Chapter 10

COMPRESSOR AND FRONT BEARING HOUSING

CONTENTS

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ILLUSTRATIONS

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TOOLS AND EQUIPMENT

Manual Ref No.	Nomenclature and description	Sect./Ref.	Part No.
	Remove/Fit compressor top-half casing		
1	Engine transportation stand	40B/1214	CP.8788
2	Extractor - Dowels - Compressor outlet casing	64VV/3062	GT.6285
3	Spanner - Jaw extension	64VV/6070049	D33771/1
4	Spanner - Jaw extension	64VV/6070046	D33291/1
5	Spanner - Jaw extension	64VV/6070048	D33770/1
6	Extractor - Remove dowels	64VV/791	HW.18677
7	Eye bolt - Lift top-half compressor casing	64VV/6118390	GU.21019
8	Washer	64VV/6118392	BT.4974
9	Lifting sling		GZ.38983
10	Nut tightening template (Right-hand)	64VV/922	HW.16494
11	Nut tightening template (Left-hand)	64VV/923	HW.16495
12	Torque wrench (Compressor case to outlet casing front bearing housing)		1703080
13	Torque wrench		1703081
14	Adapter (Used with torque wrenches)	64VV/6118403	AK.137
	Remove/Fit starter drives		
15	Extractor housing removal	64VV/2150	HW.37007
16	Spanner - Nut retaining coupling assembly - Remove/Fit	64VV/2806	GT.8685
17	Special punch - Cupwasher locking	64VV/391	HW.13656
18	Spanner - Internal nut - Retaining outer spring drive shaft	64VV/247	HW.14582
19	Withdrawing tool - Spring drive assembly from front compressor shaft	64VV/256	HW.14692

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Tools and equipment (cont.)

Manual Ref. No.	Nomenclature and description	Sect./Ref.	Part No.
20	Extractor (Fairing assembly)		GT.4856
21	Withdrawing tool - adjusting washer - Remove	64VV/248	HW.14596
	Remove/Fit front bearing housing		
22	Spanner - Jaw extension	64VV/6070048	D33770/1
23	Support bar	64VV/3079	HW.33099
24	Protective cover - Protect adapter	64VV/1640	HW.29110
25	Deleted		
26	Adapter	64VV/6118403	AK.137
27	Extractor - Remove dowels	64VV/791	HW.18677
28	Spanner - Jaw extension	64VV/6070049	D33771/1
29	Bracket - Magnetic base and clock	64VV/6118388	GU.24542
30	Dummy front bearing housing Support shaft	64VV/1639	HW.30117
	Remove/Fit stator blades		
31	Support tool (l.h.) stage 6	64VV/6118381	GU.17164
32	Support tool (r.h.) stage 6	64VV/6118382	GU.17165
33	Support strap stage 6	64VV/6118383	GU.17168
34	Support tool (l.h.) stage 11	64VV/6118384	GU.17166
35	Support tool (r.h.) stage 11	64VV/6118385	GU.17167
36	Support strap stage 11	64VV/6118386	GU.24386
37	Hook	64VV/6118391	GU.24553
	Remove/Fit rotor wheels		
38	Slotted spanner	64VV/121	HW.5660
39	Dogging spigot - Dog compressor shaft	64VV/451	HW.14583
40	Adapter plate - Compressor shaft - Remove nuts	64VV/6086624	GT.9034
41	Reduction gear - Pack nut - Remove/fit	64VV/630	HC.10

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Tools and equipment (cont.)

Manual Ref No.	Nomenclature and description	Sect./Ref.	Part No.
42	Torque wrench - Pack nut - Torque loading	64SY/4590529	3403424
43	Wrench - Pack nut - Removal	64VV/6070053	HB.47909
44	Support plate - Support compressor - 10 to 1 reduction gear	64VV/6118380	GU.17173/1
45	Extractor - Withdrawing tool - Roller bearing and air/oil seal	64VV/372	HW.14586
46	Assembling tool - Roller race - Front	64VV/142	HW.8037
47	Extractor - Withdrawing tool (Short) - Stages 1 to 5 rotor wheels	64VV/850	HW.8205
48	Split adapter - Stage 1	64VV/845	HW.8165
49	Split adapter - Stage 2	64VV/846	HW.8166
50	Split adapter - Stage 3	64VV/847	HW.8167
51	Split adapter - Stage 4	64VV/848	HW.8168
52	Split adapter - Stage 5	64VV/849	HW.8169
53	Extractor - Withdrawing tool (Long) - Stages 6 to 11 rotor wheels	64VV/858	HW.8248
54	Split adapter - Stage 6	64VV/852	HW.8242
55	Split adapter - Stage 7	64VV/853	HW.8243
56	Split adapter - Stage 8	64VV/854	HW.8244
57	Split adapter - Stage 9	64VV/855	GU.24756
58	Split adapter - Stage 10	64VV/856	HW.8246
59	Split adapter - Stage 11	64VV/857	HW.8247
60	Support strap and brackets - Stage 12	64VV/6118387	GU.24532
61	Extractor - Withdrawing tool - Operating lever connecting link pins	-	HW.17553
62	Checking gauge - Inlet guide vane angle	-	GU.25867

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Chapter 10

COMPRESSOR AND FRONT BEARING HOUSING

INTRODUCTION

1. If inspection through the air intake, as detailed in Vol.1, Part 2, Sect.3, Chap.1, reveals signs of damage to the compressor, the cause and extent of the damage must be ascertained to determine whether the engine is fit for further service or suitable for repair as described later in this chapter.

Note...

The repairs described can only be effected where damage is the result of the passage of a foreign body. Engines exhibiting damage to the l.p. turbine blades exceeding the limits of Chap.11, para.3, are not eligible for compressor repair. Engines with l.p. turbine blades showing evidence of aluminium spatter which cannot be completely removed by light abrasion are not eligible for compressor repair.

2. If ingestion of foreign matter is suspected, it is essential that the compressor is inspected for damage and the ingested matter, e.g. ice, slush, water or bird, removed as soon as possible to prevent any debris being carried further back into the compressor.

3. Although it is possible to inspect rotor blades as far as stage 4, it is only possible to completely assess damage to rotor blades up to stage 2 without removing the compressor top-half casing.

4. Removal of the top-half casing allows inspection and repair of the rotor blades and top-half stator blades. An assessment of the damage to the stator blades in the bottom-half casing may be made from the condition of those in the top-half casing.

5. A list of special tools and equipment is detailed in the Tools and equipment section of this Chap. Refer to the appropriate aircraft Air publication for instructions on removing the e.c.u. from the aircraft.

Types of damage

6. Compressor damage varies according to the type of foreign matter ingested; the effects of three main types or foreign matter are considered in the following paragraphs.

Metallic damage

7. Metallic objects which enter the compressor usually cause numerous tears and indentations on the rotor and stator blades; a careful examination for damaged blades should be made as far rearward as possible. Damage by metallic objects, e.g. nuts, setscrews or washers, is evidenced by thread impressions (fig.1) or regularly shaped marks or indentations. If such damage is observed, examine the air intake and front bearing housing for missing setscrews or similar items.

(1) Scoring on the walls of the front bearing housing and compressor casing may indicate ingestion of a heavy metallic body. Examine the turbine and exhaust unit for traces of aluminium and/or impact damage which may indicate break-up of compressor blades.

Stone damage

8. Stone damage is characterized by the marked difference between the damage on stage 1 rotor blades and that on subsequent stages. Usually, if stones are ingested by the compressor, they are shattered on the leading edges of the stage 1 rotor blades, and damage beyond this stage is not sufficient to cause concern. In addition to the obvious damage difference between the blade stages, the ingestion of shattered stone and grit causes erosion of the concave surface of the blades.

(1) If damage was caused by stones alone, engine serviceability should be assessed on the extent of damage to the stage 1 rotor blades.

Ice, slush, water or bird damage

9. Ingestion of ice, slush, water or birds may result in damage to the trailing edges of the intake guide vanes and the leading tips of the Stage 1 rotor blades. On entering the compressor, foreign matter of this type may bend stage 1 rotor blades backwards against the direction of rotation and axially forward, contacting the trailing edges of the intake guide vanes. This action will turn over the edges of the intake guide vanes and leave a damage mark on the leading edge of the affected rotor blade.

(1) In severe cases, a blade may be bent backwards until it fouls the tip of the following blade, and will inevitably foul the intake guide vanes when they are in the minimum incidence position.

Inspection

10. If it is suspected that an engine has sustained compressor damage, or where incidents which could cause compressor damage are reported, inspect the engine as follows:

(1) Examine the intake guide vanes for damage.

(2) Using a strong spotlight, examine the rotor and stator blades for distortion, damage and cracks, looking as far back into the compressor as possible.

(3) Examine the inner walls of the front bearing housing and compressor casing for damage.

(4) Check the exhaust unit and turbine blades for traces of aluminium which may indicate compressor blade failure. Refer to para.1. Note...

(5) Check the L.P. turbine blades for evidence of impact damage. Refer to para.1. Note...

(6) Examine the compressor air bleed valves for evidence of foreign matter.

(7) Check that the engine run-down time after the last flight or ground run was comparable with that after previous flights or ground runs.

(8) Rotate the compressor rotor slowly, by hand, and check that fouling does not occur between the rotor and stator blade assemblies.

Functional check after ice, slush, or water ingestion

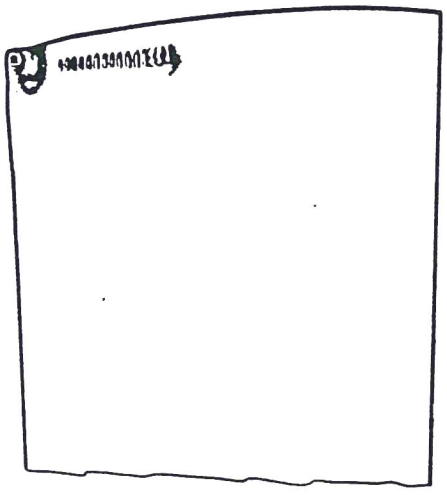
11. If it is known that ice, or water has been ingested, but Inspection (Para.10) reveals no damage proceed as follows :

CAUTION...

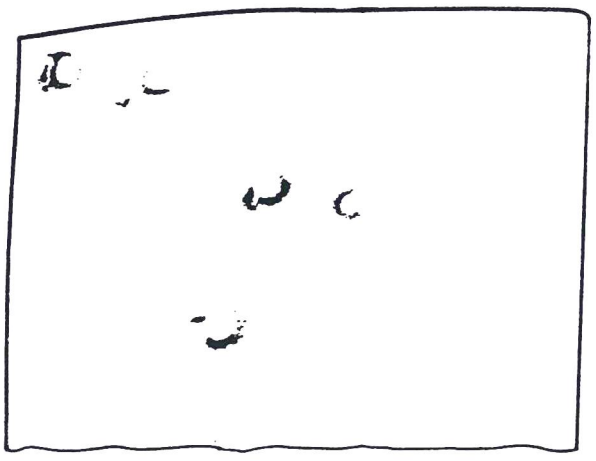
It is essential that the inspection detailed in para.10 is completed and reveals no damage before commencing the functional check.

(1) Motor the engine as described in Vol.1, Part 2, Sect.2, Chap.2, and, during the run-down, listen for any abnormal noise which may indicate engine internal damage. When the engine has stopped rotating, turn the compressor rotor by hand not less than two complete revolutions and check for freedom of rotation and any indication of internal damage.

(2) Manually operate the intake guide vanes and examine the compressor for damage and evidence of foreign matter, whilst slowly rotating the compressor by hand. If damage is not evident, start the engine (Vol.1, Part 2, Sect.1, Chap.2) and allow the engine to stabilize at the ground idling condition; stop the engine and check that the run-down time is comparable with that after previous flights or ground runs.



Typical damage caused by a 2 BA setscrew



Damage caused by pop rivet mandrel heads. This view shows the back of the blade indicating that the mandrel head has deeply cratered the reverse side

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Fig.1 Typical foreign object impression-unacceptable

(3) If the run-down time is satisfactory, restart the engine and make the following checks:

CAUTION...

If any malfunction is apparent during ground running, shut down the engine immediately and investigate and rectify the defect before continuing with the ground running checks.

(a) Open the throttle slowly until the engine reaches 7500 rev/min, carefully observing the engine instruments for any abnormal indications allow the engine to stabilize, then close the throttle.

(b) With the engine stabilized at ground idling rev/min, move the throttle lever rapidly from ground idling to the maximum rev/min position and check that the time taken to reach governed rev/min is within the specified limits (Vol.1, Part 2, Sect.2, Chap.2). Check for any abnormal noise and/or vibration and tendency to surge.

(c) At governed rev/min, check the engine instruments for indication of abnormal rev/min or jet pipe temperature.

(d) Move the throttle rapidly from governed rev/min to ground idling rev/min and check for abnormal noise and/or vibration and tendency to surge.

(4) If suspected ingestion occurred during the take-off, but performance was satisfactory during flight, inspect the compressor (para. 10). If damage is not evident, carry out the functional checks (para.11.).

12. If, after frontal inspection and functional checks, the serviceability of the compressor is in doubt, the engine must be removed from the aircraft for further investigation. If doubt still exists, the compressor top-half casing may be removed to permit closer examination of the compressor blades.

Acceptance standards - frontal inspection

13. Specific standards are difficult to establish. The number of tears or indentations should be considered in conjunction with the type of damage (para.6); there is a greater chance of severe damage being caused by the entry of, for example, a 2 B.A. setscrew than by pop rivet mandrel heads. It is necessary, therefore, not only to inspect the first stages of blades for the extent of damage but also, if possible, to determine the cause by careful examination of the damage marks. The decision to accept, repair or reject a damaged engine must be based on the broad standards detailed in the following paragraphs and the table of acceptance limits given in Fig.7.

(1) The following standards should be applied in assessing damage to the visible compressor stages by frontal inspection of the engine. The maximum number of 'acceptable' damage marks must not exceed three on any rotor blade or stator blade. Small bruises or shallow indentations (Fig.2 or 3) may be ignored.

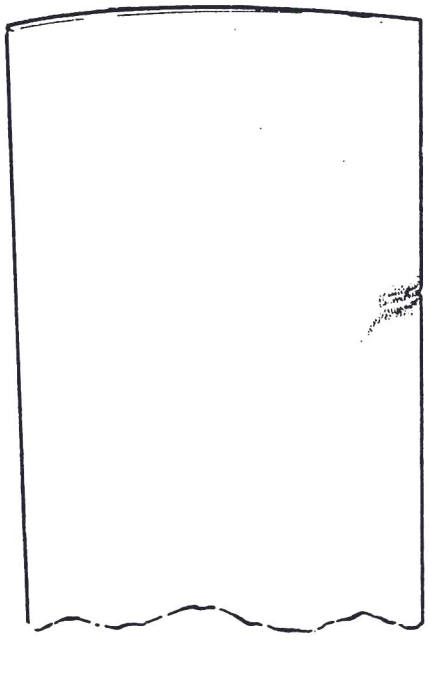

Fig.2 Acceptable bruise

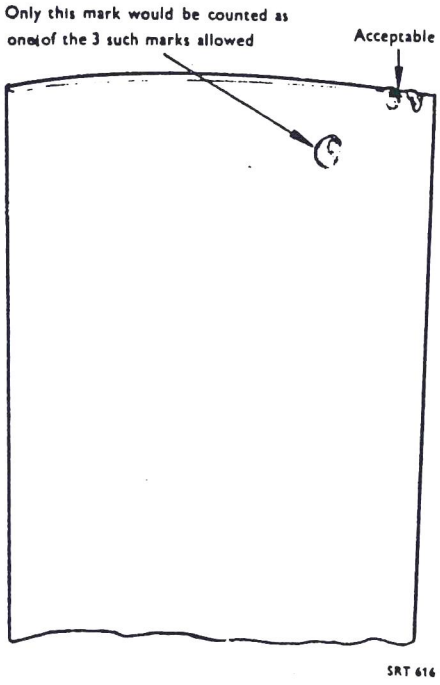

Fig.3 Acceptable indications

(2) Inlet guide vanes

(a) The following damage to inlet guide vanes is acceptable:

(i) Smooth indentations not exceeding 0.120 in. in diameter or length.

(ii) Smooth indentations not exceeding 0.630 in. in diameter or length, providing that these do not exceed three in number and that they do not encroach within 0.250 in. of any edge.

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(b) The following damage to inlet guide vanes is unacceptable:

(i) Sharp indentations or clearly defined foreign object impressions (Fig.1).

(ii) Penetration or tearing of the skin.

(iii) Two or more indentations which merge together.

(iv) Any identation on one side of the aerofoil which causes deformation of the opposite side.

(v) Rippling or corrugation of the vane surface.

(vi) Obvious abnormal twisting or bending of the aerofoil.

(c) Repair of inlet guide vanes is not permitted. If unacceptable damage is confined to the inlet guide vanes the front bearing housing may be removed and either the complete assembly replaced by a new assembly (para.27) or individual inlet guide vanes renewed (para.26).

(3) Rotor blades and stator blades

(a) Damage to either leading or trailing edges or a combination of both, exceeding a chordal depth equivalent to dimension 'X' of fig.7 is unacceptable Fig.4.

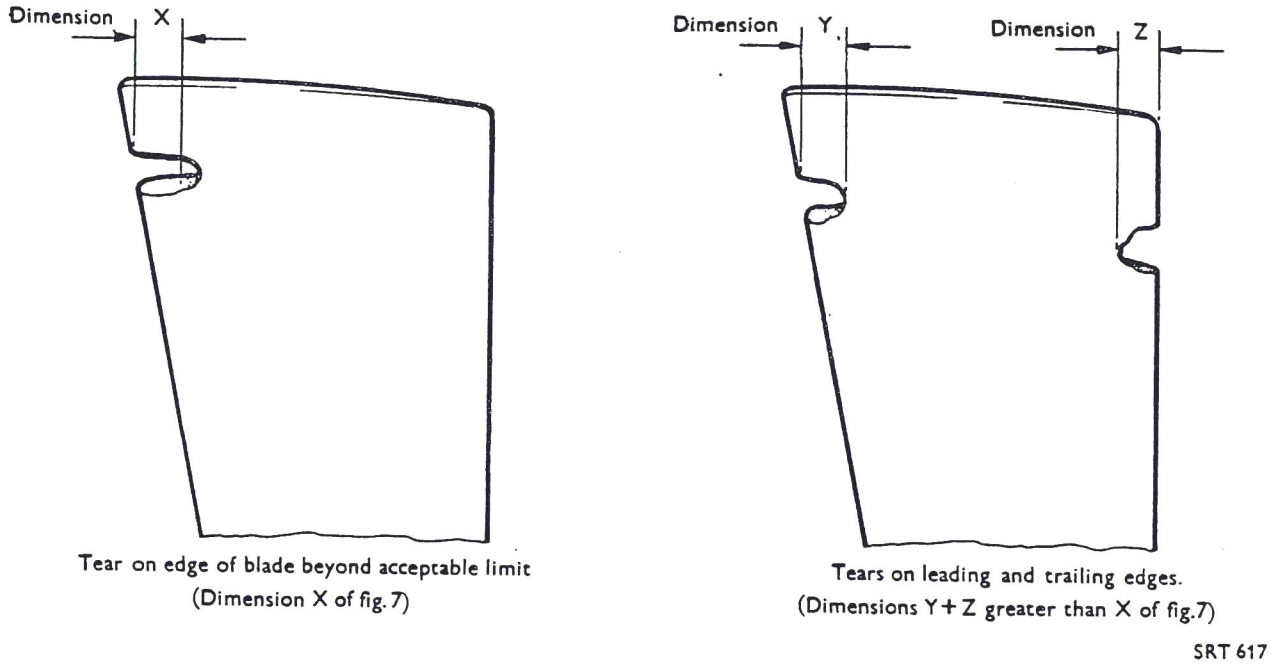

Fig.4 Unacceptable tear

(b) Cracks originating from leading or trailing edge damage marks (Fig.5), irrespective of the length of crack or the size of damage mark are unacceptable.

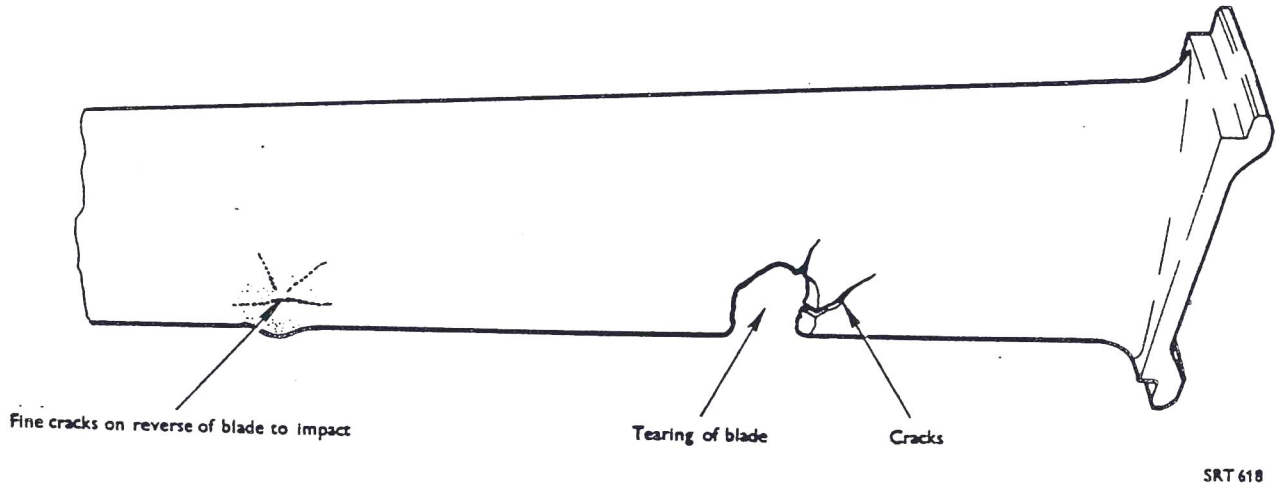

Fig.5 Unacceptable indentations and cracks

(c) Damage marks within 0.500 in. of the root fillet radius of rotor blades, other than small bruise and pit marks, are unacceptable.

(d) Damage which leaves a piece of blade which might subsequently become detached (fig.6) is unacceptable irrespective of chordal depth of damage.

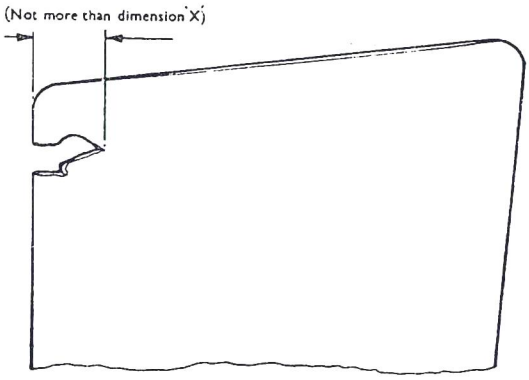

Fig.6 Piece of blade likely to become detached

(4) Compressor casings

(a) Intermittent rubs on the inner wall of the casings caused by momentary blade tip contact are acceptable without any requirement for rectification.

(b) A continuous rub or score over the full circumference of the casing inner walls may indicate failure of a first stage rotor blade retaining pin or, entrapment of a foreign body between the rotor blade tip and the casings. If this condition is apparent, effect the following:

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(c) If the rubbing and/or scoring is accompanied by extensive compressor damage, consistent with ingestion of a sharp, metallic object, it is probable that a stage 1 rotor blade pin failure has occurred and the engine mu be rejected. If minor or no blade damage is visible from the front of the engine, further investigation will be required as follows:

(i) Remove the front cowl then, retract the i.g.v. ram to facilitate inspection of the first stage rotor blades. Any one blade making contact with the compressor casings or obviously malaligned relative to the other blade, will indicate a failed blade retaining pin and the engine must be rejected. If there is no evidence of a failed blade retaining pin, effect (ii)

(ii) The front portion of a failed stage 1 rotor blade retaining pin usually moves forward, and sometimes into, the i.g.v. actuating mechanism. Test for a failed retaining pin by inserting a feeler strip (manufactured from 20 S.W.G. mild steel) formed as shown in fig.6A, between the forward edges of the stage 1 rotor blade platforms and rear edge of the i.g.v. rear half support ring then, slowly turn the engine clockwise, from the front, by hand through one complete revolution. If pin failure is not detected, i.e. does not foul the feeler strip, remove the front bearing housing to provide access to, and inspection of, the front end of stage 1 retaining pins.

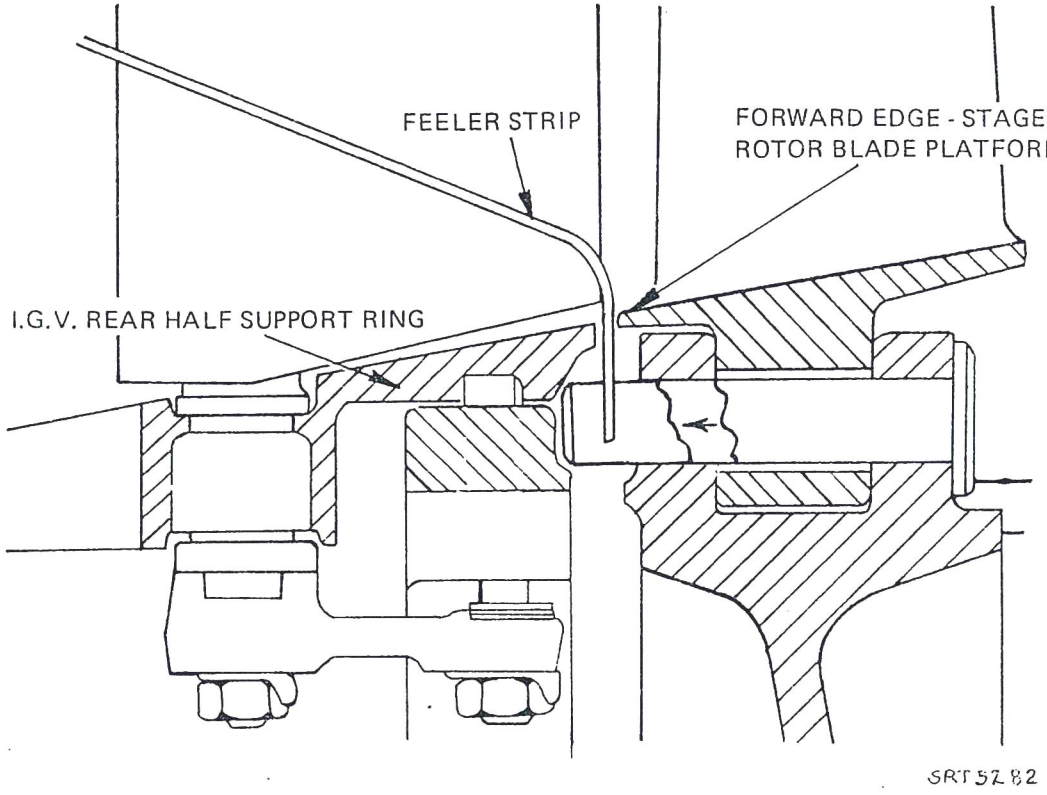

Fig.6A Check for stage 1 rotor blade retaining pin failure

(iii) If inspection does not reveal failed retaining pin(s), it may be assumed that the casing scoring has been caused by foreign body entrapment. Remove the top half casing and inspect the blades for damage (para.16).

(iv) Rectify damage as required then, to enable detection of any subsequent foreign body entrapment, paint the scored areas with an approved black air-drying enamel.

(v) Fit the compressor top half casing, as instructed in para.23A.

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(d) Remove the top half casing and inspect the blades for damage (para.16); rectify damage as required then, to enable detection of any subsequent foreign body entrapment, paint the scored areas with an approved black air drying enamel.

(e) Fit the top half casing, as instructed in para.23A.

(5) Compressor outlet casing

(a) Cracks may be observed at the junction between outlet ports 1 and 2, 2 and 3, 3 and 4, 7 and 8, 8 and 1. Circumferential cracks at these positions may be accepted within the following limits, even if they turn axially.

(i) The length of any one crack must not exceed 4.500 in.

(ii) The total length of two adjacent cracks must not exceed 7.000 in.

(iii) The cumulative length of cracking at all visible junctions must not exceed 12.000 in.

(b) Axial cracks are only acceptable provided they are covered by the change of direction instructed in (a).

(c) Any crack showing evidence of hot air leakage is unacceptable.

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14. If inspection of the inlet guide vanes and first stages of the compressor blades show that the compressor is just beyond the acceptance standards, but by blending the blades, can be brought within acceptance standards, remove the top-half casing (para.15) and rectify as necessary (para.16).

Compressor

15. Top-half casing - removing

(1) Remove the engine from the aircraft as described in the appropriate aircraft Air Publication and install the engine in its transportation stand Ref. No.1.

(2) Disconnect the low tension (l.t.) harness lead from the anti-icing hot air valve actuator and remove the hot air valve and actuator. Remove the screws which secure the air inlet elbow, to the hot air manifold and remove the elbow and pipe.

(3) Remove the pipes from the compressor air bleed valves (Chap.2).

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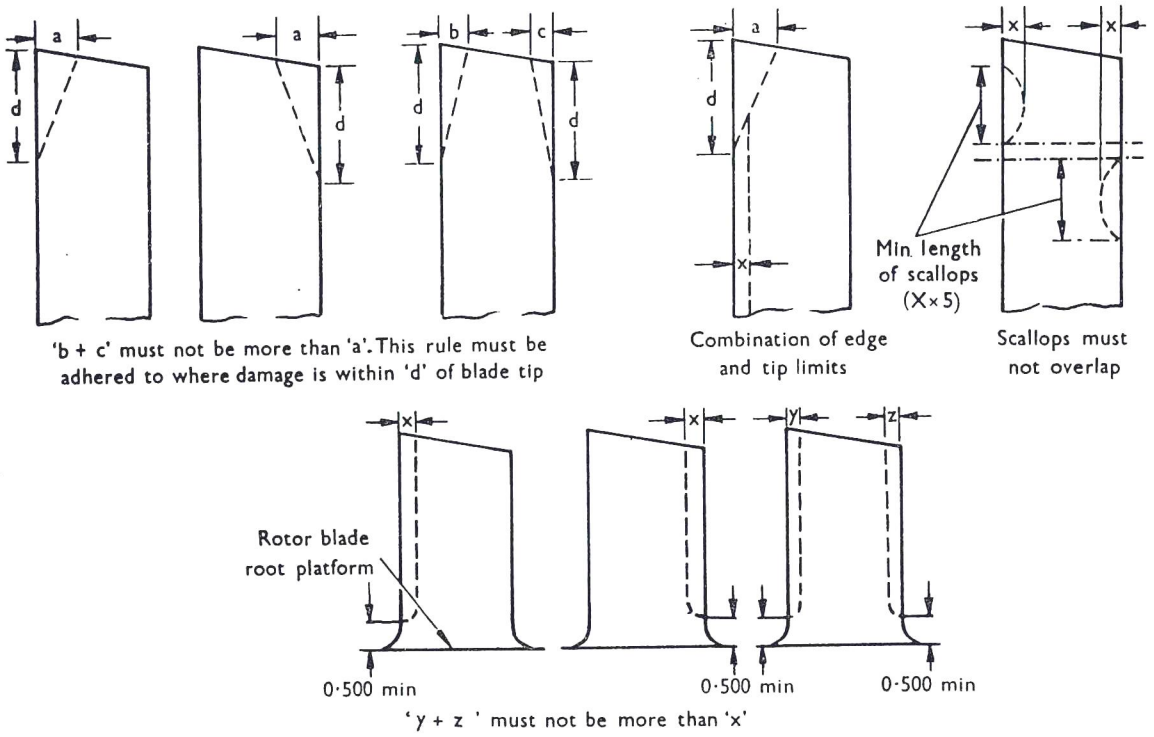

ROTOR BLADES

Stage	MAX. a(or b+c)	MAX. d	MAX. x(or y+z)	MINIMUM Chordal width after dressing or scalloping
1	0.500	1.500	0.150	1.630 Root 1.630 Mid 1.768 Tip
2	0.375	1.500	0.150	1.290 Root 1.290 Mid 1.380 Tip
3	0.375	1.250	0.150	1.100 Root 1.100 Mid 1.170 Tip
4	0.375	1.090	0.150	0.890 Root 0.900 Mid 0.940 Tip
*5	0.250	1.000	0.100	0.820
6 and 7	0.250	0.875	0.100	0.820
8	0.250	0.750	0.100	0.820
9	0.250	0.750	0.100	0.720
10 and 11	0.250	0.625	0.100	0.720
12	0.250	0.500	0.100	0.720

* After stage 4, average minimum chordal width is given, since nominal rotor blade width does not vary appreciably from root to tip

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Fig.7 Limits of acceptance for blending rotor blades in-situ

STATOR BLADES

Stage	MAX.	MAX.	MAX.	MINIMUM
	a(or b+c)	d	x(or y+z)	Chordal width after dressing or scalloping
1	-	-	0.200	1.460
2	-	-	0.200.	1.260
3	-	-	0.100	1.130
4	-	-	0.100	0.890
5	0.300	1.000	0.100	0.840
6	0.270	0.980	0.100	0.840
7	0.270	0.890	0.100	0.840
8	0.275	0.840	0.100	0.780
9	0.275	0.750	0.100	0.790
10	0.275	0.680	0.100	0.790
11	0.275	0.620	0.100	0.790

Fig.8 Limits of acceptance for blending stator blade damage in-situ

ROTOR BLADES

Stage	MAX. a(or b+c)	MAX. d	MAX. x (or y+z)	MINIMUM Chordal width after dressing or scalloping
1	0.400	1.500	0.130	1.650 Root 1.650 Mid 1.788 Tip
2	0.370	1.430	0.110	1.330 Root 1.330 Mid 1.420 Tip
3	0.320	1.250	0.100	1.150 Root 1.150 Mid 1.220 Tip
4	0.270	1.090	0.080	0.960 Root 0.970 Mid 1.010 Tip
5	0.240	0.980	0.070	0.850
6	0.215	0.870	0.070	0.850
7	0.215	0.790	0.070	0.850
8	0.215	0.720	0.070	0.850
9	0.215	0.650	0.070	0.750
10	0.215	0.590	0.070	0.750
11	0.215	0.540	0.070	0.750
12	0.215	0.490	0.070	0.750

STATOR BLADES

Stage	MAX. a(or b+c)	MAX. d	MAX. x (or y+z)	MINIMUM Chordal width after dressing or scalloping
1	-	-	0.125	1.535
2	-	-	0.100	1.360
3	-	-	0.085	1.145
4	-	-	0.070	0.920
5	0.240	0.890	0.070	0.870
6	0.220	0.810	0.070	0.870
7	0.220	0.740	0.070	0.870
8	0.230	0.700	0.065	0.815
9	0.230	0.625	0.065	0.825
10	0.230	0.570	0.065	0.825
11	0.230	0.520	0.065	0.825

Fig.9 Limits of acceptance for blending rotor and stator blade damage 'horizontal strip'

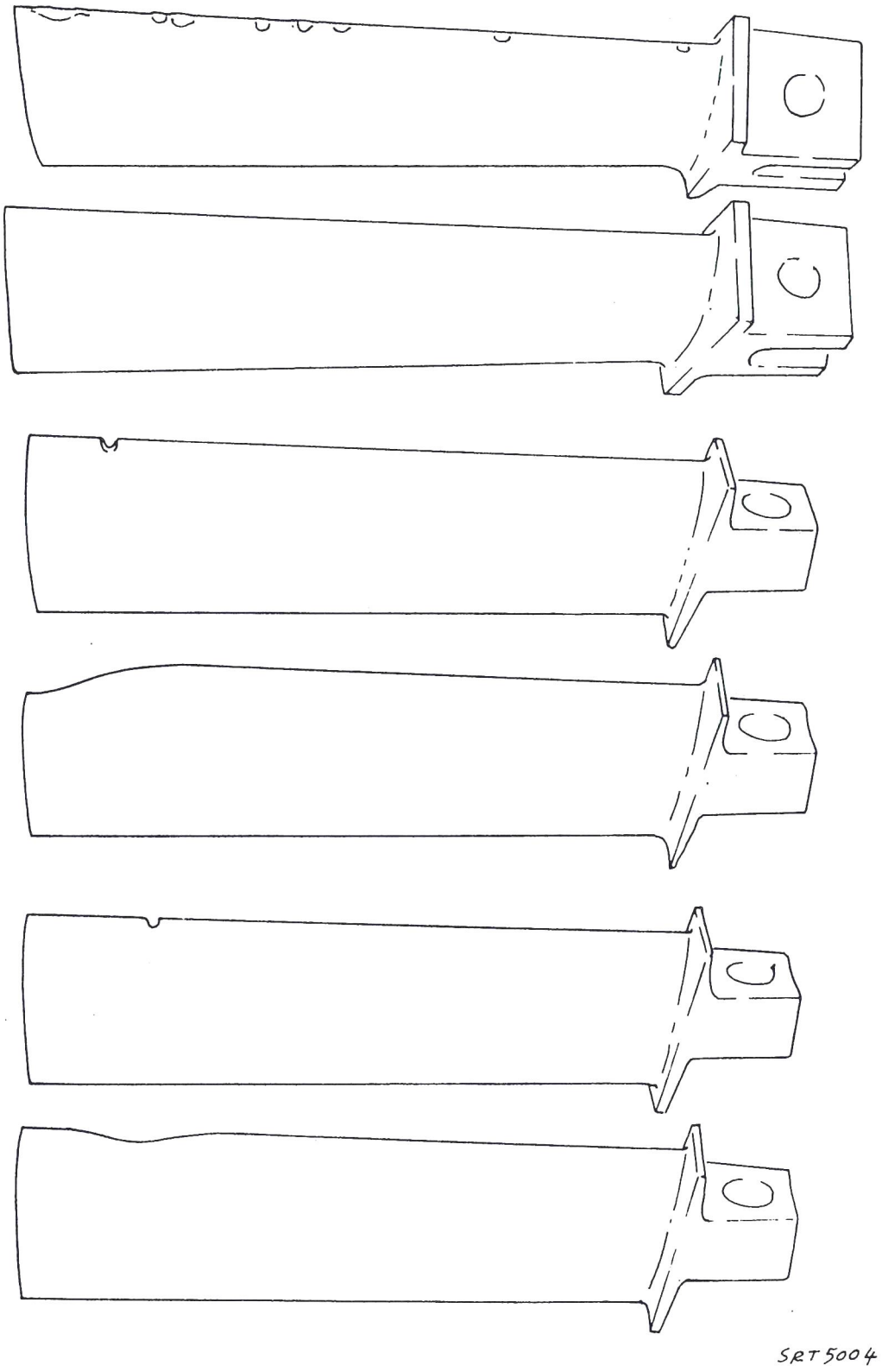

Fig.10 Typical examples of damaged rotor blades before and after blending

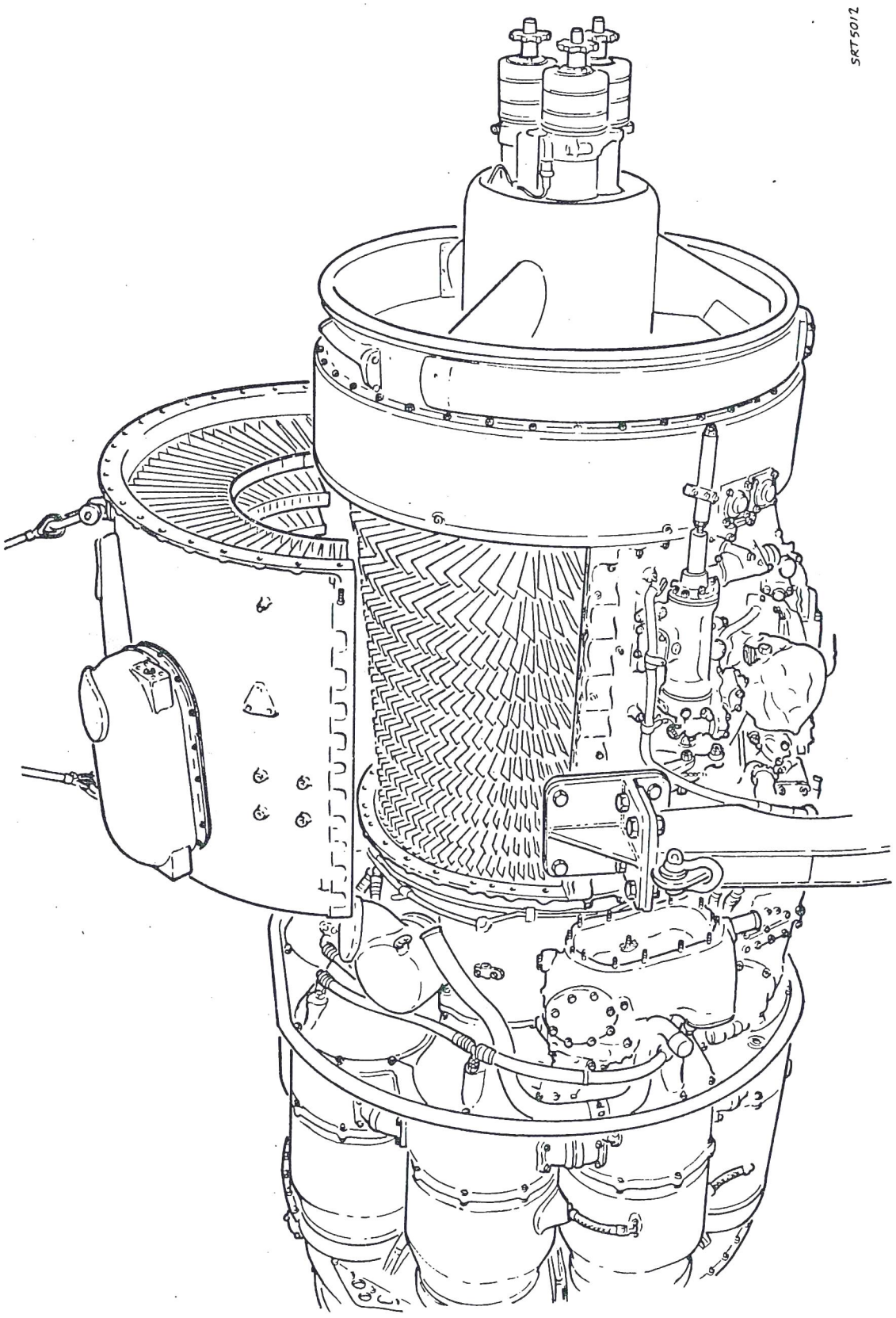

Fig.11 Top-half casing removed

(4) Remove the acceleration control unit and associated pipes and remove the fuel pumps and metering valve unit (Chap.6).

(5) Remove the pipe connecting seventh stage air to the bleed valve control unit (Chap.2).

(6) Disconnect the electrical connections and clips from the air dipping unit (Mk.122) and remove the pipes (Chap.2).

(7) Remove the screws which secure the top-half casing to the compressor outlet casing and, using the extractor Ref. No.2, withdraw the dowels sufficiently to clear the compressor (approximately 0.625 in.). Note the relative locations of the screws.

(8) Remove the blanking plug from the lifting eye insert in the top-half casing and fit the lifting eye Ref. No.7 and washer Ref. No.8.

(9) Extract the split pins from the four fitting bolts (2 front and 2 rear) which locate the compressor halves and remove the nuts and bolts.

(10) Remove the screw which secures the top-half casing to the front bearing housing and, using the extractor Ref. No.6, withdraw the dowels.

(11) Slacken the screws which secure the bottom-half casing to the front bearing housing sufficiently to prevent the top-half casing binding between the front bearing housing and the compressor outlet casing.

(12) Attach a lifting sling Ref. No.9 to the lifting eyes then, using a suitable hoist, raise the top-half casing clear of the engine.

(13) Lower the top-half casing into the vertical position onto a low wooden bench at a convenient working height to permit inspection of the stator blades.

(14) Tighten the screws which secure the bottom-half casing to the front bearing housing.

16. Rectification

(1) Damage within the blending limits shown in fig.7, and fig.8 can be rectified by dressing blades as instruction in para.17.

(2) Rotor blade damage beyond limits shown in fig.7 will necessitate dismantling the compressor in the horizontal position ('Horizontal strip' para.18) and removing the compressor wheel assemblies for repair or removal of blades, balancing and re-assembly (paras.19 to 23A).

(3) Stator blade damage beyond limits shown in fig.8, will necessitate removal and renewal of blades as instructed in 'Horizontal strip', para.18. If damage to any blade in the top-half casing is not acceptable without blending, it must be assumed that a similar condition exists in the bottom-half casing. Stators from the stage affected must be removed for examination, dressing or renewal as required.

(4) There is no limit to the number of stator blades which may be repaired. The number of rotor blades in any one stage, and the number of stages, which may be repaired by blending, is limited only by the effect on engine performance.

17. Blade dressing in-situ

(1) When blending damage to rotor and stator blades, observe the following conditions:

(a) Only the minimum of dressing should be done to bring the blades within acceptable limits.

(b) Prevent filings or metal dust from lodging in the compressor by using a piece of oil soaked rag, slit to accommodate any rotor blades being dressed. It may be found more practicable to remove stator blades that require dressing, from the top-half and bottom-half casing. Refer to stator removal 'Horizontal strip', para.18.

(c) Blades which have small pieces liable to become detached should be dressed and adjacent damage marks on any one blade can be merged by blending to bring them to an acceptable form.

(d) When a combination of tip and edge scalloping is necessary, it is preferable that the full length of the blade is dressed to dimension 'X', 'Y' or 'Z' rather than a local edge scalloping.

(e) If damage is scalloped and blended on both the leading and trailing edge of a blade, the run out of the blends must not overlap (figs.7 and 8).

(f) Care must be taken not to leave any sharp edges. The blade profile must, as near as possible, be maintained, and all scalloping must blend smoothly into the aerofoil.

(g) Scalloping is not permissible within 0.500 in of the root radius.

(h) Excessive rounding of rotor blade tips can adversely affect compressor efficiency and may reduce surge margin. Care must therefore be taken to maintain the flatness of blade tips, and to ensure that the radii at the tip corners are not increased.

(2) Blending should be effected with small, suitably shaped fine files, or a small power tool with suitable attachments, taking care to avoid making deep file or grinding marks. After blending, polish the affected area with fine emery tape.

CAUTION...

Take care not to break off pieces of blades or files which may lodge in the bottom-half compressor casing and cause further damage.

(3) After dressing, aluminium blades must be treated with an approved air-drying varnish; using only the minimum amount of varnish required to reprotect the dressed area only.

(4) After blending damaged blades there must not be any sharp corners. Typical damaged blades, before and after treatment, are shown in fig.10.

(5) Unless the dressed rotor blades are fairly evenly distrubuted amongst the blades in any stage, counterbalancing should be effected by dressing, to a similar degree, the diametrically opposite blades.

18. Compressor rotor wheels and stator blades removal (Horizontal Strip).

Note...

The following instructions apply when the repair entails removal of stator blades and/or rotor wheel assemblies. The actual number of stages removed will be governed by the extent of damage revealed during the inspection (para.14).

(1) The use of an approved penetrating oil is essential before and during dismantling. Apply oil liberally, particularly to the stator blade assembly platforms and locating grooves, the mating splines of the compressor shaft, and the screw threads of the front bearing retaining nut.

Note...

Allow time for oil to penetrate before attempting to remove components.

(2) Before removing the rotor wheels, inspect the rotor blades and mark those which are damaged beyond the acceptable blending limits of fig.9.

CAUTION...

To prevent damaging the centre main bearing air/oil seal ensure that the compressor shaft is correctly supported in the horizontal position and that its position is monitored on the dial indicator during disassembly and assembly.

Note...

Special tools required during the following operations are listed in 'Tools and Equipment' located at the front of this section.

(3) Secure the bracket Ref. No.29 to the top position of the compressor outlet casing flange, mount the magnetic dial test indicator Ref. No.29 on the bracket platform and position the dial test indicator pointer on the stage 12 spacer and record the horizontal position of rotor shaft fig.12.

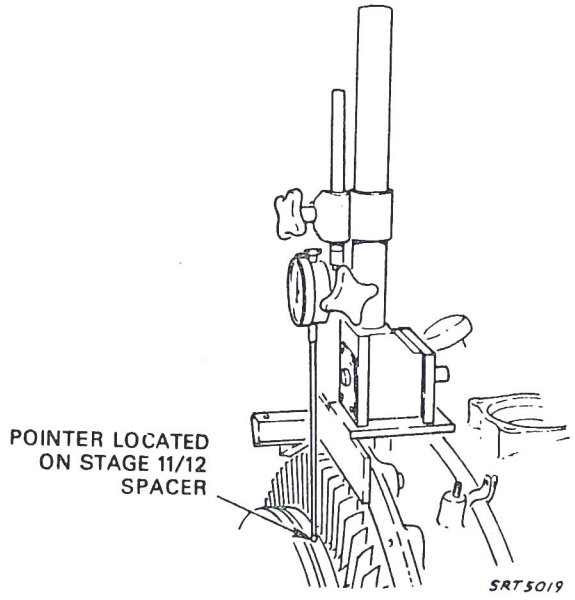

Fig.12 Bracket - Magnetic base and clock - Mounted on outlet casing - Pointer located on spacer

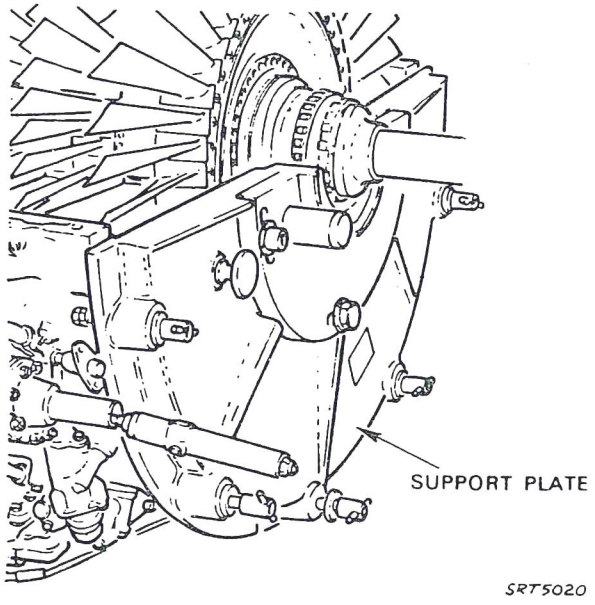

Fig.13 Support plate - supporting compressor shaft

(4) Remove the front bearing housing as described in para.25. Support the compressor shaft with the support plate Ref.44 instead of the dummy front bearing housing (fig.13).

(5) To aid re-alignment during re-assembly, apply correlation marks, using an approved marking medium, to all rotor wheels and spacers and to the front of all rotor wheels and the shaft before removing individual rotor wheels. The correlation mark on the front face of the stage 1 wheel must extend over the front bearing retaining nut. Refer fig.15.

(6) To ensure the correct nip during re-assembly, carry out a drop check on the rotor pack nut and a swash check on the stage 1 rotor wheel using a straight edge placed across the front of the compressor shaft as a datum and record the readings. The swash checks should be taken at the 3, 6, 9 and 12 o'clock positions on the face of the pin retaining flange.

(7) Remove the two stage 6 stator blade retaining washers from the bottom-half casing split-line flange.

CAUTION...

To prevent damage to the stator blade aerofoil the hook must only be applied as close as possible to the outer blade platform before pulling.

(8) Using the hook Ref.37, remove as many stator blades as possible from both sides of the bottom-half casing.

Note...

When removing any stator blade group assemblies by the above method, it is essential that the pull be made on the blade furthest away from the operator. If the hook is applied to the nearest or intermediate blade, the stator platforms will spread and bind in the compressor casing.

(9) Store the blades removed in order, in suitable marked compartmented boxes. (This procedure will apply to all stator blades as they are removed from successive stages).

(10) Using suitable hardwood or plastic drifts of local manufacture, remove the remaining stator blades by impacting the drifts carefully with a hide face hammer.

CAUTION...

Ensure that all stator blades are removed before fitting support strap.

(11) With stage 6 stator blades removed, feed stage 6 support strap Ref. No.33 (screwed end first) from left-hand side of compressor split-line flange and engage T piece end of strap in the support plate Ref. No.31. Fit support plate Ref.No.31 to the left-hand compressor split-line flange. Fit support plate Ref.No.32 to the right-hand compressor split-line flange. Thread the screwed end of the support strap through the right-hand side support plate and secure with nut and washer.

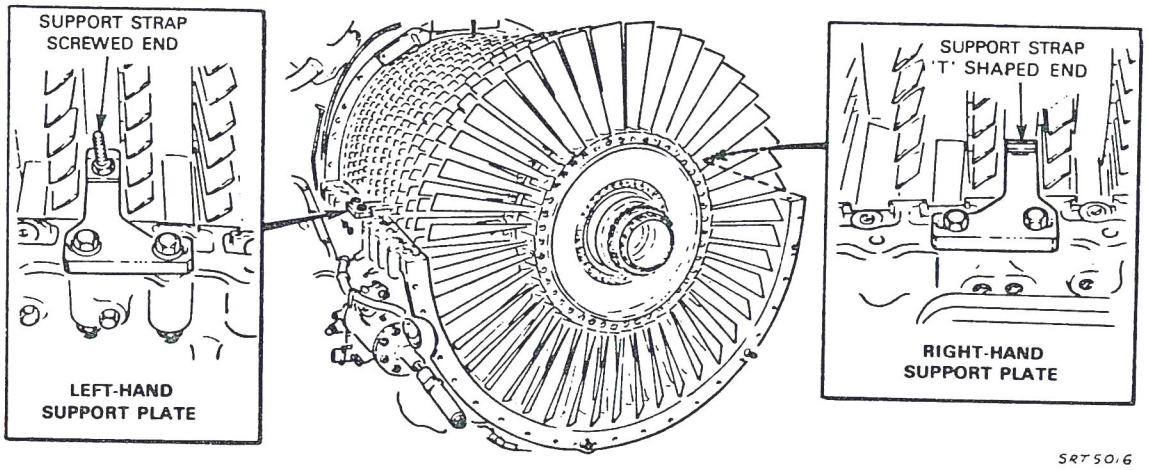

Fig.14 Rotor assembly supported by stage 6 support plates and strap

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(12) Tighten stage 6 support strap Ref.No.33 until the strap is just taking the weight of compressor rotor pack. Check the horizontal level of the compressor assembly rotor pack on the test dial indicator.

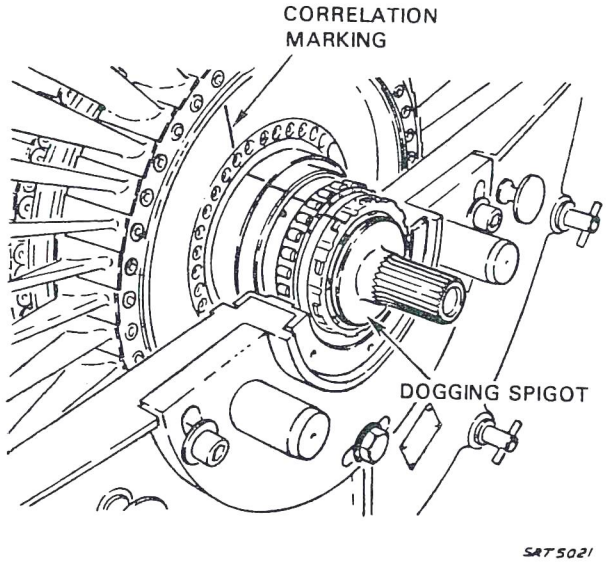

Fig.15 Dogging spigot - Dog compressor shaft

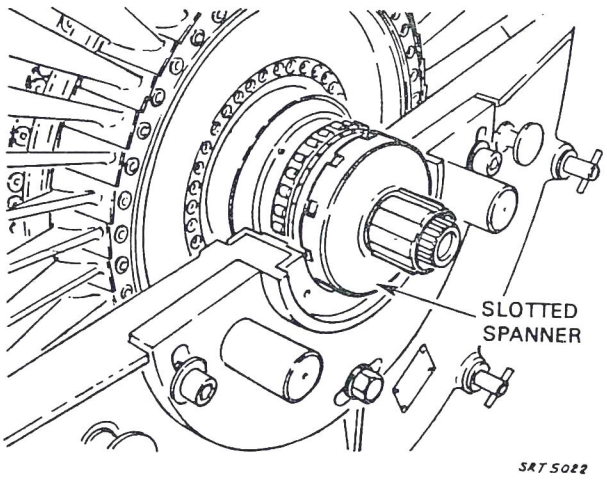

Fig.16 Slotted spanner - Fitted to front bearing retaining nut

(13) Unlock the front bearing retaining nut cupwasher. Fit dogging spigot Ref. No.39 and slotted spanner Ref. No.38 to the compressor shaft. Fit adapter plate Ref. No.40 to support plate Ref. No.44 and locate reduction gear Ref. No.41 on the adapter plate and engage reduction gear with the slotted spanner. Using pack nut wrench Ref. No.43, loosen the front bearing retaining nut by turning the wrench in an anti-clockwise direction; refer to figs.15, 16, 17 and 18.

(14) Tighten stage 6 support strap Ref. No.33 until the strap is just taking the weight of the compressor assembly rotor pack. Check the horizontal level of the compressor assembly rotor pack on the test dial indicator.

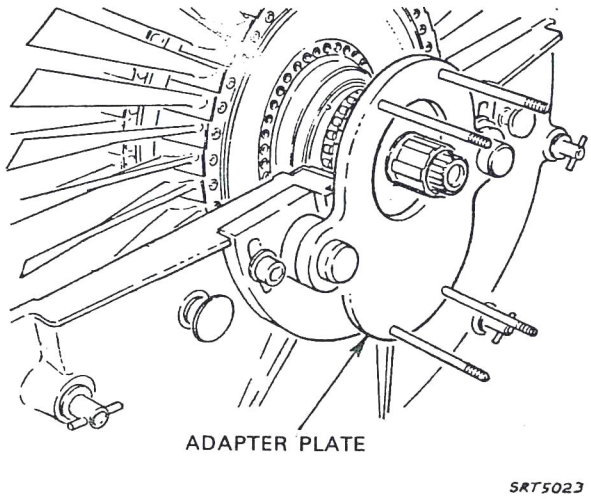

Fig.17 Adapter plate fitted to support plate

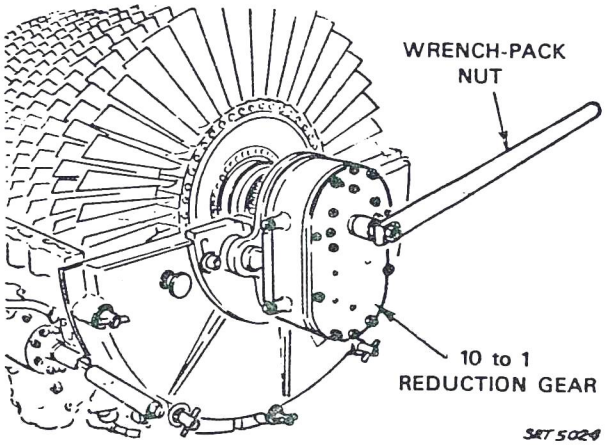

Fig.18 10 to 1 Reduction gear and wrench fitted to adapter plate

(15) Remove pack nut wrench Ref. No.43, reduction gear box Ref. No.41, adapter plate Ref. No.40, slotted spanner, Ref. No.38, dogging spigot Ref. No.39 and support plate, Ref. No.44, withdraw the front bearing nut and cupwasher. If the cupwasher is unserviceable measure and record the flange thickness to enable a replacement cupwasher of the same thickness to be used on re-assembly.

(16) Check horizontal level of compressor assembly rotor pack on the test dial indicator. Adjust stage 6 support strap if necessary.

CAUTION...

To prevent damage to the air/oil seal ensure that the, extractor, Ref.45, seal withdrawal tool is correctly aligned.

(17) Using extractor Ref.No.45 withdraw the front bearing roller track adjusting washer, and the air/oil seal. fig.19.

(18) Apply adhesive tape to protect the threads of the shaft from damage.

CAUTION...

Compressor rotor wheels are of thin sectional construction and are susceptible to damage, therefore during dismantling do not strike the wheels as this may damage the thin section of the diaphragm and/or outer rim.

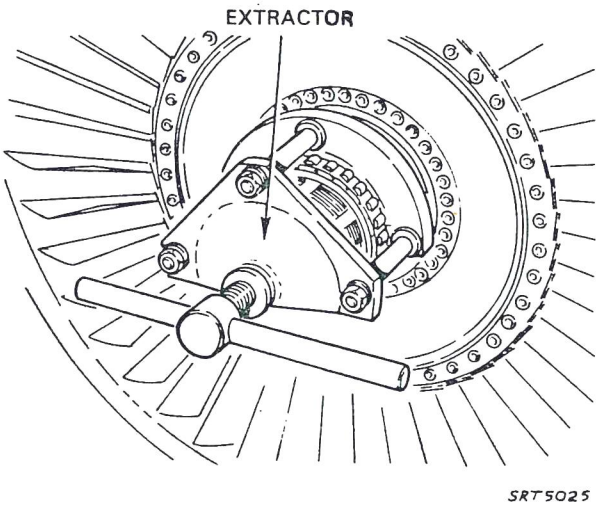

Fig.19 Removing front bearing roller track, adjusting washer and air/oil seal

WARNING...

ROTOR WHEEL EXTRACTORS ARE HEAVY ITEMS, A SUITABLE HOIST IS REQUIRED FOR LIFTING THESE TOOLS.

CAUTION...

(1) Before removing any wheel, secure the rotor blade retaining pins with adhesive tape to prevent the pins becoming dislodged.

(2) After each wheel is removed, protect the splines of the shaft from damage by wrapping with adhesive tape.

(19) Place the split adapter, Ref.48, behind the lip on the stage 1 wheel hub. Locate the extracting tool, Ref.47, supported by a suitable hoist, on the split adapter studs and secure by swinging the swivel plates on to the studs and tightening the nuts, turn the screwed bar to withdraw the stage 1 rotor wheel and spacer. Each wheel must be lifted from the rotor shaft on to suitable wooden blocks. These instructions also apply to the removal of stages 2, 3, 4 and 5 rotor wheels.

Note...

Wheels with flat headed blade retaining rings must be placed on the wooden blocks with the pin head uppermost. Wheels with headless blade retaining pins must be placed with the taped face resting on the blocks.

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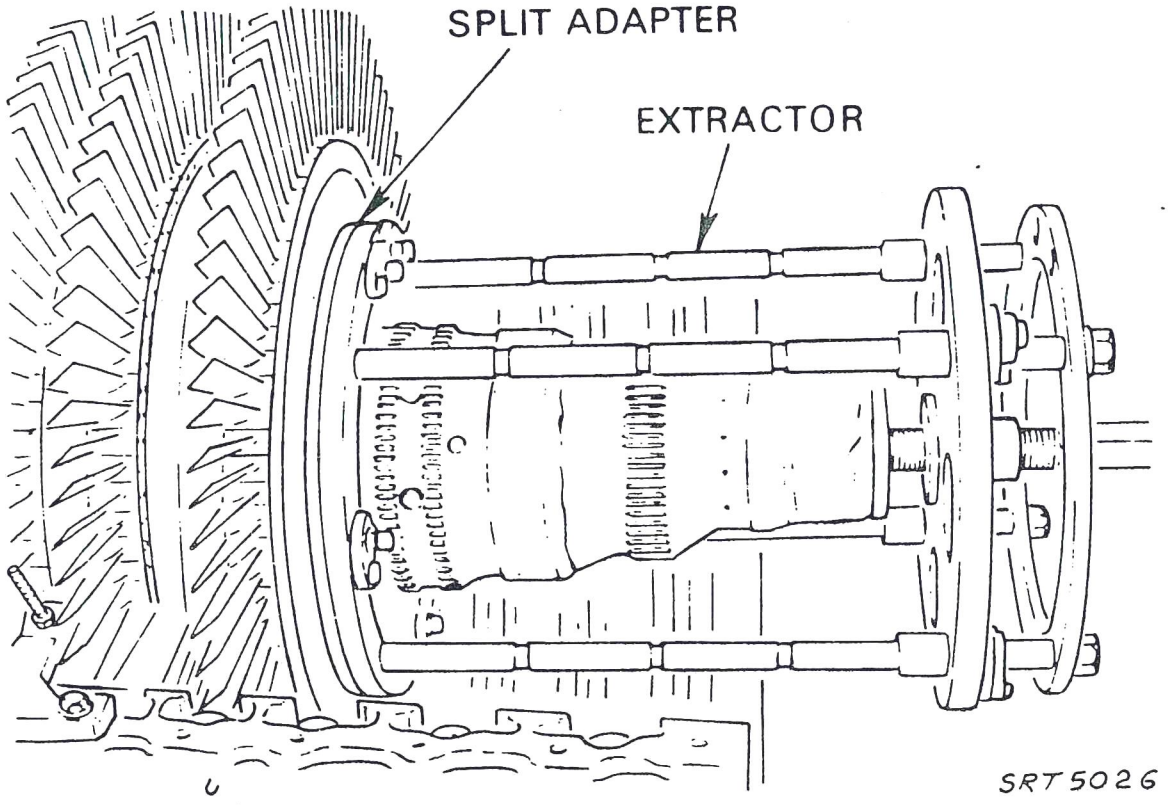

Fig.20 Extractor - Withdrawing tool (short) stages 1 to 5 rotor wheels

CAUTION...

When removing stator blades from the compressor casing remove a blade or segment assembly individually to prevent damage to the casing grooves.

(20) Remove stage 1 stator blades from the bottom-half casing.

(21) As stator blades are removed from successive stages they must be arranged in order, in suitable marked compartmented boxes.

(22) Fit the split adapter Ref.No.49 and extractor Ref.No.47 to stage 2 rotor wheel and spacer and withdraw stage 2 rotor wheel and spacer.

(23) Remove the stage 2 stator blades from the lower half casing.

(24) Fit the split adapter Ref.No.50 and extractor Ref.No.47 to stage 3 rotor wheel and withdraw stage 3 rotor wheel and spacer (vortex reducer).

(25) Remove the stage 3 stator blades from the lower-half casing.

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CAUTION...

Do not attempt to remove stage 4 rotor wheel and spacer as an assembly or the spacer will foul the stator blades.

(26) Fit the split adapter Ref.No.51 and extractor Ref.No.47 to stage 4 rotor wheel and withdraw the rotor wheel and spacer assembly until the rear face of the spacer is 0.250 in. clear of stage 5 rotor wheel. Using a suitable punch release the spacer from the wheel by driving the rotor blade retaining pins at 12, 3, 6 and 9 o'clock positions rearward. Remove stage 4 rotor wheel then remove spacer.

CAUTION...

To prevent damage ensure that stage 3 shaft splines do not foul stage 4 wheel during removal.

(27) Remove the stage 4 stator blades from the lower-half casing.

(28) Fit the split adapter Ref.No.52 and extractor Ref.No.47 to stage 5 rotor wheel and withdraw stage 5 rotor wheel and spacer.

(29) Remove stage 5 stator blades from the lower-half casing.

(30) If the extent of damage revealed during the inspection (para.14) necessitates the removal of rotor wheels beyond stage 5, the stage 11 stator blades must first be removed to enable the compressor shaft support strap to be fitted.

(31) Remove the two stage 11 stator blade retaining washers from the casing split-line flange.

(32) Remove stage 11 stator blades as described in sub-paras. (8), (9), (10).

CAUTION...

Ensure that all stator blades are removed from the casing, before fitting the support strap.

(33) With stage 11 stators removed, feed the support strap Ref.No.36 (screwed end first) from the left-hand side of the compressor split-line flange and engage the T piece end of the strap in support plate Ref.No.34. Fit support plate Ref.No.34 to the left-hand compressor split-line flange using the existing compressor split-line bolt with packing washers fitted. Fit support plate Ref.No.35 to the right-hand compressor split-line flange. Thread the screwed end of the support strap through the right-hand support plate and secure with nut and washer. fig.21 and 22.

(34) Tighten stage 11 support strap Ref.No.36 until the strap is just taking the weight of the compressor assembly rotor pack. Check the horizontal level of the rotor pack on the test dial indicator.

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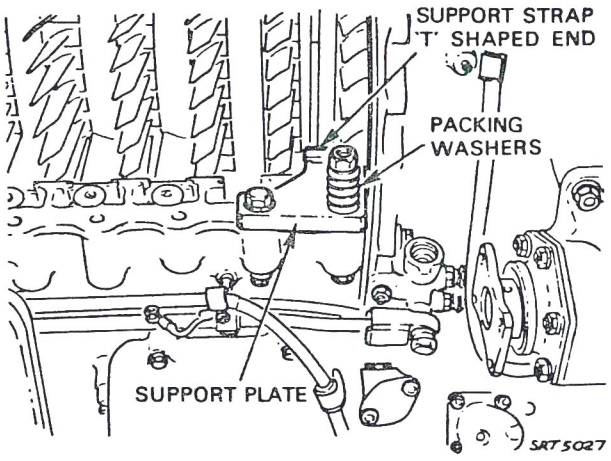

Fig.21 Stage 11 support strap and support plate (L.H.)

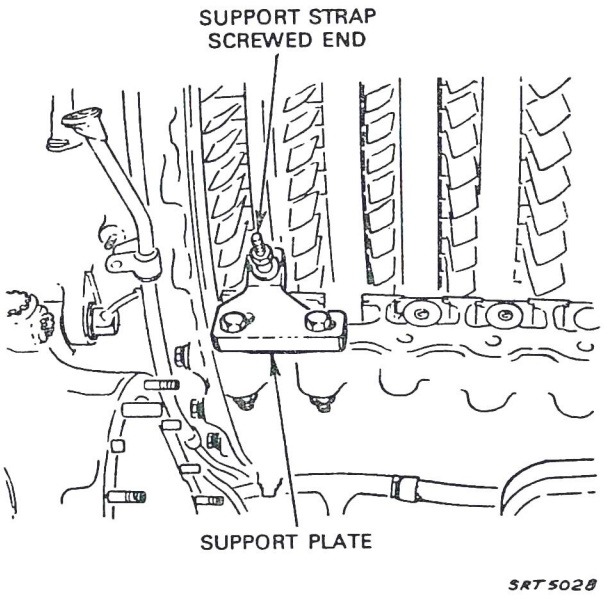

Fig.22 Stage 11 support strap and support plate (R.H.)

(35) Remove support strap Ref.No.33, support plates Ref.No.31 and Ref. No.32 from stage 6.

CAUTION...

During removal of stages 6 to 11 rotor wheels and spacers it is essential that the positional attitude of the rotor pack be raised by 0.003 in. on the test dial indicator to prevent spacers fouling stator blade tips during rotor wheel removal.

(36) Fit the split adapter Ref.No.54 and the extractor Ref.No.53 to stage 6 rotor wheel and withdraw the rotor wheel and spacer.

(37) Fit the split adapter Ref.No.55 and extractor Ref.No.53 to stage 7 rotor wheel and withdraw the rotor wheel and spacer.

(38) Remove the stage 7 stator blades from the bottom-half casing.

(39) Fit the split adapter Ref.No.56 and extractor Ref.No.53 to stage 8 rotor wheel and withdraw the rotor wheel and spacer.

(40) Remove the stage 8 stator blades from the bottom-half casing.

(41) Fit the split adapter Ref.No.57 and extractor Ref.No.53 to stage 9 rotor wheel and withdraw the rotor wheel and spacer.

(42) Remove the stage 9 stator blades from the bottom-half casing.

(43) Fit the split adapter Ref.No.58 and extractor Ref.No.53 to stage 10 rotor wheel and withdraw the rotor wheel and spacer.

(44) Remove the stage 10 stator blades from the bottom-half casing.

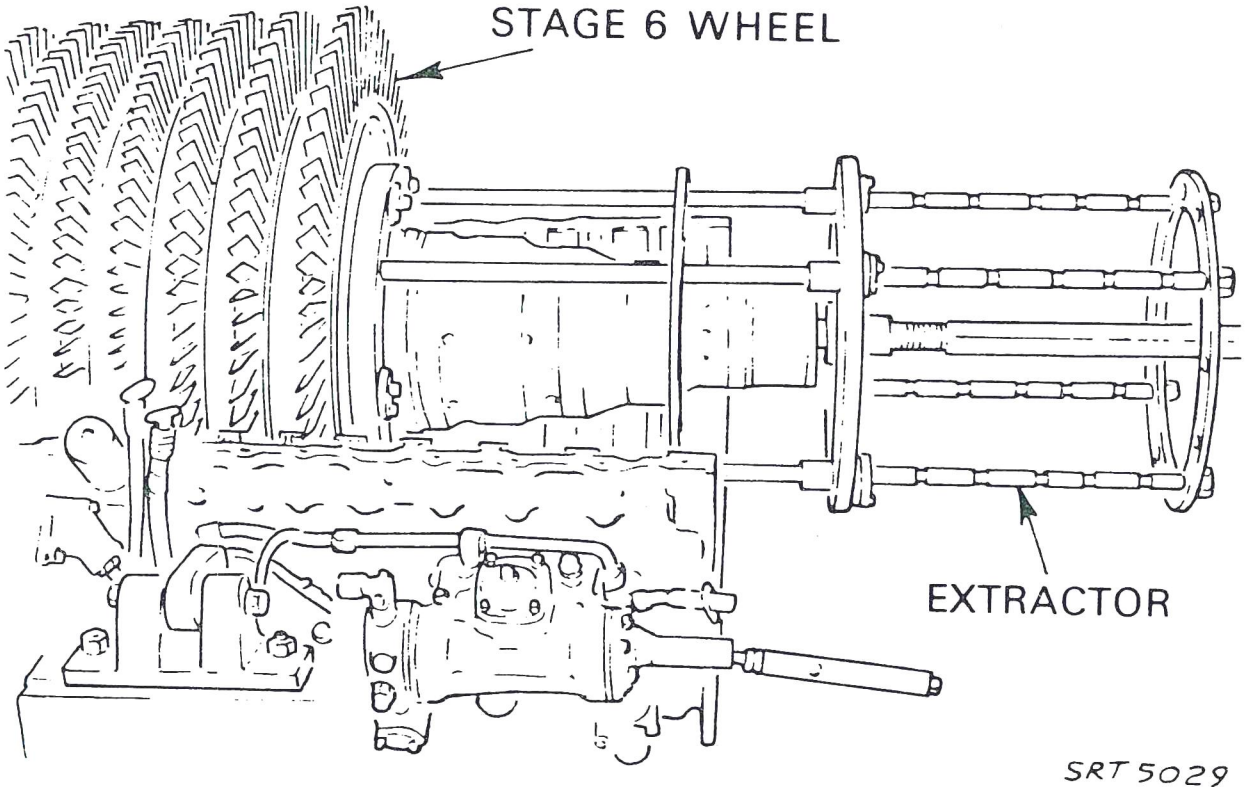

Fig.23 Extractor - Withdrawing tool (Long) Stages 6 to 11 rotor wheels

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(45) Fit the split adapter Ref.No.59 and extractor Ref.No.53 to stage 11 rotor wheel. Position a suitable locally manufactured wooden block (fig.25) under the compressor shaft to support the rotor pack. Slacken the support strap Ref.No.36. Check on the test dial indicator that the positional attitude of the rotor pack is unchanged. Remove the support strap Ref.No.36. fig.24 and 25.

(46) Adjust the pointer of the test dial indicator positioned on the stage 11/12 spacer and locate the pointer to record the rotor pack positional attitude at stage 12 rotor blade platform. fig.26.

(47) Using extractor Ref.No.53 withdraw stage 11 rotor wheel and spacer to allow sufficient clearance between stage 11 spacer and stage 12 rotor wheel for support strap Ref.No.60 to be located on the compressor shaft fig.27.

(48) Fit support strap brackets Ref.No.60 to the compressor outlet flange (fig.26) and secure with setscrews. Fit the support strap Ref.No.60 to the brackets and adjust strap to take the weight of the rotor pack. fig.27.

(49) Remove the wooden block, extractor Ref.No.53, stage 11 rotor wheel and spacer.

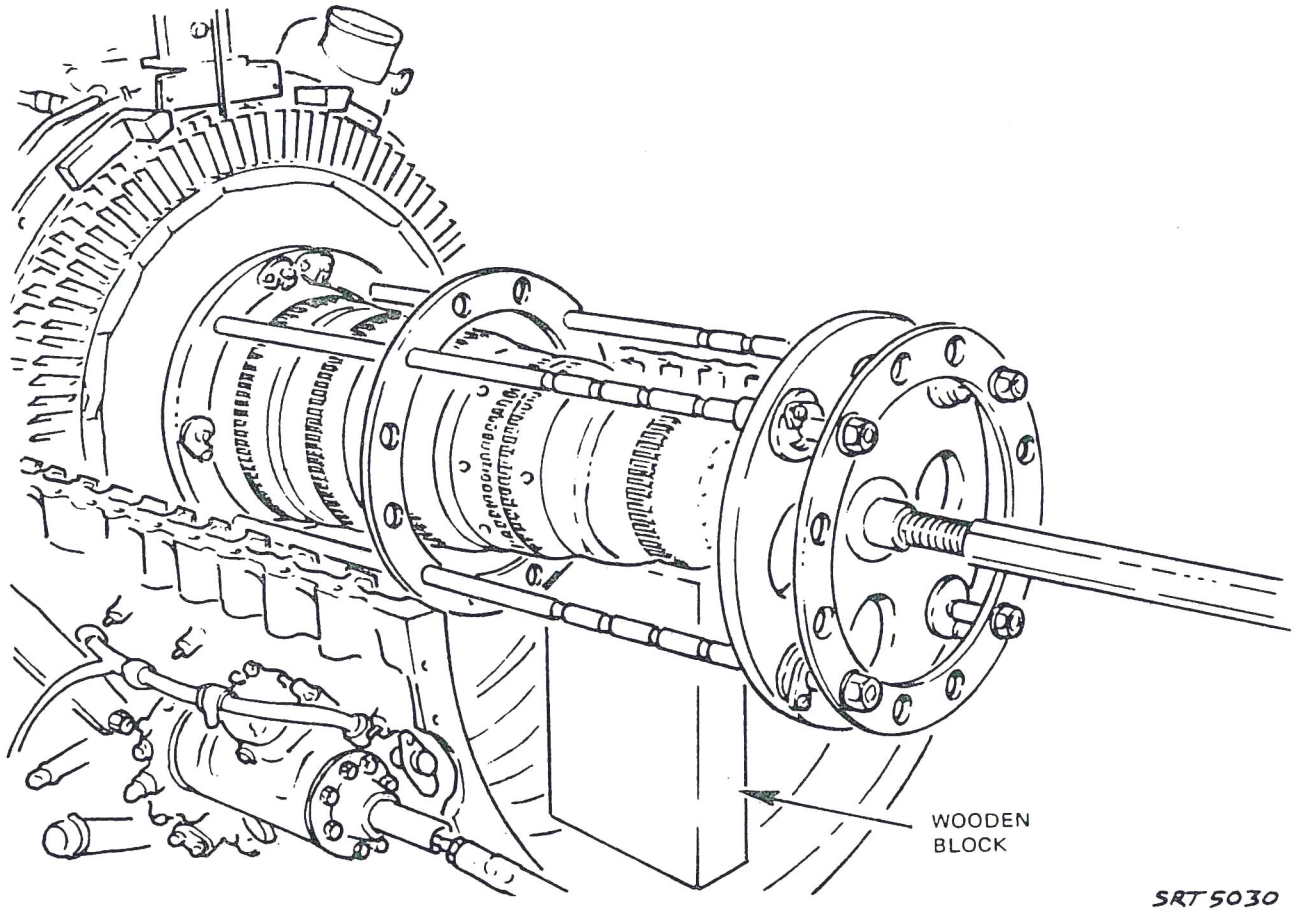

Fig.24 Stage 11 rotor wheel removal - compressor shaft supported by wooden block

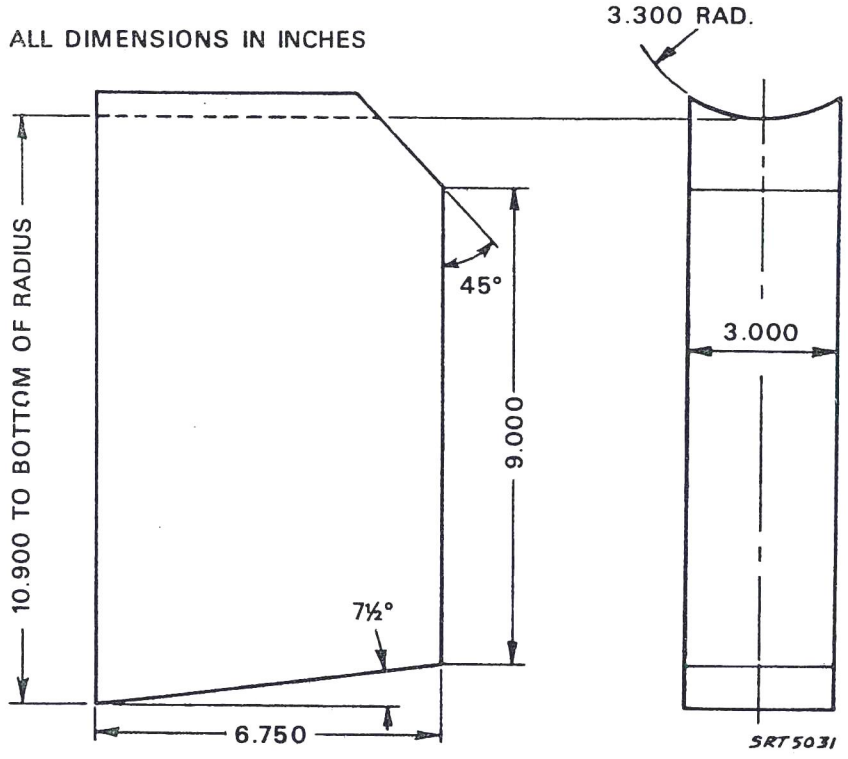

Fig.25 Wooden block - compressor shaft support

(50) Remove the protective tape from the compressor shaft front bearing seal and roller bearing location. Using the roller bearing and seal assembly, tool Ref. No.46, fit the front bearing roller race to the shaft.

(51) Fit the compressor shaft support plate Ref. No.44 to the bottom half casing, release the weight of the shaft from support strap Ref. No.60 and check the level of the compressor shaft on the dial test indicator.

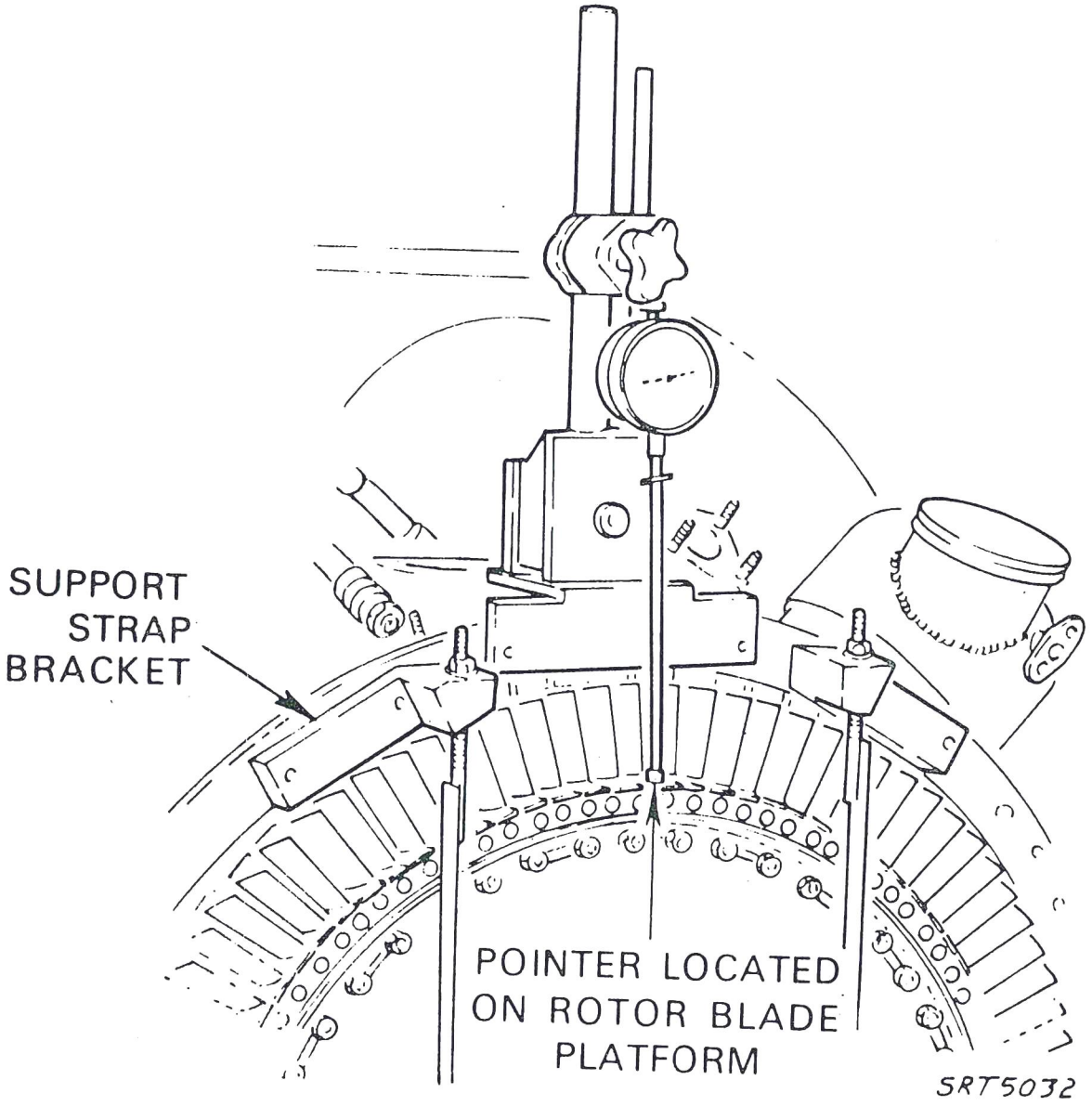

Fig.26 Dial test indicator pointer located on Stage 12 rotor blade platform

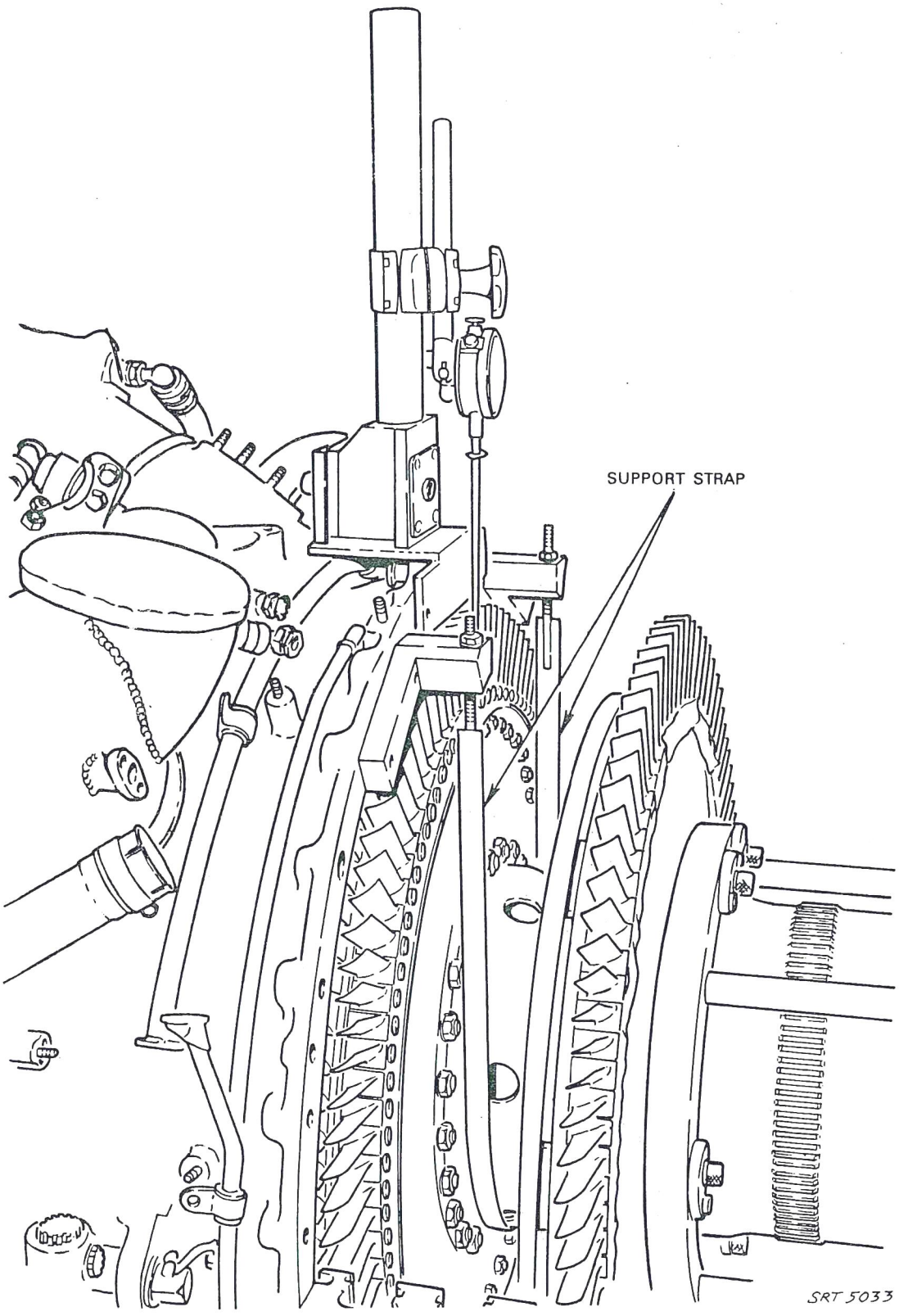

Fig.27 Stage 12 support strap located on compressor shaft - Stage 11 rotor wheel and spacer removal

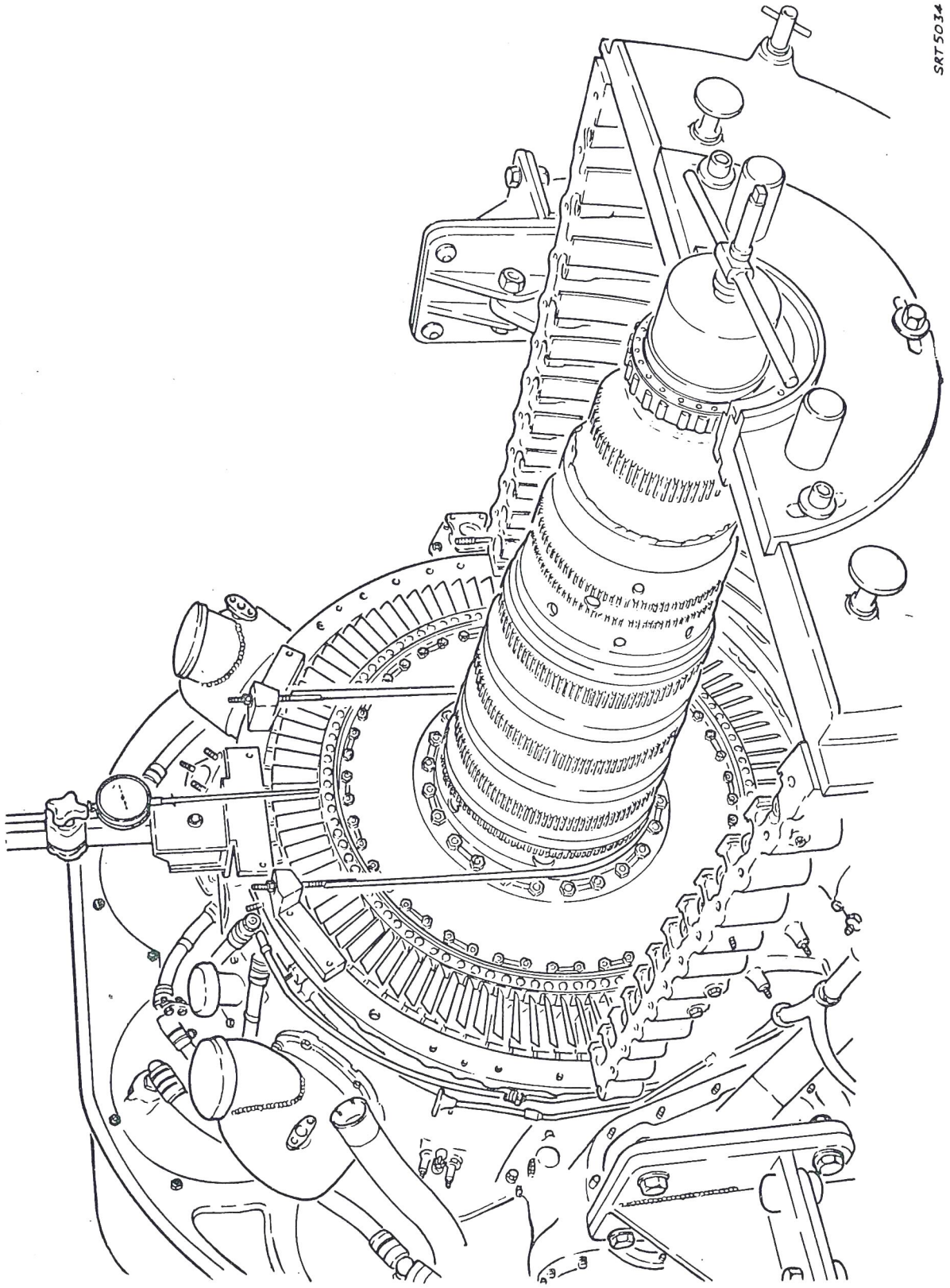

Fig. 28 Compressor assembly rotor pack supported by stage 12 support brackets and strap

19. Rotor blades - Repair or renewal

(1) Blades removed from wheels and which can be rectified by blending should be weighed before and after dressing and the final weight reduction noted on the aerofoil. The blades must be replaced in their original positions with their original retaining pins.

(2) Scrap blades should be weighed and the weight recorded. These blades should be replaced individually using blades of as near as possible the same weight. If a weight difference does occur, the increase or decrease should be marked on the replacement blade aerofoil along with the weight.

(3) Overall balance of the wheel can now be assessed using the weight change figures marked on the blade aerofoil. Any blades showing a weight change below the following figures do not require to be counterbalanced.

Stages 1 to 3 .....0.5 gm.

Stages 4 to 8 .....0.2 gm.

Stages 9 to 12.....0.1 gm.

(4) Individual blades or groups of adjacent or approximately adjacent blades having greater weight changes than those shown in sub para.(3) should, provided the number does not exceed 20% of the total number of blades in the stage concerned (sub-para.(7)), be balanced out by similar weight alterations approximately diametrically opposite. Where removal of existing blade damage does not give the correct counterbalancing, this should be corrected by tip dressing of diametrically opposite blades, (i.e. removal of material from leading and/or trailing edges tips).

(5) Where a large weight change has taken place, as in the case of inability to match the weight of a scrap blade, tip dressing will not be sufficient to provide the necessary degree of counterbalancing, and blade exchange will be required. This may be carried out by whichever procedure is most convenient as follows:

(a) Make the same weight change as is present in the blade with the high weight change by replacing a blade diametrically opposite with a suitable spare blade.

(b) The replacement blade with the high weight change and a blade approximately diametrically opposite, may be exchanged for two blades of any weight, but having the same weight difference from each other as the original blades in these positions.

(c) Exchange a blade, adjacent to the one with the high weight change, for a spare blade which compensates for the high weight change in the adjacent blade. That is, the sum of the weights of the two adjacent blades should be the same as that of the original two blades in these positions.

(d) Exchange a blade, adjacent to the one with the large weight change, with one approximately diametrically opposite, provided the weight difference between the two blades exchanged is approximately half the weight change which is required to be balanced and that the adjacent blade is the lighter.

Note...

Blade weights are temporarily marked, in units of weight, on the aerofoil tip during manufacture. These markings will assist in the selection of suitable spare blades to use as replacements. Details of the weight markings procedure are given in Table 1.

TABLE 1

ROTOR BLADE WEIGHTS

STAGE	PART NO.	MATERIAL	NOMINAL WEIGHT (gms)
1	SA.36681 GP.11458A	A/FLS	120.22 120.22
2	SA.64122 GP.11373A	A/FLS	64.00 64.00
3	SA.64123 GP.11459	A/FLS	46.00 46.00
4	SA.64124 GP.11374	A/FLS	30.15 30.15
5	SA.33291	A/FLS	21.75
6	SA.33292	A/FLS	20.00
7	SA.33293	A/FLS	19.50
8	SA.33294	A/FLS	18.75
9	SA.33295	BZ/AB	39.50

TABLE 1 (cont.)

STAGE	PART NO.	MATERIAL	NOMINAL WEIGHT (gms)
10	SA.33498	BZ/AB	37.50
11	SA.33297	BZ/AB	37.50
12	SA.33298	BZ/AB	35.15

Note...

Blades of nominal weight are marked 'A' and blades above or below nominal weight are marked plus or minus in 0.25 or 0.5 gram units depending on the nominal weight of the blades.

Blades weighing over 10 and up to 100 grams aremmarked + or - in 0.25 gm. units

Blades weighing over 100 and up to 400 grams are marked + or - in 0.5 gm. units

(6) The residual out-of-balance must not exceed the following amounts in the various stages.

Stages 1 and 2.....2 gms.

Stages 3 to 12.....1.5 gms.

(7) The residual unbalance in any stage is arrived at by adding together the amounts of unbalance, above the minimum counterbalancing limit quoted in sub.para.3, which remain after attempts to counterbalance individual blades. If the total number of significantly damaged blades (i.e. weight changes above the minimum counterbalance figures) exceed 20% of the total number of blades in the stage concerned, counterbalancing of individual blades should not be attempted and the light/heavy balance procedure (para.20) should be used.

20. Light/heavy balancing

(1) Remove the blades from the wheel concerned ensuring that each blade retaining pin is retained for re-fitting with the same blade. Each blade must be accurately weighed to within .05 gm. and the weight marked on the blade aerofoil. Starting with the heaviest blades in the set, and proceeding in decreasing order of weight, lay them out in pairs, placing them with roots opposed so as to form two horizontal rows. From the heavy end of the set, take the first pair of blades and place them on a bench root to root as before. Next to the heavy blades place the lightest from the opposite end of the set, then again taking from the heavy end and then from the light end, continue with this procedure until the two rows are completely re-laid into alternatively heavy and light pairs of blades.

(2) Commence assembling the wheel by fitting the first blade from the heavy end of the top row then, proceeding in a clockwise direction as viewed from the front of the rotor wheel, fit consecutively the remaining blades in the row. Follow on with the lower row of blades, fitting the first blade from the heavy end immediately after the last blade to be fitted from the top row.

(3) If these operations have been correctly followed, blades of similar weight will be found to occupy approximately diametrically opposite positions in the rotor wheel.

(4) On engines subjected to a horizontal compressor repair a record should be kept of the total number of stages subjected to a light/heavy balance.

21. Stator blades - Repair or renewal

(1) Inspect the top-half stator blades and apply the limits given in fig.8. Blades which can be brought within acceptable blending limits should be dressed as instructed in para.17.

(2) Blades damaged beyond blending limits must be discarded and new blades fitted.

(3) Inspect the stator blades removed from the bottom-half casing. Rectification or replacement of bottom-half casing blades is similar to that for the top-half casing.

22. Repair of damaged compressor casing inner walls

(1) Damaged on the upper and lower compressor casing inner surfaces may be blended to remove sharp edges. Blending in the region of the stator blade retaining lands is also permissible, provided such blending does not reduce the existing land sectional thickness by more than 20%. No treatment is necessary on aluminium casings after blending.

23. Compressor assembly

(1) With the dial test indicator mounted on the compressor outlet casing and set on stage 12 rotor blade platform, tighten the rotor shaft support strap, Ref.No.60, until the strap supports the rotor shaft. Check that the level of the rotor shaft is maintained on the test dial indicator.

(2) Remove support plate, Ref.No.44, and using extractor, Ref.No.45, withdraw the front bearing seal and bearing from the compressor shaft. Protect the seal and bearing shaft locations with protective tape.

(3) Prior to assembling a rotor wheel to the compressor shaft remove the protective tape and smear engine oil on the splines of the rotor wheels and shaft. Each spacer is an interference fit on the rear face of the proceeding wheel and where it is necessary to fit a spacer to a wheel, immerse the spacer in boiling water prior to fitting to the wheel.

CAUTION...

To prevent damage to the rotor wheel diaphragm do not strike the wheel on the thin sectioned diaphragm. Do not use excessive force when initially engaging a rotor wheel to the shaft splines. Use a soft faced mallet and tap the wheel hub lightly. Aluminium rotor wheels are of light construction and is is essential that extra care be exercised during their assembly to the shaft.

Note...

At all stages of the rotor shaft assembly, all correlation marks must be aligned.

(4) With the rotor blade pins in stage 11 wheel held in position with adhesive tape around the front rim of the wheel, remove the protective tape from the shaft splines and fit the wheel and spacer assembly to the shaft. If difficulty is experienced in fitting the wheel to the shaft it is permissible to lightly tap the wheel on the hub to give initial engagement in the splines and spacer.

(5) With stage 11 wheel and spacer engaged on the shaft splines, position a wooden block under the shaft to take the weight of the rotor pack. Check on the dial test indicator that the rotor pack horizontal position has been maintained.

(6) Remove the support strap and brackets, Ref.No.60, slide or lightly tap stage 11 wheel and spacer pins against stage 12 rotor wheel.

(7) Fit support strap, Ref.No.36 and support plates, Ref.No.34 and Ref.No.35 to the bottom half compressor casing as described in para.18, sub-para (33)

(8) Adjust the pointer of the dial test indicator positioned on stage 12 blade platform and locate the pointer to record the rotor shaft positional attitude at stage 11 spacer.

(9) Tighten stage 11 support strap, Ref.No.36, until the strap is just taking the weight of the compressor rotor shaft. Check the horizontal level of the rotor shaft on the dial test indicator.

(10) Remove the wooden block supporting the rotor shaft.

(11) Assemble the stage 10 stator blades as follows:

(a) Ensure that the stator blades are correctly fitted by noting that when a blade or group of blades if first entered into its channel, the blade leading edge is towards the front of the engine.

(b) Lubricate all blade channels with clean engine oil. Blades which are tight in their channels may be eased along by tapping them on their root platforms using a hide-faced mallet and suitable drifts.

(c) Fit a master group of blades followed by the remaining group of blades in the order noted on dismantling (para.18, sub-para (43) then fit the remaining master group where applicable.

(d) When fitting new blades or groups of blades check their size with existing blades in the same stage.

CAUTION...

During assembly of stages 10 to 6 rotor wheels and spacers it is essential that the positional attitude of the rotor shaft be raised by 0.003 in. on the dial test indicator to prevent spacers fouling blade tips during rotor wheel assembly.

(12) Observing the appropriate shaft/wheel correlation marks, fit stage 10 wheel and spacer assembly to the shaft, ensuring that all the blade retaining pins in the stage 11 wheel are fully engaged. If difficulty is experienced in fitting the wheel to the shaft, it is permissible to lightly tap the hub rim of the wheel to give initial engagement on the shaft splines. Ensure that the stage 11 pins are not dislodged during this process. Do not remove the tape from the front face of the previously fitted wheel, until the wheel being fitted is engaged on the shaft and is finally being pushed or tapped home against the previously fitted wheel.

(13) Fit stages 9 to 7 stator blades and stages 9 to 6 rotor wheels and spacers alternatively as described in sub-paras (11) and (12).

(14) When the rotor wheel assemblies stages 11 to 6 and stator blade stages 10 to 7 have been fitted, fit stage 6 support strap as described in para.18, sub-para.(11).

(15) Remove support strap, Ref.No.36, and strap support plates, Ref.No.34 and Ref.No.35, from stage 11.

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CAUTION...

Do not attempt to fit stage 4 rotor wheel assembly with stage 4 stator blades fitted or the spacer will foul the stator blades.

(16) Fit stages 5 to 1 rotor wheel assemblies and stator blades stages 5, 3, 2 and 1, as described in sub-paras. (11) and (12).

(17) Remove the protective tape from the air/oil seal and front bearing shaft locations. Ensure all traces of old oil or grease are removed from the threads of the shaft and front bearing retaining nut.

CAUTION...

To prevent malassembly and possible damage of rotor pack and front bearing retaining nut, it is essential that the adjusting washer is correctly located on the shaft and that the air/oil seal is correctly positioned on the sealing land locating pin.

(18) Using assembly tool, Ref.No.46, fit the adjusting washer, air/oil seal and front bearing roller track to the shaft.

(19) If a new cupwasher is to be fitted, select one which has the same flange thickness as the original, para.18, sub-para.(15). If a new cupwasher with a different flange thickness is used, record the difference.

Note...

The difference in flange thickness, will alter the drop check dimensions on the front bearing retaining nut.

(20) Fit the support plate, Ref.No.44, to the bottom half-casing front flange. Fit the dogging spigot, Ref.No.39. Fit a new or serviceable cupwasher, apply anti-seize compound ZX-38 (34B/9437518) or Silkolene 751 to the threads of the shaft and front bearing retaining nut then, fit the nut. Transfer the rotor shaft weight from the stage 6 support strap on to the support plate.

(21) Fit the slotted spanner, Ref.No.38, to the front bearing retaining nut. Fit the adapter plate, Ref.No.40, to the support plate, Ref.No.44, and locate the reduction gear, Ref.No.41, on the adapter plate and engage the reduction gear with the slotted spanner.

(22) Using the torque wrench, Ref.No.42, tighten the retaining nut until approximately 80 lbf ft (960 lb in) is recorded (800 lbf ft on shaft) and the correlation marks on the nut, shaft and stage 1 rotor wheel are in line.

(23) Check the nip of the front bearing retaining nut and the swash of the stage 1 compressor wheel as described in para.18, sub-para.(6) ensuring that:

(a) The drop check dimension on the nut is within 0.005 in. of the dimension recorded prior to disassembly and if a new cupwasher has been used, the drop dimension is adjusted to reflect the recorded difference in flange thickness (sub-para.19). S M

(b) The swash check dimensions are within 0.0025 in. of the dimensions recorded prior to disassembly.

(24) If the dimensions are not within the specified limits, disassemble the parts and investigate the cause.

(25) Assemble the parts as previously described, tightening the bearing retaining nut until the drop dimensions and the swash dimensions are within the specified limits.

(26) On satisfactory complete of the dimensional checks lock the cupwasher, using the special punch Ref.17.

(27) Remove the torque wrench, reduction gear, adapter plate, slotted spanner, dogging spigot and support plate.

(28) Fit the front bearing housing as described in para.27, then fit the starter as described in Chap.8.

(29) Remove the dial test indicator from the compressor outlet casing.

(30) Remove the rotor pack support strap from stage 6 and fit the stages 4,6 and 11 stator blades as described in sub-para.(11). With all blades in each stage fitted ensure that the master blades do not protrude above the bottom-half casing split-line flange.

23A. Fit the top half casing

(1) Before replacing a top half compressor casing, apply approximately 1 litre of anti-corrosion inhibiting fluid PX24 (34B/2244966) to the lugs of the aluminium rotor blades in stages 1 to 8 as follows:

CAUTION...

Do not apply anti-corrosion inhibiting fluid PX24 to compressor stages 1 to 4 on engines which incorporate Mod.5528, as PX24 has a detrimental effect on the Silcoset silicone compound in the bush/bore interface recess of these compressor rotor blades.

(a) Using a suitable hand spray gun, inject the fluid through the platform gap of every fourth or fifth rotor blade in each stage.

Note...

2 injections are sufficient for each gap.

(b) Continue the process described in (a) until all stages specified have been treated.

(2) Before replacing the top-half compressor casing, remove all traces of the inhibiting fluid from the aerofoil surfaces of the compressor blades by wiping with a clean cloth.

(3) Check that the compressor top-half casing and stators assembly is clean, free of loose objects and is in a satisfactory condition for fitting to the engine.

(4) Attach the lifting sling Ref.No.9 to the lifting eyes on the casing then using a suitable hoist, raise the casing clear of the bench and position it over the top of the engine.

(5) Slacken the screws which secure the bottom-half casing to the front bearing housing sufficiently to prevent the top-half casing binding between the front bearing housing and the compressor outlet casing.

(6) Carefully lower the top-half casing into position, ensuring that the rotor and stator blades do not foul.

(7) Using the torque wrench Ref.No.12, torque tighten the screws which secure the bottom-half casing to the front bearing housing to the load specified in Chap.1.

(8) Fit the dowels, plain washers, spring washers and screws, which secure the top-half casing to the front bearing housing and compressor outlet casing, to those positions which were noted during disassembly; para.15, sub-para.(7) and (10).

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(9) Insert the fitted bolts which locate the compressor casing halves, then fit the plain washers and castellated nuts.

(10) Insert the remaing bolts, then fit the plain washers, spring washers and nuts.

(11) Apply clean engine oil to the nuts then, using the tightening sequence template Ref.No.10 and 11 and the torque wrench Ref.No.13, torque tighten the nuts to the load specified in Chap.1.

(12) Fit and lock new split pins to the castellated nuts.

(13) Apply clean engine oil to the screws which secure the top-half casing to the front bearing housing and compressor outlet casing then, using the torque wrench Ref.No.12, torque tighten the screws to the loading specified in Chap.1

(14) Refit all units, pipes, clips and harness connections renewing all sealing rings and jointings.

24. Serviceability check

(1) Turn the engine, by hand, and check for freedom of movement.

(2) Bleed the fuel system as described in Chap.6.

(3) Install the engine in the aircraft as described in the appropriate Aircraft Publication.

(4) Effect a ground run in accordance with Vol.1, Part 2, Sect.2, Chap.2; check for oil, fuel and gas leaks.

(5) On completion of the ground run, check that the engine run-down time is comparable with the run-down times recorded prior to the compressor repair.

24A. Front bearing housing - Replacement of master i.g.v. quillshafts

(1) Slacken the locknut on the connecting rod of the p.v. ram and remove the operating lever cap from the control lever assembly.

(2) Unscrew and remove the coupling of the p.v. ram.

(3) Using circlip pliers, remove the circlips which secure the control lever connecting link.

(4) Using the extractor Ref. No.61 withdraw the two operating lever connecting link pins, then remove the connecting link.

(5) Unlock and remove the nuts securing the i.g.v. control lever housings to the hot air manifold and remove the housing assemblies.

(6) Unlock and remove the two castellated retaining nuts and cupwashers securing the operating lever assemblies.

(7) Remove the spring rings retaining the inner quillshafts, then push the quillshaft out of each control shaft.

(8) Fit new quillshafts retaining them with new spring rings and then rebuild and refit the control lever assemblies in the reverse manner to removal. Dl

(9) In the reverse manner to removal, reconnect the operating lever connecting link, refit the p.v. ram coupling and reconnect the i.g.v. operating lever.

(10) Reset the gap between the operating lever and the adjacent datum point on the lever bearing housing as specified in Section 2, Chapter 2, paragraph 10.

25. Front bearing housing - Removal

(1) Remove the starter fairing and starter (Chap.8).

(2) Remove the socket connection from the compressor end of the starter electrical supply cable, and remove the cable casing.

(3) Remove the nuts securing the starter drive housing to the front bearing housing then, using the extractor, Ref.No.15, withdraw the starter drive housing.

(4) Unlock the cupwasher securing the inner shaft retaining nut and, using the special spanner, Ref.No.16, remove the nut and cupwasher. Withdraw the pawl carrier assembly.

(5) Unlock the lockring securing the outer shaft nut then, using the special spanner, Ref.No.18, remove the nut.

(6) Using the withdrawing tool Ref.No.19 remove the drive shaft then, using the withdrawing tool Ref.21 remove the adjusting washer from the bore of the compressor shaft.

(7) Disconnect the intake guide vane ram spring coupling from the intake guide vane operating lever by removing the two nuts and disengaging the coupling from the lever.

(8) Remove the setscrews from the keep plates securing the oil pipes at their entry into the front bearing housing.

(9) Remove the setscrews from the keep plate securing the starter electrical cable socket to the front bearing housing and withdraw the socket connection from the front bearing housing. It may be necessary to remove the adjacent clip securing the branch cable to the compressor before the socket can be withdrawn.

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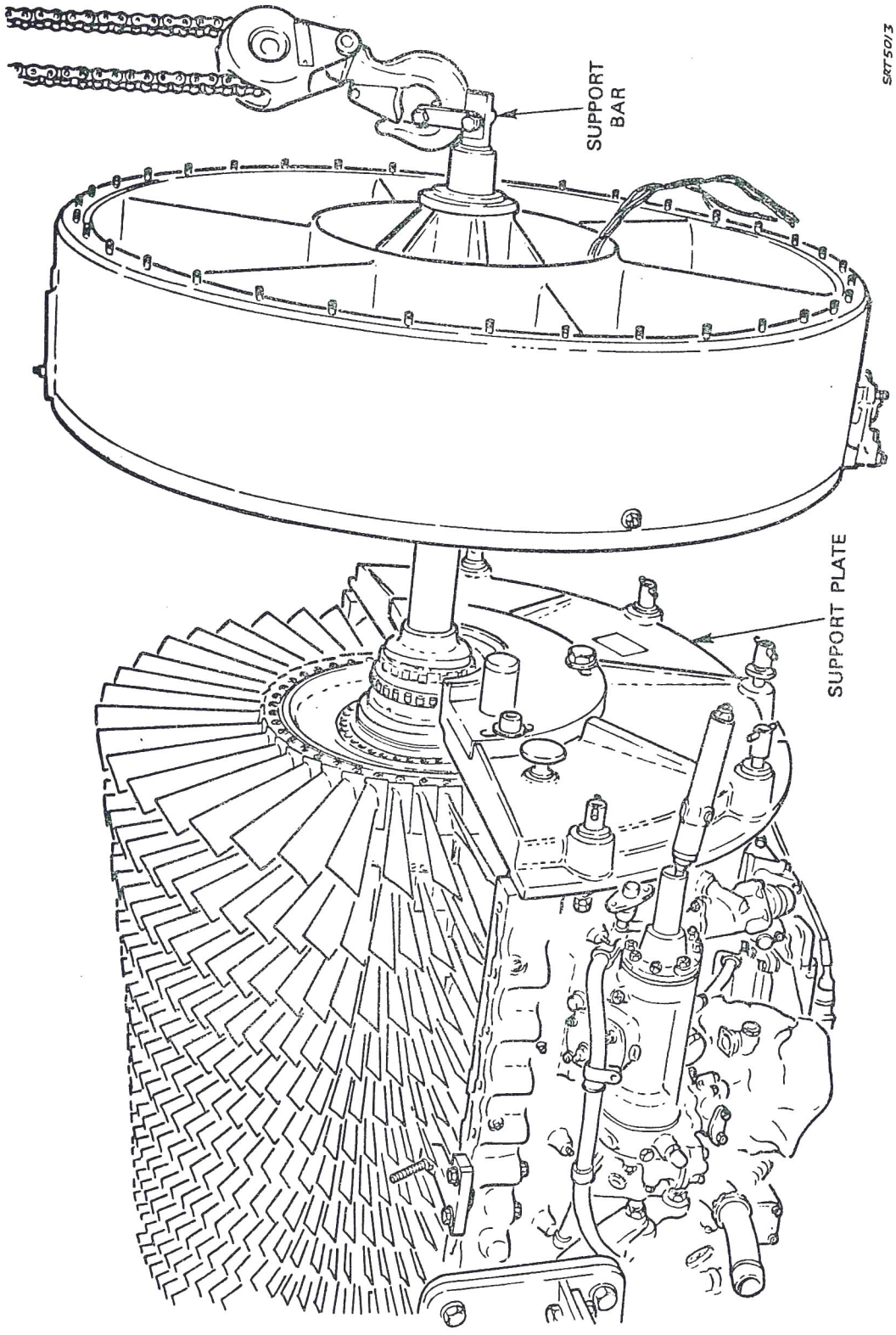

Fig. 29 Front bearing housing - removal (Horizontal strip)

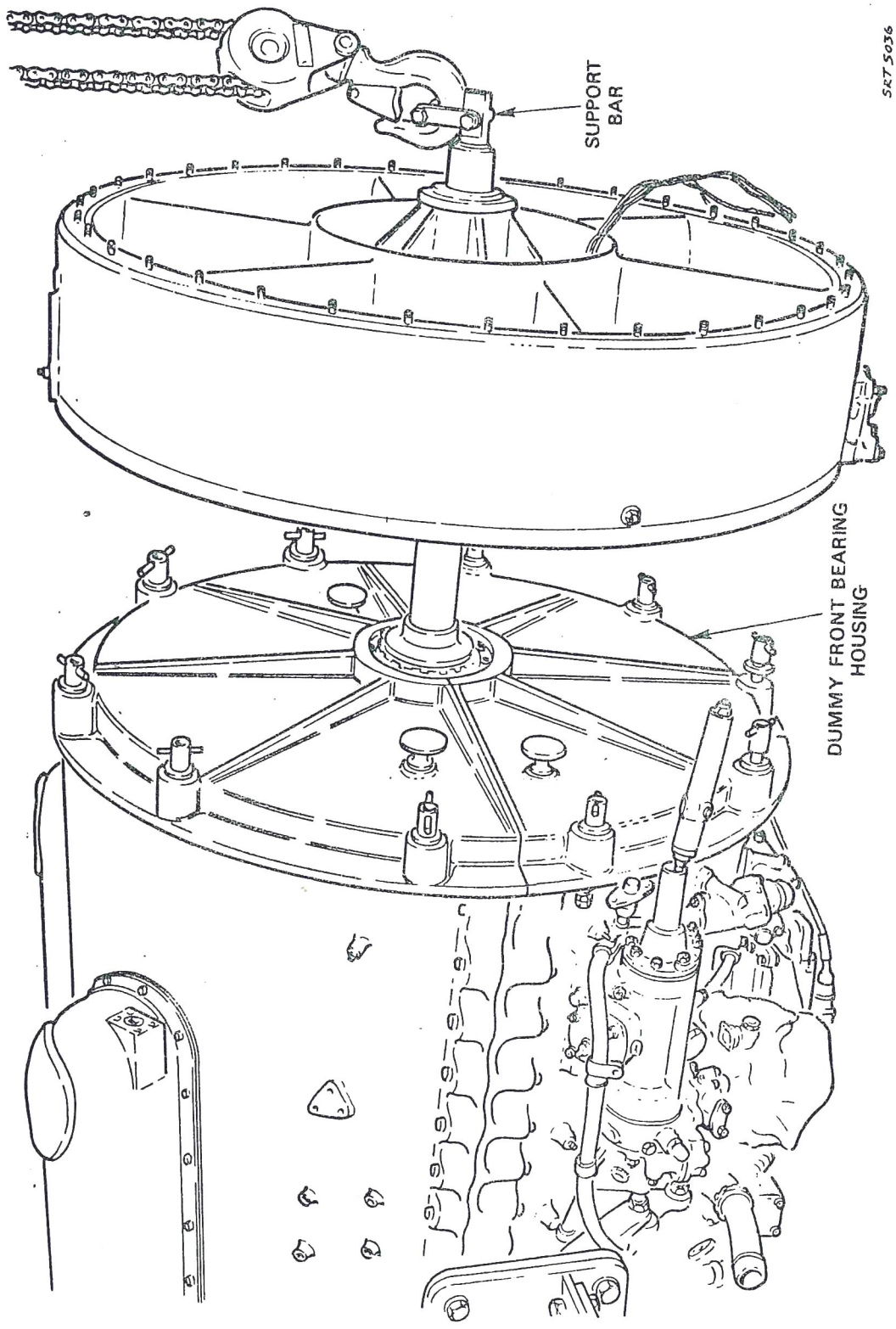

Fig.30 Front bearing housing - removal

(10) Screw the threaded sleeve of the support bar, Ref.No.23, firmly into the compressor shaft and secure the adapter of the tool to the ring of starter attachment studs, using the original attachment nuts. The starter electrical cable is to pass through the recess in the rim of the adapter plate.

(11) Unless previously removed for lifting the top-half casing, remove all but four (distributed in the upper sector of the joint) of the setscrews from the front bearing housing to compressor casing joint and, using the extractor, Ref.No.27, withdraw the ten flanged dowels from the joint.

(12) Attach lifting tackle to the link of the support bar and lift until the cable is just taut.

CAUTION...

Ensure that the compressor support bar is not subjected to a lifting load which will tilt and lock the front bearing housing preventing removal of the assembly.

(13) Unscrew and remove the remaining setscrews from the housing to compressor casing joint.

(14) Place a tray beneath the joint to catch waste oil and detach the housing from the compressor casing; slide the assembly forward along the support bar.

(15) Remove the nuts from the five special studs in the bottom-half of the dummy front bearing housing, Ref.No.30, and offer up the bottom-half to the compressor casing (with its straight edge horizontal) to support the compressor shaft. Engage the five dummy housing special studs with their corresponding housing attachment holes and fit the five special nuts; tighten the stud thumbscrews, fig.30.

(16) Fit the top half dummy housing, Ref.No.30, in the same way as the bottom-half.

(17) Check that the dummy housing is in continuous contact with the compressor casing and that the attachment studs are fully tightened, fig.30.

WARNING...

THE FRONT BEARING HOUSING IS A HEAVY UNIT, TWO MEN WILL BE REQUIRED TO LIFT THE HOUSING CLEAR.

(18) Remove the lifting tackle from the link and remove the engine front bearing housing, manually, from the support bar.

(19) Remove the support bar and adapter from the engine front bearing housing.

26. Inlet guide vanes - renewal

(1) With the front bearing housing removed from the engine, it is permissible to renew individual guide vanes which are damaged beyond acceptable limits.

(2) Remove the inlet guide vane control lever housing in accordance with items (3), (4) and (5) of paragraph 24A. of this chapter.

(3) Remove the hot air manifold from the front bearing housing.

(4) Support the front bearing housing on a stand or suitable wooden blocks, rear face uppermost.

(5) Unlock and remove the nuts and tabwashers which secure the actuating levers to the guide vanes. Withdraw the levers from the guide vanes and trunnions, then withdraw the trunnions from the actuator ring.

(6) Unlock and remove the tabwashered setscrews, then ease the surge stops from under the actuating ring.

(7) Rotate the actuating ring to bring the rollers in line with the cut-away portions of the support ring, then lift out the actuating ring and remove the rollers.

(8) Unlock and remove the nuts and setscrews which secure the support rings and fixed stops, then withdraw the stops and the rear support ring.

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(9) Remove the circlip retaining the vane outer pivot bush from the intake guide vanes which are to be replaced. Remove the bush and lift out the guide vane.

(10) Apply anti-freeze grease Ref.34B/9423141 to the guide vane pivot bush and support ring scallop prior to fitting the vane then, using new circlips refit the new guide vanes in the front bearing housing, in the reverse manner to removal.

Note...

When the surge stops have been re-fitted to the actuating ring check the contact of the upper and lower stops as follows:

(a) Move the actuating ring in an anti-clockwise direction to the limit of its angular travel.

(b) Check that the upper and lower surge stops contact the fixed stops simultaneously.

(c) If only one of the stops on the actuating ring makes contact with the fixed stop, check the gap between the remaining stop and fixed stop is not more than 0.005 in.

(d) If the gap is more than 0.005 in, fit a lower surge stop which gives the required clearance, from the range of stops available.

(e) If the surge stops have been changed the following check should be carried out.

(i) Trap the 0.150 in. gauge between the control shaft operating lever and the datum setting stop, then retain the lever in this position with a rubber band fitted round the lever and over one of the studs on the front bearing housing.

(ii) Place the front bearing housing, rear face uppermost, on a suitable work bench.

(iii) Centralize the actuating ring by inserting four feeler gauges of equal thickness between the actuating ring and the guide vane rear support ring, at equally spaced points.

(iv) Check that the clearance between the internal surge stops is 0.015 in. to 0.075 in.

(v) If the required clearance is not obtained, fit stops which give the required clearance while meeting the requirement of items (b) to (d) of this paragraph.

(11) Check the lower master i.g.v. angle

(a) Trap the 0.150in. gauge between the control shaft operating lever and the datum setting stop, then retain the lever in this position with a rubber band fitted round the lever and over one of the studs on the front bearing housing. Dls

(b) Place the front bearing housing, rear face uppermost, on a suitable work bench.

(c) Centralize the actuating ring by inserting four feeler gauges of equal thickness between the actuating ring and the guide vane rear support ring, at equally spaced points.

(d) Place the front bearing housing on the work bench front face uppermost.

(e) Using gauge Ref.No.62, check that the angle of the lower master i.g.v. is the same as shown in the log book.

Note...

(i) In cases where there is no reference angle shown in the log book check, using gauge Ref.No.62, that the lower master vane is no more than 3 deg. different from the angle of any 12 follower vanes and that the mean angle of all the vanes checked is between 40 and 41 deg.

(ii) If necessary file, or replace the operating lever datum setting stop to obtain the required angle. If the stop has to be filed then produce a slightly convex profile of the stop, to facilitate future gap checks.

(iii) A change of 0.030 in. in the datum setting stop height will produce a change of one degree in the vane angles at the datum setting.

27. Front bearing housing - replacing

(1) Before fitting a new replacement front bearing housing check the assembly for completeness and transfer all relevant serviceable parts from the original assembly. The gland sealing assembly and the oil seal housing and outer track assembly are to be transferred as a unit because the outer track is mated to the front bearing and is not interchangeable.

(2) Ensure that all mating faces are clean; apply engine oil to the internal bearing surfaces.

(3) Fit the adapter of the support bar Ref.No.23 to the starter securing studs in the new housing, tighten the nuts.

(4) Replacing the front bearing housing is the reverse of removing; note the following

(5) Renew all sealing rings and jointings.

Dls

(6) Ensure that the lifting tackle is applied to the support bar link and is giving adequate support, without imparting a lifting load, before the dummy front bearing housing is removed.

(7) Clean the mating faces on the compressor casings and the front bearing housing.

(8) Ensure that the oil pipes projecting beyond the compressor enter the sockets in the housing correctly, by moving the housing radially on the support bar.

(9) Using the torque wrench Ref.No.12, torque tighten the screws which secure the front bearing housing to the compressor casings to the load specified in Chap.1.

(10) When fitting the starter drive, obtain the correct clearance between the pawl carrier and compressor shaft as follows:

(a) Fit the original adjusting washer and the starter outer drive shaft to the compressor shaft.

(b) Fit a new or reclaimed cupwasher and the outer shaft ring nut then, using the spanner Ref.No.18, tighten the nut.

(c) Insert the inner drive shaft into the outer drive shaft, then fit the pawl carrier to the shaft assembly, interposing the compressor shaft locating bush.

(d) Fit the inner shaft locating bush, a new or reclaimed cupwasher and the inner shaft slotted nut then, using the spanner Ref.No.16, tighten the nut.

(e) Take up the carrier end float (0.008 to 0.024 in.) rearward then, using feeler gauges, measure the clearance between the front face of the compressor shaft and the opposing face of the pawl carrier.

(f) If the clearance is not between 0.040 and 0.060 in, select an outer shaft adjusting washer which will give the correct clearance.

(g) On satisfactory completion of the clearance check, lock the inner and outer shaft retaining nuts using the punch Ref.No.17.

(11) Apply a light coat of SQ.32L (34B/1417) to the starter drive housing rear face and the mating face on the front bearing housing as instructed in Sect.2, Chap.1.

(12) Fit the starter drive housing to the front bearing housing, then fit nuts and new tabwashers; tighten the nuts and bend up the locking tabs.

(13) Reset the gap between the operating lever and, the adjacent datum point on the lever bearing housing as specified in Section 2, Chapter 2, paragraph 10.

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28. Serviceability check

CAUTION...

Before the engine is run, check that all loose articles and debris have been removed from the engine and its vicinity. Check that the oil sump contains sufficient oil.

(1) Turn the compressor rotor, by hand, to check that it turns freely, without rubbing or abnormal sound.

(2) Install and ground run the engine, making the full set of post-installation checks given in Vol.1, Sect.2, Chap.2. During the ground run, check for leaks from the disturbed connections. As the engine is shut down from ground idling rev/min, note the run-down time and compare it with previously recorded times. Replenish the engine oil system.