CHAPTER 1 - GENERAL INFORMATION AND TOOLS

Contents

1. General information

A. The Chapters in this section describe the removal, replacement and adjustment of these units of the engine which may be changed in service.

B. It may be necessary to remove an engine from the aircraft to permit the removal of certain units, in these instances, reference should be made to the engine removal procedure detailed in the relevant aircraft Air Publication.

C. Joint washers, sealing rings and all locking devices (except spring washers and locking plates) which are disturbed during servicing operations, should be renewed.

D. Before effecting servicing operations on the engine, refer to paragraph 8 'Precautions'.

NOTE

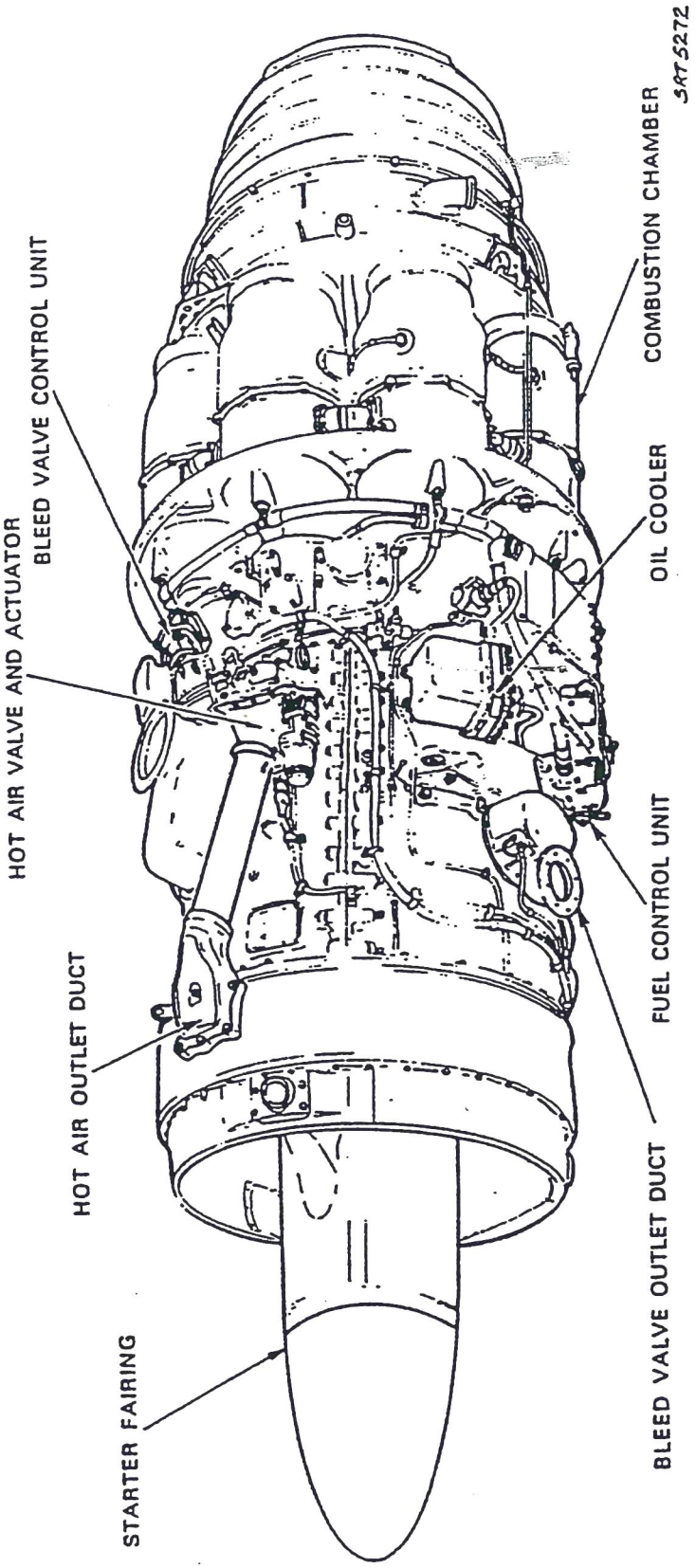
Handle hazardous materials in an environmentally friendly manner and in accordance with local regulations.

2. Lubricants for assembling

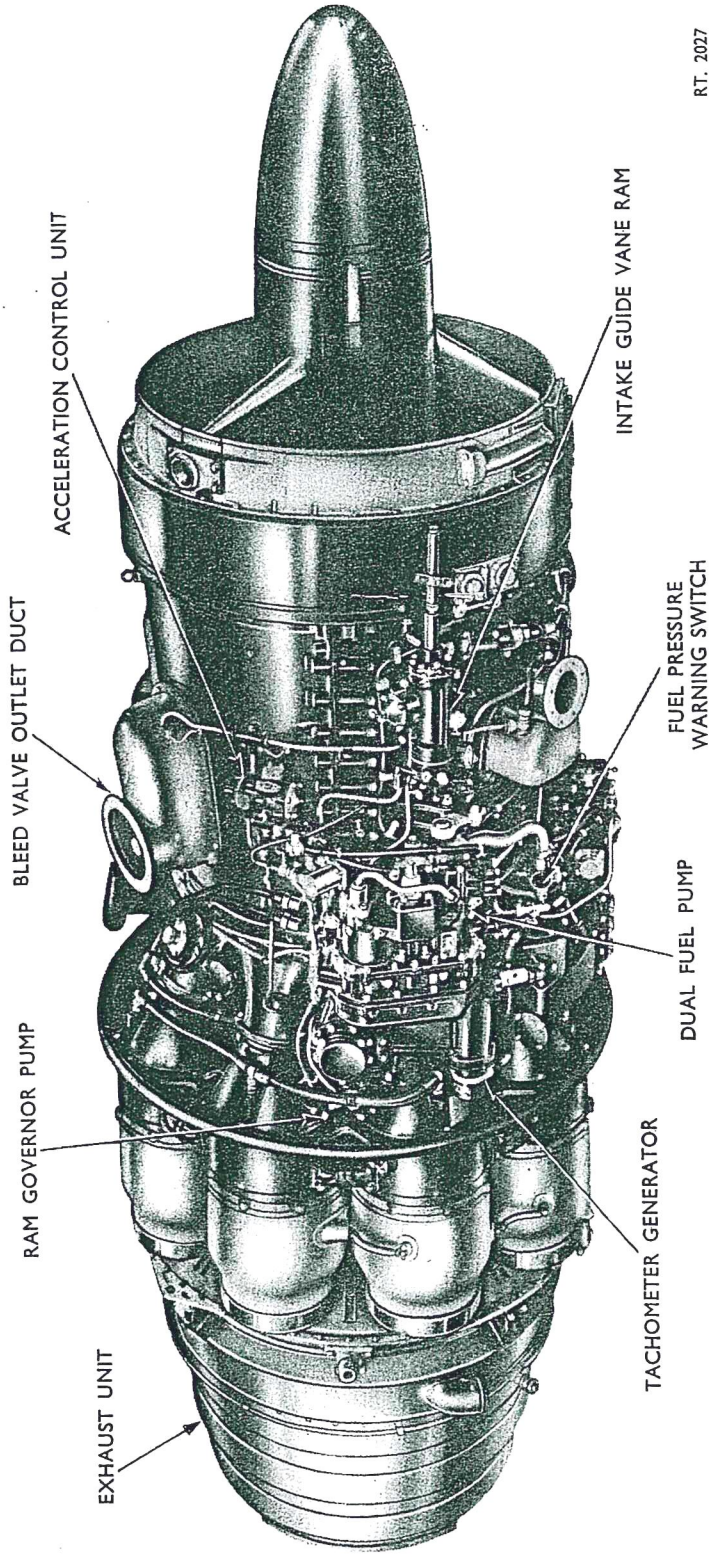
A. It is essential that the correct lubricants are used during servicing and assembling.

(1) On control rod ball-joints, use low temperature grease XG-295 (Ref.No.34B/9423152 N.A.T.O. Code No. G-352).

(2) On screw threads use engine oil OX-38 (D.Eng.R.D.2487).



Location of engine units (left-hand side)
Fig.1



Location of engine units (right-hand side)
Fig.2

3. Identification, inspection, lubrication and fitting of rubber and synthetic rubber parts

A. Identification

(1) Rubber sealing ring identification is by the part number which is shown on the envelope in which sealing rings are individually packed. On the envelope (and on all associated packaging) is marked, as a minimum, the following information (examples given in brackets):

Description of part	(ring, sealing)
Quantity	(one, 1)
Rolls-Royce part number	(000,000)
Cure date	(2Q68)

(2) The sealing ring material is identified by self-colouring of the ring or by colour markings on the ring. A sealing ring which has become separated from its envelope can be identified as follows:

(a) Match the colour code marking on the sealing ring with the same marking in the identification of rubber sealing rings shown in the following table. Record the material code shown.

(b) Refer to the appropriate 'Schedule of Spare Parts' which relates the material code to the sealing ring part number, material description, dimensions and location.

B. Inspection

(1) Examine parts for signs of 'ageing' or degradation due to oxidation. This is shown by surface cracks and deterioration. To check, flex the part gently and discard if cracks are present before or after flexing.

(2) Do not automatically discard parts due to the presence of a white or coloured 'bloom' on their surface. Such blooms are often desirable anti-ageing layers and originate from the anti-oxidants used in high grade rubber.

(3) Examine, and discard if faulty, all parts for:

(a) Permanent distortion, flats and other obvious defects.

(b) Tackiness or surface hardening or softening.

(c) Blistering, peeling or cracks when rubber is extended or flexed.

(d) Chafing of outer covering and corrosion of, or damage to, end fittings of hose assemblies and cable harnesses.

(e) Corrosion of metal elements in bonded rubber to metal assemblies.

IDENTIFICATION OF RUBBER SEALING RINGS		
Identification colour code		Material code
Base colour	Number and colour of spots or lines	
black	1 yellow	F/E or WAD
black	1 yellow, 1 white	PE/FK or WAJ
black	1 yellow, 1 blue, 1 green	R/G or WAG
black	2 yellow	E/ORK
black	2 yellow, 1 blue	PE/EK or WAM
black	2 yellow, 2 green	VE/S or WAT
black	3 yellow	PE/OZR or WAK
black	4 yellow	VE/KR or WAS
black	part number in white ink	PE/DCR or WAL
black	1 white, 1 blue	PE/ELR
black	1 white, 2 blue	B/SK or WAB
black	1 white, 2 green	E/PVC or WAQ
black	1 white, 1 blue, 1 yellow	E/XCF or WAP
black	1 blue, 1 green	E/ORP
black	1 blue, 1 white, 1 green	PE/ERS
black	1 blue, 1 green, 1 yellow	N/GP or WAC
black	2 blue	E/ORS
black	3 blue	N/Q
black	1 green, 1 white	PE/FR
black	1 green, 1 yellow	E/OR
black	1 green, 2 yellow	E/ORK or WAN
black	3 green	PE/RN
black	4 green	VE/HT or WAR
brick red	2 black graphite	SE/DT
red	1 green	GF/ST
red	None, self-coloured	E/ET
orange	None, self-coloured	SE/MP or WAH
green	None, self-coloured	SE/F
blue	None, self-coloured	SE/G
pale blue	None, self-coloured	SE/CH or WAU
grey	None, self-coloured	SE/FM
brown	None, self-coloured	SE/MH
brownish red	None, self-coloured	SE/DTA
light brown	None, self-coloured	WAF
brown	None, packaged	WAY
brown	None, packaged	WAZ
CAUTION: THIS SEALING RING MUST ONLY BE USED ON TRANSPORTATION PARTS		
red	None, self-coloured	WAW
black	None, self-coloured	WDR

(f) Obstruction of the bore (flexible hoses).

(4) Pressure test flexible hoses as instructed in the relevant sections of this manual. If it is essential to fit a flexible hose when no facilities for pressure testing exist, then the hose must be removed for testing at the first available opportunity. On completion of pressure testing, drain the hose, blow through with clean air and seal the ends with blanks.

(5) Test electrical cables and harnesses for resistance, leakage and conductivity, as well as for chafing of the loom and satisfactory condition of the end fittings, as instructed in the relevant sections of this manual.

C. Lubrication

(1) Avoid indiscriminate use of lubricants when fitting rubber sealing rings: use only the recommended lubricant and apply sparingly immediately before fitting the rings to a unit or engine. Failure to observe the foregoing instructions can result in premature swelling of the rubber sealing rings during assembling.

CAUTION: DO NOT USE A LUBRICANT ON RUBBER SEALING RINGS OTHER THAN THAT RECOMMENDED FOR THE PARTICULAR APPLICATION.

(2) The choice of lubricant is controlled by the environment of the rubber sealing rings, i.e. air, fuel or oil system, rather than by the type of material from which they are manufactured. Unless otherwise instructed, the lubricants to be used during the fitting of rubber sealing rings are as follows:

(a) Air system - Silicone rubber lubricant, XG-25034B/2248408

(b) Fuel system - Liquid paraffin, 63G/2102397

(c) Oil system - clean engine oil, 34B/9100591

D. Fitting

(1) Use new rubber sealing rings when assembling units or engines.

(2) Cancelled

(3) Ensure that grooves and mating faces, to which the rubber sealing rings are to be fitted, are clean and smooth then lightly smear the grooves and mating faces with the recommended lubricant. Apply the lubricant, sparingly, to the total surface area of the rubber sealing rings before fitting.

(4) Take care to avoid stretching or twisting the rubber sealing rings whilst fitting; ensure that when fitted the rings are not twisted and that they are correctly seated in their grooves.

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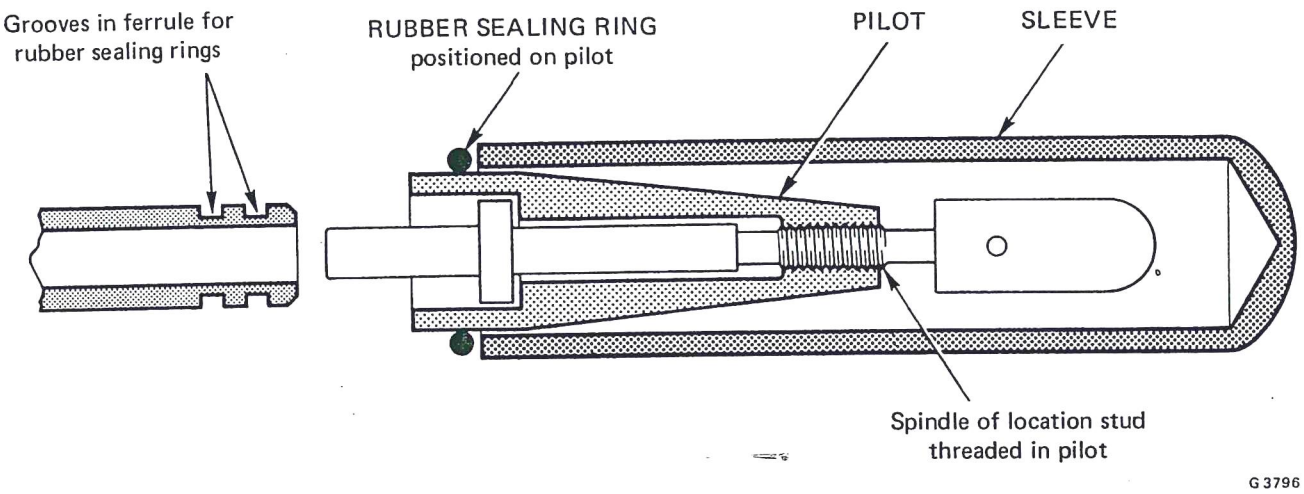

Typical pilot and sleeve assembling tool
Fig.3

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(5) Do not fit rubber sealing rings to any section of the engine whilst it is still hot, otherwise the sealing rings may stretch and be more liable to damage.

(6) Prevent rubber sealing ring breakages when fitting these items in such locations as fuel pipe double grooved ferrules by using a suitable pilot and sleeve assembling tool (Fig.3).

(7) Before fitting ferrules and tubes into their mating sockets check that the exposed surfaces of the rubber sealing rings are thinly coated with the recommended lubricant. Use a straight pushing movement to fit the ferrules and tubes into their sockets; this action will prevent twisting of the rubber sealing rings.

4. Apply jointing compound

WARNING: DO NOT SMOKE WHEN USING METHYLENE CHLORIDE; ENSURE THAT THE WORKPLACE IS WELL VENTILATED.

CAUTIONS: 1. ENSURE THAT METHYLENE CHLORIDE IS APPLIED ONLY TO JOINT FACES AS IT CAN DAMAGE AND REMOVE PAINT.

2. DO NOT APPLY TOO MUCH JOINTING COMPOUND TO THE JOINT FACES; EXTRUDED COMPOUND CAN BLOCK INTERNAL OIL AND/OR AIR PASSAGES.

3. ALLOW A PERIOD OF AT LEAST 10 MINUTES AIR-DRYING TIME TO ENSURE THAT THE SOLVENT IN THE COMPOUND HAS EVAPORATED; THE SOLVENT CAN CAUSE CORROSION.

A. Clean the joint faces using a clean cloth moistened with methylene chloride (33C/2244574); allow the faces to dry.

B. Using a clean stiff brush moistened with methylene chloride spread a thin even film of jointing compound PL.32 (33H/1983516, 33H/2202370 or 33H/2245078 as appropriate), over both joint faces and allow to air-dry for at least 10 minutes. Close the compound container to prevent evaporation of the solvent.

NOTE: Avoid using a brush with bristles set in glue or rubber.

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5. Torque tightening technique

General

A. A predetermined torque load is applied to nuts, bolts and setscrews to prevent overstressing and to provide optimum security. During assembling of the parts and assembling of the complete engine, nuts, bolts and setscrews must be tightened to either a special load for a particular application or to a standard load for the size of screw thread used. The parts to be torque tightened to special loads are listed in the relevant topic. Tables of standard torque loads are in this Standard Practice. Parts for which no special load is specified in the relevant topic should be tightened to the standard loads listed in the tables.

Lubrication

A. Lubrication is of great importance in achieving the correct tension in a threaded assembly because most of the applied torque is absorbed by friction at the screw thread and on the mating faces of the parts.

B. The standard lubricant to be used is clean engine oil, i.e. any of the approved oils used for the engine lubrication system, or graphite-base lubricant PL.198 which should be applied to the bolt threads and nut abutment faces.

C. PL.198 is the only lubricant, as an alternative to engine oil, which is approved for general use on threaded parts. The use of any other lubricants, including solid film lubricants in any form or any containing molybdenum disulphide is prohibited unless specifically instructed.

D. When a special lubricant is required, e.g. for extremely high torque loading or high temperature operating zones of the engine, the correct lubricant will be specified in the relevant topic.

E. The mean tensile load induced by the same applied torque can be as much as 80 per cent greater using an incorrect lubricant; bolts can be severely overstressed to the point of constant torquing.

Retightening of nuts

CAUTION: FAILURE TO CARRY OUT THE FOLLOWING INSTRUCTION COULD RESULT EITHER IN AN INADEQUATE CLAMPING LOAD OR, IF THE CORRECT TORQUE LOAD IS EXCEEDED IN AN ATTEMPT TO INCREASE THE CLAMPING LOAD, IN DAMAGE TO THE THREADS. THIS MAY NOT BE OBVIOUS AT THE TIME BUT MAY CAUSE FAILURE OF THE JOINT DURING SERVICE.

A. Whenever it becomes necessary to retighten nuts, remove the nuts, clean and lubricate the threads, and abutment faces refit the nuts and retighten to the specified torque load.

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Preliminary smoothing of threads and mating faces

A. Smooth the threads

NOTE: Smoothing the threads is necessary only when threaded parts are being fitted with loads in excess of 250 lb.ft. being applied.

(1) Lubricate the threads and mating faces of the nut and washer with clean engine oil or PL.198 unless otherwise instructed.

(2) Tighten the nut until approximately half the recommended torque load value is obtained.

(3) Remove the nut re-lubricate threads and mating faces, then re-tighten until the full torque load value is reached.

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B. Smooth the mating faces

Shrouded tab washers are prone to 'dishing' during manufacture and do not always flatten satisfactorily with a single torque tightening application; therefore, where shrouded tab washers are used, effect a double tightening procedure, as follows:

(1) Lubricate the screw threads and mating faces with clean engine oil or PL.198 unless otherwise instructed.

(2) Tighten the nut to the full torque load.

(3) Remove the nut, re-lubricate threads and mating faces, then re-tighten until the full torque load value is obtained.

Torque tightening involving locking device

A. Where locking plates, tabwashers or split pins (cotter pins) are used as locking devices the following instructions must be complied with:

CAUTION: 1. FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN FAILURE OF THE UNIT OR ENGINE.

2. DO NOT SLACKEN THE NUT TO OBTAIN THE LOCKING POSITION.

(1) If a single torque load value is specified, it is permissible, and in many instances necessary, to exceed the prescribed torque load value by continuing to tighten the nut until the next locking position is reached.

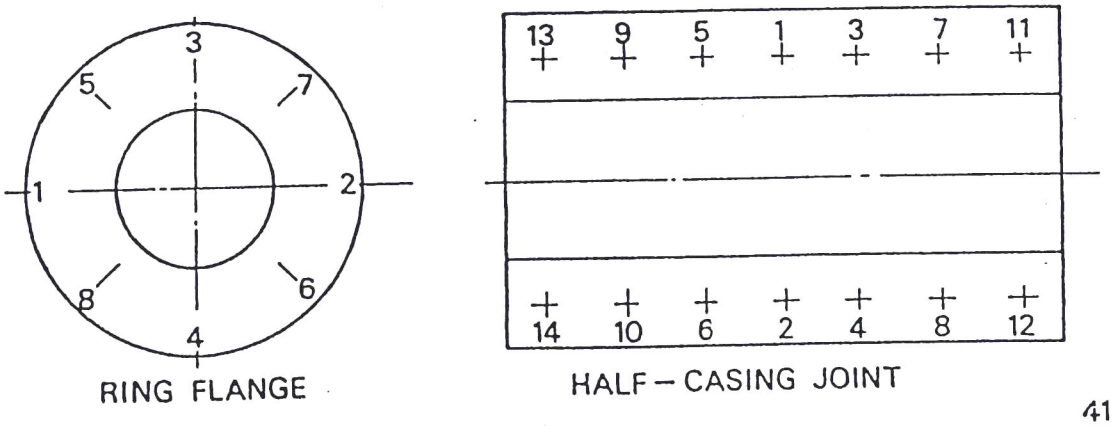
(2) If a minimum and a maximum torque load value is quoted, the final torque load value applied must be within the prescribed range.

Torque tightening sequence

A. Where close pitch bolting is used and where it is necessary to make a seal, adjacent fasteners should not be tightened successively; tighten in a symmetrical pattern to ensure that strain is not induced into the structure. Unless specified otherwise in the manual, the following procedure is recommended.

(1) On flanges, lightly nip two fasteners approximately opposite to each other and then lightly nip up another pair approximately at 90 degrees to the first pair; bisect the resulting angles and proceed as before; refer to Fig.1. When the faces are in light contact with all fasteners lightly nipped, apply the specified tightening torque in a similar sequence.

(2) On half-casing joints, e.g. compressor casings, use the same method but tighten the mid-section positions first and then work outwards from the centre, refer to Fig.4.



Examples of bolt tightening sequences used on ring flange and half-casing joints
Fig.4

B. Reserved

Hand torque wrenches

A. Flexible beam type

(1) To obtain a correct reading, the handle should be gripped lightly with one hand. As the pull must be applied at right-angles (90 degrees) to the centre line of the wrench, the handle should float on the pivot-point thus concentrating the force or load at the correct point, refer to Fig.5. The position of the hand should not be altered so as to change the concentration of the force from the pivot-point to any other position on the handle. The following table lists flexible beam type torque wrenches and their torque load ranges:

Part number	Range		Size of drive	
	Nm	lbf.in.	mm.	in.
1703079	0 to 5,650	0 to 50	5,56	7/32
1702294	0 to 5,650	0 to 50	6,35	1/4
1703151	3,390 to 15,8	30 to 140	6,35	1/4
1703081	17,0 to 67,8	150 to 600	9,52	3/8
3403424	0 to 203	0 to 1800	12,70	1/2

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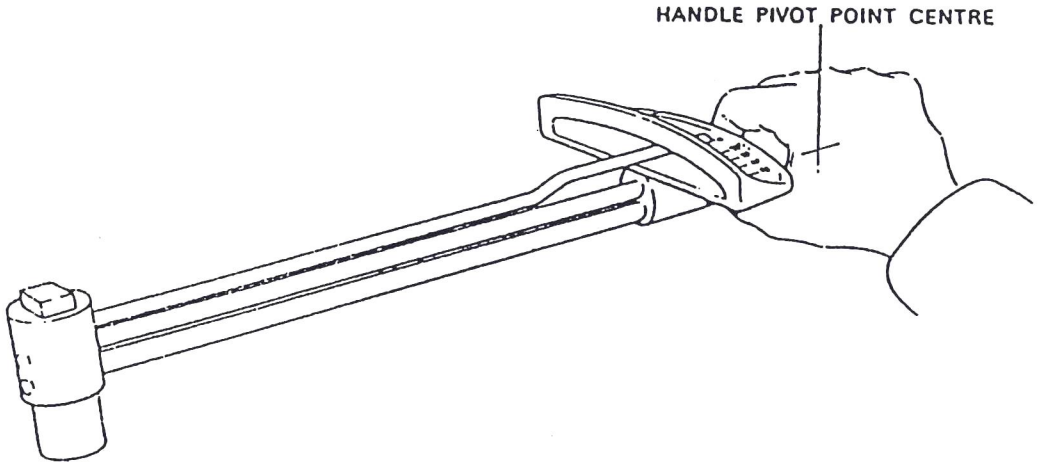

Correct method of holding a flexible beam torque wrench
Fig. 5

(2) All wrenches must be checked periodically on the setting rig, to ensure that they are reading accurately. Interchangeable sockets, adapters and extension bars are provided for use with all wrenches.

(3) To ensure the greatest possible accuracy in reading the scale values, choose a torque wrench which, when in use, will register within the higher range of the scale. The first and final quarter of the scale should not be used for mandatory loads. This is because the accuracy with which small loads can be read at the beginning or end of the scale is not considered adequate, and, wherever possible, a wrench should be selected where full benefit would be obtained from the scale provided. Some flexible beam torque wrenches may have the 'unacceptable' part of the scale blank. Before use set the wrench to zero load.

B. Screwdriver type

(1) To obtain a correct reading the handle must be gripped as if holding a screwdriver, and rotated smoothly until the required load figure is indicated. The following table lists the screwdriver type torque wrench and the torque loading range.

Part number	Range		Size of drive	
	Nm	lbf.in.	mm.	in.
1703038	0,9 to 2,7	8 to 24	6,35	1/4

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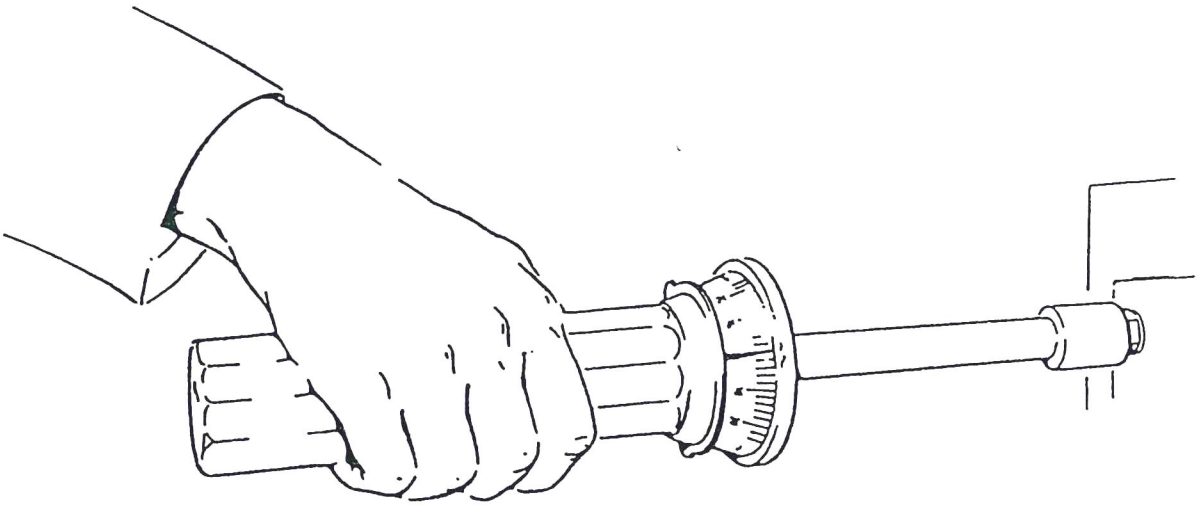

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Correct method of holding a screwdriver torque wrench
Fig.6

(2) Screwdriver type wrenches in service must be inspected for accuracy. Under conditions of no load, check that the torque indicating pointer reads zero on the scale: if necessary adjust as instructed in the torque wrench manufacturer's instruction book.

Power wrenches

A. Power wrenching must be used only for preliminary tightening of nuts and bolts. The power wrench must be set to give 50 per cent of the final torque load, and the final torque applied using the approved hand torque wrench.

Torque multiplier

A. The torque multiplier is a mechanical gearbox or hydraulic unit used in conjunction with the torque wrench, in order to achieve higher torque loads than those possible with the normal range of torque wrenches. It is essential therefore, that the torque wrench scale reading is correlated to the ratio of the unit being used. The torque multiplier should be calibrated at regular intervals and maintained in accordance with the manufacturers instructions.

CAUTION: WHEN MEASURING TORQUE DO NOT USE UNIVERSAL JOINTS AS THESE MAY PRODUCE SERIOUS INACCURACIES.

Extension spanners

A. Extension spanners can be used in either of two angular positions relative to the torque spanner. Whenever extension spanners are used the following rules and formula must be used.

B. It is essential that, unless inaccessibility dictates otherwise, the extension spanner should always be in-line with the torque spanner and the torque spanner scale readings adjusted accordingly.

C. Where the extension has to be fitted at the alternative position because of limited access, the shortest possible extension shall be used and care taken to apply the load at the wrench handle at RIGHT-ANGLES to the length of the wrench, to avoid errors.

D. It is also essential to note that with the extension spanner in the alternative 90 degrees angular position, the torque reading correction factor does not normally apply, if the extension spanner is of the correct design. In Fig.7 dimensions A and C are identical.

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$$\text{Scale reading} = \frac{\text{Required torque x Length of lever (A)}}{\text{Total lever length (B)}}$$

NOTE: 1. All lengths are measured using the pivot in the handle as the datum.

2. Length B should be measured parallel to the torque wrench lever as shown in Fig.7.

Example:

A nut with 0.250 in. thread dia. is to be tightened to 10 Nm using a torque wrench 250 mm. long and with an extension of 76 mm., fitted in the preferred position, giving a total lever length of 326 mm.

The indicated scale reading must be:

$$\frac{10 \times 250}{326} = 7{,}6 \text{ Nm}$$

NOTE: The lengths A and B may be in any units, Imperial or Metric, provided they are both in the same units.

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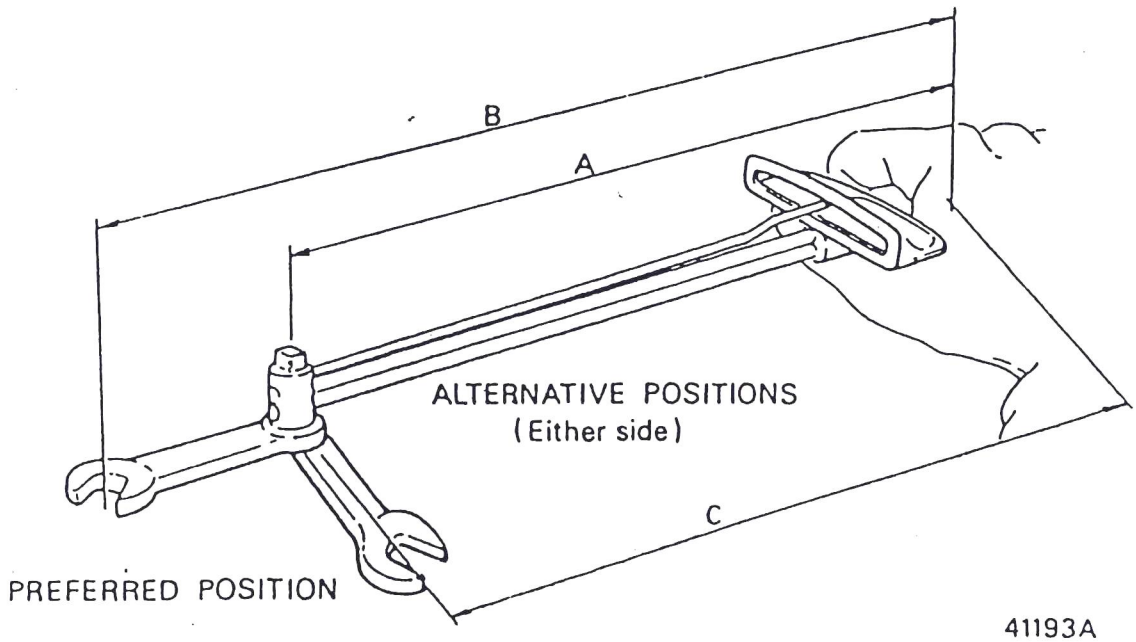

Torque wrench and extension
Fig. 7

In-built (locking) torque for self-locking fasteners

A. The in-built torque is the torque required to start the nut or setscrew turning when:

(1) The nut is engaged on the stud or bolt (or the setscrew is engaged in the insert or captive nut) with the full chamfer of the stud or bolt (or setscrew) extending beyond the locking device of the nut, insert or captive nut.

(2) There is no axial load on the nut or bolt.

B. Do not alter the in-built torque of a nut or insert by 'crimping' the lock device or by 'easing' it with a thread tap.

IN-BUILT LOCKING TORQUE

Nominal thread size - in.	Minimum		Maximum	
	Nm	lbf.in.	Nm	lbf.in.
4 UN	0.056	0.50	0.338	3.0
6 UN	0.113	1.00	0.676	6.0
8 UN	0.169	1.50	1.017	9.0
10 UN	0.225	2.00	2.030	18.0
0.250 in.	0.394	3.50	3.390	30.0
0.3125 in.	0.733	6.50	6.780	60.0
0.375 in.	1.070	9.50	9.040	80.0
0.4375 in.	1.580	14.00	11.300	100.0
0.500 in.	2.030	18.00	17.000	150.0
0.5625 in.	2.710	24.00	22.600	200.0
0.625 in.	3.620	32.00	33.900	300.0
0.750 in.	5.650	50.00	45.200	400.0
0.875 in.	7.910	70.00	67.800	600.0
			Nm	lbf.ft.
1.000 in.	10.4	92.00	90.30	66.60
1.125 in.	13.2	117.00	102.00	75.00
1.250 in.	16.2	143.00	113.00	83.30

Range of in-built torque limits for self-locking nuts wire-thread inserts and captive nuts
Fig.8

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C. There are various methods of checking locking torque but the ultimate criterion is that the correct locking torque must be present when the bolt, nut or setscrew is finally fitted, and in principle all such self-locking fasteners should be checked at that stage. In practice it is not always necessary to measure locking torque during final fitting, and some relaxation is possible depending upon the particular application. The following procedures take this into account:-

(1) No.10 UN and 0.250 in. fasteners used in applications for which no special instructions are given in the manual, may be checked for correct locking torque by hand during final fitting. If the locking device cannot be fully engaged when tightened as much as possible with the fingers, then the fastener is acceptable.

(2) All other applications of No.10 UN and 0.250 in. fasteners involve joints where high integrity is essential and are covered by special instructions in the manual. In all these instances, the locking torque must be measured during final fitting.

(3) On all fastener sizes above 0.250 in., whether the torque load is standard or non-standard, the actual locking torque must be measured during final fitting.

D. To ensure the correct locking torque during final fitting, fasteners may be checked before this stage using the gauges listed in Fig.9. By this means, the need to remove and replace fasteners during final fitting can be avoided.

CAUTION: CONTAMINATION OF SILVER-PLATED NUTS OR INSERTS BY CADMIUM OR MOLYBDENUM DISULPHIDE CAN RESULT IN SERIOUS FAILURE DURING SUBSEQUENT SERVICE. GAUGES USED ON SILVER-PLATED FASTENERS MUST NOT BE USED FOR CHECKING ANY OTHER PARTS.

THREAD BASIC SIZE	GAUGE No.
0.190 - 32	HC.21739
0.250 - 28	HU.21740
0.3125 - 24	HC.21741
0.375 - 24	HC.21742
0.4375 - 20	HU.22844
0.500 - 20	HC.22845
0.5625 - 18	HC.22846
0.625 - 18	HC.22680

Torque check gauges
Fig.9

Fitting non self-locking nuts to studs or bolts; also fitting bolts, used as setscrews, in non self-locking thread holes

A. Apply the standard torque loads listed below unless special torque loads are specified elsewhere:

TIGHTENING TORQUE - NON SELF-LOCKING				
Nominal thread size in.	Unplated and silver plated		Cadmium plated	
	Nm	lbf.in.	Nm	lbf.in.
No.6 UNF	1,10	10	0,90	8
No.8 UNF AND 2 B.A.	1,70	15	1,10	10
No.10 UNF	4,00	35	2,80	25
I.B.A.	5,70	50	4,00	35
0.250 in.	11,30	100	8,50	75
0.3125 in.	19,20	170	15,30	135
0.375 in.	33,90	300	26.60	235
0.4375 in.	50,90	450	40,70	360
0.500 in.	84,80	750	65,00	575
0.5625 in.	107,40	950	83,60	740
0.625 in.	152,60	1350	118,7	1050

Standard torque loads for fitting non self-locking nuts and bolts
Fig.10

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Fitting self-locking nuts to studs and bolts; also bolts used as setscrews, in self-locking wire-thread inserts or in self-locking thread captive nuts

A. Apply the standard torque loads listed below unless special torque loads are listed elsewhere.

B. Self-locking nuts and inserts have a limited life which depends, mainly, on their ability to retain their in-built locking torque. For values of acceptable range of in-built torque, refer to Fig.8.

TIGHTENING TORQUE - SELF-LOCKING				
Nominal thread size in.	Unplated and silver plated		Cadmium plated	
	Nm	lbf.in.	Nm	lbf.in.
No.6 UNF	1,40	12	1,10	10
No.8 UNF AND 2 B.A.	2,30	20	1,70	15
No.10 UNF	4,50	40	3,40	30
0.250 in.	11,30	100	10,20	90
0.3125 in.	23,70	210	19,20	170
0.375 in.	41,80	370	35,00	310
0.4375 in.	55,40	490	46,30	410
0.500 in.	89,3	790	72,30	640
0.5625 in.	114,10	1010	93,80	830
0.625 in.	163,90	1450	135,60	1200

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Standard torque loads for self-locking nuts, setscrews in wire-thread inserts and captive nuts
Fig.11

Tube connections (union nuts, tube and hose connections)

CAUTION: PREVENT DAMAGE TO PIPES AND UNIONS BY USING A SUITABLE SPANNER TO PREVENT ROTATION OF THE UNION WHEN ASSEMBLING OR DISASSEMBLING A PIPE CONNECTION.

A. Apply the torque load values listed in Fig.12 to all standard tube/pipe connections unless otherwise instructed.

B. Bed-in nut and nipple connections as follows:

(1) Using clean engine oil as a lubricant on the threads and abutment faces assemble nut and nipple to the union and tighten to the recommended torque load value.

(2) Loose the connection by slackening the nut half a turn.

(3) Tighten and loosen twice more

(4) Finally tighten to recommended torque load value.

CAUTION: DO NOT EXCEED THE SPECIFIED TORQUE LOAD VALUE WHEN TRYING TO ACHIEVE A SATISFACTORY SEAL.

C. Rectify a leaking connection by disassembling the nut and nipple connection examining parts for cause of failure to seal, and, if necessary, fitting new parts. Reassemble as detailed in B.(1) to (4).

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TIGHTENING TORQUE - TUBE CONNECTIONS			
Nominal thread size - in.	Nm	lbf.in.	lbf.ft
0.4375-20	16.50	145	-
0.5000-20	19,00	170	-
0.6250-18	24,00	215	-
0.6875-16	27,00	240	-
0.7500-16	30,00	265	-
0.8125-16	33,00	295	-
0.8750-14	37,00	325	-
1.0625-12	47,00	420	-
1.1875-12	56,00	500	-
1.3125-12	67,00	590	-
1.6250-12	99,00	-	73
1.8750-12	135,00	-	99

Standard torque loads for tube connections
Fig.12

Screwed unions and hexagon-headed blanking plugs

A. The torque tightening values for both unions and hexagon-headed blanking plugs are identical for given thread diameters and are given in Fig.13. The values are based on the practice of tightening the union to a torque approximately 20 per cent higher than for the union nut; this reduces the tendency for the union to turn when the tube nut is tightened or loosened.

B. When fitting unions or plugs, clean engine oil should be used to lubricate the threads, except when the fittings are to be secured into magnesium alloys. If they are to be fitted to magnesium alloys the threads and abutment face of the unions or plugs should be smeared with jointing compound PL.32L (33H/1983516) which must be allowed to air dry for approximately 10 minutes before assembly.

C. After ensuring that the items are clean, and fitting any necessary joint washers, they should be assembled to the torque values specified in Fig.13.

UNIONS AND HEXAGON-HEADED BLANKING PLUGS			
Nominal thread size -in.	Tightening torque		
	Nm	lbf.in.	lbf.ft.
0.250-28	5	44	-
0.3125-24	9	80	-
0.3750-24	12	110	-
0.4375-20	20	175	-
0.500-20	23	205	-
0.5625-18	26	230	-
0.6250-18	29	260	-
0.750-16	36	320	-
0.8125-16	40	355	-
0.875-14	44	390	-
1.0625-12	57	505	-
1.1875-12	68	-	50
1.3125-12	80	-	59
1.6250-12	120	-	87.5
1.8750-12	160	-	119

Torque tightening values for unions and hexagon-headed blanking plugs
Fig.13

Fitting serrated-head sealing plugs

A. Apply the torque loads listed in Fig.14 to sealing plugs fitted into either aluminium or magnesium unless special values are specified elsewhere.

B. When fitting sealing plugs, clean engine oil should be used to lubricate the threads, except when the plug is to be screwed into magnesium alloys. If they are to be fitted to magnesium alloys the threads and abutment face of the plug should be smeared with jointing compound, PL.32L, (33H/1983516) which must be allowed to air dry for approximately 10 minutes before assembly.

C. Do not overtighten sealing plugs beyond the recommended torque load value to cure a leak. If necessary, fit a new sealing plug and/or recondition the plug seating.

TIGHTENING TORQUE - SERRATED-HEAD SEALING PLUGS		
Nominal diameter -in.	Nm	lbf.in.
0.250	2.26	20.0
0.3125	3.39	30.0
0.375	5.08	45.0
0.4375	7.34	65.0
0.500	10.2	90.0
0.5625	10.2	90.0
0.625	15.8	140.0
0.6875	20.3	180.0
0.750	20.3	180.0

Standard torque loads for fitting serrated-head sealing plugs (Unified or Whitworth threads)

Fig.14

Fitting studs

A. Studs are usually fitted as replacements, when fitting replacement studs refer to the relevant topic.

6. Special torque loads

A. Using engine oil as lubricant.

(1) Nut, high pressure oil filter cover - 90 lbf in.

(2) Bolt, return oil filter cover - 90 lbf in.

(3) Nuts, main fuel manifold to burners - 150 lbf in.

(4) Nuts, pilot fuel manifold to burners - 80 lbf in.

(5) Nuts, burner main fuel connection - 300 lbf in.

(6) Setscrews, front bearing housing to compressor casing - 80 lbf in.

(7) Nuts, compressor casing halves - 220 lbf in.

(8) Setscrews, compressor casing to compressor outlet casing - 125 lbf in.

(9) Nuts, auxiliary gearbox housing bracket - 135 lbf in.

(10) Nuts, exhaust unit to nozzle box - 50 lbf in.

(11) Gland nuts, securing pipe between the upper outlet connection and the metering block - 150 lbf in.

(12) Gland nuts, securing pipe between the fuel cooled oil cooler and the metering block - 150 lbf in.

(13) Screws, filter housing to pump - 75 lbf in.

EJ
Ghr

(14) Nut, jet pipe top temperature control, actuator lever ball end to control rod - 30 lbf in.

(15) Screw, control rod end to relay lever Mod.5849 - 75 lbf in.

(16) Nut retaining coupling shaft, right-hand auxiliary gearbox (Mk.109) - 70 lbf in.

B. Using anti-seize compound ZX-28G (Ref.No.34B/9437518) as lubricant.

(1) High energy igniter plugs - 100 lbf in.

7. Locking devices

To accommodate locking devices, it is permissible to continue tightening to the next locking position. For all locking wire applications use 22 S.W.G. stainless steel wire.

8. Precautions

Unless otherwise stated, do not use grease or any other substance on gaskets, sphericals and mating joint faces in the air/fuel system.

It is possible for deposits of cadmium to be transferred from a cadmium plated tool to the surface of an engine component; in the case of titanium components this could result in rapid failure of the component under certain running conditions. The failure is caused by the cadmium reacting at certain temperatures with the titanium resulting in embrittlement and cracking. In view of this, any tool or item or equipment which is liable to come into contact with titanium must not be cadmium plated.

WARNING: THE ELECTRICAL ENERGY WHICH MAY BE STORED IN THE CONDENSERS OF THE HIGH ENERGY IGNITION UNITS IS POTENTIALLY LETHAL. BEFORE HANDLING THE UNIT, PLUG OR H.T. CABLE, DISCONNECT THE L.T. SUPPLY AND WAIT FOR AT LEAST ONE MINUTE TO PERMIT THE STORED ENERGY TO DISSIPATE.

If it is necessary to rotate, or 'motor' the engine disconnect the low tension (l.t.) electrical supply to the high-energy ignition units.

Before commencing work on or near an engine, ensure that the starting switch is OFF and that the high pressure and low pressure fuel cocks are CLOSED.

The air intake and the final nozzle must be protected by the covers provided and all apertures which are uncovered as work progresses must be immediately and adequately blanked. Transportation blanks removed from a replacement unit should be fitted to the unserviceable unit as soon as convenient after it is removed.

EJ
Ghr

WARNING: THE SYNTHETIC LUBRICATING OIL IN THIS ENGINE MAY CAUSE SKIN IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

CAUTION: SYNTHETIC OIL IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE ANY COMPONENT NOT NORMALLY IN CONTACT WITH IT. SPILLED OIL MUST BE WIPED UP IMMEDIATELY. THE OIL MUST NOT BE MIXED WITH ANY OTHER OIL.

Only the oil specified in Leading Particulars may be used for internal lubrication of the engine and for assembling the parts which are lubricated by the oil.

Before a replacement unit is fitted, it must be drained and flushed out to ensure that inhibiting oil does not mix with the fluid in the system.

CAUTION: ENSURE THAT PIPES ARE NOT FOULING, AS THIS CAN RESULT IN CHAFING AND SUBSEQUENT LEAKAGE.

To avoid damage to rubber seals and pipe union threads, all pipes should, where possible, be disconnected at their seal housing flanges. During reassembling, special care is required to ensure that each rubber sealing ring is correctly located in its groove and does not become trapped between the joint faces. After replacing or reconnecting any pipes, check that there is adequate clearance around the complete length of the pipes.

Ensure that all bonding leads are refitted correctly; leads which are too slack or too tight are liable to failure.

A note should be made of all tools and loose items used in the vicinity of the engine and a check made on completion of work. Ensure that all tools and loose items are removed before attempting to start the engine.

8A. Identification of 12-point self-locking nuts for low and high temperature applications

A. These two types of self-locking nuts are geometrically similar, but with the following distinguishing features.

(1) Nuts that must be used in the hotter engine zones, in working temperatures of 230°C (446°F) to 650°C (1,202°F) are non-magnetic, silver plated and partially knurled on the flange; see Fig.15.

(2) Nuts that are restricted to use in the colder engine zones, in working temperatures not exceeding 230°C (446°F) are magnetic, cadmium plated and coated with molybdenum disulphide (black). They feature a plain flange. See Fig.15.

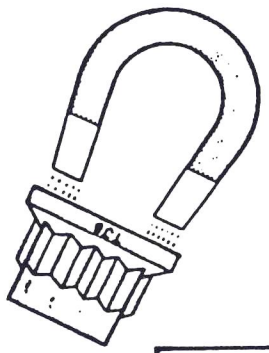
(3) Positive identification of used nuts into these two broad groups, can only be done by individually checking each nut with a magnet.

(4) Ensure that only the correct nut (as defined in the schedule of spare parts) is fitted. It must not be assumed that all low temperature zones of the engine feature cadmium plated nuts, as quite often high temperature type nuts are by design to be found in these areas.

IDENTIFICATION OF SELF-LOCKING NUTS

FITTING OF LOW TEMPERATURE NUTS IN HIGH TEMPERATURE AREAS WILL CAUSE ENGINE FAILURE

LOW TEMPERATURE NUTS UP TO 230°C



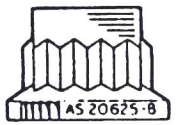
MATERIAL:- MEDIUM CARBON Ni-Cr-Mo STEEL

FINISH :- CADMIUM PLATE + BLACK COATING OF MOLYBDENUM DISULPHIDE

IDENTIFICATION:-NUT FLANGE HAS NO KNURLING

THESE NUTS ARE **MAGNETIC**

HIGH TEMPERATURE NUTS UP TO 650°C



MATERIAL:- 15% Cr - 25% Ni HEAT & CORROSION - RESISTANT STEEL.

FINISH:- SILVER PLATE

IDENTIFICATION:- NUT FLANGE IS **KNURLED**

THESE NUTS ARE NOT MAGNETIC

THESE NUTS BECOME BLACK AFTER USE

LOW TEMPERATURE NUTS ARE BLACK & HIGH TEMPERATURE NUTS ARE BRIGHT WHEN NEW BUT-

DO NOT IDENTIFY BY COLOUR AFTER USE

NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS		NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS		SBAC N°
THESE NUTS HAVE MANUFACTURER'S CODE ONLY ON THE FLANGE				THESE NUTS HAVE PART N° AND/OR MANUFACTURER'S CODE ON THE FLANGE	No 8-36	1205943	U125943	AS20623
	No 10-32	1205924	U125924		No 10-32	1205944	U125944	AS20624
	.250-28	1205925	U125925		.250-28	1205945	U125945	AS20625
	.3125-24	1205926	U125926		.3125-24	1205946	U125946	AS20626
	.375-24	1205927	U125927		.375-24	1205947	U125947	AS20627
	.4375-20	1205928	U125928		.4375-20	1205948	U125948	AS20628
REGULAR NUT	.500-20	1205929	U125929	REGULAR NUT	.500-20	1205949	U125949	AS20629
THESE NUTS HAVE PART N° & MANUFACTURER'S CODE ON THE FLANGE				THESE NUTS HAVE PART N° AND/OR MANUFACTURER'S CODE ON THE FLANGE	No 8-36	1209171	U129171	AS27821
	No 10-32	1209162	U129162		No 10-32	1209172	U129172	AS27822
	.250-28	1209163	U129163		.250-28	1209173	U129173	AS27823
	.3125-24	1209164	U129164		.3125-24	1209174	U129174	AS27824
	.375-24	1209165	U129165		.375-24	1209175	U129175	AS27825
DEEP COUNTERBORED NUT				DEEP COUNTERBORED NUT				

Identification of 12-point self-locking nuts
Fig.15

LC
Blr

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8B. Temporary marking of turbine engine components

A. Temporary marking of turbine engine hot-end components

(1) When it is necessary to make temporary markings on the hot-end components of turbine engines, for example to indicate damage or to ensure correct re-assembly, this must be done using a marking agent which has no deleterious effect when the components are subsequently heated, should the marking agent accidentally not be removed.

(2) 33C/9730870 tailors chalk is to be used as a marking agent.

(3) On no account may the following be used:

(a) Blackboard chalk or common (natural) chalk; these are varieties of calcium carbonate, deposits from which would produce a deep etching on metals subjected to high temperatures (tailors chalk is made of talc which would not have the same effect).

(b) Lead pencils, wax pencils, crayons or any other material which can leave a carbon deposit, subsequent heating of which would lead to local carburisation and hardening.

(4) As a safety measure and to prevent possible failure, markings should be completely removed before assembly or engine operation; methylated spirit or petrol being used.

B. The following media are approved for the temporary marking of all components except hot-end components:

Blr

(1) Soapstone pencil.

(2) P.L. crayon.

(3) Magic marker.

(4) Electrolytic marking using E.M.16A electrolyte with Rolls-Royce electrolyte marking lead.

(5) French chalk (talc).

(6) Spectra-colour opaque yellow (33C/2204535).

8C. Remove jointing compound from joint faces

WARNING...

DO NOT SMOKE WHEN USING METHYLENE CHLORIDE; ENSURE THAT THE WORKPLACE IS WELL VENTILATED.

CAUTION...

Ensure that methylene chloride is applied only to joint faces as it can damage and remove paint.

A. Remove the jointing compound using a clean cloth moistened with methylene chloride (33C/2244574).

LC
Blr

8D. Installation of rigid tubes

A. Introduction

The following standard practice defines the handling, alignment, clearance and other requirements to be met when installing rigid tube assemblies.

B. Purpose

This Standard Practice will ensure that:

(1) Tubes are not damaged during handling.

(2) Tubes are not damaged in service by frettage with adjacent tubes or components.

(3) Unreasonable loads are not imposed on tubes by badly aligned end fittings.

(4) Tubes are not damaged by applying excessive force to tubes when locating clip securing parts.

C. Protection and handling

(1) Provision shall be made for suitable storage, tubes can be damaged if left in an unsupported position.

(2) Suitable blanking caps or other means of protecting sealing surfaces and preventing ingress of foreign matter shall be used.

(3) Protective caps shall be of a design that fit externally over tube ends to prevent the caps entering the tube bores or being left on during installation.

(4) Care shall be taken when resting tubes to prevent damage to unprotected sealing faces.

(5) The mating/sealing faces on the engine or accessory shall also be protected.

D. Inspection

(1) All joint faces, tubes and tube bores (if feasible) shall be visually checked to ensure free from damage, dirt, grease, grit or any other foreign matter.

(2) If any damage is found, refer to the following Acceptance Standards.

(a) Tube main body.

(i) Cracking is not acceptable.

(ii) Fretting up to 0.005 in. deep is acceptable.

(iii) Scratches up to 0.005 in. deep are acceptable.

(iv) Scores up to 0.005 in. deep are acceptable.

(v) Damage other than specified, is not acceptable.

(b) Tube flanges, sealing faces and sealing ring locations.

(i) No damage is acceptable.

(3) It is not permitted to hand finish a sealing surface to remove a scratch. This action can cause a greater leak.

E. Installation

NOTES: 1. Tube assemblies with centre fittings shall be treated in the manner detailed in this Standard Practice, but ensure centre fitting is first to be tightened and locked.

2. Special care is to be taken with unsupported 'pipe to pipe' disconnects.

3. All tubes should be thoroughly cleaned and blown through with a dry air supply prior to installation.

4. Accessory mounting bolts may be slackened during fitting of the tube assembly to obtain a more favourable fitting condition, provided:

(a) That after resecuring the accessory in its final position it is confirmed that none of the associated tubes have been stressed in doing so.

(b) That no other tubes are positively secured to the accessory prior to its resecuring.

(c) That on no account shall bolts which are part of the accessory be slackened or removed to facilitate assembly of a tube.

(1) Bolted flange adapters

(a) Remove blanks from tube and mating faces.

(b) Fit and lubricate seals as required.

(c) Carefully align one flange, tighten bolts only sufficiently to retain seal.

(d) Ensure seal is correctly located on the other end, locate flange fitting by flexing tube by hand, ensure total flange area contact can be obtained. Install bolts and tighten sufficiently to retain seal.

NOTE: Flange bolt holes must align with mating tappings without subjecting the tube to a torsional or axial load.

(e) Assemble clipping points onto mating features but do not tighten fully.

(f) Alternating between tube flanges, torque tighten nuts or bolts in incremental steps (this is done to equalize any stress along the length of the tube). Perform final torque check of bolts.

NOTE: Where self locking inserts are used, locking torque must be checked in accordance with values specified in Chapter 1, Torque Tightening Technique, or relevant Fits, Clearances and Torque Loadings Section.

(g) Progressively tighten clipping points attachment fasteners. This will minimise stresses being induced into the assembly.

NOTE: During this tightening sequence it is not acceptable for the attachment fasteners to pull the tube into position or for the tube assembly to be forced into position.

(h) If during any of the above operations the requirements specified cannot be achieved or other fitting problems occur, supervision shall be consulted.

(2) Single nut conical sealing joints

(a) Remove blanks from tube and mating faces.

(b) Carefully locate tube assembly in approximately the correct position.

(c) Locate the ferrule at one end of the tube in its conical seating, engage the nut on its mating thread, tighten the nut with the fingers and ensure that the tube is square to the back of the nut.

NOTE: If self locking type nuts are used, spannering will be required to seat the nut assembly.

(d) Locate the ferrule at the other end of the tube assembly in its conical seating. If required, flex the tube by hand to align it, then engage the nut on its mating thread. On no account shall force be used to align the tube ends. The ends should be positioned and located with the retaining nuts to equalize the error at each end.

(e) Tighten the nut and ensure that the tube is square to the back of the nut. If this is not possible consult supervision.

(f) Assemble clipping points onto mating features but do not tighten fully.

(g) Torque tighten the nuts to the procedure and torque value specified in Chapter 1, Torque Tightening technique or relevant Fits, Clearances and Torque Loadings Section.

NOTE: When tightening or untightening screwed union joints, torque reaction shall be applied to avoid distortion to connected parts.

(h) Loosen connections by backing off nuts half a turn. Tighten and loosen twice more.

CAUTION: DO NOT EXCEED SPECIFIED TORQUE VALUE WHEN TRYING TO ACHIEVE A SATISFACTORY SEAL.

(j) Tighten to recommended torque value without pausing.

(k) Progressively tighten clipping points attachment fasteners. This will minimise stresses being induced into the assembly.

NOTE: During this tightening sequence it is not acceptable for the attachment fasteners to pull the tube into position or for the tube assembly to be forced into position.

(l) If during any of the above operations the requirements specified cannot be achieved or other fitting problems occur, supervision shall be consulted.

(m) Wire lock nuts as required.

F. Clearance

(1) After securing tube clips, check that a minimum clearance of 0.05 in. exists between tube and any adjacent component.

(2) If this clearance is not present at any position, slacken the clippings, obtain the clearance and re-tighten clippings. If clearance is still unobtainable, install a new tube.