



AP 113B-0222-1

June 1973

GENERATOR

LUCAS AEROSPACE TYPE B2702/1

(AM TYPE 517)

GENERAL AND TECHNICAL INFORMATION

TECHNICAL SERVICES
DIVISION
ELECT. & GEN. INST. GROUP
25 MAR 1987
A & AEE BOSCOMBE DOWN
A/MESSURY SP4 OJF

BY COMMAND OF THE DEFENCE COUNCIL

Mike Whitmore.

Ministry of Defence

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Publications authority : ATP / MOD (PE)

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AP100B-01 Order 0504 (RAF)

Dec 86 (Amdt 3)

Page (i)/(ii)

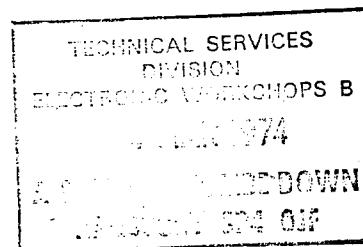
AMENDMENT RECORD SHEET

To record the incorporation of an Amendment List in the publication,
sign against the appropriate A. L. No. and insert the date of incorporation.

A. L. No.	AMENDED BY	DATE
1	<i>W. S. S.</i>	6/9/74
2	<i>R. Few</i>	11/4/75
3	<i>D. B. S.</i>	25/3/87
4	<i>M. H. M.</i>	16-4-93
5	<i>D. B. S.</i>	17-5-93
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RECORD OF ADVANCE INFORMATION LEAFLETS (AIL)

RECORD OF SERVICE TEMPORARY AMENDMENT LEAFLETS (STAL)

*Insert specific identity of STAL

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Preliminary material

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- ▶ Contents (this page)
- ▶ List of related publications
- ▶ Warnings

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- ▶ 2-3 Standard serviceability test - using test rig, generator, Mk.8
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- 3 Bay servicing

▶ LIST OF RELATED PUBLICATIONS

AP113A-0308-1	Servicing Techniques
AP100B-10	Engineering Substances Hazardous to Health
AP120B-0102-1	Generator Test Rigs
JSP(F)395	Catalogue of Hazardous Stores
AP120B-0115-1	Mk 8 Series Generator Test Rig
AP100D-20	
EMER MANAGEMENT	
S250	

WARNINGS

CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH

MAKE SURE YOU KNOW THE SAFETY PRECAUTIONS AND FIRST AID
INSTRUCTIONS BEFORE YOU USE A HAZARDOUS SUBSTANCE

READ THE LABEL ON THE CONTAINER IN WHICH THE SUBSTANCE IS SUPPLIED

READ THE DATA SHEET APPLICABLE TO THE SUBSTANCE

OBEY THE LOCAL ORDERS AND REGULATIONS

WARNINGS

- (1) TRICHLOROETHANE. TRICHLOROETHANE IS USED IN THE MAINTENANCE OF THIS EQUIPMENT. REFER TO JSP(F)395 AND AP100B-10.
- (2) LETHAL VOLTAGE. DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. REFER TO EMER MANAGEMENT S250 OR TO AP100D-20, AS APPROPRIATE.

Chapter 1
DESCRIPTION AND OPERATION

CONTENTS

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LEADING PARTICULARS

► Generator Type 517 (Lucas Aerospace B.2702/1)	...	Ref. No.	5UA/4357524
Output	...	30V d.c., 200A, 6kW	
Speed range	...	2860 to 10000 rev/min	
Rotation (from drive end)	...	...	Clockwise
Brushes - grade	...	...	PEG. 11
Length - new	...	...	0.895 in
Length - minimum permissible	...	...	0.562 in
Brush spring loading	...	...	23 to 29 oz
Commutator diameter - new	...	...	2.805 to 2.795 in
Minimum permissible	...	...	2.675 in
Resistance of windings at 20 deg. C - armature	...	0.0088 to 0.0095 ohm	
Shunt field	...	...	1.41 to 1.49 ohm
Overall dimensions			
Length (flange face to terminal box)	...	...	12.22 in
Outside diameter	...	...	6.95 in
Weight	...	...	61.25 lb
Terminals - main	...	...	3/8 UNF (0.375 in)
Auxiliary	...	...	2BA (0.1875 in)
Lubricant	...	Grease, special purpose	DTD.900/4802A

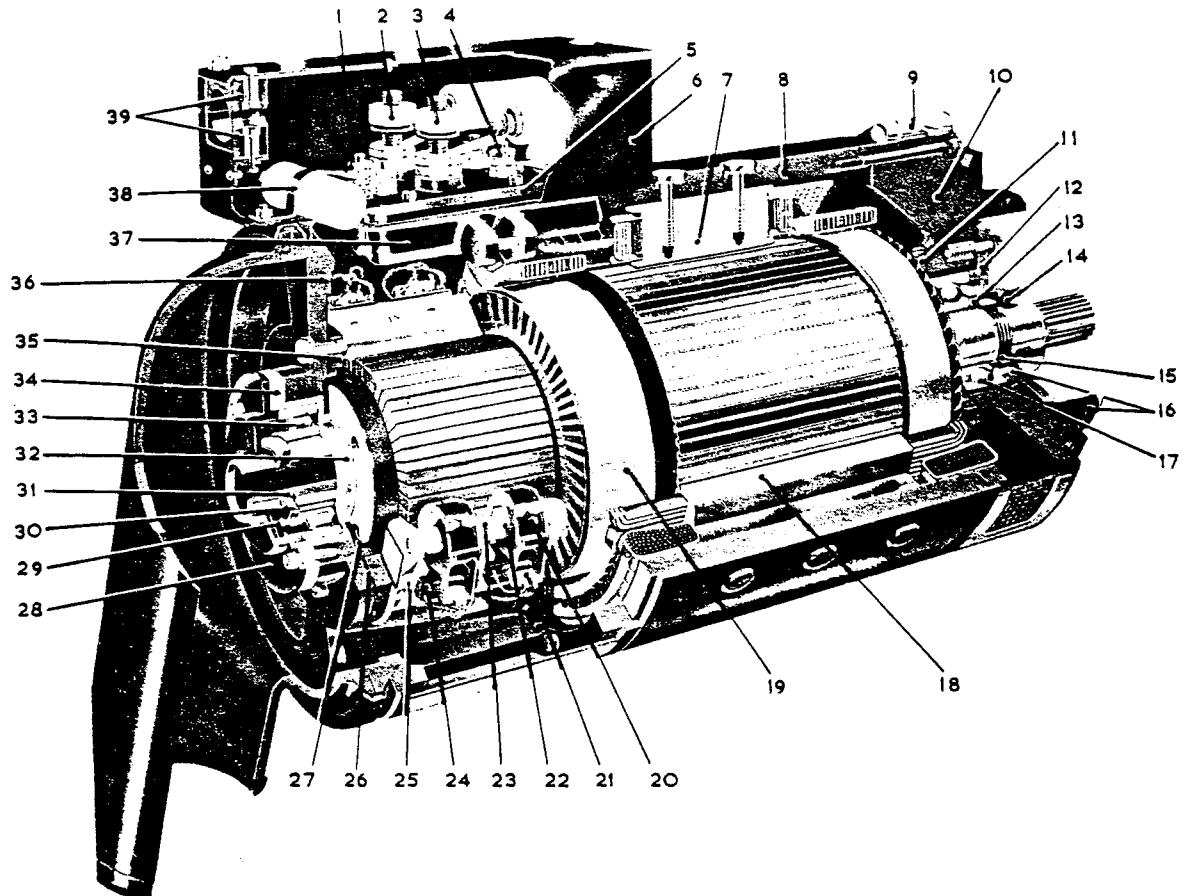


Fig.1 Section view

Key to fig.1

1 Field terminal (No.5)	20 Brush spring
2 Negative output terminal (No.2)	21 Trigger
3 Positive output terminal (No.1)	22 Sleeve
4 Equalising terminal (No.3)	23 Mounting spindle
5 Terminal block	24 Split brush
6 Terminal box	25 Brush box
7 Interpole piece	26 Insulating ring
8 Yoke	27 Insulation
9 Window cover strap	28 Bearing cap
10 Driving-end frame	29 Felt seal
11 Retaining plate	30 Circlip
12 Oil seal housing	31 Washer
13 Spacer	32 Spacer
14 Oil seal	33 Roller bearing
15 Clamping nut	34 Liner
16 Sealing rings	35 Brush box carrier ring
17 Ball bearing	36 Commutator-end frame
18 Main pole piece	37 Saddle
19 Banding ring	38 Capacitor and clamp
	39 Cable clamping cleats

Modification state

► This Chapter incorporates Lucas Aerospace modifications up to and including Mod. LG2046.

Introduction

1. The Type 517 (B.2702/1) generator is a 30V d.c., 6kW four pole shunt wound unit with compensating and interpole windings.

DESCRIPTION (fig.1)

2. The generator is of conventional design, the armature being supported in a ball bearing at the drive-end and a roller bearing at the commutator-end. An oil seal is mounted on the drive shaft outside the ball bearing.

Brushgear

3. The brushgear consists of four brush boxes, each containing a pair of brushes, arranged at 90 deg. spacing around the periphery of the commutator. The brush boxes are mounted on a carrier ring which in turn is mounted on a spigot on the inner face of the end frame; screws pass through slots in the end plate and into the carrier ring. The slots allow a 10 deg. range of adjustment of the carrier ring in relation to the end frame.

Electrical connections (fig.2)

4. Four terminals are provided and are contained in a terminal box which is secured on the circumference of the commutator-end frame and which also forms the anchorage points for the brush inspection windows cover strap. A terminal block in the terminal box carries the four terminals, two being for the generator output and two for field control. The output terminals are coded 1 (+) and 2 (-); the control terminals are coded 3 for equalising and 5 for shunt field. Two other terminals, each coded 4, are not to be used for any external connections.

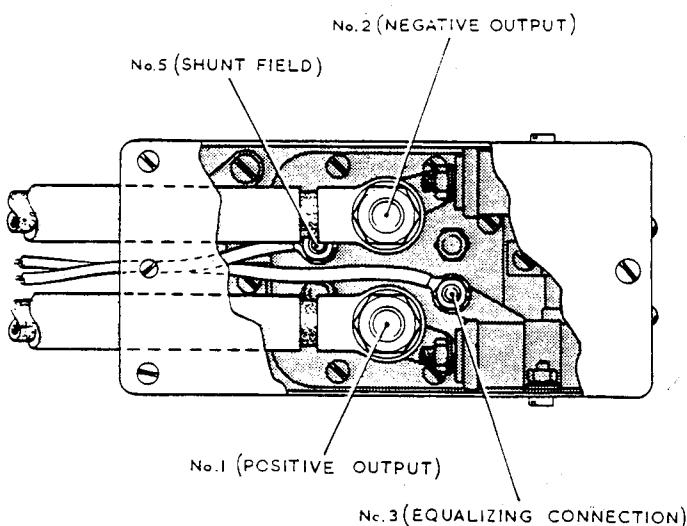


Fig.2 Terminal connections

Suppression (fig.3)

5. Also within the terminal box (para.4) are four capacitors, each of $2\mu\text{F}$ rating, one attached to each of the four terminals. Modification LG2046 introduced a new type capacitor to replace the existing type which is obsolete. The new type has a smaller diameter and is fitted with a removable split brass sleeve, also introduced by modification LG2046, to enable it to be secured by the existing capacitor clamps.

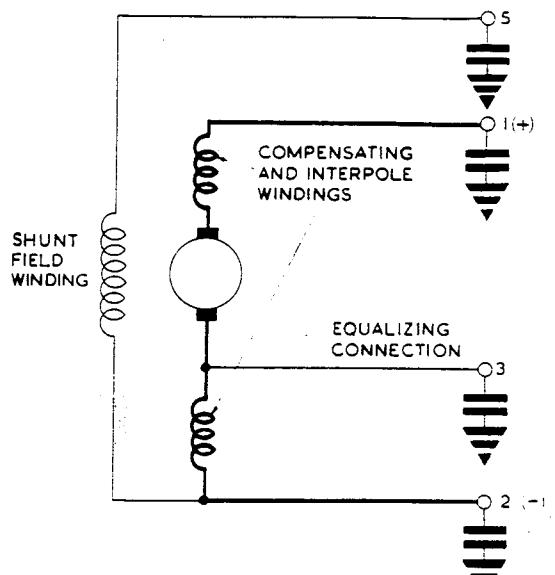


Fig.3 Generator circuit diagram

OPERATION

6. Being a shunt wound self-excited generator, variations in speed would produce variation in output. To overcome this, the generator is used in conjunction with a voltage regulator Type 94 in the field circuit which controls the output to a nominal 28V over the normal speed range.

Cooling

7. The generator must be air blast cooled, and can be supplied with air inlet ducts to suit various installations. The air enters the generator through ports in the face of the commutator-end frame and exits through radial ports in the circumference of the driving-end frame; a wire mesh cover strap around these ports prevents ingress of foreign bodies.

8. The relation between ambient or air inlet temperature and air flow is as follows:

Air inlet temp. (deg.C)	+70	+50	+30	+10	-10	-30
Desired air flow (lb/min)	15.7	12.2	10.0	8.5	7.4	6.5

INSTALLATION

9. The unit is spigot mounted and secured by a quick-release manacle ring. For location purposes the spigot flange has a blind dowel hole 0.343 in diam. in line with the centre line of the terminal box. The spigot has a rubber sealing ring to prevent lubricant leakage from the driving medium. The mating end of the armature shaft has twenty serrations.

Chapter 2-1

STANDARD SERVICEABILITY TEST - MK 5D RIG

Introduction

1. The following tests are to be applied to the unit before it is put into service, or at any time when its serviceability is suspect.

TEST EQUIPMENT

2. The following test equipment or suitable equivalents is required.

General

Ref. No.	Description
1A/9102367	Balance, spring, 0-4 lb
5G/9156675	Tester, insulation, Type C
5QP/1057049	Test set, multirange No. 1
5G/2986	Mounting bracket
5G/2989	Adaptor plate
37L/6425	Manacle clamp

Fig. 1

Ref. No.	Description
5G/2924	Bench, generator test, Mk 5D
10W/7450	Resistance, variable (RV.1)

Fig. 2 - as for Fig. 1 plus

Ref. No.	Description
5UC/5937	Voltage regulator Type 94
5UC/5209	Trimmer resistance (RV.1)
5CW/543	Switch, on-off, Type B (SW.1)
5CW/2828	Switch, on-off, Type C (SW.2)
5Q/141	Millivoltmeter, 150-0-150mV (V.1)

TESTING

3. The unit is checked and tested as detailed in the following paragraphs. Before running the generator on the test rig, check the armature for freedom of rotation. The oil seal should be removed unless adequate lubrication can be ensured during testing. Check that the brushes are not less than 0.562 in in length and that the brush spring loading is between 23 and 29 oz. Details of the Mk 5 test rig are to be found in AP120B-0102-1.

Polarity

4. Mount the generator in the test bench. Run the generator in its stated direction of rotation and check, using a multirange test set selected to the 0-100V range, that the polarity at the output terminals agrees with the terminal markings (term.1 pos., term. 2 neg.).

Performance

5. Three tests are carried out, namely minimum speed, maximum speed and excitation. Mount the generator in the test bench and proceed as follows:

Minimum speed

6. (1) Connect the generator to the test circuit shown in fig. 1.
- (2) Set the variable resistor RV.1 to a value of 0.7 ohm.
- (3) Run the generator at 2860 rev/min under a loading of 200A.
- (4) If necessary adjust RV.1 to maintain an output of 27.5V.
- (5) Check that there is no more than pinpoint sparking at the brushes.
- (6) Shut down the test rig and switch off. Disconnect the test circuit.

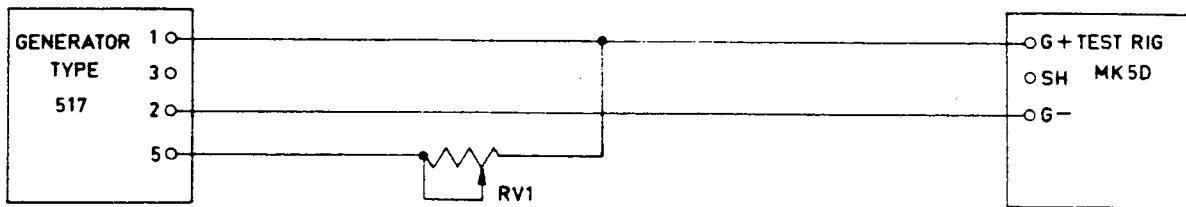


Fig. 1 Minimum speed test

Maximum speed

7. (1) Connect the generator to the test circuit shown in fig. 2.
- (2) Run the generator at 10000 rev/min; close switch SW. 2.
- (3) Load the generator to 200A and check that output voltage is between 27.5 and 28.5V. If necessary adjust the remote trimmer RV.1 to achieve this.
- (4) Check that there is no more than pinpoint sparking at the brushes.
- (5) Reduce speed to 2860 rev/min; reduce load to zero and open switch SW. 2.
- (6) Continue with excitation test.

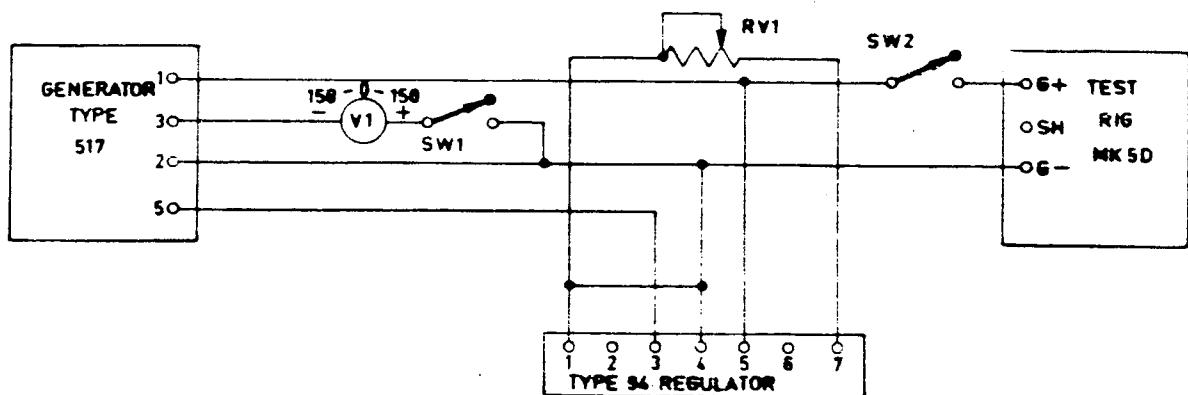


Fig. 2 Maximum speed test

Excitation

~~Switches off all load~~

8. (1) Run the generator at 2860 rev/min.
- (2) Close switch SW.1; check that the indication on V1 is between 60 and 100 millivolts.
- (3) Open switch SW.1. Shut down the test rig and switch off.
- (4) Disconnect the test circuit; remove the generator from the test rig.

Insulation resistance

9. As soon as possible after the performance test, whilst the generator is still warm, check the insulation resistance as follows:

- (1) Disconnect the four capacitors from their respective terminals.
- (2) Using an insulation resistance tester Type C check that the insulation resistance between each terminal and frame is not less than 0.5 megohm.
- (3) Reconnect the four capacitors.

Chapter 2-2

**STANDARD SERVICEABILITY TEST
USING TEST RIG, GENERATOR, Mk7 (NTS. 9748/1) (5G/4354)
(Completely revised)**

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Introduction

1. The tests described in this Chapter shall be applied to the generator before it is put into service or at any time that its serviceability is suspect.
2. The Air Publication for the Lucas Aerospace test rig NTS. 9748/1, AP120B-0101-1, should be read in conjunction with the instructions given in this Chapter.

Test equipment and ancillary mounting equipment

3. The following items of test equipment and ancillary mounting equipment will be required:-

TEST EQUIPMENT

Ref. No.	Description
5G/4354	Tester, generator, Mk7 (NTS. 9748/1)
5G/1112740	Tester, insulation resistance, Mk2
1H/97	Spring balance, 0-4 lb
5UC/5209	Resistance trimmer, 5 ohm (fig. 2, IRV1)
5UC/5937	Voltage regulator, Type 94 (fig. 2)
5Q/4347727	Millivoltmeter 350-0-350mV

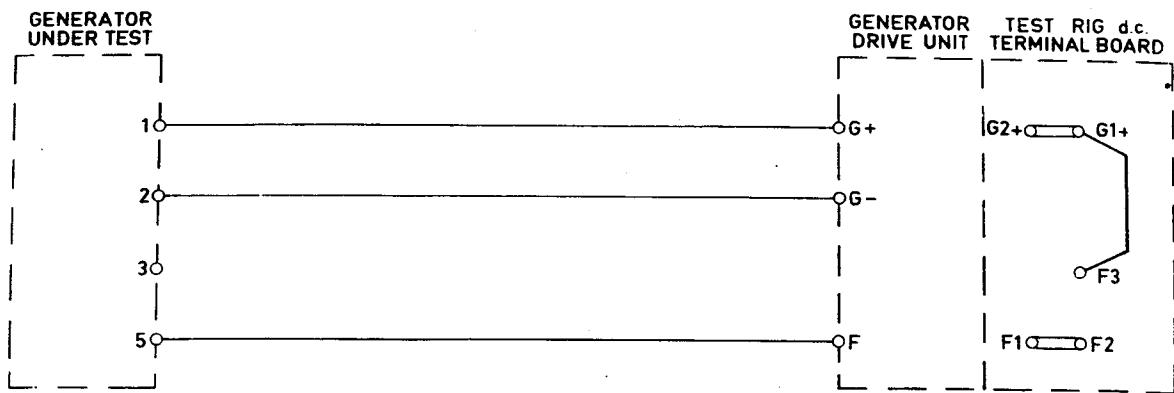


Fig. 1 Connections to drive unit

ANCILLARY MOUNTING EQUIPMENT

Ref. No.	Description
5G/6200025	Mounting plate, GM-65896 (Post Mod DC(M) 1135)
5G/5725	Mounting plate, GM-53371 (Pre Mod DC(M) 1135)
5G/4414865	Coupling, GM-65552
5G/4414851	Air adaptor, GM-53373

PREPARATIONS FOR TESTING

General

4. (1) If the drive-end oil seal is to remain fitted during testing, mounting plate GM-65896 must be used, and the oil supply from the drive unit connected to it.
- (2) The generator shall be cooled for all tests by blast air, ducted in at the commutator-end. A static pressure head of at least 6 in water gauge must be maintained.
- (3) The generators shall be driven in a clockwise direction when viewed from the drive-end.
- (4) Excitation control: unless stated to the contrary the shunt field may be controlled either by means of a manual rheostat connected between terminals 1 and 5 or by Carbon Pile Regulator, Type 94 (A. M. Reference 5UC/5937).
- (5) All brushes must be 100 per cent bedded as detailed in AP113A-0308-1 Chap. 3 (Servicing Technique No. 2), before testing is commenced.

Preliminary tests

5. Before mounting the generator on the test rig, check for freedom of rotating parts by turning the armature by hand. There should be no excessive end play in the bearings; a slight radial play, which can just be felt, is permissible.

Basic settings of controls, switches and links

6. Before commencing the tests, set the controls, switches and links on the test rig as detailed in the following sub-paras. In subsequent instructions

for specific tests, only those settings relevant to the test in hand will be given when these vary from the basic settings.

(1)

LINKS

The following links shall be fixed in position across the corresponding terminals (refer to fig. 1).

F3 to G1+

G1+ to G2+

F1 to F2

(2)

CONTROLS

Set the following controls in the fully counter-clockwise position.

RV1, RV2, RV3, RV4, IV1, IV2 and the SPEED SETTING CONTROL (RV5) to zero.

(3)

SWITCHES

Switch	Position	Switch	Position
S1	OFF	S8	1
S2	CW	S9	2
S3	1-when using mounting plate GM 53371	S10	1
	3-when using mounting plate GM 65869	S11	OFF
		S12	OFF
		S13	1
S4	OFF	S14)	
S5	OFF	to)	OFF
S6	1	S42)	
S7	OFF		

(4)

DRIVE UNIT CONTROLS

Lubricating oil by-pass valve) Fully counter-clockwise

Lubricating oil pressure valve)

Fully counter-clockwise

Cooling oil by-pass valve)

Fully counter-clockwise

Cooling oil pressure valve)

IN (CLOSED)

Mounting the generator

Using mounting plate GM 53371

7. (1) Remove the generator drive-end bearing oil seal assembly as detailed in Chap. 3, para. 5, sub-para. (6) and (7).

(2) Fit a slave oil seal housing, less oil seal, in place of removed assembly. Otherwise remove oil seal from housing as detailed in Chap. 3, para. 5, sub-para. (8).

(3) Mount the generator on to the drive unit.

(4) Connect the generator terminals to the drive unit terminals as shown in fig. 1.

(5) Connect the cooling air supply to generator, using adaptor GM 53373.

Using mounting plate GM 65896

8. (1) Mount the generator on to the drive unit.

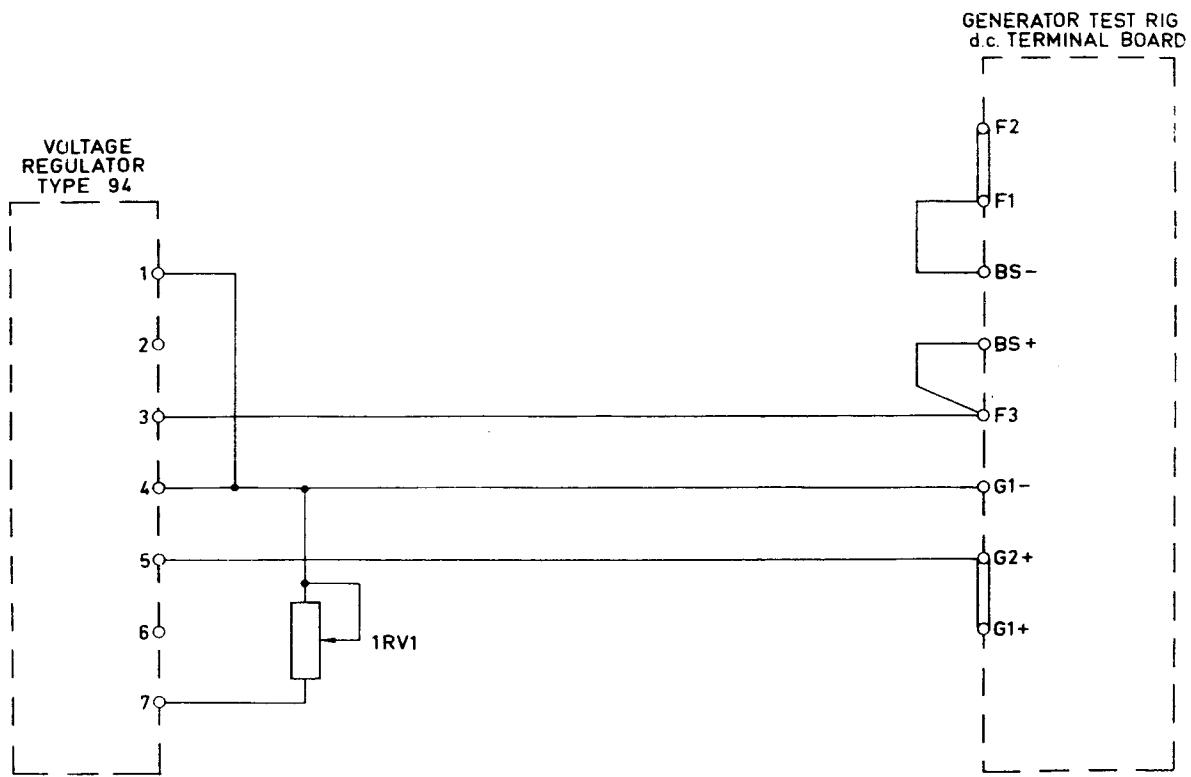


Fig. 2 Connections to control console

- (2) Connect lubricating oil supply and scavenge pipes to mounting plate.
- (3) Connect the generator terminals to the drive unit terminals as shown in fig. 1.
- (4) Connect the cooling air supply to generator, using adapter GM 53373.

Starting the test rig

9. (1) Set switch S1 (drive cubicle) to ON; check that IL1 and IL7 (8) are illuminated.
- (2) Operate PB1.
- (3) Operate PB2, PB3 and PB4 in succession and check that lamps IL2, IL3 and IL4 are illuminated.
- (4) If mounting plate GM 65896 is being used, operate PB6 and check that IL6 is illuminated. Allow a few seconds for oil flow to stabilize then adjust the lubricating oil by-pass and pressure control valves as necessary to give an oil pressure of 50 lbf/in².
- (5) Adjust the cooling air control lever to obtain a 12 in head of water indicated on pressure gauge.
- (6) Operate PB7 to start the generator drive and adjust RVS, (SPEED SETTING CONTROL) to obtain an initial speed, indicated on M7, of 2860 rev/min.

TESTINGMinimum speed test

10. (1) Set S12 to ON.

(2) Adjust RV3 until M8 indicates 28V.

(3) Check that current indicated by M11 is not greater than 5.6A.

(4) Set S15 to position 2.

(5) Maintaining M8 indication at 28V by adjusting RV3 as required, load the generator to 200A, indicated by M9, by means of d.c. load bank switches S34 to S39 and RV2.

(6) Check that current indicated by M11 is not greater than 12A.

(7) Check that sparking at generator brushes is no more than pinpoint.

(8) Switch off all loading and set S15 to OFF.

(9) Set S12 to OFF and RV3 fully counter-clockwise.

(10) Reduce generator speed to zero by turning RV5 (SPEED SETTING CONTROL) to zero position.

(11) Operate PB8 to shut down all ancillary motors and set S1 (drive cubicle) to OFF.

(12) Set the lubricating oil by-pass and pressure valves fully counter-clockwise.

(13) Disconnect and remove link F3-G1+.

Maximum speed test

11. (1) Connect a Type 94 regulator (ref. para. 3) to the test rig d.c. terminal board as shown in fig. 2.

(2) Start up the test rig as detailed in para. 9.

(3) Increase the generator speed to 10,000 rev/min by adjusting RV5 (SPEED SETTING CONTROL).

(4) Set RV3 and RV4 fully clockwise.

(5) Set S12 to ON.

(6) Adjust test circuit 1RV1 until M8 indicates 28V.

(7) Check that M11 is indicating not less than 0.9A. Note value.

(8) If the reading on M11 is so low as to be unreliable, set S11 to ON and S12 to OFF and note reading on M10.

CAUTION...

Meter range of M10 is 0 to 2 amperes.

When the value has been noted, set S12 to ON and S11 to OFF.

(9) Set S15 to position 2.

(10) Load the generator to 200A, indicated by M9, by means of d.c. load bank switches S34 to S39 and RV2.

- (11) Check that current indicated by M11 exceeds that noted in para. (7) or (8) by not less than 0.2A. If necessary for a low value, repeat the operations of sub-para. (8).
- (12) Check that sparking of generator brushes is no more than pinpoint.
- (13) Switch off all loading and set S15 to OFF.
- (14) Reduce generator speed to 2860 rev/min by adjusting RV5 (SPEED SETTING CONTROL).
- (15) Set S12 to OFF.

Excitation test

12. (1) Set S12 to ON.
- (2) Adjust test circuit 1RV1 until M8 indicates 28V.
- (3) Using a millivoltmeter (ref. para. 3) check voltage across generator terminals 2 and 3; value is to be between 60 and 100 mV.
- (4) Set S12 to OFF.
- (5) Reduce generator speed to zero by turning RV5 (SPEED SETTING CONTROL) to zero position.
- (6) Operate PB8 to shut down all test rig motors and set S1 (drive cubicle) to OFF.
- (7) Disconnect and remove generator from test rig.

Insulation resistance test

13. As soon as possible after the functional test, while the generator is still warm, carry out an insulation resistance test as follows:-

- (1) Disconnect the capacitors (refer to Chap. 3).
- (2) Using an insulation resistance tester (ref. para. 3) set to the 250V range, measure the resistance between all terminals commoned together and frame; the minimum acceptable value is 0.5 megohm.
- (3) Reconnect the capacitors (refer to Chap. 3).

OIL SEAL ASSEMBLY

14. If mounting plate GM. 53371 was used for testing, re-assemble generator oil seal assembly as follows:-

- (1) Remove the oil seal housing, fitted for testing, from the generator.
- (2) If a slave housing was used, refit original oil seal assembly as detailed in Chap. 3, para. 26, sub-para. (2).
- (3) If the original housing was used, refit the original oil seal into the oil seal housing and refit the assembly to the generator as detailed in Chap. 3, para. 26, sub-para. (2).

Chapter 2-3

STANDARD SERVICEABILITY TEST
USING TEST RIG, GENERATOR, Mk8 SERIES (WITHOUT DATA LOGGER)
(AIL 1/92 INCORPORATED)

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- 4 Examination
- 5 Mounting the generator
- 6 Test rig preparation
- 7 Gearbox warm up procedure
- Testing
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- 11 Insulation resistance test
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Introduction

- 1 The tests detailed in this chapter shall be applied whenever the equipment is put into service, or at any time that its serviceability is suspect.
- 2 The Air Publication AP120B-0115-1, Mk 8 Series Generator Test Rig, is to be used in conjunction with this chapter at all times.

WARNING

LETHAL VOLTAGE. DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. REFER TO THE LETHAL VOLTAGE WARNING IN THE PRELIMINARY PAGES OF THIS PUBLICATION.

Test equipment

- 3 The following items of test equipment are required. The Test Equipment Numbers (TE No) given in column (1) of the following list are used throughout this chapter to provide an easy means of identifying items of test equipment.

NOTE

Suitable equivalents for TE items 7, 8 and 9 can be used.

TE No	Section Reference	Part No	Description	Test Application
(1)	(2)	(3)	(4)	(5)
1	5G7346929	GM-E-280025/A/R	Test Rig Mk 8A (Army only)	Functional
or	5G7346930	GM-E-280025/B/R	Test Rig Mk 8B (RAF/RN)	Functional
or	5G7763	GM-E-280025/C/R	Test Rig Mk 8C (RAF/RN)	Functional
2	5G7402747	GM-B-103350-S	Mounting Adaptor Kit	
	Comprising:-			
2a	5G7969517	GM-C-103400	Mounting Adaptor	Functional
2b	5G7969430	GM-C-103401	Drive Shaft	Functional
2c	5G7969722	GM-C-103369	Cable Assembly	Functional
3	5UC4 379135		Trimmer Resistor	Functional
4	5340-99-		Manacle Clamp	Functional
	7786172			
5	37L4521178	G.18574	Manacle Clamp	Functional
6	5UC4 379166		Voltage Regulator	Functional
7	5G6505337	BMB Mk 2	Ins.Resistance Tester	Insulation
8	10S2523606	Fluke 25	Multimeter	Functional
9	5Q4347727		Millivoltmeter	Functional

PREPARATION FOR TESTS

Examination

4 Examine the generator, particularly for the following:

- cleanliness
- distortion
- cracking
- corrosion
- security of fastenings
- damage to paint finish
- oil ingress around stator winding at drive end
- spline drive profile for wear or damage

4.1 Ensure that the generator can be freely rotated by hand.

4.2 Remove the terminal block cover.

Mounting the generator

5

5.1 Ensure that the generator can be freely rotated by hand to ensure there is no obstruction between the rotor and stator.

5.2 Install the mounting adaptor (TE 2a) on the test rig (TE 1) using manacle clamp (TE 4), and torque the clamp to 50-60 lbf ins (5.65 - 6.78 Nm).

5.3 Fit the drive shaft (TE 26) to the test rig (TE 1).

5.4 Mount the generator on the mounting adaptor (TE 2a) and attach using the manacle clamp (TE 5). Torque the clamp to 19.5 lbf ins (2.20 Nm).

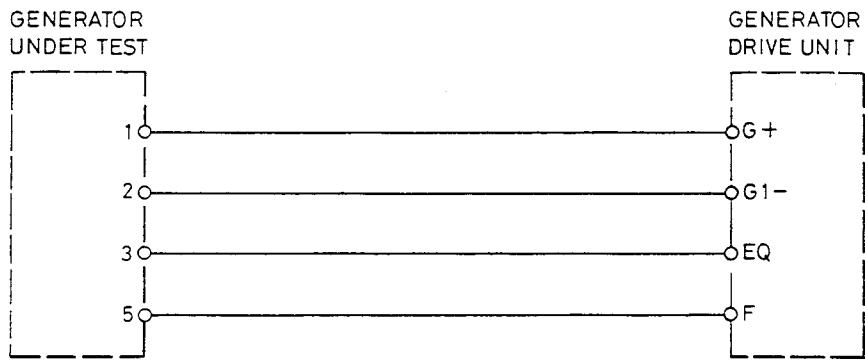


Fig 1 Generator to drive unit circuit diagram

5.5 Connect the generator to the test rig as shown in fig 1 using cable assembly (TE 2c).

5.6 Connect the regulator to the test circuit as shown in fig 2.

5.7 Fit the cooling air hose to the generator air inlet and secure with a suitable clamp.

5.8 Connect the oil drain pipe to the mounting adaptor (TE 2a).

Test rig preparation

6

NOTES

- (1) The basic switch positions are detailed in AP120B-0115-1; all switches are to be set to the basic position before commencing this procedure.
- (2) The drive unit control push-buttons are illuminated on selection and extinguished on de-selection i.e.:

LOAD BANK COOLING SYSTEM: With fan at rest, PBS7 (RED) will be lit and PBS8 (GREEN) extinguished. To start the fan press PBS8; PBS8 will light and PBS7 will extinguish.

Gearbox warm-up procedure

7 Refer to the NOTES above and proceed as follows:

7.1 Set SW40 to ON.

7.2 Operate PBS9. Ensure that all warning lamps are lit except PBS9 and 12 and 14 to 17 inclusive.

7.3 Release PBS9. Ensure LP 2, 4, 6, 7 and 8, together with PBS5 and 7, remain illuminated.

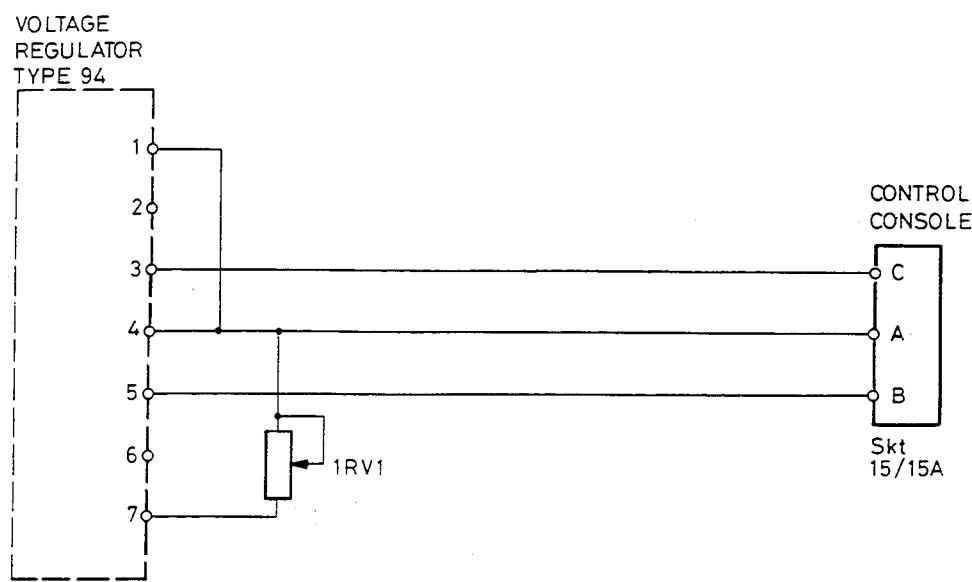


Fig 2 Voltage regulator to test circuit connections

7.4 Operate PBS6. Ensure LP7 and PBS5 extinguish and that PBS6 is illuminated.

7.5 Allow the gearbox to warm-up (10-40 minutes), indicated by LP6 extinguishing. Operate PBS5 and ensure that PBS5 and LP7 are illuminated and PBS6 extinguished.

7.6 Set SW40 to OFF.

7.7 Set the following switches to the positions indicated:

REMOTE DRIVE PANEL

Set SW1 to GEN COOL & LUBE
Set SW2 to CW

7.8 Open valve CV1 by turning counter-clockwise.

7.9 Set SW40 to ON.

7.10 Operate PBS9. Ensure that all warning lamps are lit except PBS9 and 12 and 14 to 17 inclusive.

7.11 Release PBS9. Ensure that LP 1, 2, 3, 7 and 8, together with PBS3, 5 and 7 remain illuminated.

NOTE

If LP6 remains illuminated, refer to paragraphs 7.1 thru 7.5.

7.12 Operate PBS2, 4, 6 and 8. Ensure that LP1, 2, 3, 7 and 8 are extinguished and that PBS10 is illuminated after 15 seconds.

► TESTINGMinimum speed test

8

8.1 Operate PBS11 and increase RV1 until the rig speed (M1) indicates 2860 rev/min.

8.2 Adjust 1RV1 until M10 indicates 28VDC \pm 0.5 VDC. Ensure that the field current does not exceed 5.6A.

8.3 Set SW24 to 0/P2 (600).

8.4 Set load master switch SW29 to ON. Using a combination of SW30 thru 34 and RV6, adjust the load current (M11) to 200A. Maintain the output voltage at 28VDC by adjusting 1RV1.

8.5 Set SW24 to FIELD 25. Ensure that the field current (M11) does not exceed 12A.

8.6 Remove all previously applied loads and set SW29 to OFF.

Maximum speed test

9

9.1 Using RV1 increase the rig speed to 10000 rev/min.

9.2 Adjust 1RV1 until M10 indicates 28VDC. Ensure that M11 is indicating not less than 0.9A. Note this value.

9.3 Set SW26 to 0/P2 (600).

9.4 Set SW29 to ON. Using a combination of SW30 thru 36 and RV6, load the generator to 200A, as indicated on M9.

9.5 Set SW26 to FIELD 25. Ensure that the current indicated on M11 exceeds that noted in paragraph 9.2 by not less than 0.2A.

9.6 Ensure that the sparking at the generator brushes is no more than pinpoint.

9.7 Reduce the loading to zero and set SW29 to OFF.

9.8 Using RV1, reduce the rig speed to 2860 rev/min.

Excitation test

10

10.1 Adjust 1RV1 until M8 indicates 28VDC.

10.2 Using a millivoltmeter (TE9), check the voltage across generator terminals 2 and 3. The value must be between 60 and 100 mV.

10.3 Reduce the rig speed (M1) to zero using RV1.

10.4 Operate PBS10 then operate PBS1, 3, 5 and 7. Ensure that LP1, 3, 7 and 8 illuminate within 2 minutes.

► 10.5 Set SW40 to OFF and close valve CV1 by turning clockwise.

Insulation resistance test

11

- 11.1 Disconnect and remove the generator from the test rig.
- 11.2 Disconnect the capacitors (refer to Chapter 3 of this publication).
- 11.3 Use the insulation resistance tester (TE7), set to the 250V range, and measure the insulation resistance between all terminals connected together and the frame. The minimum acceptable value should not be less than 0.5 megohms.
- 11.4 Reconnect the capacitors disconnected in paragraph 11.2.

Completion

- 12 Disconnect the oil drain pipe from the mounting adaptor. Remove the mounting adaptor and the drive shaft from the test rig and replace in the storage case.

Chapter 3
BAY SERVICING

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Introduction

1. The following instructions apply only to authorized units having the necessary spares and test facilities; they are in addition to the instructions contained in Chapters 1 and 2-1 or 2-2. The Servicing Techniques referred to are to be found in AP113A-0308-1, which is to be read in conjunction with these instructions.

TOOLS, MATERIALS, TEST EQUIPMENT

2. In addition to the test equipment listed in Chap. 2-1 or 2-2, the following special tools and materials or suitable equivalents, are required.

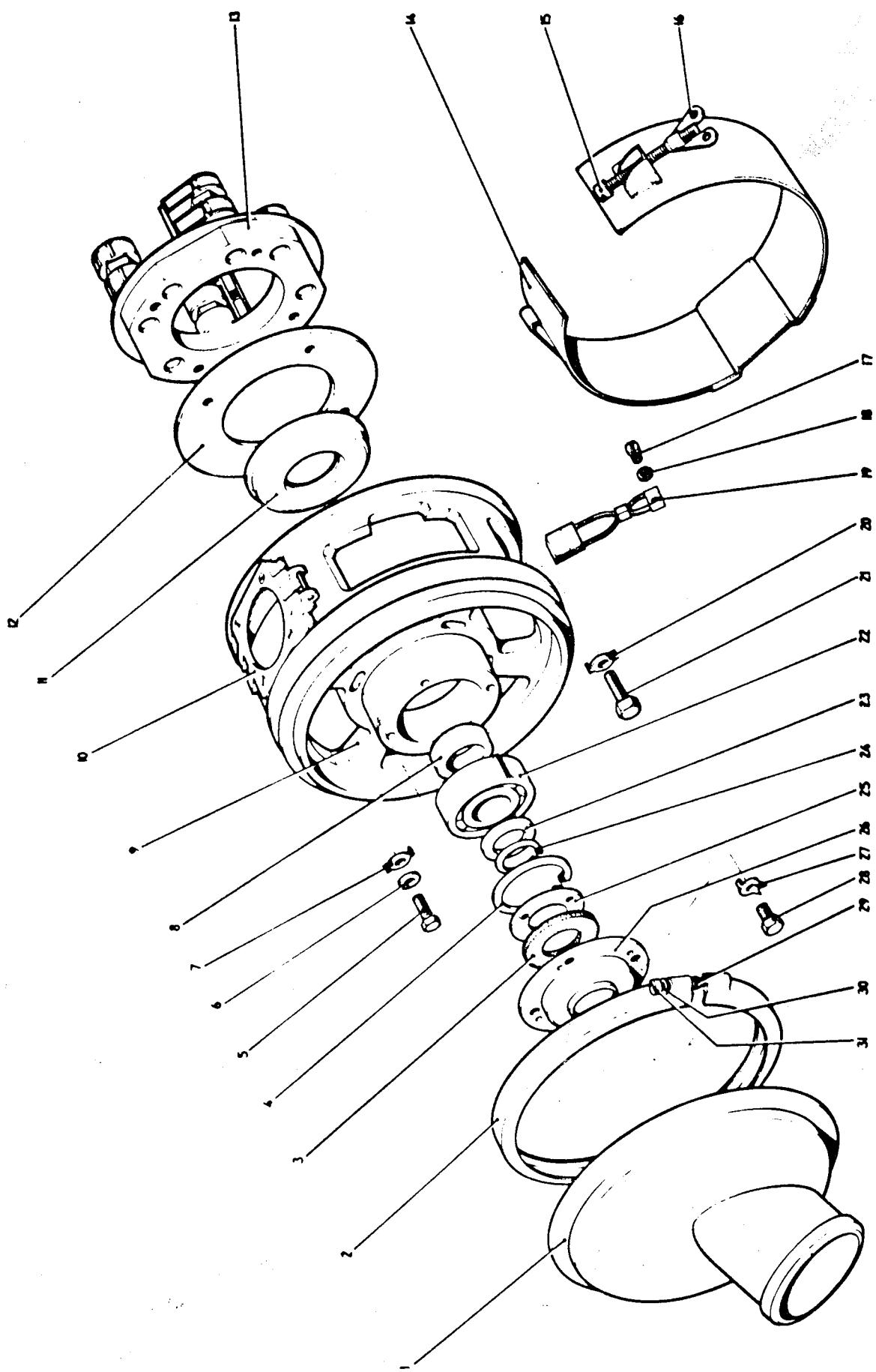


Fig. 1 Generator, commutator-end - exploded view

Key to fig.1

1	Vent casing	15	Clamp-bolt
2	Clamp-ring	16	Wing-nut
3	Felt seal	17	Screw
4	Circlip	18	Spring washer
5	Screw	19	Brush and tag assembly
6	Plain washer	20	Tabwasher
7	Tabwasher	21	Screw
8	Spacer	22	Roller bearing
9	Commutator-end frame assembly	23	Washer
10	Saddle assembly (see also fig.2, item 21)	24	Circlip
11	Insulator	25	Retaining washer
12	Insulator	26	Bearing end cap
13	Brushgear assembly	27	Tabwasher
14	Window strap assembly (brushgear)	28	Screw
		29	Coil circlip
		30	Spring washer
		31	Screw

TOOLS

Ref. No.	Description	Application
5UA/6546	Punch, oil seal, NT.3823	Oil seal fitting
5UA/6611	Base, oil seal, NT.3951	

MATERIALS

Ref. No.	Description	Application
34B/1457	Grease, special purpose 5 (DTD.900/4802A) AN/ARAK 260	Bearings
33B/9437454	Varnish, V.130/2)	Assembling
-	Transparent self adhesive tape	Oil seal fitting
33B/9428917	Varnish, antitracking (Red)	Brush gear

DISMANTLING

3. To dismantle the generator refer to fig.1 and proceed as follows:

- (1) Slacken the screw (31) of the clamp-ring (2) until the clamp-ring and the vent casing (1) can be removed.
- (2) Remove the wire locking from the wing-nut (16). Slacken off the wing-nut until the clamp-bolt (15) can be unhooked from the saddle assembly (10). Unhook the other side of the window strap assembly (14) from the other side of the saddle assembly (10) and remove strap.
- (3) Remove the screws (17) and spring washers (18) securing the brush tags to the brushgear. Remove the brush/tag assemblies (19).

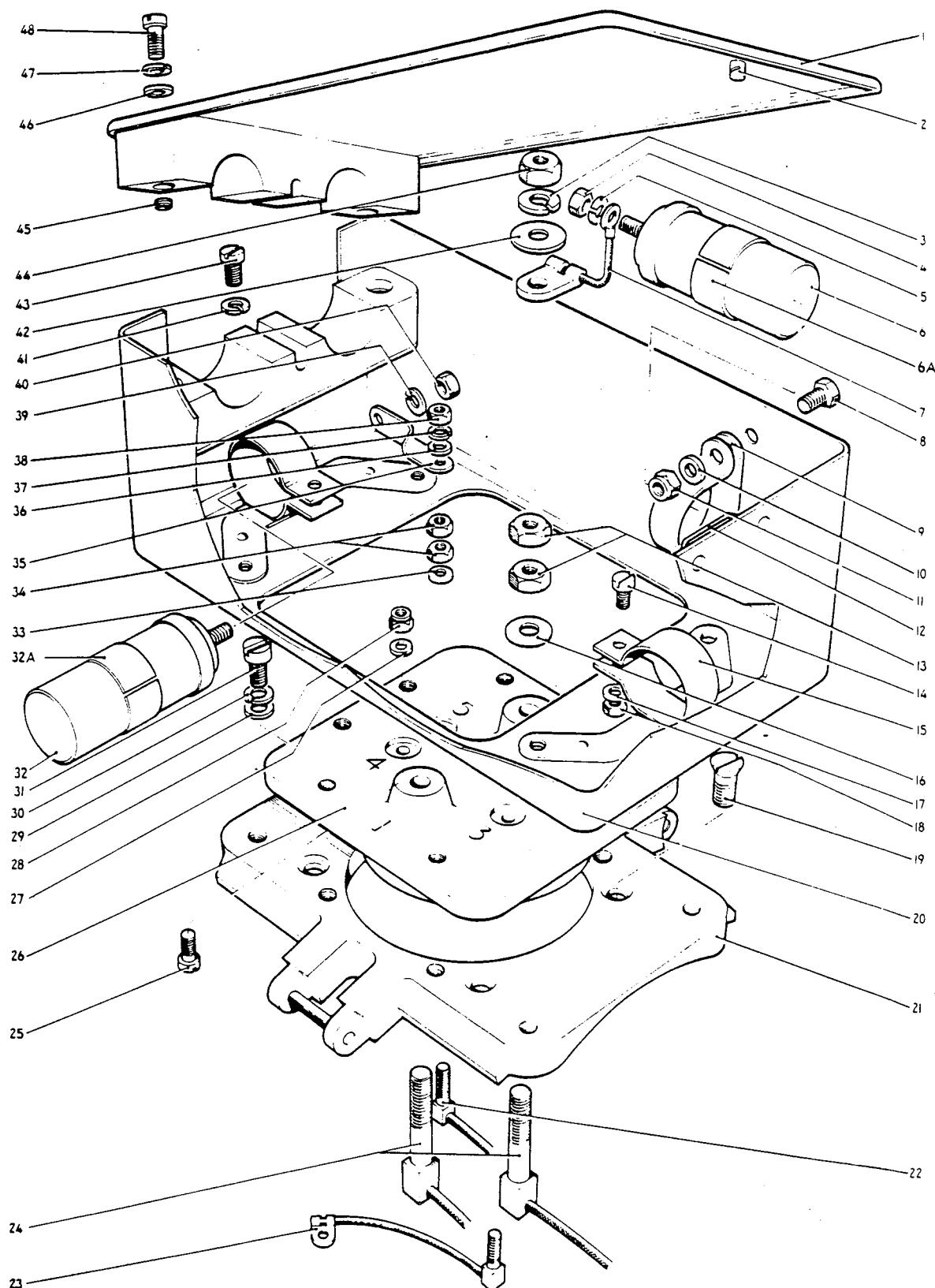


Fig.2 Generator terminal box - exploded view

Key to fig.2

1	Terminal box cover	25	Blanking bolt
2	Dzus fastener	26	Terminal block
3	Spring washer	27	Plain washer
4	Nut	28	Stiffnut
5	Spring washer	29	Plain washer
6	Capacitor	30	Spring washer
► 6A	Split sleeve (Mod. LG2046)	31	Screw
7	Lead assembly	32	Capacitor
► 8	Screw	32A	Split sleeve (Mod. LG2046)
9	P-clip	33	Plain washer
10	Plain washer	34	Locknuts, secondary terminal posts
11	Stiffnut	35	Link
12	Dzus fastener catch	36	Plain washer
13	Locknuts, main terminal posts	37	Spring washer
14	Screw	38	Nut
15	Capacitor clip	39	Spring washer
16	Plain washer	40	Nut
17	Plain washer	41	Spring washer
18	Stiffnut	42	Plain washer
19	Screw	43	Screw
20	Terminal box	44	Nut
21	Saddle assembly	45	Coil circlip
22	No.5 terminal post (see also fig.3, item 1)	46	Plain washer
23	No.3 terminal assembly	47	Spring washer
24	Main terminal posts (see also fig.3, item 2)	48	Screw

4. Refer to fig.2 and proceed as follows:

- (1) Unlock the Dzus fastener (2) of the terminal box cover (1).
- (2) Loosen the captive screws (48) of the terminal box cover (1) until the cover can be removed.
- (3) From each main terminal post (24) remove the nut (44), spring washer (3) and plain washer (42).
- (4) At each main terminal capacitor assembly (6) remove the stiffnut (11), plain washer (10) and screw (8), securing the P-clip (9) to the side of the terminal box (20). Remove complete the P-clip (9), split sleeve (6A) (Mod. LG2046) and capacitor (6) complete with lead assembly (7).
Suitably identify assembly for re-assembling.
- (5) From each secondary terminal post (23, 22) remove the nut (38), spring washer (37) and plain washer (36).

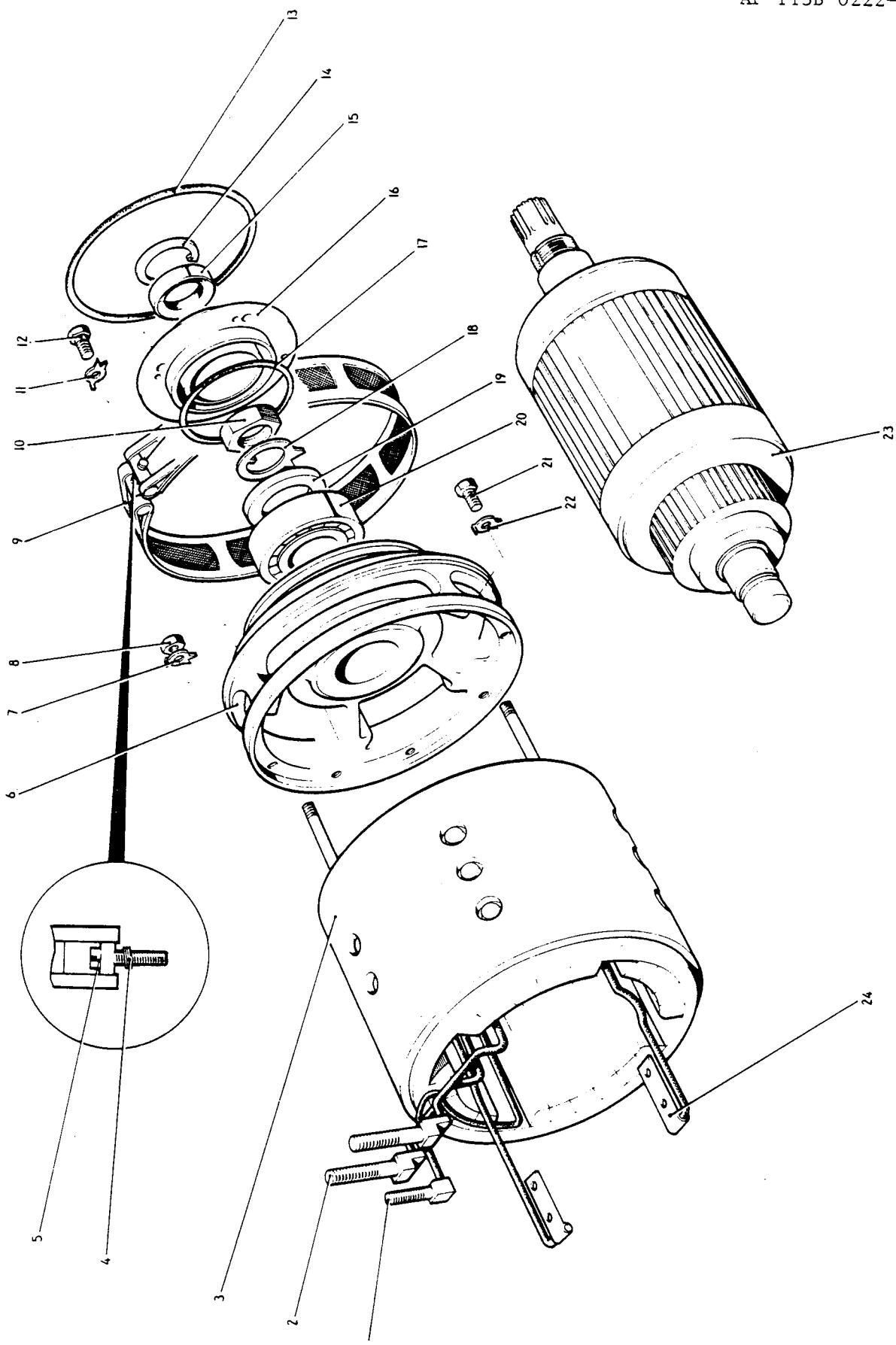


Fig.3 Generator, drive-end and armature - exploded view

Key to fig.3

1	No.5 terminal post and lead	13	Sealing ring
2	Main terminal posts and leads	14	Circlip
3	Yoke and coil assembly	15	Oil seal
4	Coil circlip	16	Oil seal housing
5	Screw	17	Sealing ring
6	Drive-end frame assembly	18	Lockwasher
7	Tabwasher	19	Spacer
8	Nut	20	Ball bearing
9	Window strap assembly (cooling air)	21	Screw
10	Shaft nut	22	Tabwasher
11	Tabwasher	23	Armature
12	Screw	24	Brushgear connection tags

► (6) From each secondary terminal capacitor clip (15) remove the stiffnut (18), plain washer (17) and screw (14). Carefully open up the clips (15). Remove the capacitors (32) complete with links (35) and split sleeve (32A) (Mod. LG2046). Suitably identify capacitor for re-assembling.

(7) Remove the screws (43) and spring washers (41) securing the terminal box (20). Lift the terminal box away from the saddle assembly (21).

(8) From each secondary terminal post (23, 22) remove the two locknuts (34) and plain washer (33).

(9) From each main terminal post (24) remove the two locknuts (13) and plain washer (16).

(10) Remove the screws (31), spring washes (30) and plain washers (29) securing the terminal block (26) to the saddle assembly (21).

(11) Suitably mark the terminal block (26) and saddle assembly (21) to aid re-assembling then remove the terminal block (26) complete with blanking bolts (25) fitted in positions 4 and the terminal post 3 and lead (23); at the same time push clear the main terminal posts (24) and terminal post 5 (22).

Note...

The tag at the end of item 23 will have been disconnected at the brushgear during the action in para.3 sub-para.(3).

(12) Remove terminal post 3 and lead (23).

5. Refer to fig.3 and proceed as follows:-

(1) Remove the sealing ring (13) from the skirt of the drive-end frame assembly (6).

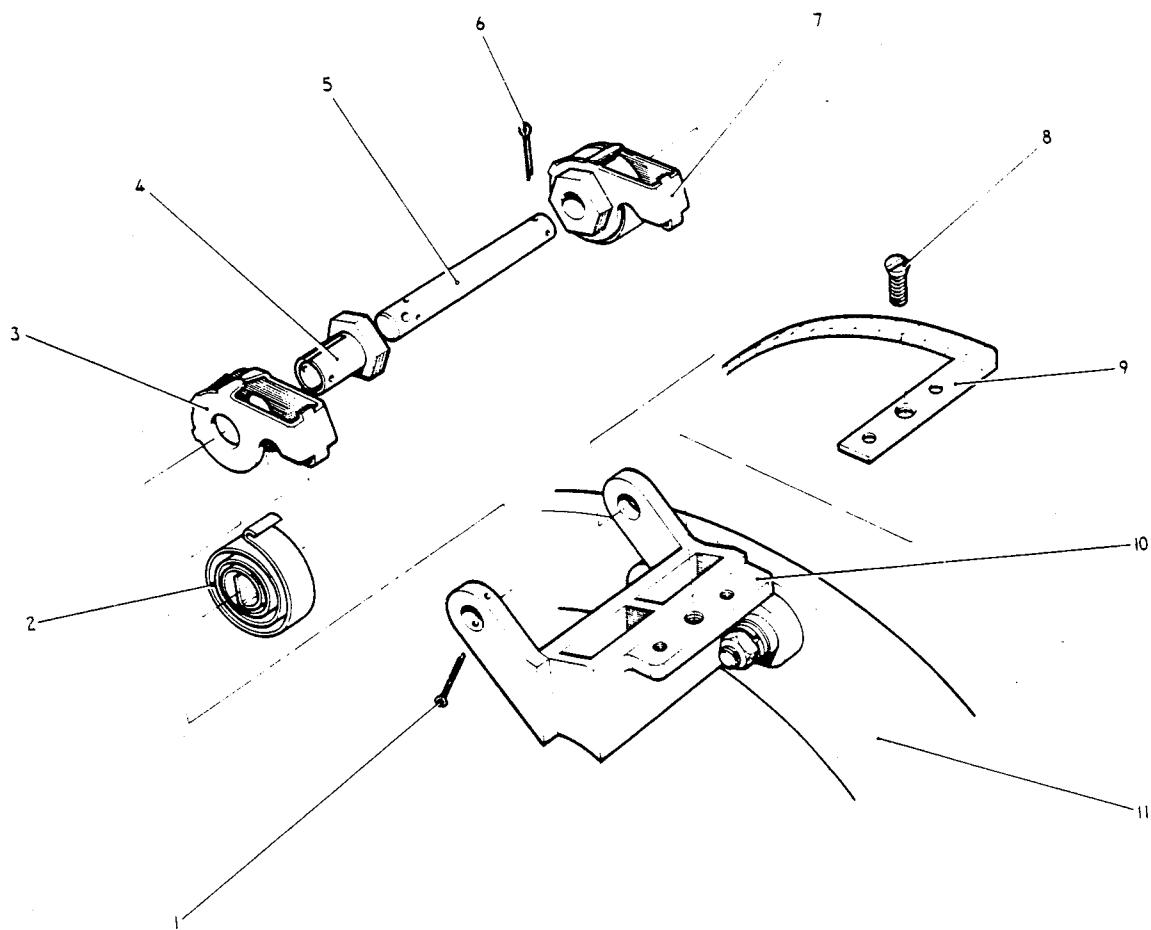


Fig.4 Generator brushgear - part exploded view

Key to fig.4

- 1 Splitpin - spring post
- 2 Brush spring
- 3 Brush trigger
- 4 Trigger sleeve
- 5 Brush spring post
- 6 Splitpin - spring adjuster

- 7 Assembly of items 2, 3, 4
- 8 Screw (jumper lead attachment)
- 9 Jumper lead assembly
- 10 Brush box
- 11 Brush ring

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- (2) Loosen the captive screw (5) of the window strap assembly (9) until the strap can be removed.
- (3) Unlock the tabwashers (22) and remove screws (21) and tabwashers (22).
- (4) Unlock the tabwashers (7) and remove the nuts (8) and tabwashers (7).
- (5) Suitably mark the mating perimeters to aid re-assembling then part the drive-end frame assembly (6) complete with armature (23) and oil seal assembly (16, 15, 14), from the yoke and coil assembly (3).

Note ...

The inner race of the armature roller bearing, the spacer, washer and circlip (fig. 1, items 22, 8, 23, 24) will remain on the armature shaft during this operation.

- (6) Unlock the tabwashers (11) and remove the screws (12) and tabwashers (11).
- (7) Remove the oil seal assembly (16, 15, 14) and sealing ring (17).
- (8) Remove the circlip (14) and press out the oil seal (15) from the oil seal housing (16).
- (9) Unlock the lockwasher (18) and remove the shaft nut (10) and lockwasher (18) from armature shaft (23).
- (10) Remove spacer (19) from armature shaft.
- (11) Pull armature (23) clear of drive-end frame assembly (6).
- (12) Remove ball bearing (20) from its housing in the drive-end frame assembly (6).
- (13) Suitably mark the mating perimeters to aid re-assembling.
- (14) Refer to fig. 1. Unlock the tabwashers (20) and remove the screws (21) and tabwashers (20).
- (15) Part the yoke and coil assembly (3) from the commutator-end frame assembly (fig. 1, item 9), taking care that the leads and respective tags (24) or terminals posts (1, 2) do not foul the brushgear.

6. Refer to fig. 1 and proceed as follows:-

- (1) Unlock the tabwashers (27) and remove screws (28), tabwashers (27) and bearing end cap (26).

- (2) From inside the bearing end cap (26) remove the circlip (4), retaining washer (25) and felt seal (3).
- (3) Remove the outer race and roller cage of the roller bearing (22).
- (4) Suitably mark the brushgear assembly to aid re-assembly, then unlock the tabwashers (7) and remove screws (5), plain washers (6), tabwashers (7) and the brushgear assembly (13).
- (5) Remove the flat insulator ring (12) and the dished insulator (11).

CLEANING

► WARNING

TRICHLOROETHANE. TRICHLOROETHANE IS USED IN THE MAINTENANCE OF THIS EQUIPMENT. REFER TO THE TRICHLOROETHANE WARNING IN THE PRELIMINARY PAGES OF THIS MANUAL.

7 Clean the components as detailed in Servicing Technique No 5.

EXAMINATION AND RENEWAL OF PARTS

8 The following items, removed during dismantling, are to be discarded and new items provided for re-assembling.

Locking wire
 Tabwashers
 Lockwashers
 Sealing rings
 Oil seal
 Brush and tag assembly
 Felt seal

9 The following items, removed during dismantling, are to be examined for serviceability for further use, and if necessary discarded and new items provided for re-assembling.

Spring washers
 Circlips
 Stiffnuts
 Ball and roller bearings (see para 11)

10 All other minor items, especially those with screw threads, are to be examined for serviceability during assembling. Examine the sub-assemblies as detailed in the following paragraphs.

Bearings

11 Examine the bearings as detailed in Servicing Technique No. 1. Note that at this stage the inner race of the roller bearing is still fitted to the armature shaft. If new bearings are to be fitted they are to be selected to give a clearance fit in their housings and a clearance fit on the drive-end of the shaft and an interference fit on the commutator-end of the shaft.

12. To renew the roller bearing, refer to fig. 1 and proceed as follows:-
 - (1) From the armature shaft (fig. 3, item 23) remove the circlip (24) and washer (23).
 - (2) Remove the inner race of the bearing (22) from the shaft; collect the spacer (8). Examine the spacer for damage.
 - (3) Refit the spacer (8) with the smaller diameter toward the commutator.

Note ...

The spacer is a push fit on to the armature shaft.

- (4) Fit the inner race of the new roller bearing (22) as detailed in Servicing Technique No. 1. The temperature of the heating medium is to be 60 deg. C. Ensure that the race butts hard up against the spacer (8).

- (5) Fit the washer (23) and circlip (24).

Armature

13. (1) Examine for signs of scuffing or abrasion at the perimeters of the windings.
- (2) Examine the commutator for pitting or burning. If necessary skim the surface of the commutator as detailed in Servicing Technique No. 3.

Note ...

- (1) Minimum permissible commutator diameter - 2.675 in (67.96 mm).
 - (2) Mica undercut - between 0.026 and 0.032 in (0.66 and 0.81 mm).
 - (3) Kopp reading is 140.
- (3) Check concentricity of commutator with commutator-end bearing inner race - total eccentricity not to exceed 0.0005 in (0.013 mm), bar to bar lift not to exceed 0.0001 in (0.003 mm).
- (4) Using a Type C insulation resistance tester check the resistance between the commutator and shaft - it shall be not less than 10 megohm.

Note ...

If the insulation resistance is low it may be improved by baking the armature in an air circulating oven at a temperature of 110 deg. C for a period of four hours.

Brushgear assembly

14. (1) Examine the area covered with antitracking varnish, and touch up any damaged or scratched areas using varnish, antitracking (ref. para. 2).

(2) Check each brush spring for correct tension. With brush trigger in line with outer face of brush box, tension is to be between 23 and 29 oz (652 and 822 gramme). To adjust tension refer to fig. 4 and proceed as follows:-

(a) Using a $\frac{1}{4}$ BSF spanner on the hexagon of the trigger sleeve (4), hold the sleeve against the tension of the spring (2) and remove split-pin (6).

(b) Adjust the sleeve to obtain the correct tension then lock in position using a new splitpin (6).

Note ...

Positioning of holes in sleeve (4) and post (5) allow adjustment in movements of $1/16$ turn.

(3) To renew a brush spring or other component refer to fig. 4 and proceed as follows:

(a) Using a $\frac{1}{4}$ BSF spanner on the hexagon of each trigger sleeve (4) in turn at the relevant brush box (10) hold the sleeve against tension of spring (2) and remove the sleeve locking splitpin (6), then allow the sleeve to turn to reduce spring tension to zero.

(b) Remove the splitpin (1) securing the brush spring post (5) in the brush box.

(c) Pull the post (5) clear of the brush box (10) and collect the two brush triggers (3) each containing a brush spring (2) and sleeve (4).

(d) Pull the sleeve (4) clear of the trigger (3) and collect the spring (2).

(e) Fit spring (2) into the trigger (3) so that the spring hook engages on the squared lugs of the trigger.

(f) Into the trigger/spring assembly fit the sleeve (4) so that inner lip of spring engages in the slot in the sleeve.

Note ...

The sleeve is to be positioned in the trigger so that in each pair assembled in a brush box the hexagon heads are centrally

disposed.

- (g) In turn place each trigger/spring/sleeve assembly (7) into the arms of the brush box (10) and at the same time feed through the brush box post (5).
- (h) Align the outer hole in the post with the holes in the brush box outer arm and secure using a new splitpin (1).
- (j) Adjust spring tension, as detailed in sub-para. (2) above.

Yoke and coil assembly

15. (1) Examine for signs of scuffing or abrasion at the perimeters of the pole pieces.
- (2) Check the security of the leads, terminal posts and brush gear connection tags (fig. 3, items 1, 2, 24).
- (3) Using a Type C insulation resistance tester check the resistance between the terminal posts and connection tags commoned together and the frame; the resistance shall be not less than 10 megohm.

Note ...

If the insulation resistance is low it may be improved by baking the yoke assembly in an air circulating oven at a temperature of 110 deg. C for a period of four hours.

Terminal box assembly

16. (1) Check each of the four capacitors (fig. 2, items 6, 32) as detailed in Servicing Technique No. 6.
- (2) Check that the Dzus fastener and its associated catch bar (fig. 2, items 2, 12) are not damaged or distorted.
- (3) Check each captive screw is fitted with a spring washer and plain washer under its head (fig. 2, items 48, 47, 46) and is retained captive to the cover by a coil circlip (fig. 2, items 1, 45).

Commutator-end frame assembly

17. Examine the area covered with antitracking varnish and touch up any damaged or scratched areas using varnish, antitracking (ref. para. 2).

ASSEMBLING

General

18. During assembling all internal and external nuts, screws, exposed screw threads, washers etc. are to be treated with varnish V.130/2 after final locking. Joint faces, spigots, etc. which must make electrical contact for screening purposes are to be free from any insulating film and are to be lightly smeared with grease during assembling operations. Any capillary spaces formed by the mating of the surfaces, other than those already specified, are to be sealed using varnish V.130/2.

Generator

19. Refer to fig. 1 and proceed as follows:-

- (1) Into the commutator-end frame assembly (9) fit the ~~damaged~~ insulator (11) and the flat insulator ring (12).
- (2) Align the reference marks on the frame assembly (9) and brushgear assembly (13) then secure brushgear in position using screws (5), plain washers (6) and new tabwashers (7).
- (3) Using an insulation resistance tester Type C check the resistance between each of the two brush box pairs, and between each brush box pair and frame; the resistance shall be not less than 10 megohm.

20. Refer to fig. 3 and proceed as follows:-

- (1) Align the reference marks on the yoke and coil assembly (3) and the commutator-end frame assembly (fig. 1, item 7) and fit together, ensuring that the leads and tags or terminal post (1, 2, 24) do not foul the brushgear or become damaged. Check that the terminal posts (1, 2) protrude through the saddle assembly (fig. 1, item 10) and that the tags (24) are correctly positioned on the brushgear. Secure the main assemblies using screws and new tabwashers (fig. 1, items 21, 20).
- (2) Pressure fill the ball bearing (20) with grease (ref. para. 2) as detailed in Servicing Technique No. 1.
- (3) Fit the ball bearing (20) into its housing in the drive-end frame assembly (6).
- (4) Fit the drive-end frame/ball bearing assembly on to the armature shaft (23). Fit the spacer (19), a new lockwasher (18) and shaft nut (10). Tighten nut and lock with lockwasher.

(5) Fit new sealing ring (17) to the oil seal housing (16) then fit the oil seal housing (16) to the drive-end frame assembly (6). Secure in position using screws (12) and new tabwashers (11). Do not lock tabwashers at this stage.

(6) Align the reference marks on the drive-end frame assembly (6) and the yoke and coil assembly (3) then fit the armature (23) through the yoke and coil/commutator-end frame assembly (see sub-para. (1)), ensuring that no damage is incurred to the armature, field coils or brushgear and that the spacer (fig.1, item 8) on the commutator end of the shaft is located in the bearing housing of the commutator-end frame assembly.

(7) Secure the main assemblies together using nuts (8) and new tabwashers (7) and screws (21) and new tabwashers (22).

(8) Fit the window strap assembly (9) and tighten the captive screw (5) and wirelock.

21. Refer to fig.1 and proceed as follows:-

(1) Fit the outer race and cage of the roller bearing (22) into the bearing housing of the commutator-end frame assembly (9). Lubricate the bearing with grease (ref. para.2) as detailed in Servicing Technique No.1.

(2) Into the bearing end cap (26) fit a new felt seal (3), retaining washer (25) and secure with circlip (4).

(3) Fit the bearing cap assembly (26) to the commutator-end frame assembly (9) and secure using screws (28) and new tabwashers (27).

22. Refer to fig.2 and proceed as follows:-

(1) Check that the terminal block (26) is fitted with blanking bolts (25), plain washers (27) and stiffnuts (28) in the two terminal positions 4.

(2) Fit terminal post 3 and lead (23) into position in the terminal block (26).

(3) Fit the terminal block (26) to the saddle assembly (21) aligning the marks made during dismantling; ensure that the three terminal posts (24, 22) from the yoke and coil assembly are fed through their respective holes in the terminal block.

(4) Secure with the terminal block (26) in position using screws (31) spring washers (30) and plain washers (29).

(5) On to each main terminal post (24) fit a plain washer (16) and secure with two locknuts (13).

(6) On to each secondary terminal post (23, 22) fit a plain washer (33) and secure with two locknuts (34).

(7) Fit the terminal box (20) on to the saddle assembly (21) and secure using screws (43) and spring washers (41).

(8) Check that each secondary terminal capacitor (32) is fitted with a terminal link (35) secured by a nut (4) and spring washer (39) and a split sleeve (32A) (Mod. LG2046).

(9) In turn, fit each secondary capacitor (32) into the mounting clip (15). Ensure that the link (35) locates correctly on the respective secondary terminal post (23, 22) and that the split sleeve (32A) (Mod. LG2046) is under the mounting clip (15).

(10) Secure each secondary capacitor (32) into its clip (15) using screw (14), plain washer (17) and stiffnut (18) and the link (35) to its terminal post (23, 22) using plain washer (36), spring washer (37) and nut (38).

(11) Check that each main terminal capacitor (6) is mounted in a P-clip (9) and is fitted with a split sleeve (6A) (Mod. LG2046) and a lead assembly (7) secured by a nut (4) and spring washer (5).

(12) In turn, fit each main capacitor assembly (sub-para. (11) above) into the terminal box (20). Ensure that the lead assembly tag (7) locates correctly on the respective main terminal post (24) and that the split sleeve (6A) (Mod. LG2046) is under the P-clip (9).

(13) Secure each main capacitor P-clip (9) to the terminal box (20) using screw (8), plain washer (10) and stiffnut (11) and the lead assembly (7) to its terminal post using plain washer (42), spring washer (3) and nut (44).

(14) Fit the terminal box cover (1) in position and secure using the two captive screws (48) and Dzus fastener (2).

23. Refer to fig.1 and proceed as follows:-

(1) Check that the brushgear connector plates from the coil assembly (fig.3, item 24) and the tag of terminal post (fig.2, item 23) are correctly aligned with the appropriate brush boxes, then fit new brushes (19) to the brush boxes and secure brush tags and connector plates using screws (17) and spring washers (18).

(2) Bed the new brushes as detailed in Servicing Technique No.2, motoring the generator from a supply not exceeding 18V d.c.

(3) Place the vent casing (1) in position, fit the clamp-ring (2) and tighten the clamp-ring screw (31).

At this stage the generator is assembled sufficiently to allow any testing to be carried out (see para.24).

TESTING

24. The generator is tested as detailed in Chapters 2-1 or 2-2. If the generator is to be tested with the oil seal fitted, the oil seal should be fitted as detailed in para. 26 sub-para. (2) prior to testing and not as part of final assembly. The insulation resistance checks are as detailed in Chap. 2-1 or 2-2 except that resistance values are to be not less than 2 megohm.

25. On completion of testing, carry out the final assembling detailed in para. 26.

FINAL ASSEMBLING

26. After testing is completed continue final assembling as follows:-

(1) Refer to fig. 1. Place in position the brushgear window strap assembly (14); to the appropriate bars on the saddle assembly (10) hook on the strap (14) and the clamp bolt (15). Tighten the wing-nut (16) and wire lock.

(2) Refer to fig. 3. Remove the screws (12) and tabwashers (11) and the oil seal housing (16). Fit a new oil seal (15) into the housing using the tools listed in para. 2 and secure in place with circlip (14). Cover the splines of the armature shaft (23) with transparent self-adhesive tape to protect the oil seal lip during assembling, then refit the oil seal housing (16) complete with oil seal (15). Secure housing using screws (12) and tabwashers (11). Fit a new sealing ring (13) to the skirt of the drive-end frame assembly (6).

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