setting is correct, the fit of the rollers to the ring will be smooth yet firm. There should be no play as evidenced by rocking or side motion.

Note ...

The dimensions of the ring bore automatically account for the allowable tolerance in the C-3 value of the expander.

TABLE 12 EXPANDER SETTING VALUES (C-3)

Expander R5170G series Pipe size	Tube material	Set diameter minimum inch	Set diameter maximum inch
04020S	304 1/8 hard	0.230	0.231
06028	3AL-2.5V Ti	0.342	0.343
0628S	304 1/8 hard	0.339	0.340
08035S	304 1/8 hard	0.455	0.456
08036	3AL-2.5V Ti	0.455	0.456
10044	3AL-2.5V Ti	0.567	0.568
10049S	304 1/8 hard	0.558	0.559
12054	3AL-2.5V Ti	0.674	0.675
12058S	304 1/8 hard	0.671	0.672
16065S	304 1/8 hard	0.907	0.908
16073	3AL-2.5V Ti	0.896	0.897

Adjustment of expander setting

50 Adjustment of the C-3 value is possible within a limited range. The C-3 value is determined by the travel of the mandrel which is defined by the position of the stop collar.

Adjustment procedure

51 Place stop collar in a vice (with soft jaws) and loosen locknut by turning so as to move away from the stop collar, then proceed as follows:

51.1 Remove expander from vice.

51.2 Turn stop collar towards the locknut to increase C-3 or away from the locknut to decrease the size. One full turn of the stop collar changes the C-3 value by 0.002 in.

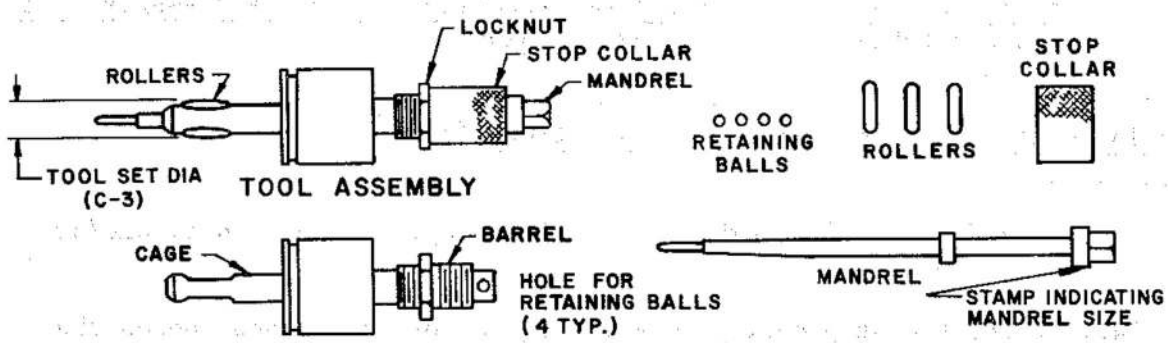


Fig 24 Expander components

51.3 Measure the new C-3 value using a ring gauge or 'V'-anvil micrometer (para 45 to 48).

51.4 When the desired setting is set, hold the stop collar in a vice and tighten the locknut against the stop collar.

51.5 As a check, remeasure the C-3 value.

Expander care and inspection

General

52 The expander must be cleaned and lubricated on a regular basis using either the lubricant provided in the kit or OX38 (Nato O-149). Expanders are to be visually inspected before use and cleaned if necessary. After the completion of ten swages expanders are to be cleaned and inspected closely, using a tenpower (X10) magnifier, to examine the rollers for signs of pitting or spalling.

Precautions before use

53 The procedures to be followed before an expander is used are as follows:

53.1 Before each use. Visually examine the expander, the roller area and rollers for cleanliness. If any dirt is seen or the expander has been used for more than the swaging operations proceed as para 53.2.

Note ...

When cleaning an expander do not immerse the whole tool in solvent, since this could remove lubricant from the internal bearings.

53.2 Clean the roller area of the expander by immersing the end in a mineral oil solvent followed by drying with a jet of compressed air.

53.3 With the tool clean of grease and chips, visually examine the rollers and mandrel for signs of pitting or spalling (fig 18). Use a X10 magnifier (or more) to detect any sign of damage.

53.4 If any pitting or spalling is seen do not use the tool.

CAUTION ...

Use of a damaged expander creates acceleration wear and swages will be unacceptable thus scrapping the pipe.

Replacement of expander mandrels and rollers (fig 24)

Disassembly of tool

54 The procedure to disassemble the tool to replace the mandrel and/or rollers is as follows:

54.1 Place the stop collar in a vice, use soft jaws, and loosen the locknut by turning so as to move away from the stop collar.

54.2 Remove tool from vice and turn stop collar until the thread disengages from the threads on the board.

54.3 Pull the stop collar from the barrel with care so as not to lose the four retaining balls. Remove any balls which do not fall out.

54.4 Remove the mandrel by pulling it out of the barrel and stop collar.

54.5 With the mandrel withdrawn, the rollers are free to be removed from the cage. Hold the tool with the cage down and guide one roller at a time, first into the cage bore and then out of the tip of the cage.

Visual inspection

55 Inspect the surfaces of the mandrel and rollers visually for any sign of deterioration, if any is visible replace the components. Heat stain is common to certain sizes of tool and is not detrimental. Mandrels and rollers which show discolouration, but are otherwise smooth and free from wear, are satisfactory for further use.

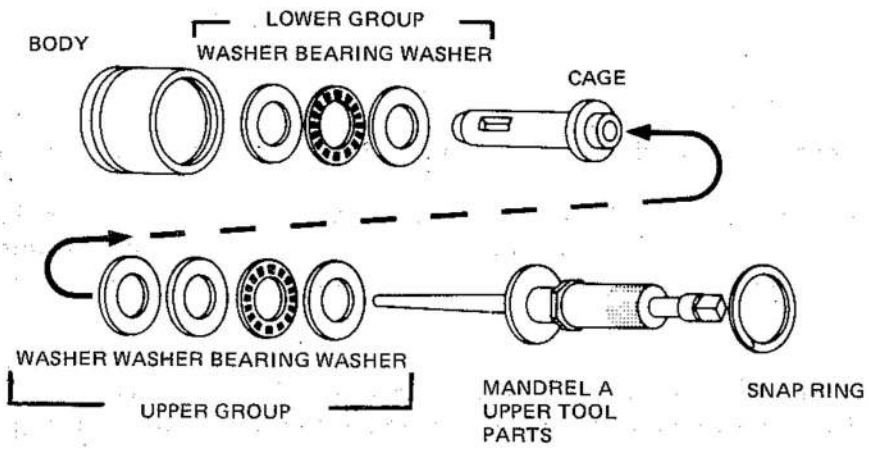


Fig 25 Expander internal components

Reassembly of tool

56 The procedure to reassemble an expander, incorporating new components, if required, is as follows:

56.1 Insert mandrel into stop collar.

56.2 Insert mandrel and stop collar into the barrel and cage. Do not engage the threads at this step.

56.3 With the mandrel tip just behind the roller cavity of the cage fit the rollers. Each roller has a similar taper to that of the mandrel. The rollers must be inserted one at a time into the bore of the cage keeping the larger diameter of the rollers towards the tip of the cage. Use a pencil or other instrument to guide them into position.

56.4 With the rollers in their slots push the mandrel deeper into the tool to prevent the rollers from falling out.

56.5 Insert the retaining balls making certain that the collar of the mandrel is within the barrel.

56.6 Engage the threads of the stop collar and the barrel.

56.7 Set the tool to the correct expansion value, C-3 which is always bigger than the expansion value shown on the tool identification band (para 43).

56.8 Measure the expander setting (para 44) and adjust to the correct value (para 50).

56.9 Check the setting, if correct the expander is ready for use.

Replacement of expander cages

Disassembly

57 Cage replacement is recommended if the peen along the sides of the roller cavity breaks down sufficiently to allow the rollers to fall out. The procedure is as follows:

57.1 Remove the snap ring using a fine screwdriver pin, or other instrument. The technique is to prise one end radially inward then upwards and out of the groove.

57.2 Holding the stop collar, lift the upper portion of the tool, comprising the stop collar, locknut, barrel and mandrel, out of the body. Leave all the bearings and thrust washers in the body.

57.3 As the mandrel is withdrawn, the rollers are freed and can be removed from the cage. Store them safely.

57.4 Holding the body with the cage pointing downward slowly push the cage out of the body. All the washers and bearings on the roller side of the cage collar, 'the lower group', are to remain in the body. The washers and bearings above the cage collar must be lifted off the cage without disturbing their sequence. This is the 'upper group'.

Reassembly, with replacement cage

58 The positioning of the bearings and thrust washers within the expander body is critical to the proper functioning of the tool. It is vital to maintain all components of the upper and lower groups in their original positions. The procedure is as follows:

58.1 Place the cage into the body so that the collar of the cage rests on the top washer of the lower group.

58.2 Insert the washers and bearings of the upper group into the body maintaining their original position.

58.3 Insert the mandrel, with the upper tool parts on it, until the tip just reaches the roller slots.

58.4 Insert the rollers as detailed in para 56.3 and then turn the tool so that the cage is positioned vertically downwards.

58.5 Guide the barrel and all internal parts down into the body.

58.6 Maintaining a downward pressure on the mandrel, position the snap ring into its groove. Use a pin or fine screwdriver to force the lower end of the ring down into the groove. Then progress round the body until the whole of the circumference snaps into the groove.

58.7 The C-3, expansion value (para 45 to 49) and insertion depth must now be checked and reset, if incorrect.

Note ...

The expander setting, C-3, is highly dependent upon the insertion depth. Thus if the C-3 diameter exceeds the maximum specified the insertion depth may be less than the nominal and vice-versa.

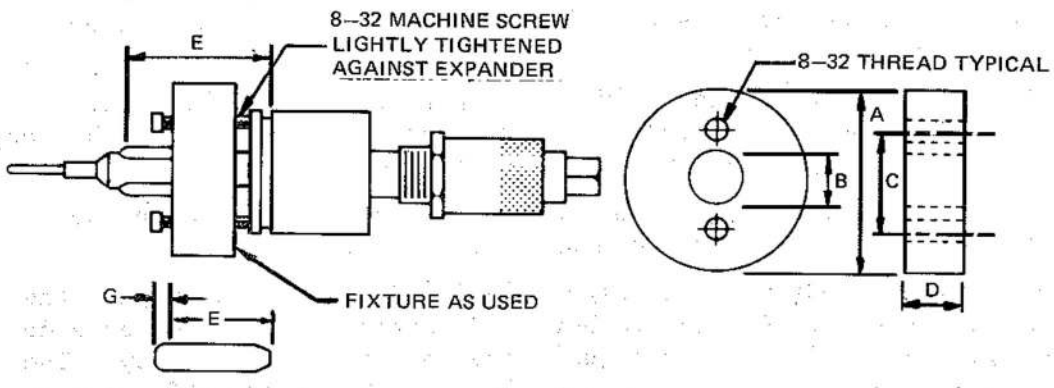


Fig 26 Expander insertion depth fixture

TABLE 13 DIMENSIONS OF 'E' DIMENSION CHECKING FIXTURE

Expander dash size	'G' dimension inch	Dimension 'E', Tolerance ± 0.010 in R5170 series	R5166 series	'A' minimum	B * + 0.005 - 0 in	C ± 0.010 in	D max
04	0.050			1.000	0.193	0.650	0.500
05	0.050	1.330	1.330	1.250	0.245	0.750	0.500
06	0.050			1.500	0.310	0.806	0.500
08	0.095	1.490	1.490	1.500	0.411	1.000	0.625
10	0.095	1.757	1.500	1.750	0.520	1.100	0.750
12	0.095	1.794	1.500	1.750	0.620	1.255	0.750
14	0.095	2.010	NA	2.000	0.740	1.520	1.000
16	0.095	2.010	1.915	2.000	0.860	1.520	1.000
20	0.095	2.262	1.975	2.500	1.100	1.900	1.000
24	0.095	2.519	2.093	2.750	1.324	2.200	1.250

Notes ...

(1) *Bore diameter shown will accommodate most expander sizes. Certain expanders designed for heavy wall tubing should have fixtures with reduced bore diameters to provide close fit to the applicable cage diameter.

(2) Dimension 'E' is measured when the front radius of the roller ends. Dimension 'G' may be used to facilitate measuring.

(3) All dimensions are in inches.

Measurement of expander insertion depth, 'E'

59 During the operation of the expander while swaging, a force is exerted on the cage, pulling the cage into the tube and thus away from the tool body. It is therefore extremely important to eliminate any looseness or play in this direction while 'E' is being measured. For this purpose a fixture as shown in fig 26 should be used.

60 To measure the 'E' dimension position the fixture on the expander (fig 26) and adjust the screws, if necessary, so that the ring retains the ends of the rollers. Using the fixture to take up play in the stop collar assembly proceed as follows:

60.1 Depress the mandrel fully and measure dimension E using an optical comparator, vernier caliper or micrometer height gauge. It may be advisable to take the mean of several readings.

61 If the dimension does not fall within the prescribed tolerance the fault is due to incorrect positioning of the internal thrust washers and bearings (para 57.4 and 58.2).

SPECIAL REPAIR TECHNIQUES

Male connector resurfacing

62 Slight scratches or minor surface damage to the sealing surface of the male fitting can be repaired using a resurfacing tool, Pt No R24837-6, and a kit to apply a new coat of solid film lubricant to the sealing surface, Pt No R24837-8-3. The resurfacing tool is illustrated in fig 27.

Notes ...

(1) Shoulder fittings should not be repaired and if the seal is damaged a repair length fitting should be installed.

(2) Resurfacing is a crtical operation and the procedure must be adhered to closely.

Resurfacing procedure

63 The procedure to resurface a male fitting is as follows:

63.1 Select the size of resurfacing tool and emery disc to suit the size of the fitting.

63.2 Disassemble the resurfacing tool by unscrewing the cap screw. Without disturbing the position of the Teflon cup and lock sleeve, insert one of the coarse emery discs against the convex surface of the tool body. The grit to face out. Reassemble the tool and tighten the cap screw to finger tightness.

63.3 Insert the tool into the fitting until the emery contacts the sealing surface. Some force may be required to push the Teflon cup into the fitting bore.

Note ...

The tightness of the fit insures chip removal when the tool is withdrawn.

63.4 Using modest pressure oscillate the tool until a smooth surface is achieved. Rotate the fitting occasionally to keep the abrasive action uniform.

63.5 Withdraw the tool and repeat steps 63.2 to 63.4 using progressively finer emery discs.

63.6 When the surface is smooth and free from scratches clean the fitting using trichloroethane and a lint free cloth. Allow to dry for five minutes.

Note ...

Toluene cleaning solvent and Q-tips are contained in the repair kit.

63.7 Apply phosphoric acid etching agent with a clean Q-tip and allow one minute to dry.

63.8 Rinse the surface with deionized (distilled) water using a clean Q-tip. Allow to dry for two minutes.

63.9 Clean with trichloroethane or Toluene and allow to dry for five minutes.

63.10 Shake the Perma-Slik 'S' vial until its entire contents are thoroughly mixed. Apply to the sealing surface with a clean Q-tip using smooth strokes to achieve a uniform thickness.

63.11 Dry the coating:

63.11.1 Either, allow 30 minutes to air dry

63.11.2 Or, bake dry for five minutes at a temperature of 93 °C (200 °F).

63.12 Ensure that the bore of the fitting is clean. It is now ready for use.

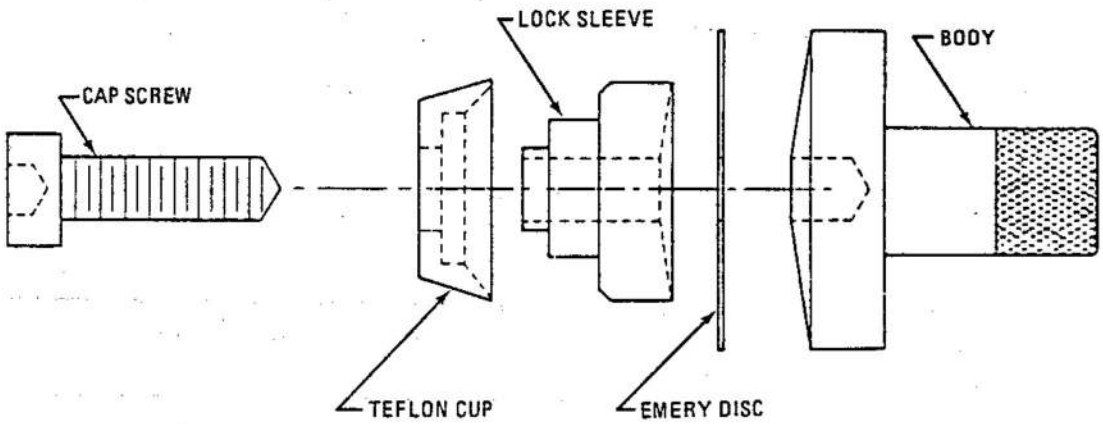


Fig 27 Resurfacing tool components

▶ Dynaring washers

64 Dynaring washers may be used as a repair method for leaking dynatube connectors. The dynaring washers can be used when the leak is caused by damage to the dynatube fitting which cannot be repaired by the normal procedure of torquing the joint or resurfacing the dynatube male end. This repair is to be used only as a field expediency. The washer must be replaced each time the connector is disconnected. The fitting procedure is as follows:

64.1 Disconnect the connector nut, (fig. 28).
64.2 Select washer for applicable connector (Table 14).
64.3 Fit dynaring washer between sealing surfaces.
64.4 Tighten connector nut to torque specified in Table 2.

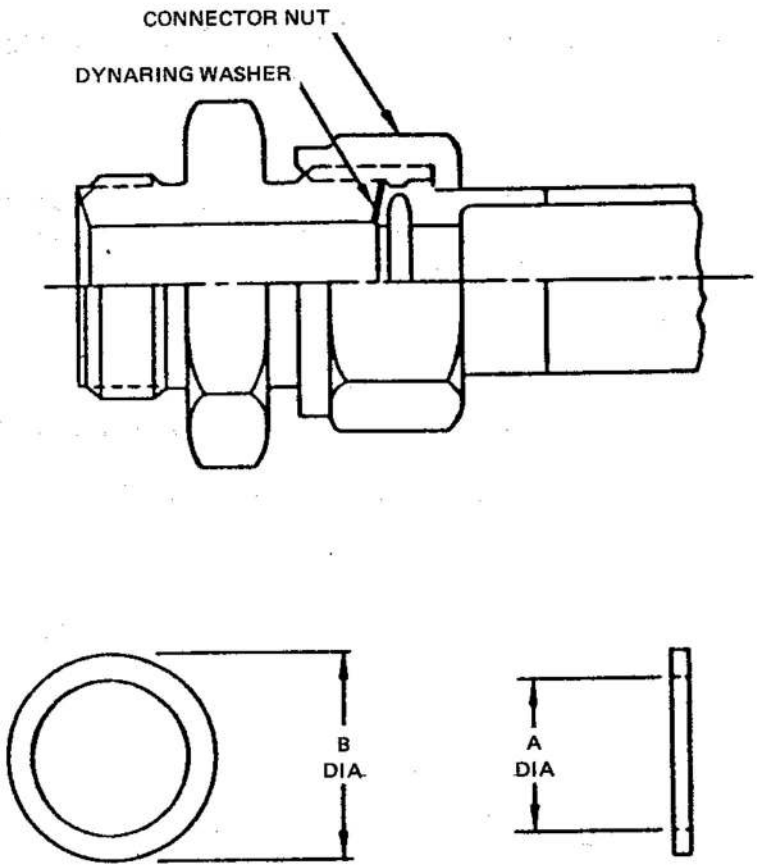


Fig 28 Dynaring washer assembly and size

TABLE 14 DYNARING WASHERS

Dash size	Tube o.d.	A diam inch	B diam inch	Manufacturers Part No.
-4	1/4	0.198	0.372	AP 2641N04
-5	5/16	0.265	0.435	AP 2641N05
-6	3/8	0.321	0.485	AP 2641N06
-8	1/2	0.422	0.642	AP 2641N08
-10	5/8	0.542	0.760	AP 2641N10
-12	3/4	0.694	0.904	AP 2641N12
-16	1	0.907	1.143	AP 2641N16
-20	1.1/4	1.150	1.408	AP 2641N20

◀

► Testing procedure

65 After manufacture all pipelines are to be proof pressure tested in accordance with Chap 17 of this publication.

65.1 The proof pressure is twice working pressure held for a duration of five minutes. ◄

Chapter 11-1

ROSAN PIPE FITTINGS

Contents

Para
1 Introduction
Description
2 Construction
3 Sealing
4 Standard ports
5 Broaching serrations
6 Serration cutters
7 Tooling
Installation procedure
9 Assembly of an adapter to a component
10 Removing a lock ring and adapter

Table
1 Dimensions of standard ports
2 Adapter removal and insertion tools
3 Serration size data
4 Serration broaching tools
5 Setting torques for RF 5000 series fittings

Fig
1 Adapter fitting
2 Section of standard port
3 Pipe, adapter, component, assembly
4 'O'-ring installation tool
5 'O'-ring installation
6 Dimensions of standard port
7 Dimensions of serrations
8 Correctly matched serrations
9 Lock ring installation
10 Combination drive tool and locking wrench
11 Lock ring removal tool, closed
12 Lock ring removal tool, open
13 Broaching tool

Introduction

1 Rosan adapter fittings are used to make connections to fixed components in a system, based on a standard port machined into the component body. The fittings are locked against turning by a serrated ring which also serves to provide a drive when installing or removing the adapter. Simple tools are used for these operations. Although Rosan adapters are available to match both AN, MS and Dynatube fittings, in this chapter only the Dynatube pattern are described. These are suitable for connection to rigid pipelines or to flexible hoses.

Note ...
Metric conversions are only given in this publication where a component is not basically measured in imperial dimensions.

DESCRIPTION

Construction (fig 1)

2 The adapter comprises a main body with a thread to mate with a machined port in the main component (fig 2). A toroidal seal 'O' ring backs the thread and a tapered section provides both a primary seal and extra lateral support. The adapter is locked into the port by a sliding lock ring, which is held captive on the adapter. The outer end of the adapter is identical to the male portion of a Dynatube fitting.

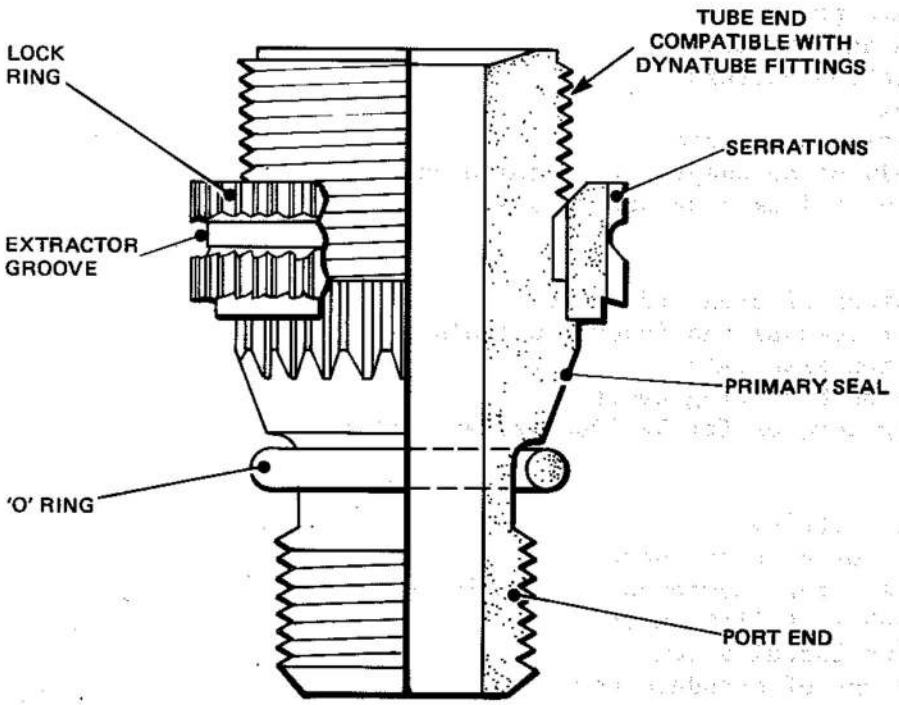


Fig 1 Adapter fitting

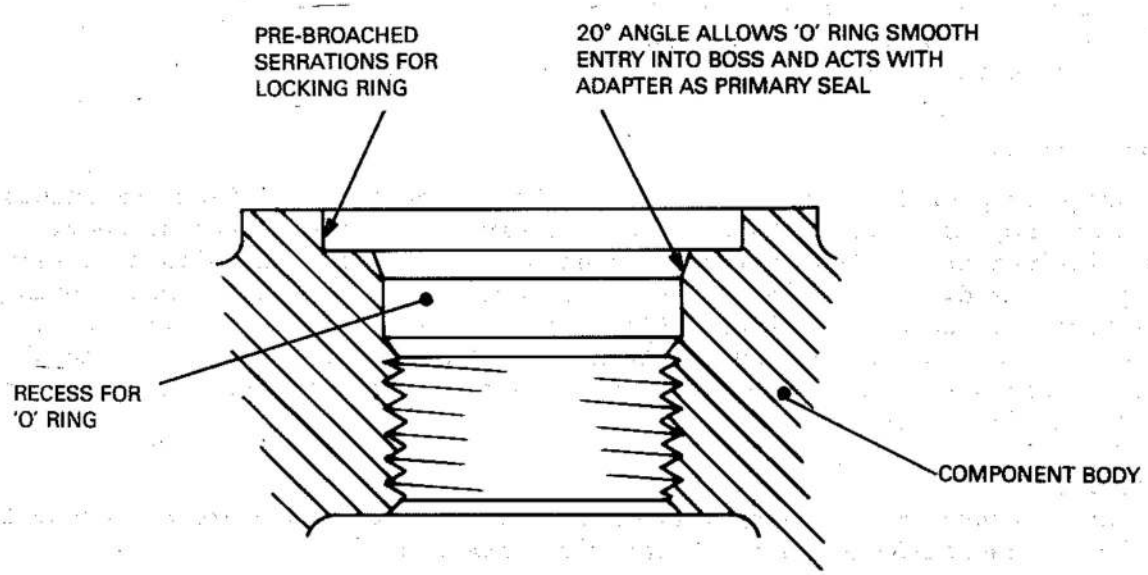


Fig 2 Section of standard port

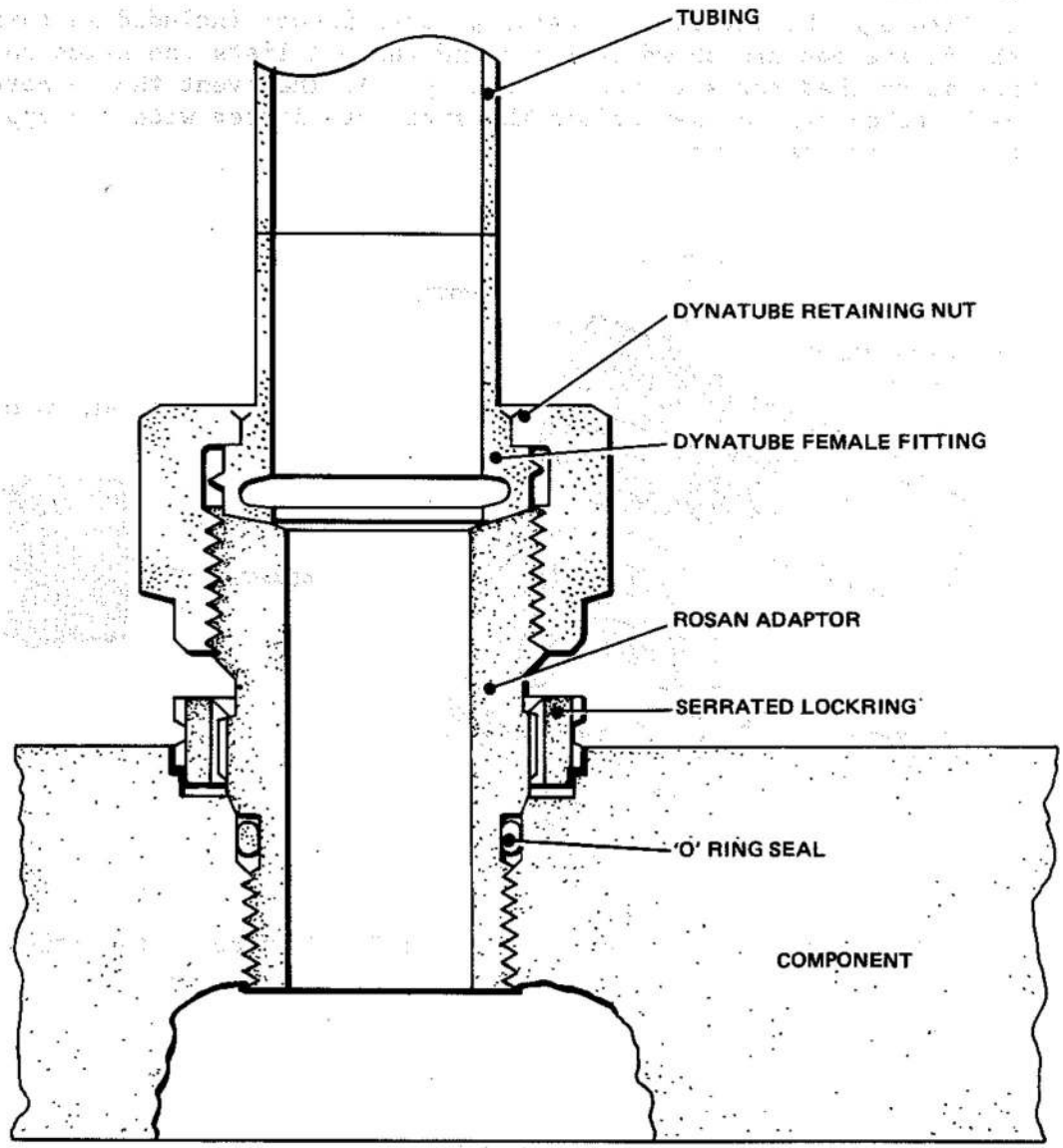


Fig 3 Pipe, adapter, component, assembly

Sealing

3 The 'O' ring must be fitted using a bullet shaped tool placed over the threads so that the surfaces of the 'O' ring are not nicked or abraded (fig 4 and 5). Either a fluid given in Chap 11 Table 1 or a lubricant compatible with the system fluid should be used to facilitate the operation.

Note ...

Ensure that the 'O' ring is not twisted and is properly seated in its groove.

Standard ports

4 Although the method of machining ports is not included in this chapter the dimensions are shown in fig 6 and Table 1 lists the sizes so that ports may be checked for size when necessary. In the event that a port may not be broached for the serrations the sizes are listed with the appropriate tools in Tables 3 and 4.

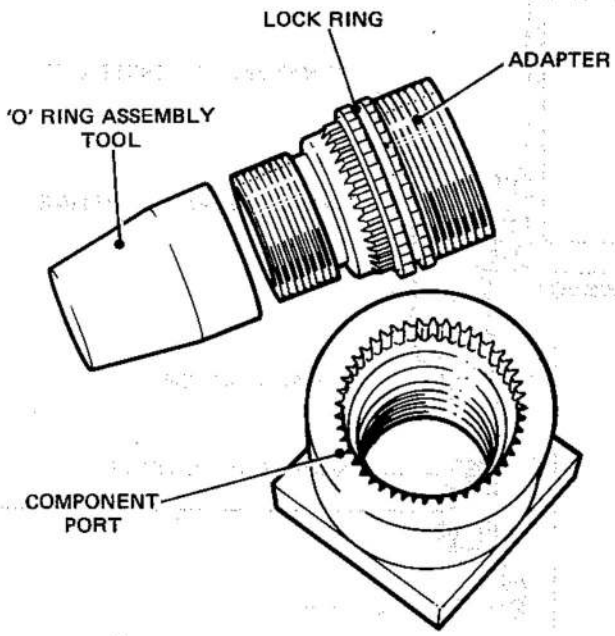


Fig 4 'O' ring installation tool

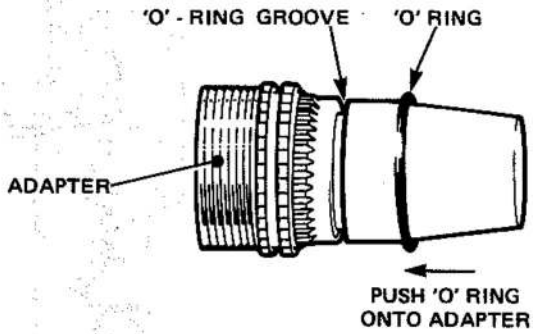


Fig 5 'O' ring installation

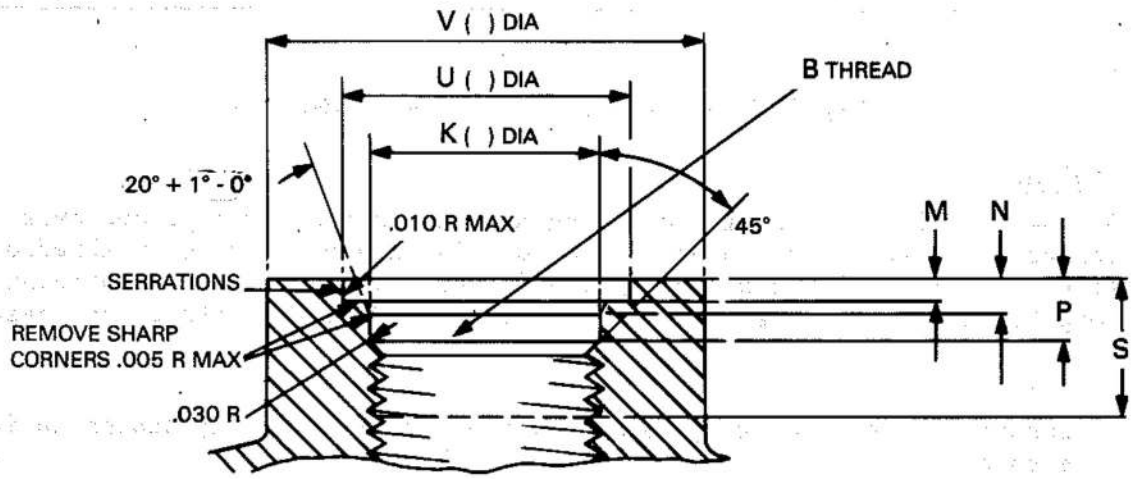


Fig 6 Dimensions of standard port

Broaching serrations

5 Normally the port bore will have been machined into the component body at time of manufacture but it may be necessary to form the serrations using the tool appropriate to the body material. Heavier duty tools are needed for high strength steel bodies than for aluminium.

Serration cutters

6 The serration cutters are expendable tools and are fitted onto the appropriate tool body, according to the size of tooling, (Table 1).

TABLE 1 DIMENSIONS OF STANDARD PORTS

Dash No.	Tube od	MIL-S-8879 UNJF AND UNJF-3B	Controlled minor dia when pre-broaching	K dia. -0.002 -0.000	M +0.010 -0.000	N +0.005 -0.000	P +0.005 -0.000	S Min full thread depth	U +0.003 -0.000	Porting Tool No. 1	Min boss dia.
-2	.125	.2160-28	.1827 .1857	.254	.088	.153	.296	.507	.381	RFPT-02	.500
-3	.188	.2500-28	.2167 .2197	.286	.088	.153	.296	.568	.448	RFPT-03	.620
-4	.250	.3125-24	.2734 .2764	.339	.088	.153	.296	.568	.495	RFPT-04	.680
-5	.312	.3750-24	.3359 .3389	.401	.088	.153	.296	.594	.601	RFPT-05	.790
-6	.375	.4375-20	.3903 .3933	.464	.103	.168	.311	.631	.675	RFPT-06	.852
-8	.500	.5625-18	.5099 .5129	.582	.103	.168	.311	.672	.784	RFPT-08	1.040
-10	.625	.6875-24	.6484 .6514	.725	.103	.168	.311	.693	1.015	RFPT-10	1.165
-12	.750	.8125-20	.7653 .7683	.899	.103	.168	.343	.763	1.139	RFPT-12	1.415
-14	.875	.9375-20	.8903 .8933	1.030	.103	.168	.343	.800	1.311	RFPT-14	1.540
-16	1.000	1.1250-18	1.0714 1.0744	1.162	.103	.168	.343	.806	1.427	RFPT-16CT	1.665
-20	1.250	1.3125-18	1.2599 1.2629	1.387	.130	.195	.375	.838	1.750	RFPT-20CT	—
-24	1.500	1.6260-18	1.5724 1.5754	1.664	.130	.195	.375	.877	2.005 2.000	RFPT-24CT	—

Notes . . .

(1) All dimensions are in inches

(2) It is vital to check dimensions M and U before using serration broaching tools.

TABLE 2 ADAPTER REMOVAL AND INSERTION TOOLS

Dash size	Adapter Pt No	Kit Pt No	'O' ring installation No	Tool No Combination wrench and drive tool	Locking removal	Nato Stock No
* -4	RF 5004-13	KM9RF5004	ORT312	RF 5004DW	RF 04 LPDE	5180-00-785-5062
-5	RF 5005-13	KM9RF5005	ORT375	RF 5005DW	RF 05 LPDE	TBD
* -6	RF 5006-13	KM9RF5006	ORT437	RF 5006DW	RF 06 LPDE	5180-00-785-5063
* -8	RF 5008-13	KM9RF5008	ORT562	RF 5008DW	RF 08 LPDE	5180-00-785-5068
* -10	RF 5010-13	KM9RF5010	ORT687	RF 5010DW	RF 10 LPDE	5180-00-785-5069
* -12	RF 5012-13	KM9RF5012	ORT812	RF 5012DW	RF 12 LPDE	5180-00-785-5073
-14	RF 5014-13	KM9RF5014	ORT937	RF 5014DW	RF 14 LPDE	TBD
-16	RF 5016-13	KM9RF5016	ORT1125	RF 5016DW	RF 16 LPDE	5180-00-785-5080

Note ...

(1) Sizes marked * are used on Harrier GR5

(2) Sizes for Tri-Star not yet scheduled

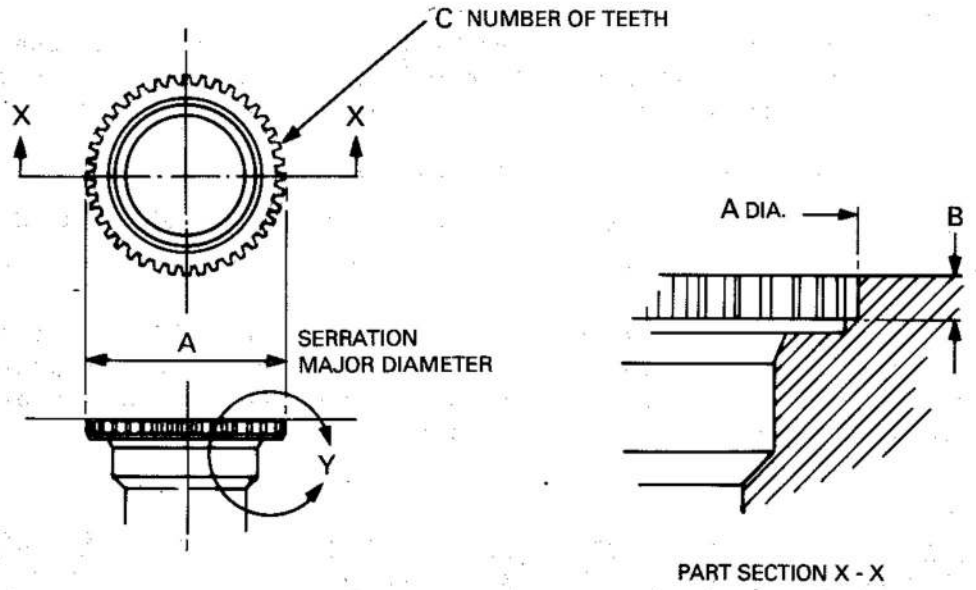


Fig 7 Dimensions of serrations

TABLE 3 SERRATION SIZE DATA

Part No	Serration cutter No	A dia min inch	B dim min inch	C No teeth
PS 10035-4	RFOPB 5004-3	0.524	0.061	30
PS 10035-5	RFOPB 5005-3	0.635	0.061	36
PS 10035-6	RFOPB 5006-3	0.710	0.073	36
PS 10035-8	RFOPB 5008-3	0.826	0.073	40
PS 10035-10	RFOPB 5010-3	1.052	0.073	38
PS 10035-12	RFOPB 5012-3	1.182	0.073	40
PS 10035-14	RFOPB 5014-3	1.354	0.073	50
PS 10035-16	RFOPB 5016-3	1.471	0.073	36

Note ...

Only Rosan tools RFOPB-5000 series or RFOPB-5000HD series may be used to cut serrations.

Tooling

7 Six tool kits are provided to cover the range of adapters used for pipe sizes $\frac{1}{4}$ in to $\frac{3}{4}$ in (dash sizes -4 to -12) (Table 2). The tools contained in each kit are as follows:

7.1 'O' ring installation tool - ORT series.

7.2 Combination lock ring wrench and drive tool - RF xxxx DW series.

7.3 Removal tool, locking RF xxxx LPD series.

8 Serration cutting tools are manufactured for the range of port sizes but are not included in the kits. Components are normally supplied with the ports machined to accept the adapters, but the cutters can be used to restore damaged serrations. (Table 3 and fig 7).

CAUTION

Replacement of a Rosan adapter is not authorized on an aircraft. The hydraulic component must be removed to a hydraulic bay where the adapter may be replaced.

INSTALLATION PROCEDURE

Assembly of an adapter to a component

9 After selection of the adapter fitting for the port size (Table 1), check setting torque (Table 7), select a suitable torque wrench and proceed as follows:

9.1 Ensure that the adapter is fitted with the correct 'O' ring (para 3).

9.2 Select the drive tool, which is combined with a wrench, to suit the size of adapter, from Table 4.

9.3 Lubricate the internal surfaces of the port cavity using a fluid specification given in Chap 11 Table 1.

9.4 Insert the smaller thread of the adapter into the port and screw down until the fitting is seated.

CAUTION ...

Once the adapter fitting is seated to not turn it counter-clockwise since this could damage to 'O' ring seal.

9.5 Using the proper combination drive tool and wrench engage the serrations of the tool with those on the external serrations of the adapter lock ring.

9.6 Apply a torque of the minimum value shown in Table 5:

9.6.1 If the serrations of the lock ring align with those of the adapter (fig 7) proceed to step 9.7. If not, proceed to 9.6.2.

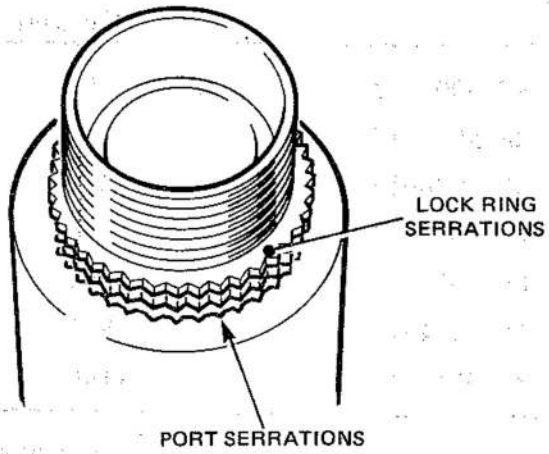


Fig 8 Correctly matched serrations

9.6.2 To match the serrations slowly torque the adapter towards the maximum value (Table 5) until the serrations are in line, and unscrew the tool from the adapter.

Note ...

This extra turning will normally be between 3^{o} and 8^{o} and it is not necessary to reach the maximum torque.

9.7 Apply zinc chromate primer Ref No 33A/9106663 Nato 8010-99-9106663 with a brush or small syringe to the counterbore (serration) area of the port.

Note ...

Do not allow the primer to dry before the completion of step 9.8.

9.8 Screw the correct lock ring tool onto the adapter until it touches the lock ring, then use a set spanner and continue to turn the tool until it contacts the face of the port.

CAUTION ...

Any sudden increase in torque may indicate that the lock ring and port serrations are not aligned. If so, use the removal tool (para 10) lift the lock ring and realign as described in para 9.6.2.

9.9 Remove excess zinc chromate primer which has flowed over the port face.

TABLE 5 SETTING TORQUES FOR RF5000 FITTINGS

Tube od inch	Basic fitting Part No	Installation torque in/lbf	
		Minimum	Maximum
► 0.250	RF 5004-13	50	65
0.375	RF 5006-13	140	200
0.500	RF 5008-13	270	375
0.625	RF 5010-13	620	700 ◄
0.750	RF 5012-13	855	945
0.875	RF 5014-13	955	1105
1.000	RF 5016-13	1140	1260

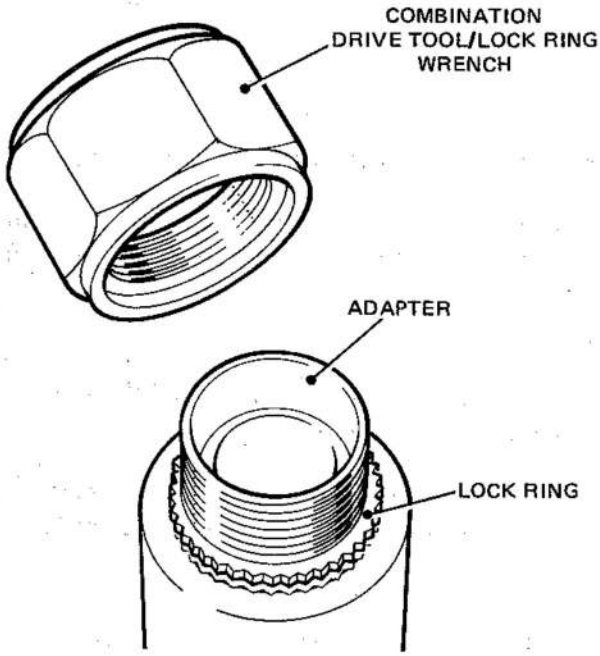


Fig 9 Lock ring installation

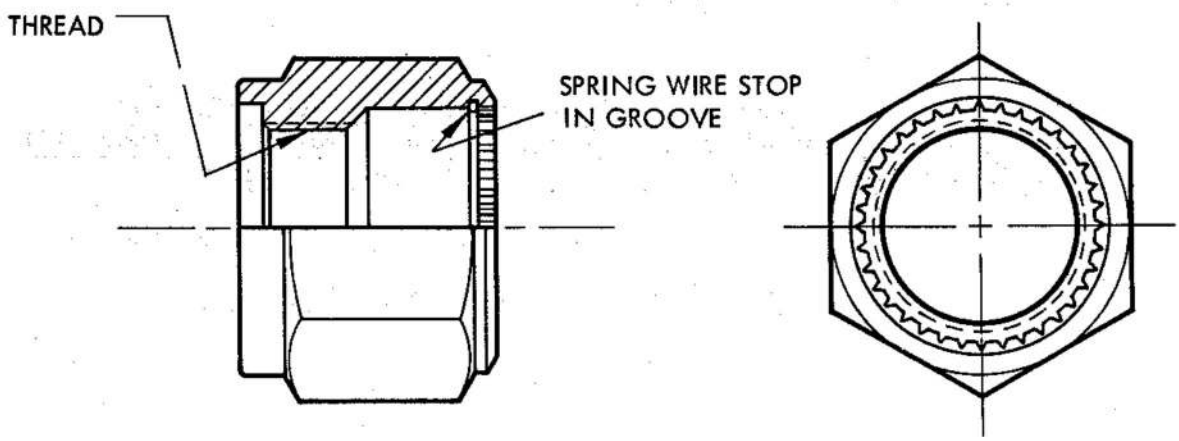


Fig 10 Combination drive tool and locking wrench

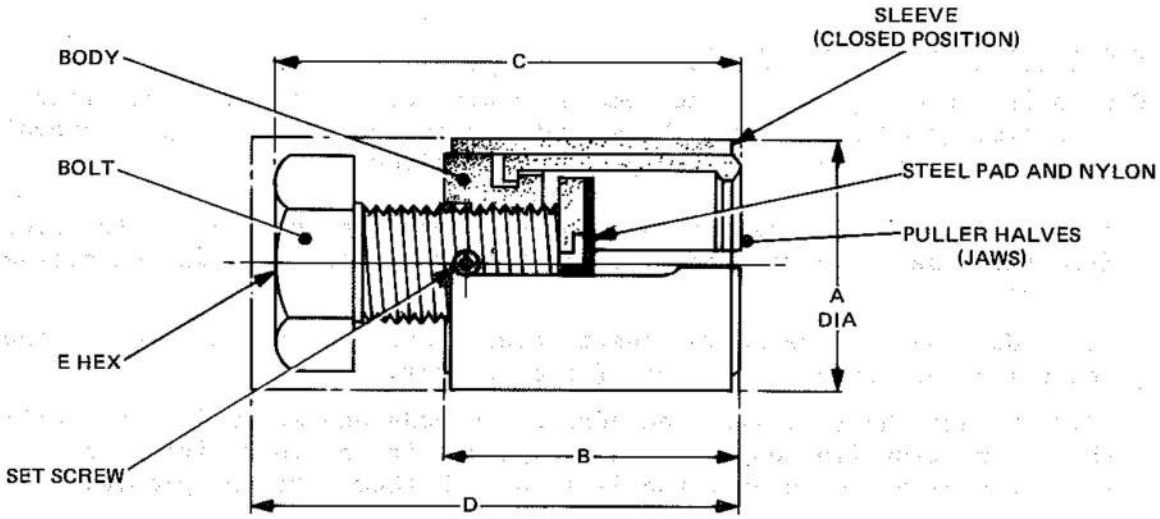


Fig 11 Lock ring removal tool, closed

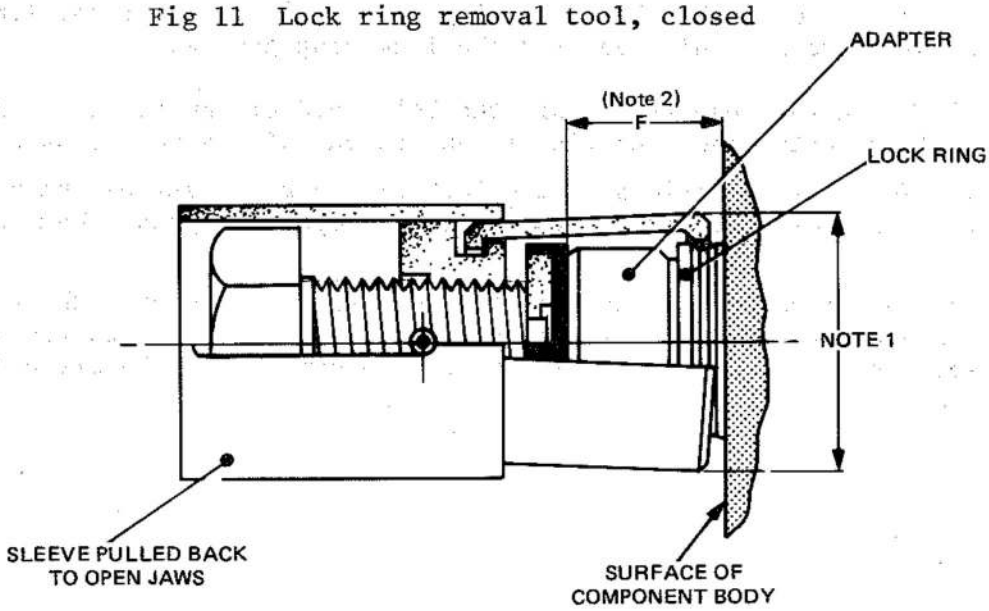


Fig 12 Lock ring removal tool, open

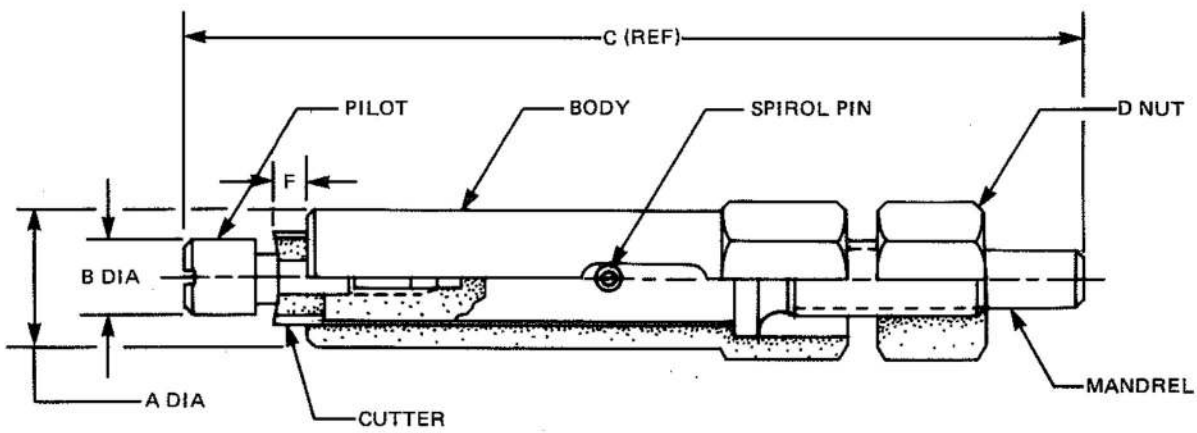


Fig 13 Broaching tool

Removing lock ring and adapter

10 When it becomes necessary to remove an adapter fitting the lock ring must be disengaged first from the serrations in the port, using a removal tool selected from Table 5; then proceed as follows:

10.1 Spread the jaw halves apart by holding them and pulling the sleeve from the assembly until the stop pin bottoms in the slot in the sleeve (fig 9).

10.2 Holding the jaw halves apart, place tool over the adapter so that the nylon pad contacts the top of the adapter.

10.3 Engage the tool with the adapter threads and screw it down until the jaw pulling lips engage with the groove in the lock ring, then slide the sleeve down over the jaws to lock them into the groove.

Note ...

Any resistance to the sleeve sliding down indicates that the lips of the jaws have not fully entered the lock ring groove.

10.4 Use a set spanner to turn the bolt head clockwise, while holding the sleeve until the lock ring is pulled out of the port counterbore.

10.5 When the serrations of the lock sleeve are clear of the port, loosen the bolt and lift up the sleeve to open the jaws. Remove the tool.

10.6 To remove the adapter fit the lock ring wrench over the adapter to engage with the serrations and use a spanner to unscrew the adapter. Discard the 'O' ring which will have been damaged by the dismantling operation.

Chapter 12

AN (AMERICAN) FLARED PIPE FITTINGS

Para
1 Introduction
Description
2 Types and construction
3 Pipe coupling and fitting standards
4 Tightening fittings
5 Precautions
6 Coupling assembly
8 Tube materials
9 Protection and blanking plugs
10 Identification
11 Part numbering system
Procedure to assemble a flared fitting
12 General
15 Tube preparation
17 Flaring
18 Cleaning
Testing
19 Test pressure
Inspection prior to installation
21 Fittings and pipe assemblies
22 Tubing
Installation of replacement pipe assemblies in aircraft
24 Procedure
26 Leaks during system testing
27 Leakage from an installed fitting
28 Repair of the pipe assemblies
29 Corrective work on fittings

Fig Page
1 Typical styles of AN fittings 2
2 Flared fitting assembly 3
3 Flared tube, sleeve and nut 4
4 Damage to fittings 9
5 Permissible repairs to fittings 11

Table Page
1 Identification colour of AN fittings 5
2 AN (American) flared fittings, size data 6

Introduction

1 The American, 'Aviation Navy' (AN) fittings are used on imperial (inch) size pipes and hoses for low and medium pressure systems, of not more than 24.13 bar (350 lbf/in^2). The couplings are provided in different materials to suit the system pressure and the material of the piping. They are suitable for use with carbon steel, stainless steel and 1/2 in (12.7 mm) or larger aluminium (5052), as well as aluminium alloy (6061-T6) tubing. The coupling comprises a nut and sleeve, which are retained on the tube by flaring the end of the tube to 37 degrees angle. Tool kits are provided to form the appropriate flares (Chap 3 para 7 and 8).

AN-832-
UNION



FLARED TUBE
BULKHEAD AND UNIVERSAL

AN-833-
ELBOW



FLARED TUBE
BULKHEAD UNIVERSAL 90°

AN-834-
TEE



FLARED TUBE
BULKHEAD AND UNIVERSAL

AN-837-
ELBOW



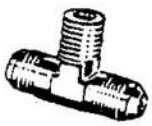
FLARED TUBE AND
UNIVERSAL 45°

AN-6289-
NUT



FLARED TUBE
UNIVERSAL FITTING

AN-825-
TEE



FLARED TUBE
PIPE THREAD ON SIDE

AN-826-
TEE



FLARED TUBE
PIPE THREAD ON RUN

AN-827-
CROSS



FLARED TUBE

AN-824-
TEE



FLARED TUBE

AN-821-
ELBOW



FLARED TUBE 90°

AN-822-
ELBOW



FLARED TUBE AND
PIPE THREAD 90°

AN-815-
UNION



FLARED TUBE

AN-894-
BUSHING



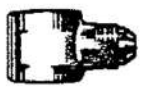
SCREW THREAD
EXPANDER

AN-775-
BOLT



UNIVERSAL FITTING

AN-776-
ELBOW



UNIVERSAL 90°

AN-929-
CAP



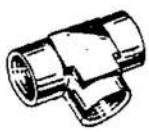
PRESSURE SEAL
FLARED TUBE FITTING

AN-806-
PLUG



FLARED TUBE

AN-938-
TEE



INTERNAL SCREW THREAD

AN-939-
ELBOW



INTERNAL SCREW
THREAD 90°

AN-941-
ELBOW



INTERNAL SCREW
THREAD 45°

Fig 1 Typical styles of AN fittings

DESCRIPTION

Types and construction (fig 1)

2 The coupling comprises a sleeve (AN819) and a nut (AN818) which are used in conjunction with a range of unions, elbows, tees together with adaptors to MS type (Chap 13). Table 2 lists the applicable size data for AN fittings.

Pipe coupling and fitting standards

3 To ensure a perfect fit between the coupling and mating components, or to the union, for pipe to pipe joints, a perfectly aligned and tension free pipe run must be achieved. This is to ensure correct contact of the flared pipe to the conical seating of the union, which is essential to prevent leakage or seeping from the coupling. The tube flare must be accurately formed and conform to GO and NO GO gauges (Chap 3 para 8.10.2).

Tightening fittings

4 The coupling nuts and mating threads must be coated with the appropriate lubricant before assembly (Table 1). Tighten the nut by hand until a resistance to turning is encountered. If it is impossible to run the nut down with the fingers, a set spanner may be used to bottom the connection. At this point a final torquing should be applied. Use two set spanners, one on the union, the other on the nut, and turn the nut through 1/6 turn, one flat of the hexagon, unless otherwise specified in the publication relating to the aircraft or engine.

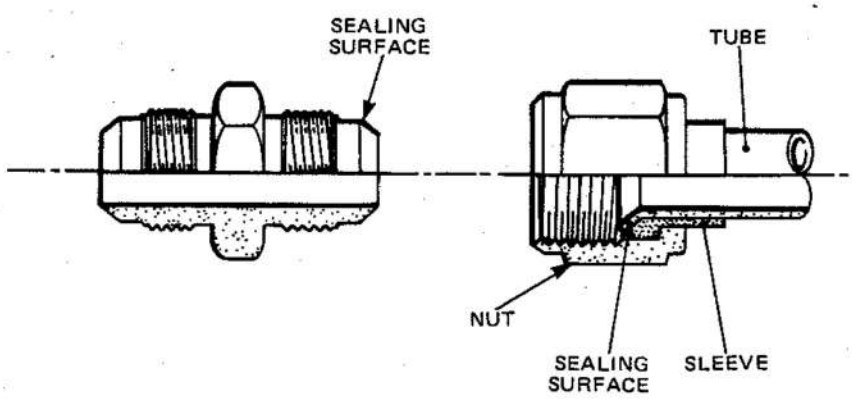


Fig 2 Flared fitting assembly

Precautions

5 Finger tightness should ensure contact of the flared tubing end with the conical seating. If this is not achieved or resistance is not felt during tightening movement check for:

5.1 Tight threads.

5.2 Incorrect flaring of tube.

5.3 Distortion or maladjustment of pipe assembly.

5.4 Distortion or pull up of structure.

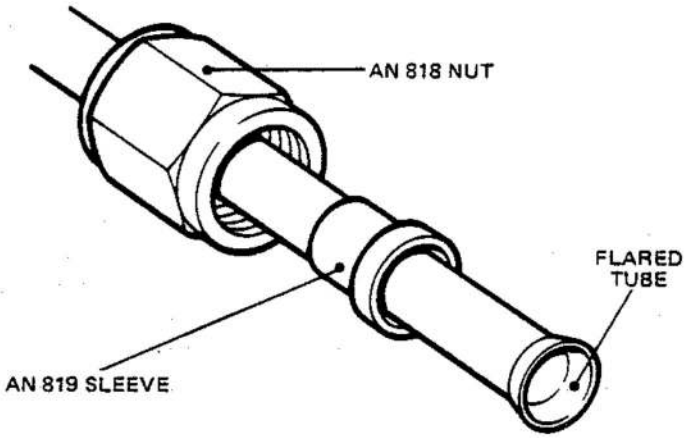


Fig 3 Flared tube, sleeve and nut

Coupling assembly

6 The use of two spanners for tightening and releasing fittings is mandatory, except when tightening or releasing nuts onto a major component or locked bulkhead fittings.

7 When tightening or releasing a standard pipe to pipe coupling only the spanner on the loose nut should be rotated, the second spanner being held stationary and used to react to tightening torque thus preventing any torque being induced into pipe assemblies.

Tube materials

8 AN fittings may be used only with tubing materials which are suitable for flaring. The specification to be used will be found in the publication relating to the aircraft/engine.

Protection and blanking plugs

9 The available cap assembly (AN 929) and plug (AN 806) are illustrated in fig 1. It is essential that full use is made of these items when dismantling.

Identification

10 AN fittings are made of aluminium alloy, carbon steel, corrosion resistant steel (CRES), or aluminium bronze and are identified by their distinguishing colour, Table 1.

TABLE 1 IDENTIFICATION COLOUR OF AN FITTINGS

Material of fitting	Identifying colour	Letter code (in Pt No)
Aluminium alloy	Blue	D
Carbon steel	Black	Nil
CRES	Natural	C
Aluminium bronze	Cadmium plated and not coloured	-

Note ...

MS fittings are identified by similar colours.

Part numbering system

11 The part numbering system is as follows:

11.1	Prefix	AN - Aviation Navy
11.2	Design Part No	Taken from fig 1 illustration
11.3	Size of tubing	Dash No
11.4	Material	Refer to Table 1

11.5 Thus:
AN-821-4-D is an AN flared elbow for 1/4 in diameter tubing, elbow material, aluminium alloy.

PROCEDURE TO ASSEMBLE A FLARED FITTING

General

12 The assembly of a flared fitting is carried out by sliding the fitting nut followed by the sleeve onto the squared and deburred tube end, and then forming a 37 degree flare on the end of the tube. Use the tools and adaptor set described in Chap 3, para 7 and 8.

Note ...

The same tools are used to square the end of the tube and to chamfer it internally and externally prior to assembly.

13 After the flare has been formed it must be checked using the gauges as described in Chap 3 para 8.10.2.

14 The pipe assembly must be pressure tested upon completion of assembly of the fittings.

Tube preparation

15 Inspect the tube for roundness, cleanliness and freedom from marks and scratches.

TABLE 2 AN (AMERICAN) FLARED FITTINGS, SIZE DATA

Pipe size, dash	Tubing outside diameter nominal inch	mm	Thread size dia	inch TPI	Hexagon A/F size Male nuts caps and bushings	Female nuts	Unions
-3	3/16	4.8	3/8	24	-	0.5	-
-4	1/4	6	7/16	20	0.69	0.56	0.62
-5	5/16	8	1/2	20	0.75	0.62	0.69
-6	3/8	10	9/16	18	0.81	0.69	0.75
-8	1/2	13	3/4	16	1.00	0.88	0.88
-10	5/8	16	7/8	14	1.12	1.00	1.00
-12	3/4	19	1 1/4	12	1.38	1.25	1.25
-16	1	25	1 5/16	12	1.62	1.50	1.50
-20	1 1/4	32	1 5/8	12	1.88	1.81	1.75
-24	1 1/2	38	1 7/8	12	2.19	2.12	2.00

Note ...

The tubing is to be rejected if any draw marks (longitudinal ridges or hollows) are visible.

16 Cut off the tubing to the required length using a fine toothed hacksaw blade and, using the tools, square the end and form internal and external chamfers (Chap 3 para 7 and 8).

Flaring

17 The procedure to assemble a flared fitting after preparing the tubing is as follows:

17.1 Slide the fitting nut followed by the sleeve on to the tube and then use the flaring tool with 37 degree die blocks to flare the end of the tubing. The sleeve and nut cannot now be removed from the tubing.

17.2 Check that the flare has been correctly formed and that there are no surface irregularities nor any sign of splitting. Use the GO and NO GO gauge for 37 degree American flare (Chap 3 para 8.10.2).

17.3 Upon completion of the pipe assembly it must be cleaned and tested.

Cleaning

CAUTION ...

It is important that the cleaning procedures for liquid and gaseous oxygen pipes are strictly adhered to: (refer to AP 107D-0001-1, Chap 4). Many materials, particularly oil and grease, are subject to spontaneous combustion when exposed to undiluted oxygen under pressure.

18 Prior to testing, storage or fitting to an aircraft, pipe assemblies must be cleaned as detailed in Chap 15.

TESTING

CAUTION ...

Before connecting the pipe assembly to test equipment refer to installation procedure (para 24 and 25).

Test pressure

19 The test pressure for pipe assemblies with AN couplings is limited by pressure limits of the 'coupling to fitting' sealing surfaces rather than that of the tubing in the assembly.

20 Testing is to be carried out on the hydraulic test bench at a pressure of 34.47 bar (500 lbf/in^2) for a duration of five minutes. The requirement is as follows:

20.1 There must be no leakage at this test pressure.

Note ...

The normal maximum working pressure for all sizes of AN fitting is 24.13 bar (350 lbf/in^2).

► 20.2 The pipe test procedure is to be carried out in accordance with Chap. 17 of this publication. ◄

INSPECTION PRIOR TO INSTALLATION

Fittings and pipe assemblies

21 Each assembly is to be checked as follows prior to installation:

21.1 Visual or flow check to ensure that the passage or passages are free from obstruction.

21.2 Visual assessment of all sealing surfaces to ensure that they are smooth and without scratches or indentations which could provide a leakage path.

21.3 The hexagon and spanner flats are to be undamaged.

Note ...

Fig 4 illustrates typical damage to fittings but the sleeve and nut are illustrated in fig 3.

Tubing

22 Tubing is to be inspected both prior to and after installation as follows:

22.1 For dents, any dent which has a depth less than 20 per cent of the tubing diameter is acceptable unless it is on the heel of a short bend radius.

22.2 For nicks, any nick of greater depth than 15 per cent of the wall thickness of the tube is unacceptable.

CAUTION ...

Any aluminium, aluminium alloy or steel tubing carrying pressures in excess of 69 bar (100 lbf/in^2) with nicks in excess of 15 per cent of the wall thickness is to be rejected.

23 Nicks of less than 15 per cent of the wall thickness of aluminium, aluminium alloy or steel tubing may only be accepted after the tubing has been reworked by burnishing with hand tools.

INSTALLATION OF REPLACEMENT PIPE ASSEMBLIES IN AIRCRAFT

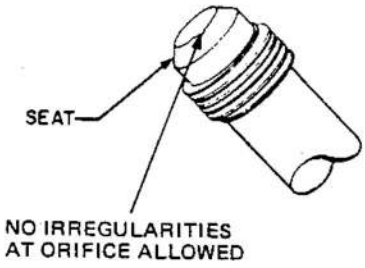
Procedure

24 The pipework should be clean. Check that the protective caps are undamaged and if ingress or dirt seems possible, reclean the pipe (Chap 15), then proceed as follows:

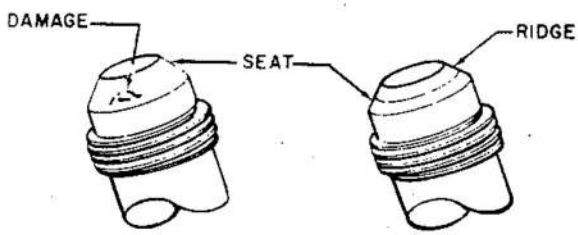
24.1 Remove the protective caps and examine seating and mating surfaces for scratches or other defects likely to provide leakage paths.

24.2 Clean pipe and coupling mating surfaces using a lint free cloth. Use clean white spirit, where necessary, to remove any PX24 protective coating on steel fittings.

24.3 Loosely assemble the pipe to match the fairlead positions, ensuring that clearances to other pipes, components and bulkheads are adequate, and that the pipe run is tension free (para 3).

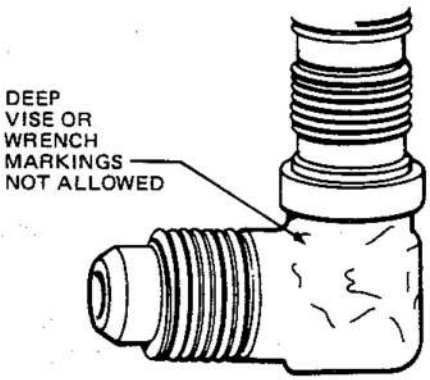


DAMAGED ORIFICE

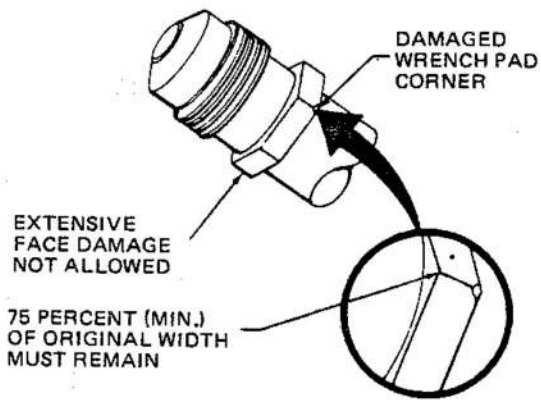


NO RIDGE OR OTHER SURFACE DAMAGE ALLOWED THAT CAN BE DETECTED BY FINGER NAIL

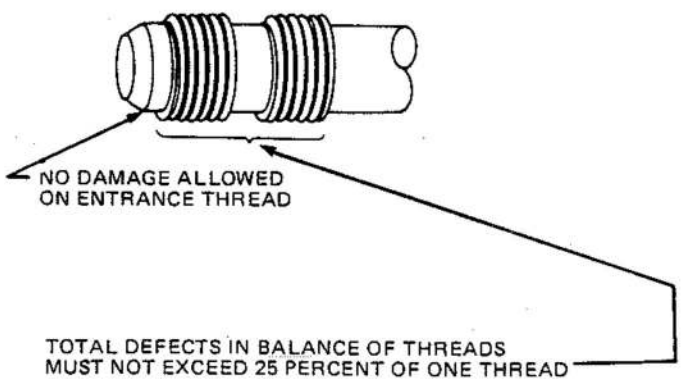
DAMAGED OR RIDGED SEAT



WRENCH MARKINGS



DAMAGED WRENCH PAD



DAMAGED THREADS

Fig 4 Damage to fittings

24.4 Lightly tighten all coupling nuts until resistance to turning is encountered. Should it be impossible to run the nut down with the fingers, use a set spanner, but take care to locate the bottoming point.

Note ...

It is important that the final tightening commences at the point where the nut just begins to bottom.

CAUTION ...

Two spanners must be used to tighten the halves of a union. One spanner to turn the union nut, and the other to prevent any movement of the composite unit (elbow, tee cross or pipe).

25 Make the final tightening, observing the caution, as follows:

25.1 Using a set spanner turn the union nut 1/6 turn (one flat on a hexagon nut).

25.2 Tighten the remaining unions on the pipe assembly in the same manner.

25.3 The assembly is now ready for system testing.

Leaks during system testing

CAUTION ...

On no account may union nuts be tightened while the system is under pressure. This can cause permanent deformation of the threads.

26 If the connection leaks during system pressure testing, release the pressure, tighten the union nut by an additional 1/6 turn and retest.

26.1 If leakage persists, loosen and completely disconnect the nut. Inspect components of the fitting for scores, cracks, presence of foreign material, or damage due to previous overtightening.

26.2 Reassemble fitting run nut up finger tight if possible and repeat spanner tightening procedure (para 25).

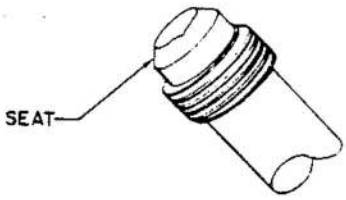
26.3 Do not in any circumstances tighten the fitting nut more than 1/3 of a turn (two flats of the hexagon on the nut).

Leakage from an installed fitting

27 Do not tighten. Loosen and completely disconnect the nut. Then proceed as described in para 26.1, 26.2 and 26.3.

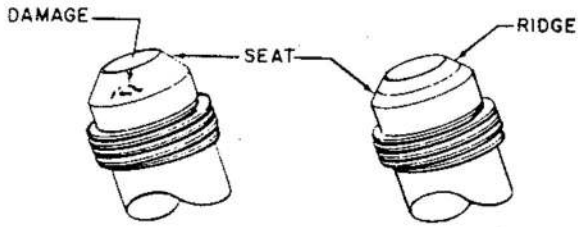
Repair of pipe assemblies (fig 5)

28 Since it is not possible to remove a damaged sleeve and nut without cutting off the flare and thus shortening the assembly, corrective work is limited to polishing of seatings, improving the surfaces of hexagons and repairs to threads. Indentations and nicks in the tubing may be repaired as described in para 23.



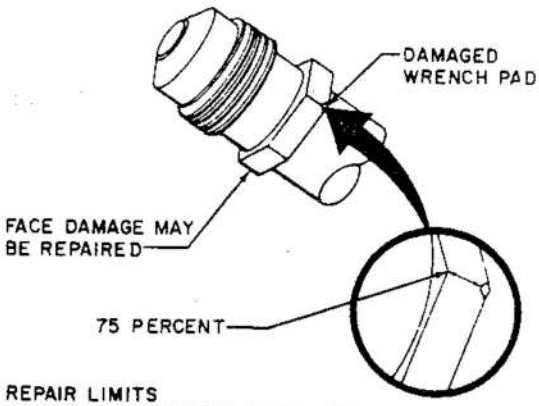
REPAIR LIMITS:
80 PERCENT OF SEAT MUST BE RETAINED AFTER REWORKING DAMAGED AREA

DAMAGED ORIFICE



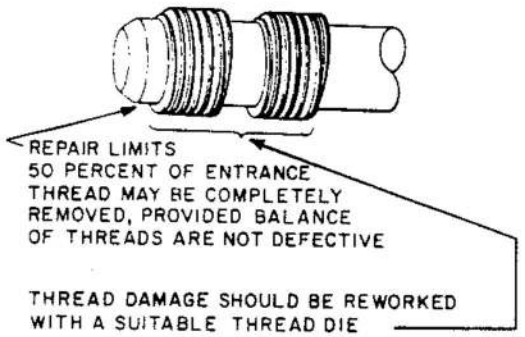
REPAIR LIMITS:
80 PERCENT OF SEAT MUST BE RETAINED AFTER REWORKING DAMAGED AREA
NO RIDGE ALLOWED THAT CAN BE DETECTED BY FINGER NAIL

DAMAGED OR RIDGED SEAT



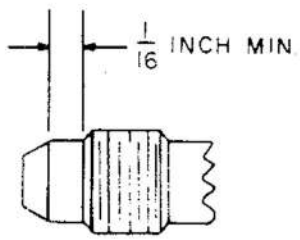
REPAIR LIMITS
MAXIMUM OF ONE CORNER MAY BE REWORKED PROVIDED 75 PERCENT OF REWORKED FLANGE WIDTH IS NOT DAMAGED

DAMAGED WRENCH PAD



TOTAL OF DEFECTS IN BALANCE OF THREADS WILL NOT EXCEED 25 PERCENT OF ONE THREAD, PROVIDED ENTRANCE THREAD IS NOT DAMAGED

DAMAGED THREADS



REPAIR LIMITS
MINIMUM 1/16" MUST BE MAINTAINED BETWEEN SEALING SURFACE AND START OF FIRST THREAD.

MACHINING LIMIT

Fig 5 Permissible repairs to fittings

Notes ...

(1) Provided the material specification of the tubing is suitable a repair could be made by using a Permaswage fitting (Chap 9).

(2) Any visible penetration of the tube wall surface by chafing, rubbing or fretting is to be investigated and the cause of the damage corrected.

(3) After correcting such conditions the pipe assembly must be replaced regardless of the type of metal, system fluid or pressure ranges involved.

Corrective work on fittings (fig 5)

29 The permissible rework on fittings is as follows:

29.1 Damaged orifices, may be hand stoned to blend rough edges and burrs provided 80 per cent of the original sealing surface is retained and contains no scratches, nicks, dents or circumferential ridges which could create a leakage.

29.1.1 Repair may be effected by facing back the seating provided 1/16 in (1.6 mm) dimension is maintained.

29.2 Damaged seatings may be smoothed provided 80 per cent of the seating remains effective. No ridge allowed that can be detected by finger nail.

Note ...

Surface finish of seatings to be 0.025 mm (0.001 in) RMS or better.

29.3 Damaged threads; the repair limits are:

29.3.1 50 per cent of entrance threads may be completely removed, provided the rest of the threads are not defective.

29.3.2 Total of defects in the rest of the threads must not exceed 25 per cent of one thread provided entrance thread is undamaged.

29.4 Damaged spanner pad or hexagon; repair is limited to a maximum of one corner provided 75 per cent of the reworked face width, or hexagon flat, is undamaged.

29.5 Damaged union nut; the hexagon may be repaired as para 29.4. 50 per cent of the entrance thread may be removed provided the rest of the threads are not defective.

Chapter 13

MS (AMERICAN) FLARELESS PIPE FITTINGS

Para

1 Introduction

Description

2 Types and construction

3 Pipe coupling and fitting standards

4 Tightening fittings

5 Precautions

6 Coupling assembly

8 Tube materials

9 Protection and blanking plugs

10 Identification

11 Part numbering

Procedure to assemble a flareless fitting

12 General

13 Tube preparation

14 Setting procedure

16 Presetting inspection

17 Cleaning

Testing

18 Proof pressures

Inspection prior to installation

20 Fittings and pipe assemblies

21 Tubing

Installation of replacement pipe assemblies in aircraft

23 Procedure

25 Leaks during system testing

26 Leakage from an installed fitting

27 Repair of pipe assemblies

28 Corrective work on fittings

Table

		Page
1	Identification colour of MS fittings	5
2	MS (American) fittings, size data	7
3	Hand presetting tools (Deutsch)	8
4	Thread lubricants	8
5	Turn values for presetting operation, with mandrels	8
6	Turn values for presetting operation, without mandrels	10
7	Tube projection from sleeve pilot	11
8	Minimum inside diameter of tubing at sleeve cut	12
9	Proof pressures for 6061-T6 aluminium alloy tubing	13
10	Proof pressures for annealed 304,321 and 347 stainless steel tubing ...	13
11	Proof pressures for 304 1/8H stainless steel tubing	14

Fig

		Page
1	Typical styles of MS fittings and part number breakdown	3
2	Flareless fitting assembly	4
3	Long sleeve and short nut	4
4	Section through a preset sleeve	11
5	Damage to fittings	15
6	Permissible repairs to fittings	17

Introduction

1 The American military specification (MS) pipe couplings are used on imperial (inch) size pipes and hoses, and are provided in different materials to suit the system pressure and the material of the piping. They are suitable for use with aluminium alloy, carbon steel and corrosion resistant steel tubing and also with newer materials including titanium. The couplings are secured to the pipe by a sleeve which itself is fixed to the pipe by a setting operation (fig 2).

Note ...

Metric conversions are only given in this publication where a component is not basically measured in imperial dimensions.

DESCRIPTION

Types and construction (fig 1)

2 The coupling comprises a sleeve (MS 21922) and nut (MS 21921) which are used in conjunction with a range of unions, elbows and tees, together with adaptors to AN type (fig 1). Table 2 lists the applicable size data.

Pipe coupling and fitting standards

3 To ensure a perfect fit between the coupling and mating components, or to the union for pipe to pipe joints, a perfectly aligned and tension free pipe run must be achieved. This is to ensure correct contact of the sleeve to the conical seating, which is essential to prevent seeping or leakage from the coupling. The end of the tube is to be square and free from internal and external burrs.

Tightening fittings

4 The coupling nuts and mating threads must be coated with the appropriate lubricant before assembly (Table 4). Tighten the nut by hand until a resistance to turning is encountered. If it is impossible to run the nut down with the fingers, a set spanner may be used to bottom the connection. At this point final torquing should be applied. Use two set spanners, one on the union the other on the nut, and turn the nut through 1/6 turn, one flat of the hexagon, unless otherwise specified (para 14) or in the publication relating to the aircraft or engine.

Precautions

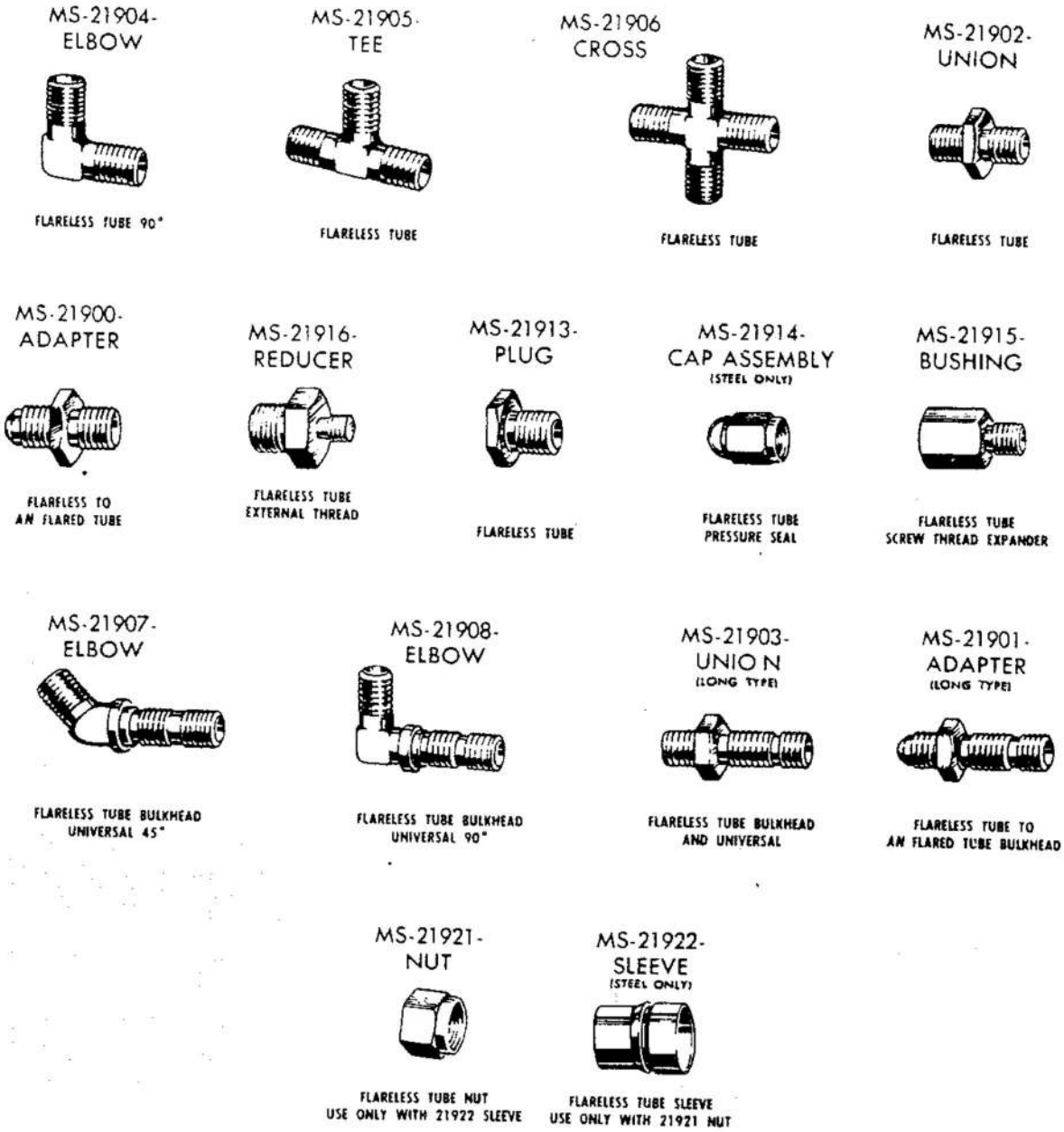
5 Finger tightness should ensure contact of the sleeve tapered end with the conical seating. If this is not achieved or resistance is not felt during the tightening movement check for:

5.1 Tight threads

5.2 Incorrect presetting of sleeve

5.3 Distortion or maladjustment of pipe assembly

5.4 Distortion or pull up of structure.



Example of Code:

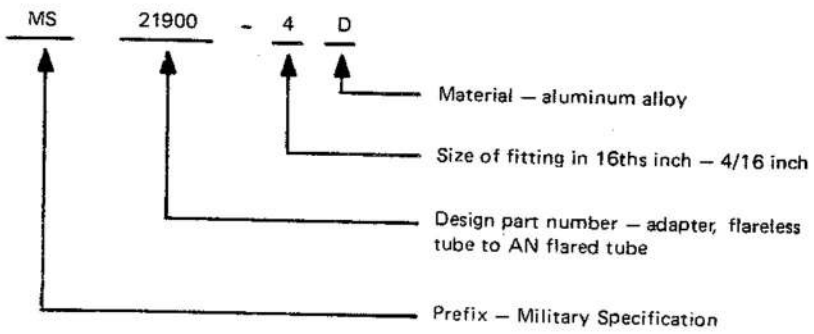


Fig 1 Typical styles of MS fittings and part number breakdown

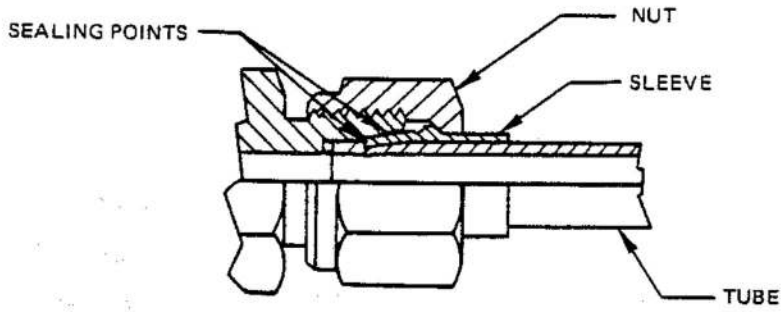


Fig 2 Flareless fitting assembly

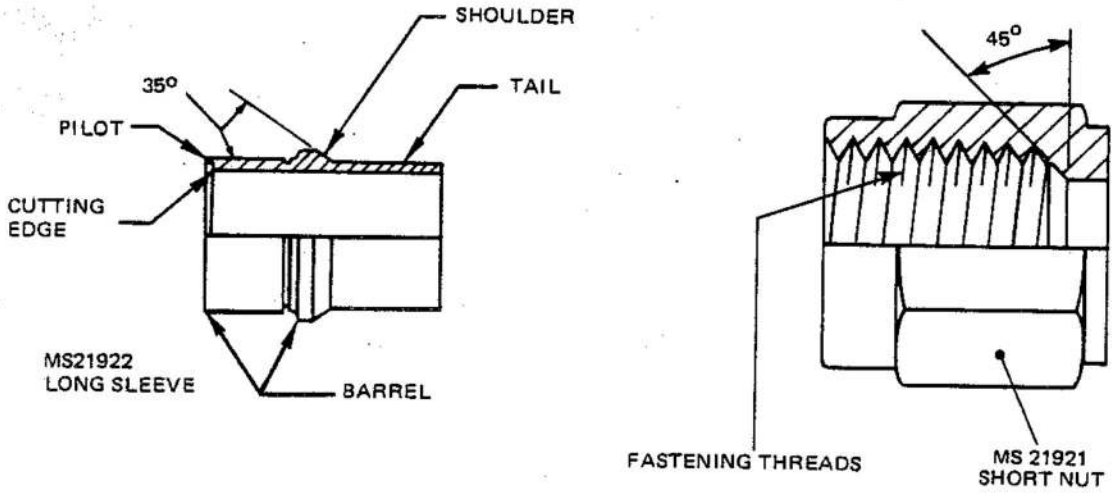


Fig 3 Long sleeve and short nut

Coupling assembly

6 The use of two spanners for tightening and releasing fittings is mandatory, except when tightening or releasing nuts onto a major component or locked bulkhead fitting.

7 When tightening or releasing a standard pipe to pipe coupling only the spanner on the loose nut should be rotated, the second spanner behind held stationary and used to react to the tightening torque thus preventing any torque being induced into pipe assemblies.

Tube materials

8 MS fittings may be used with the majority of types of tubing material. The specifications most commonly used are:

8.1 Aluminium alloy tubing 6061-T6

8.2 Annealed stainless steel tubing 304, 321 and 347

8.3 1/8H stainless steel tubing, 304.

Notes ...

(1) Since these materials are supplied in a wide range of wall thicknesses the aircraft/engine publication must be referred to, to find the correct size.

(2) Specification 5052-0 aluminium alloy tubing is not to be used with flareless fittings. Use 6061-T6 tubing in place of 5052-0.

(3) Other materials may be used only if allowed by the aircraft/engine publication.

Protection and blanking plugs

9 The available cap assembly (MS-21914) and plug (MS-21915) are illustrated in fig 1. It is essential that full use is made of these items when dismantling.

Identification

10 MS fittings are made of aluminium alloy, carbon steel, corrosion resistant steel (CRES) or aluminium bronze and are identified by their distinguishing colour, Table 1.

TABLE 1 IDENTIFICATION COLOUR OF MS FITTINGS

Material of fitting	Identifying colour	Letter code (in Pt No)
Aluminium alloy	Blue	D
Carbon steel	Black	Nil
CRES	Natural	C
Aluminium bronze	Cadmium plated and not coloured	-

Note ...

AN, flared, fittings are identified by similar colours.

Part numbering (fig 1)

11 The part numbering system is as follows:

11.1	Prefix	MS - military specification
11.2	Design part No	Taken from fig 1 illustration
11.3	Size of tubing	Dash No
11.4	Material	Refer to Table 1.

PROCEDURE TO ASSEMBLE A FLARELESS FITTING

General

12 The assembly of a flareless fitting is carried out by using a setting tool, which is a hardened steel replica of a male union body, selected according to the diameter of the pipe (Table 3), in conjunction with the sleeve and nut which are to be fitted. The operation clinches the internal cutting edge of the sleeve on to the pipe and also tapers the barrel of the sleeve to mate with the 24 degree angle of seating in the male portion of the coupling. In the case of thin walled tubes (Table 6) a mandrel is to be inserted into the bore during presetting to avoid excessive tube collapse (para 14.3). The pipe assembly must be pressure tested upon completion of assembly of the fittings.

Notes ...

(1) It is desirable, but not mandatory, to use a mandrel for all presetting operations.

(2) It is mandatory to use a mandrel for thin walled tubes.

(3) In emergency a standard fitting body can be used in place of the setting tool. In this case a mandrel must be used. Use the body once only.

Tube preparation

13 The tube must be cut-off squarely and be deburred externally and internally. The method is described in Chap 3, paras 8.5, 8.6 and 8.7.

Setting procedure

14 After procuring the specified sleeve and nut check that the pipe end is in good condition and select the following items:

14.1 Presetting tool of the size given in Table 3 and clamp it into a vice securely mounted on a bench.

14.2 Lubricant from Table 4 and lubricate fitting threads, tool seat and the shoulder of the sleeve (fig 3).

14.3 Mandrel. This consists of a short piece of cylindrical bar, preferably steel or other hard material, selected so that its outside diameter is from 0.002 to 0.005 in (0.05 to 0.13 mm) less than the inside diameter of the tubing.

TABLE 2 MS (AMERICAN) FLARELESS FITTINGS SIZE DATA

Pipe size, dash	Tubing outside diameter		Thread size, inch		Hexagon A/F size		
	inch	nominal mm	dia	TPI	Male nuts and adaptors inch	Female nuts inch	Unions inch
-3	3/16	4.8	3/8	24	-	0.5	-
-4	1/4	6	7/16	20	0.69	0.56	0.62
-5	5/16	8	1/2	20	0.75	0.62	0.69
-6	3/8	10	9/16	18	0.81	0.69	0.75
-8	1/2	13	3/4	16	1.00	0.88	0.88
-10	5/8	16	7/8	14	1.12	1.00	1.00
-12	3/4	19	1 1/4	12	1.38	1.25	1.25
-16	1	25	1 5/16	12	1.62	1.50	1.50
-20	1 1/4	32	1 5/8	12	1.88	1.81	1.75
-24	1 1/2	38	1 7/8	12	2.19	2.12	2.00

Notes ...

(1) Female nut is MS 21921 used with MS 21922 sleeve.

(2) Male nut is either MS 33656, style E or G; or MS 33514, style E or G.

TABLE 3 HAND PRESETTING TOOLS (DEUTSCH)

Deutsch Part No	Dash size	Tube outside diameter in	Tube outside diameter mm
270-00202	-2	1/8	3.18
270-00203	-3	3/16	4.76
270-00204	-4	1/4	6.35
270-00205	-5	5/16	7.94
270-00206	-6	3/8	9.52
270-00208	-8	1/2	12.70
270-00210	-10	5/8	15.87
270-00212	-12	3/4	19.05
270-00216	-16	1	25.40
270-00220	-20	1 1/4	31.75
270-00224	-24	1 1/2	38.10
270-00232	-32	2	50.80

TABLE 4 THREAD LUBRICANTS

System	Specification of lubricant US	UK	Nato
Hydraulic	MIL-H-5006	OM15	H515
Fuel	MIL-H-5006	OM15	H515
Oil	MIL-O-6032	OX27	O-156
Freon	MIL-L-6085A	OX14	O-147
Pneumatic	MIL-G-4343	XG269	-

TABLE 5 TURN VALUES FOR PRESETTING OPERATION, WITH MANDRELS

Tube outside diameter in	Tube outside diameter mm	Turns or fraction of turn, for all materials
1/8	3.18	1
3/16	4.76	1
1/4	6.35	1
5/16	7.94	1
3/8	9.52	5/6
1/2	12.70	5/6
5/8	15.87	2/3
3/4	19.05	2/3
1	25.40	2/3
1 1/4	31.75	2/3
1 1/2	38.10	2/3
2	50.80	2/3

Note ...

These figures also apply when a solid mandrel is used.

15 Preset the sleeve as follows:

15.1 Slide a nut, then a sleeve onto the tube, ensuring that the pilot and cutting edge of the sleeve points towards the end of the tube.

15.2 Ensure that lubricant is present (para 14.2).

15.3 Place tube end firmly against the bottom of presetting tool seat, slowly screw nut onto the tool threads using a set spanner until the tube cannot be rotated by thumb and fingers.

15.3.1 At this point, the cutting edge of the sleeve is gripping the tube sufficiently to prevent tube rotation, and the fitting is ready for the final tightening force necessary to set the sleeve on the tube.

15.4 Tighten the nut by the turns or fraction of a turn specified in Table 5 (with a mandrel) or Table 6 (without mandrel).

Note ...

Some thin walled tubes listed in Table 6 are exceptions and a mandrel must be used. Thus the turns for these are as specified in Table 5, not Table 6.

15.4.1 Tightening the nut in accordance with these tables will seat the sleeve cutting edge into the outer surface of the tube. This permanently assembles the sleeve to the tube.

CAUTION ...

Sleeves shall not be removed from the tube and reassembled under any circumstances.

15.5 After presetting, uncouple the nut from the threads of the presetting tool, and inspect the sleeve assembly.

Presetting inspection (fig 4)

16 After presetting inspect the tube and sleeve as follows:

16.1 The sleeve cutting lip should be embedded into the tube outside diameter by approximately 0.003 to 0.008 in (0.08 to 0.20 mm), (dimension 1) depending on the size and material of the tubing and a lip of material raised under the pilot at (2).

16.2 The pilot of the sleeve should contact or be quite close to the outside diameter of the tube (3).

16.3 Dimension (4), tube projection from the pilot of the sleeve to the end of the tube should be approximately as given in Table 7.

16.4 The sleeve should be slightly bowed (6).

16.5 The sleeve may rotate on the tube and have a longitudinal movement not exceeding 0.015 in (0.4 mm).

16.6 The sealing surface (5) of the sleeve which contacts the 24° angle of the fitting body seat must be smooth, free from scores, and showing no longitudinal or circumferential cracks.

TABLE 6 TURN VALUES FOR PRESETTING OPERATION, WITHOUT MANDRELS

Tube size inch	dash	Tube material	Wall thickness, inches 0.018	0.020	0.022	0.025	0.028	0.035	0.042	0.049	0.058	0.065	0.072	0.083	0.095	0.109	0.120
1/8	-2	MIL-T-6845	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6										
		MIL-T-8504	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6									
		6061-T6AL	1	1	1	1	1	1									
3/16	-3	MIL-T-6845	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1								
		MIL-T-8504	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1								
		6061-T6AL		*	1	1	1	1	1								
1/4	-4	MIL-T-6845	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1							
		MIL-T-8504			*	1 1/6	1 1/6	1	1	1							
		6061-T6AL		*	1	1	1	1	1	1							
5/16	-5	MIL-T-6845	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1	1	1					
		MIL-T-8504				*	1 1/6	1 1/6	1	1	1	1					
		6061-T6AL		1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1					
3/8	-6	MIL-T-6845			1 1/6	1 1/6	1	1	1	5/6	5/6	5/6	5/6	5/6			
		MIL-T-8504						1 1/6	1 1/6	1	5/6	5/6	5/6	5/6			
		6061-T6AL		1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1	1	1			
1/2	-8	MIL-T-6845					1 1/6	1 1/6	1	1	5/6	5/6	5/6	5/6	5/6	5/6	5/6
		MIL-T-8504						1 1/6	1 1/6	1	5/6	5/6	5/6	5/6	5/6	5/6	5/6
		6061-T6AL			1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1	1	1	1	1	1
5/8	-10	MIL-T-6845				*	1 1/6	1 1/6	1 1/6	1	1	5/6	5/6	5/6	5/6	5/6	5/6
		MIL-T-8504						*	1 1/6	1 1/6	1	1	5/6	5/6	5/6	5/6	5/6
		6061-T6AL				*	1 1/6	1 1/6	1 1/6	1 1/6	1 1/6	1	1	1	1	1	1
3/4	-12	MIL-T-6845					*	1 1/6	1 1/6	1	5/6	5/6	2/3	2/3	2/3	2/3	2/3
		MIL-T-8054						*	1 1/6	1 1/6	1	1	5/6	5/6	5/6	5/6	5/6
		6061-T6AL					1	1	1	1	5/6	5/6	5/6	5/6	5/6	5/6	5/6
1	-16	MIL-T-6845						*	1 1/6	1 1/6	1	1	5/6	5/6	5/6	5/6	5/6
		MIL-T-8504							*	1 1/6	1 1/6	1 1/6	1	5/6	5/6	2/3	2/3
		6061-T6AL						1	1	1	1	1	5/6	5/6	5/6	5/6	5/6
1 1/4	-20	MIL-T-6845							1 1/6	1 1/6	1 1/6	1 1/6	5/6	2/3	2/3	2/3	2/3
		MIL-T-8504								1	1	1	1	1	1	5/6	5/6
		6061-T6AL							1 1/6	1 1/6	1 1/6	1	1	1	1	1	1
1 1/2	-24	MIL-T-6845								1 1/6	1 1/6	1 1/6	1	1	1	5/6	5/6
		MIL-T-8504								1 1/6	1 1/6	1	1	1	5/6	5/6	5/6
		6061-T6AL							1 1/6	1 1/6	1 1/6	1 1/6	1	1	1	1	1
2	-32	MIL-T-6845								1 1/6	1 1/6	1 1/6	5/6	5/6	2/3	2/3	5/6
		MIL-T-8504								1 1/6	1	1	1	5/6	5/6	5/6	5/6
		6061-T6AL								1 1/6	1 1/6	1	1	1	1	1	1

Notes ..

(1) * To avoid excessive tube collapse a mandrel must be used for these sizes.

(2) Figures given are for sleeve MS 21922 and nut MS 21921.

Note ...

Crazing cracks in the finish are not detrimental to the safety or function of the fitting.

16.7 The minimum diameter at the sleeve cut (7) must not be less than that given in Table 8.

TABLE 7 TUBE PROJECTION FROM SLEEVE PILOT

Tube dash size	Tube outside diameter in	mm	Approximate tube projection in	mm
-2	1/8	3.18	0.11	2.8
-3	3/16	4.76	0.11	2.8
-4	1/4	6.35	0.11	2.8
-5	5/16	7.94	0.156	4.0
-6	3/8	9.52	0.172	4.4
-8	1/2	12.70	0.188	4.8
-10	5/8	15.87	0.203	5.1
-12	3/4	19.05	0.22	5.6
-16	1	25.40	0.23	5.8
-20	1 1/4	31.75	0.25	6.4
-24	1 1/2	38.10	0.25	6.4
-32	2	54.80	0.28	7.1

Note ...

These figures are not an inspection standard.

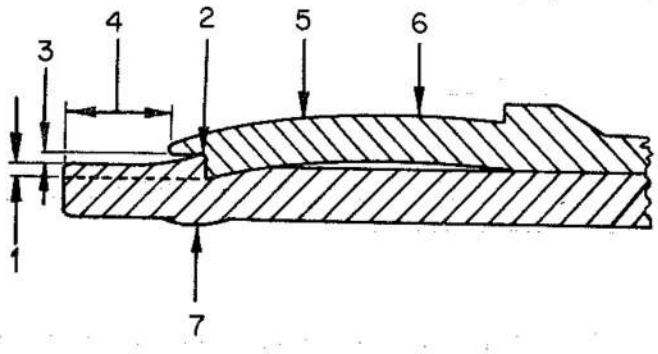


Fig 4 Section through a preset sleeve

TABLE 8 MINIMUM INSIDE DIAMETER OF TUBING AT SLEEVE CUT

Tube outside diameter	6061 aluminium		1/8 hard stainless steel		Annealed stainless steel	
	wall thickness	minimum id	wall thickness	minimum id	wall thickness	minimum id
1/8	0.020	0.060	0.016	0.070	0.020	0.060
3/16	0.028	0.095	0.018	0.110	0.020	0.115
1/4	0.035	0.150	0.020	0.165	0.028	0.155
5/16	0.049	0.180	0.022	0.225	0.035	0.225
3/8	0.049	0.240	0.025	0.290	0.049	0.270
1/2	0.065	0.330	0.028	0.400	0.058	0.380
5/8	0.083	0.420	0.035	0.485	0.065	0.475
3/4	0.095	0.530	0.042	0.610	0.083	0.590
1.0	0.065	0.830	0.065	0.840	0.083	0.800

16.8 As a final check that the fitting is properly preset the pipe assembly should be pressure tested.

Cleaning

WARNING ...

IT IS IMPORTANT THAT THE CLEANING PROCEDURES FOR LIQUID AND GASEOUS OXYGEN PIPES ARE STRICTLY ADHERED TO: (REFER TO AP 107D-001-1, CHAP 4). MANY MATERIALS, PARTICULARLY OIL AND GREASE, ARE SUBJECT TO SPONTANEOUS COMBUSTION WHEN EXPOSED TO UNDILUTED OXYGEN UNDER PRESSURE.

17 Prior to testing, storage or fitting to an aircraft, pipe assemblies must be cleaned as detailed in Chap 15.

TESTING

CAUTION ...

Before connecting the pipe assembly to test equipment, refer to installation procedure (para 23).

Proof pressures

18 The wide range of wall thickness in the tubing of American origin used in conjunction with MS fittings leads to there being some appreciably differing test pressures. These are given in Tables 9, 10 and 11.

► 19 The pipe testing procedure is to be carried out in accordance with Chap 17. Reference must be made to Tables 9, 10 and 11 for proof test pressures.

19.1 The duration of testing is to be five minutes. ◄

TABLE 9 PROOF PRESSURES FOR 6061-T6 ALUMINIUM ALLOY TUBING

Wall thickness inches	Outside diameter of tubing, inches - lbf/in²									
	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2
.016	4000	3000								
.020	6000	4000	3000	1500	1500	1500				
.028	6000	6000	4000	3000	1500	1500	1500			
.035		6000	6000	4000	3000	1500	1500	1500	1500	
.042			6000	6000	4000	3000	1500	1500	1500	
.049				6000	4000	3000	3000	1500	1500	1400
.058					6000	3000	3000	1500	3000	
.065					6000	4000	4000	3000	3000	
.083						6000	6000	4000	4000	
.095							6000	4000	4000	
.109							6000	6000	6000	
.120								6000	6000	

Note ...

lbf/in²	bar	lbf/in²	bar
1400	95.53	4000	275.79
1500	103.42	6000	413.69
3000	206.84		

TABLE 10 PROOF PRESSURES FOR ANNEALED 304, 321 AND 347 STAINLESS STEEL TUBING

Wall thickness inches	Outside diameter of tubing, inches - lbf/in²								
	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4
.016	4000	3000	1500	1500	1500	1500			
.020	6000	4000	3000	3000	1500	1500			
.028	6000	6000	4000	4000	3000	1500	1500	1500	
.035		6000	6000	4000	4000	3000	1500	1500	1500
.042		6000	6000	6000	4000	3000	3000	1500	1500
.049			6000	6000	4000	4000	3000	1500	1500
.058				6000	6000	4000	4000	3000	1500
.065					6000	6000	4000	3000	1500
.083					6000	6000	6000	4000	3000
.095						6000	6000	4000	4000
.109						6000	6000	6000	4000
.120							6000	6000	4000

TABLE 11 PROOF PRESSURES FOR 304 1/8H STAINLESS STEEL TUBING

Wall thickness inches	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4
.016	6000	6000	6000	4000	3000	1500			
.020	6000	6000	6000	6000	4000	3000	3000		
.028	6000	6000	6000	6000	6000	4000	4000	3000	3000
.035	6000	6000	6000	6000	6000	6000	4000	3000	3000
.042			6000	6000	6000	6000	6000	4000	4000
.049				6000	6000	6000	6000	4000	4000
.058					6000	6000	6000	6000	6000
.065						6000	6000	6000	6000
.083							6000	6000	6000
.095								6000	6000

INSPECTION PRIOR TO INSTALLATION

Fittings and pipe assemblies (fig 5)

20 Each assembly is to be checked as follows prior to installation:

20.1 Visual or flow check to ensure that the passage or passages are free from obstruction.

20.2 Visual assessment of all sealing surfaces to ensure that they are smooth and without scratches or indentations which could provide a leakage path.

20.3 The hexagons on the fittings are undamaged.

Note ...

Fig 5 illustrates typical damage to fittings but the sleeve and nut are illustrated in fig 3.

Tubing

21 Tubing is to be inspected both prior to and after installation as follows:

21.1 For dents, any dent which has a depth less than 20 per cent of the tubing diameter is acceptable unless it is on the heel of a short bend radius.

21.2 For nicks, any nicks of greater depth than 15 per cent of tube wall thickness are unacceptable.

CAUTION ...

Any aluminium, aluminium alloy or steel tubing carrying pressures in excess of 69 bar (100 lbf/in²) with nicks in excess of 15 per cent of the wall thickness is to be rejected.

22 Nicks of less than 15 per cent of the wall thickness of aluminium, aluminium alloy or steel tubing may only be accepted after the tubing has been reworked by burnishing with hand tools.

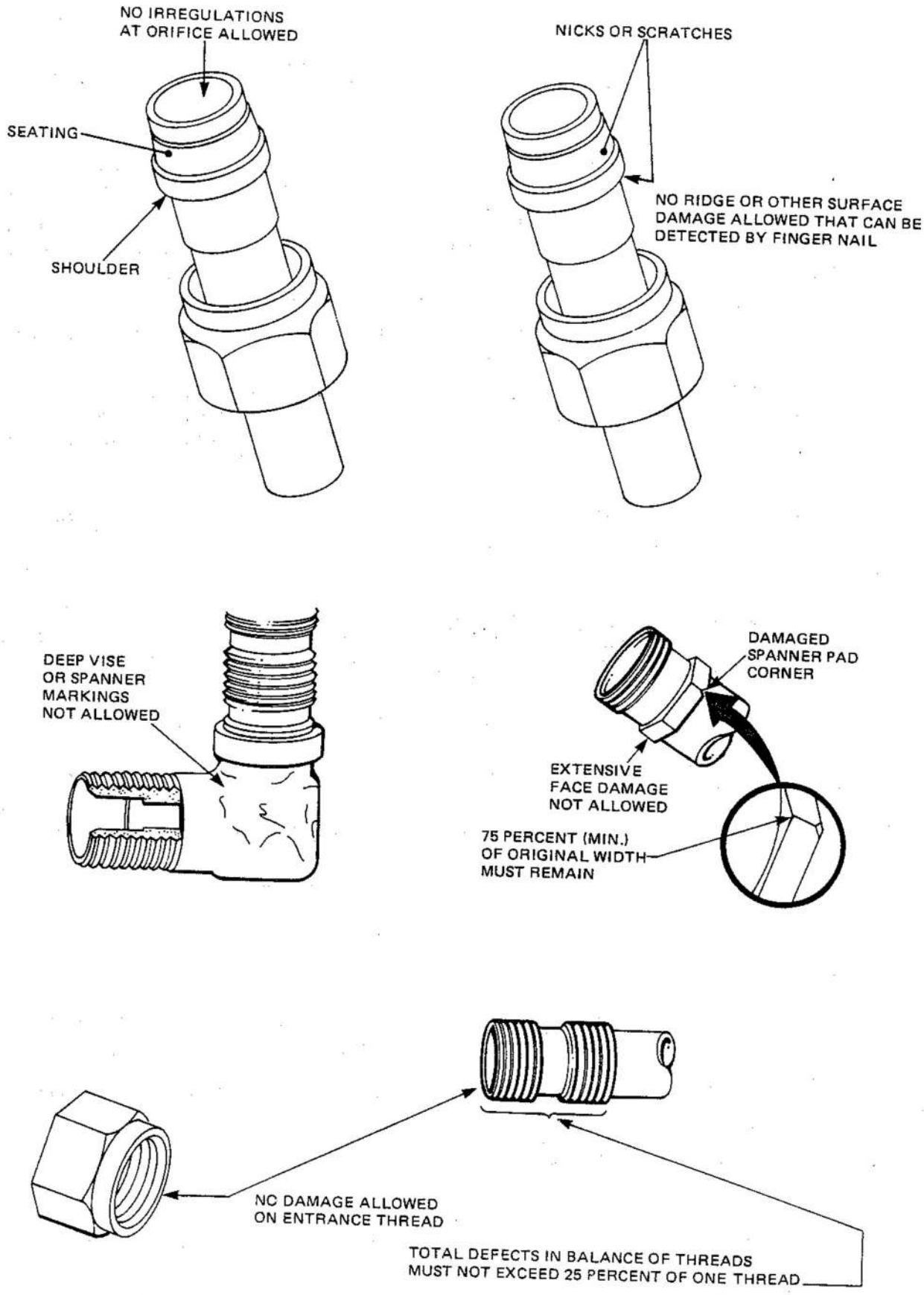


Fig 5 Damage to fittings

INSTALLATION OF REPLACEMENT PIPE ASSEMBLIES IN AIRCRAFT

Procedure

23 The pipework should be clean. Check that the protective caps are undamaged and if ingress or dirt seems possible, reclean the pipe (Chap 15), then proceed as follows:

23.1 Remove the protective caps and examine seating and mating surfaces for scratches or other defects likely to provide leakage paths.

23.2 Clean pipe and coupling mating surfaces using a lint free cloth. Use clean white spirit, where necessary, to remove any PX24 protective coating on steel fittings.

23.3 Loosely assemble the pipe to match the fairlead positions, ensuring that clearances to other pipes, components and bulkheads are adequate, and that the pipe run is tension free (para 3).

23.4 Lightly tighten all coupling nuts until resistance to turning is encountered. Should it be impossible to run the nut down with the fingers, use a set spanner, but take care to locate the bottoming point.

Note ...

It is important that the final tightening commences at the point where the nut just begins to bottom.

CAUTION ...

Two spanners must be used to tighten the halves of a union. One spanner to turn the union nut, and the other to prevent any movement of the composite unit (elbow, tee cross or pipe).

24 Make the final tightening, observing the caution, as follows:

24.1 Using a set spanner turn the union nut 1/6 turn (one flat on a hexagon nut).

24.2 Tighten the remaining unions on the pipe assembly in the same manner.

24.3 The assembly is now ready for system testing.

Leaks during system testing

CAUTION ...

On no account may union nuts be tightened while the system is under pressure. This can cause permanent deformation of the threads.

25 If the connection leaks during system pressure testing, release the pressure, tighten the union by an additional 1/6 turn and retest.

25.1 If leakage persists, loosen and completely disconnect the nut. Inspect components of the fitting for scores, cracks, presence of foreign material, or damage due to previous overtightening.

25.2 Reassemble fitting, run nut up finger tight if possible and repeat spanner tightening procedure (para 24).

25.3 Do not in any circumstances tighten the fitting nut more than 1/3 of a turn (two flats of the hexagon on the nut).

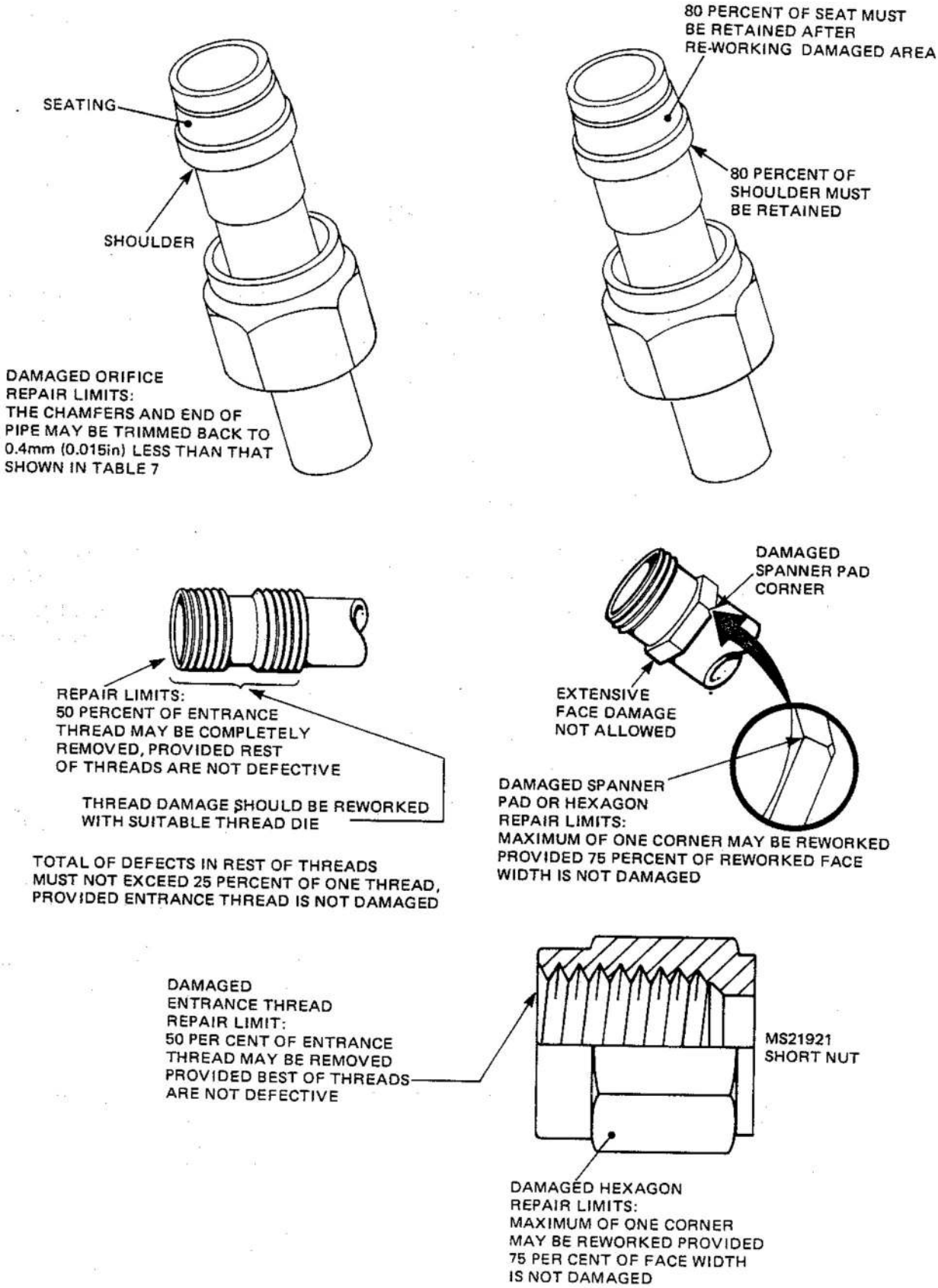


Fig 6 Permissible repairs to fittings

Leakage from an installed fitting

26 Do not tighten. Loosen and completely disconnect the nut. Then proceed as described in paras 25.1, 25.2 and 25.3.

Repair of pipe assemblies

27 Since it is not permissible to replace MS sleeves (para 15.4.1), corrective work is limited to polishing of seatings, improving the surfaces of hexagons and repairs to threads (fig 6). Indentations and nicks in pipes may be corrected as detailed in para 22.

Notes ...

(1) Any visible penetration of the tube wall surface, by chafing, rubbing or fretting is to be investigated and the cause of the damage corrected.

(2) After correcting such conditions the pipe assembly must be replaced regardless of the type of metal, system fluid or pressure ranges involved.

Corrective work on fittings (fig 6)

28 The permissible rework to fitting is as follows:

28.1 Damaged orifices may be corrected by trimming back the chamfers and the end of pipe to 0.4 mm (0.015 in) less than that shown in Table 7.

28.2 Damaged sleeves may be reworked on damaged seating or shoulder provided 80 per cent of the seating and 80 per cent of the shoulder are retained.

28.3 Damaged threads; the repair limits are:

28.3.1 50 per cent of entrance threads may be completely removed, provided the rest of the threads are not defective.

28.3.2 Total of defects in the rest of the threads must not exceed 25 per cent of one thread provided entrance thread is not damaged.

28.4 Damaged spanner pad or hexagon; repair is limited to a maximum of one corner provided 75 per cent of the reworked face width, or hexagon flat, is not damaged.

28.5 Damaged union nut; the hexagon may be repaired as para 4. 50 per cent of the entrance thread may be removed provided the rest of the threads are not defective.

Note ...

Since the union nut is retained on the pipe by the sleeve, repair may be limited or impossible. In this case, provided the tubing material and wall thickness is acceptable, a Permaswage union can be fitted in place of the defective coupling (Chap 9).

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Chapter 14

AIRCRAFT PITOT AND STATIC SYSTEM PIPE CONNECTIONS AND UNIONS

CONTENTS

Para
1 General

General

1 This chapter describes the design requirement to make it mechanically impossible to cross connect an aircraft's pitot and static systems. This is achieved by using larger diameter pipe and union thread diameters for the static system and retaining smaller pipe and unions for the pitot system. New aircraft instruments are supplied with corresponding dissimilar size connections which are:

1.1 For pitot systems - 7/16 in x 20 UNF threads for 7.94 mm (5/16 in) pipe.

1.2 For static systems - ½ in x 20 UNF threads for 9.52 mm (3/8 in) pipe.

Note ...

The corresponding union thread sizes for metric systems are for pitot systems M16 x 1.5 and for static systems M18 x 1.5.

2 Conversion information to adapt the new type instruments to earlier aircraft systems is contained in Chap 14-1, 14-2 and 14-3.

Note ...

Information concerning hoses and fittings for these systems is given in AP101A-0301-1 for repairable hoses and fittings. AP101A-0305-1 describes hose assemblies which are non-repairable.

Chapter 14-1

PIPE CONNECTIONS TO AIRCRAFT INSTRUMENTS AND EQUIPMENTS

CONTENTS

Para
1 Design requirements
4 New instruments
5 Aircraft installations

Table Page
1 Pitot and static connections for new instruments 1

Design requirements

1 To avoid incorrect connection of pitot and static lines, there is a design requirement to make it mechanically impossible to cross connect the pitot and static systems. This is achieved in the aircraft installation by the introduction of 9.52 mm (3/8 in) diameter alloy tubing (30B/1054954) for the static lines, while retaining 7.94 mm (5/16 in) diameter alloy tubing (30B/1054948) for the pitot lines, and in the instruments by providing a different screwed recess for pitot and static connections.

2 For all new instruments, the manufacturers are required to provide a 7/16 in x 20 UNF screwed recess for the pitot connection and a ½ in x 20 UNF screwed recess for the static connection.

3 To connect the instruments manufactured to this standard to the aircraft system the connections listed in Table 1 are to be used.

TABLE 1 PITOT AND STATIC CONNECTIONS FOR NEW INSTRUMENTS

Ref No	Description	AGS Drg No
28F/4051940	Pitot connector (screwed)	3092
28F/4051941	Pitot connector (plain) 7.94 mm (5/16 in) dia outlet	3093
28F/4051942	Static connector (screwed)	3094
28F/4051943	Static connector (plain) 9.52 mm (3/8 in) dia outlet	3095
28F/4051944	'O' ring gasket for 7/16 in x 20 UNF (pitot connector)	3098
28F/5194563	'O' ring gasket for ½ in x 20 UNF (static connector)	3099

New instruments

4 New instruments to this standard will be supplied without connectors and, when it is necessary to return them to stores, the connectors should be removed and retained for further use. A new 'O' ring gasket is to be used whenever a connector is fitted.

Aircraft installations

5 New aircraft installations are designed to use these connections to connect the instrument directly to the aircraft pitot static system, and in these circumstances the appropriate connector and 'O' ring gasket should be used.

6 Earlier aircraft installations, however, utilize 7.94 mm (5/16 in) diameter alloy tubing for both pitot and static lines and new series instruments, when fitted with their appropriate connectors, cannot be connected directly to the aircraft system. It may be necessary to adjust the length of pitot piping but in the case of the static connection it is necessary to alter the aircraft installation by sleeving the 7.94 mm (5/16 in) diameter pipe to 9.52 mm (3/8 in) diameter to permit the new series connection to be used.

Chapter 14-2

PROCEDURE FOR ALTERING AIRCRAFT INSTALLATIONS TO SUIT NEW INSTRUMENTS

CONTENTS

Para
1 Earlier instruments
4 Limited space adaptors

Fig
1 Static pipe sleeve ... ... Page 2
2 Stepped adaptor 2

Earlier instruments

1 Earlier instruments are normally connected into the aircraft pitot and static lines at 7.94 mm (5/16 in) elbow, tee or straight unions, utilizing union nuts. These connections should be used to connect the pitot pipelines to the instrument. It may be necessary to adjust the length of the aircraft pitot pipe to accommodate the new instrument connector.

2 The new static connectors, however, are 9.52 mm (3/8 in) diameter and it is necessary to sleeve the aircraft static pipe to increase the 7.94 mm (5/16 in) diameter tubing to 9.52 mm (3/8 in) diameter. The sleeving procedure is detailed in para 3 below. It will normally be found to be most convenient to effect this change of diameter on the aircraft side of the first union and replace this union with its equivalent 9.52 mm (3/8 in) version. The instrument may then be connected to this union by the plain static connector (AGS 3095), or by a short length of 9.52 mm (3/8 in) diameter tubing and the screwed static connector (AGS 3094).

3 The sleeve is illustrated in fig 1 and the procedure to fit a sleeve is as follows:

3.1 Remove any pipes to be sleeved from the aircraft and ensure they are not deformed.

3.2 Thoroughly clean and degrease the tubing and sleeve, using Trichloroethane (33D/2201949), immediately prior to gluing.

3.3 Apply Araldite (33H/9437791) to the exterior of the 7.94 mm (5/16 in) diameter tubing and with a rotating action, slide the 9.52 mm (3/8 in) diameter sleeve (30B/1054954) on until the ends are flush.

3.4 Ensure a smooth finish to the Araldite at each end of the sleeve. Care should be taken to prevent the adhesive entering the bore of the pipe.

3.5 The mixing and curing instructions, supplied with the Araldite, are to be followed carefully, the tubing is not to be replaced on the aircraft until the sleeve is secure, and has been tested for leaks between the pipe and the sleeve.

Limited space adaptors

4 In some aircraft due to space limitations it may be necessary to shorten the length (A) of the sleeve. The length must not be less than 12.7 mm (½ in).

5 It may be necessary to make a stepped adaptor as shown in fig 2. In this case the straight length of tube (B) must not be less than 14.3 mm (9/16 in), and the length of sleeve not below 12.7 mm (½ in) (fig 2).

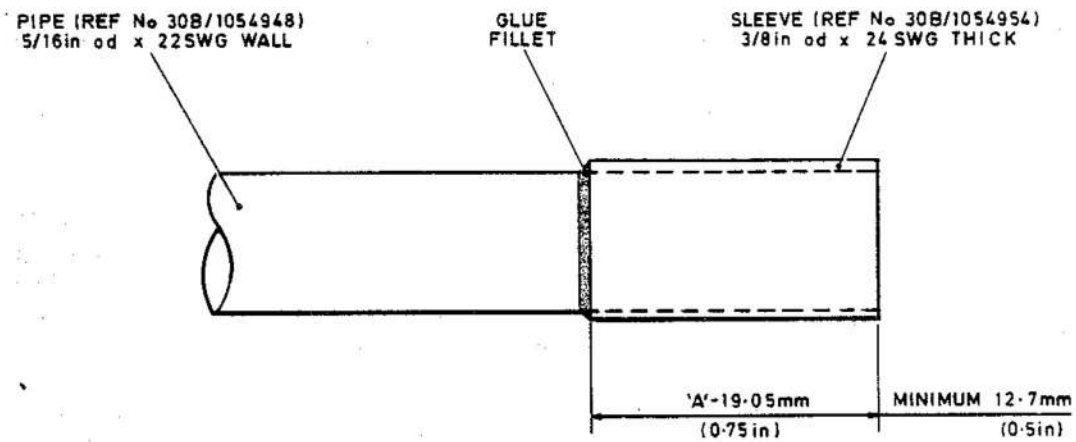


Fig 1 Static pipe sleeve

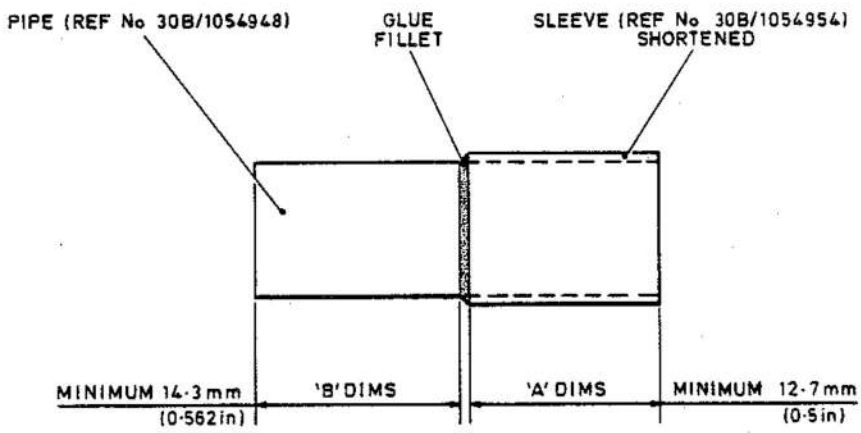


Fig 2 Stepped adaptor

Chapter 14-3

AGS 838 TYPE UNIONS - ASSEMBLY INSTRUCTIONS

CONTENTS

Para
1 Assembly technique
2 Testing

Table Page
1 Applicable AGS 838 series unions 2

Assembly technique

1 The following technique is to be observed whenever AGS 838 type unions are assembled:

1.1 Ensure that all components are clean and that threads are free from burrs etc. Also ensure that the alloy tubing is not reduced in diameter, either by wear or overtightening. If metal components are dirty, clean them with Trichloroethane (33D/2201949) (Chap 15).

1.2 Check that the rubber seal (or silicon seal) is firmly held in the union nut. Reject and scrap any unsatisfactory items.

1.3 Slide nut and bush assembly on to tubing and check that it is a close but free push fit on the tubing. Reject and scrap any unsatisfactory items.

1.4 Insert the end of the tubing into the recessed portion of the union body, ensuring that the tube is fully home and that any spring in the pipelines, which would place the joint in tension, is eliminated.

1.5 Slide the union nut up to the body and fully tighten with the fingers until the tubing has been gripped by the rubber bush. Check that the tube is fully home in the union body.

1.6 Using correct spanner continue to tighten nut until the tubing is firmly held. Ideally a torque of 2.8 Nm (25 lbf/in) should be applied. This is equivalent to quarter of a turn applied in excess of finger tightness in the case of rubber bushes, and one third turn in excess of finger tighteness for silicon bushes. Overtightening, with the danger of wasting the alloy tubing, must be avoided.

1.7 Ensure pipe is fully home in the union body, by reference to witness marks where applicable.

1.8 Carry out appropriate leak tests specified for particular systems.

Testing

2 Any joint found leaking during test is not to be rectified by further tightening but is to be dismantled and inspected for the cause of leaks not noticed during previous assembly. It is then to be reassembled in accordance with the foregoing instructions.

TABLE 1 APPLICABLE AGS 838 SERIES UNIONS

Ref No	AGS Pt No	Description	Nominal size	
			inch	mm
28F/1046307	AGS 838/1	Straight union body	$\frac{5}{16}$	7.94
28F/1046308	AGS 838/2	Tee union body	$\frac{5}{16}$	7.94
28F/1046309	AGS 838/3	Elbow union body	$\frac{5}{16}$	7.94
28F/1037653	AGS 838/13	Nuts, union	$\frac{5}{16}$	7.94
28F/4051864	AS 6710	Straight union body	$\frac{3}{8}$	9.52
28F/4051875	AS 6711	Tee union body	$\frac{3}{8}$	9.52
28F/7106548	AS 6712	Elbow union	$\frac{3}{8}$	9.52
28F/1037452	AS 8599	Nuts, union	$\frac{3}{8}$	9.52

19062/8271346 8/84 LT1526 LP770/314

Chapter 15

CLEANING OF RIGID PIPELINES

Introduction

1 It is important to remove all contamination from both the inside and outside of pipes in readiness for fitting to the aircraft. Cleaning, de-greasing and protective materials are of great importance to proper maintenance of equipment. These materials must be handled carefully when used, personnel should be aware of the particular purpose for which the material is intended. In some instances there is danger to health of personnel and risk to equipment.

CAUTION ...

Carry out safety precautions as laid down by AP 3158 Vol 2 Lft/H24.

All pipes are to be cleaned prior to storage testing and post testing.

General procedure

2 The procedure to be used for cleaning all hydraulic/pneumatic pipes is as follows:

2.1 Clean the exterior of the pipes and couplings with a clean lint free cloth moistened with tricholroethane.

2.2 Flush through and completely fill the bore of the pipe with distilled or filtered tricholroethane at a pressure not exceeding 0.7 bar (10 lbf/in^2); flush pipe until bore is clean.

2.3 Pass clean dry hot air through the bore of the pipe to evaporate all traces of tricholroethane.

CAUTIONS ...

(1) No trace of tricholroethane shall remain in the pipe on completion of the procedure. Masking tape, rags or similar shall not be used for blanking. The tricholroethane used for flushing shall be replaced when a drop evaporated on clean white paper leaves a perceptible dirt mark.

(2) It is important that cleaning procedures laid down in AP107D-0001-1 Chap 4 be strictly adhered to when cleaning liquid and gaseous oxygen system parts.

Chapter 16

THE MANUFACTURE OF RIGID OXYGEN PIPELINES

CONTENTS

Para
1 Introduction
2 Tubing
3 End fittings
4 Safety precautions
5 Manufacturing procedure (Warning)
6 Cleaning
7 Testing (Warning)
8 Purging and bagging (Warning)

Introduction

1 This chapter is designed to give guidance in the manufacture of rigid pipes specifically for use in oxygen systems. All the instructions in this chapter should be carried out in conjunction with the information contained in the relevant sections of AP 107D-0001-1 and previous chapters of this publication.

Tubing

2 Metal tubing for use on aircraft is listed in AP 1086 under sections 30A and 30B, and is available in various sizes and materials conforming to BS and DTD specifications, a list of which will be found in AP 119A-0301-1, Metals and Alloys. Tubing for use in oxygen systems must conform to the correct specifications and must be approved for use in oxygen systems at the appropriate pressure. Damaged or defective tubing is not to be used and care should be taken in handling and storing new tubing (AP 830, vol 2 leaflet A1). Before use, tubing is to be cleaned and inspected to ensure that no damage exists. In order to prevent premature failure due to fatigue, great care must be taken to avoid scratching or scoring the tube when handling or during pipe manufacture.

End fittings

3 Although rigid pipe end fittings are manufactured in many shapes and sizes, only the following five types are used in oxygen systems:

3.1 Standard swaged fittings.

3.2 Standard stainless steel flared fittings.

3.3 Miflex couplings.

3.4 AN (American) flared fittings.

3.5 MS (American) flareless fittings.

Note...

Detailed information and specifications of these fittings is included in the preceding chapters of this publication.

Safety precautions

4 Before work is carried out on any item of an oxygen system, the safety precautions for oxygen components detailed in AP 107D-0001-1 Chap 2 are to be

complied with.

Manufacturing procedure

5 Oxygen pipes are to be manufactured in accordance with the following procedure:

5.1 Obtain a suitable length of tube of the same specification as the original pipe.

5.2 Bend the tube to shape using either a pattern or template, following the principles detailed in Chapter 2 of this publication and AP 119G-0104-1.

Note...

The original pipe may be used as a pattern if available.

5.3 Before the pipe is assembled, the ends of the tube and the end fittings to be used are to be cleaned iaw AP 107D-0001-1 Chapter 4.

WARNING...

WHEN CLEANING WITH TRICHLOROETHANE, THE SAFETY PRECAUTIONS LAID DOWN IN AP 119A-0512-1 CHAPTER 2 MUST BE COMPLIED WITH.

5.4 If flared end fittings are to be used, flare the ends of the tube in accordance with Chapter 3 or 5 of this publication.

5.5 Make up the assembly in accordance with the relevant previous chapter depending on which type of fittings are being used, with the following exceptions:

5.5.1 DO NOT USE LUBRICANT ON ANY TYPE OF FITTING.

5.5.2 DO NOT USE LOCTITE ON SWAGED FITTINGS.

Cleaning

6 All pipes are to be cleaned both before and after testing in accordance with AP 107D-0001-1 Chapter 4.

Testing

7 Pressure test all pipes with dry nitrogen to the proof pressure recommended according to type, size and system. Pipes are to be immersed in a water bath and covered with a guard. Once pressurized, the pipe assembly should be allowed to stabilize for 5 minutes, after which no leaks are acceptable. For test procedure refer to Chapter 17 of this publication.

WARNING...

ASSEMBLIES UNDER TEST MAY BURST, ESPECIALLY AT MEDIUM AND HIGH PRESSURE, AND MUST BE GUARDED SO THAT THERE IS NO HAZARD TO THE OPERATOR.

Purging and bagging

8 After testing, clean the pipe again in accordance with AP 107D-0001-1. Chapter 4, then purge with dry nitrogen for at least 3 minutes. Fit clean blanking caps to each end of the pipe, and label and seal in a clean polythene bag.

WARNING...

DO NOT USE ANY TYPE OF BLANKING PLUG OR CAP WHICH CAN FRAGMENT AS PARTICLES COULD PASS INTO THE BORE OF THE PIPE ASSEMBLY.

Chapter 17

PRESSURE/FLOW TESTING OF RIGID PIPELINES

Para

1 General
3 Test equipment
5 Pressure testing
6 Test medium
7 Test procedure
10 Post testing
11 Blanking plugs

General

1 This test procedure covers the range of locally manufactured pipes and is to be used in conjunction with the relevant sub-chapter of this publication to determine the correct system pressure and proof pressure for testing purposes.

2 Absolute standards of cleanliness are to be observed at all times and care must be exercised to prevent the ingress of foreign matter into pipe assemblies.

WARNING ...

ASSEMBLIES UNDER TEST MAY BURST, ESPECIALLY AT MEDIUM AND HIGH PRESSURE, AND MUST BE GUARDED SO THAT THERE IS NO HAZARD TO THE OPERATOR.

CAUTIONS ...

(1) The prevention of leaks during testing by overtightening is prohibited.

(2) These procedures are not to be used for liquid or gaseous oxygen system pipes and hoses for which the procedures laid down in Chap 16 are to be adhered to.

Test equipment

3 The following equipment is required for complete examination and testing of assemblies:

3.1 Regulated pressure supply (for example, hand pump) with gauge, using a particular fluid as a pressurising medium.

3.2 Electrical probe illuminator and dental mirror, for internal examination of pipe assemblies.

3.3 Where practical, facilities for drying with a continuous blast of hot air over external surfaces and through internal diameter of the assembly at a temperature of between 160° and 180°C for a period of 30 minutes.

4 Assemblies which convey a gas under pressure require in addition:

4.1 Regulated clean, dry compressed air/nitrogen supply regulator and with gauge, together with a water container of sufficient size to enable the assembly to be submerged.

Pressure testing

5 When a pipe assembly is considered to be serviceable, either after local manufacture, or after removal from an aircraft for examination it must be pressure tested to the applicable test proof pressure for its type, size and system. The data is given in the sub-chapter relevant to the particular pipe assembly to be tested.

Test medium

6 The test medium to be selected in the first instance is the fluid which normally passes through the pipe, however, fuel pipes are to be tested using OM15, then cleaned. Additionally, pipes used in gaseous systems are to be tested with nitrogen, the assembly being immersed in water, then cleaned.

Test procedure

7 Lay the assembly on a bench in an unrestricted position. Blank off one end of the pipe and connect a regulated supply to the other end as specified in the installation tables.

WARNING ...

ASSEMBLIES UNDER TEST MAY BURST, ESPECIALLY AT MEDIUM AND HIGH PRESSURES, AND MUST BE GUARDED SO THAT THERE IS NO HAZARD TO THE OPERATOR.

8 Refer to the installation data table for the pipe assembly to be tested and note correct test pressure for the size and type then proceed as follows:

8.1 Thoroughly bleed assembly and slowly apply the applicable test procedure for five minutes.

8.2 During period of test, observe pressure gauge and watch assembly for signs of leakage, deformation of the pipe and pipe connections as pressure is applied.

CAUTION ...

If there is leakage from the unions during this test they must on no account be overtightened to stop the leak. Release pressure, disconnect end fittings and examine sealing faces for cleanliness and scores, then retest.

9 After successful completion of the test using a liquid medium, test assemblies which convey a gas under pressure as follows:

9.1 Disconnect the assembly from the fluid test equipment and clean.

9.2 Connect assembly to a regulated, clean, dry supply of air or nitrogen, lay assembly in an unrestricted position in a tank of water.

9.3 Slowly apply correct test pressure and maintain for five minutes.

9.4 Check for deformation and any signs of leakage. Leaks will be apparent either as a thin trickle or stream of bubbles. Locate exact position of emanation of bubble stream as leaks from test adaptors, connections etc, can be mistaken for pipe or coupling failures.

Post testing

10 After completion of testing, disconnect the hose assembly from the test equipment and clean the assembly in accordance with Chap 15.

Blanking plugs

11 After tests have been completed threaded end couplings and any other threaded connections are to be fitted with the correct protective cap or plug. Use polythene bags placed over the open ends to seal 'V' flanges and other orifices for which caps and plugs are not available. Secure the bag in place with adhesive tape.

CAUTION ...

Do not use any type of blanking plug or cap which can fragment as particles could pass into the base of the assembly.

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