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Chapter 15

MOTOR-GENERATOR, DE HAVILLAND TYPE B 503-4

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Motor-generator, Type B 503-4	*Ref. No.* 5UB/6332
Overall length	19·19 *in.*
Overall height	7·38 *in.*
Maximum width (over inlet and exhaust funnels)	9·38 *in.*

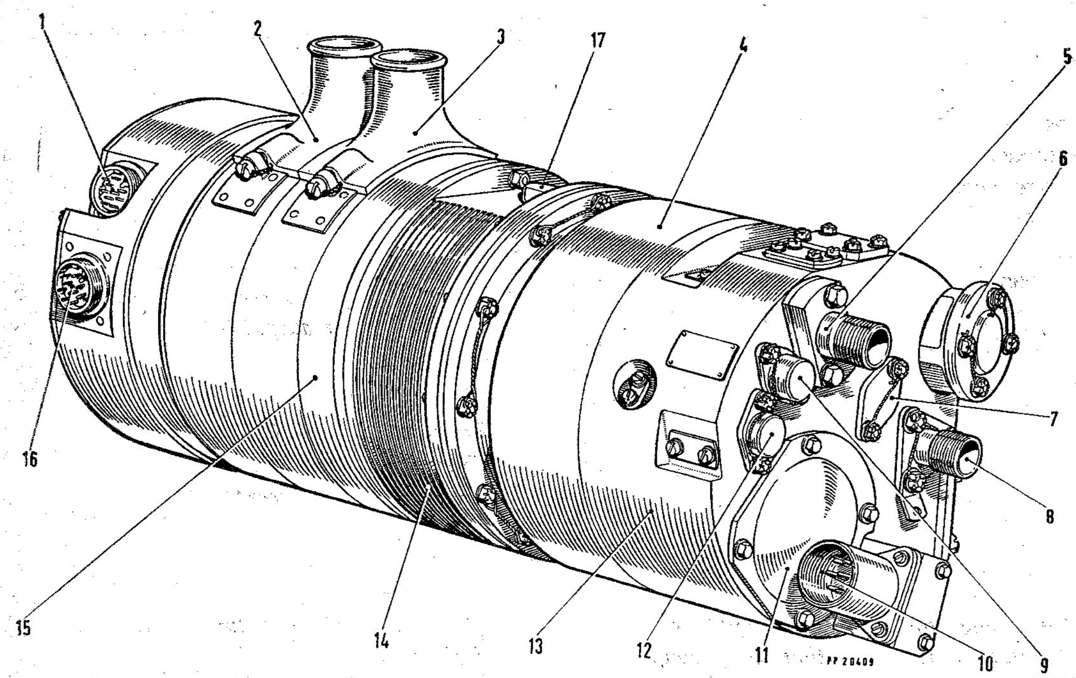
LEADING PARTICULARS—*continued*

Generator

Output voltage (pre-set over range)	115-118V *a.c. (r.m.s.)*
Output voltage (variations) ...	±1 *per cent (750W to max. output)*
Output voltage (variations)	±2 *per cent (375W to 750W)*
Output voltage (maximum no-load)	138*V a.c. (r.m.s.)*
Rated power output	1·75*kW at* 0·95 *P.F.*
Output frequency	2400 *c/s*
Output frequency (variations) ...	±1 *per cent (750W to max output)*
Output frequency (variations)	±2 *per cent (375W to 750W)*
Recovery time after load change (frequency)	0·5 *sec*
Rating	*Continuous*

Motor

Hydraulic supply pressure	2650–2950 *lb/in.² at unit*
Hydraulic fluid minimum flow	3·66 *gal/min*
Hydraulic fluid, temp. range	... 10 *deg. C to* 80 *deg. C for specified output*
Hydraulic fluid	*D.T.D.*585 (*OM*-15, *Ref. No.* 34*B*/9100572)



1 12 POLE CONNECTOR (FIELD AND SWITCH CONNECTIONS)
2 COOLING AIR EXHAUST FUNNEL
3 COOLING AIR INLET FUNNEL
4 GEAR HOUSING
5 OUTLET AND NON-RETURN VALVE
6 BLANKING PLATE AT END OF ACTUATOR
7 BLANKING PLATE
8 INLET UNION AND INLET FILTER
9 SWASH-PLATE SPRING ADJUSTER COVER PLATE
10 9-POLE SOCKET (TRANSDUCER AND FEED-BACK POTENTIOMETER CONNECTIONS)
11 TRANSDUCER RECESS COVER PLATE
12 SERVO FILTER COVER PLATE
13 GENERATOR
14 OIL TANK
15 MOTOR
16 12-POLE CONNECTOR (CAPACITOR AND JUNCTION BOX CONNECTIONS)
17 DIPSTICK

Fig. 1. Motor-generator assembly, Type B503-4

Introduction

1. The a.c. generator described in this chapter is used to provide a 115V 2400c/s constant frequency supply for the weapon installations of certain aircraft.

2. The generator is driven by a specially designed hydraulic motor and has an oil tank for internal lubrication of the gear train, the three units being secured together by studs and nuts to form a single assembly. It is operated in conjunction with a Control Unit, Series B300 (*A.P.*4343*B*, *Vol.* 1, *Book* 2, *Sect.* 8, *Chap.* 6) and a Capacitor and Junction Box, Type B700-2 (*A.P.*4343*B*, *Vol.* 1, *Book* 2, *Sect.* 8, *Chap.* 7).

3. The hydraulic motor is of the swash-plate type and is operated by fluid supplied from engine-driven pumps at pressures between 2650 and 2950 lb/in^2. The motor is maintained at a constant speed by the regulation of its fluid input through a servo-assisted throttle valve which is controlled by a transducer coupled to a frequency-sensitive circuit connected to the generator output, and by the adjustment of the swash-plate angle proportionately to the pressure drop across the throttle. Constant output voltage is provided by the voltage control circuit contained in the B300 seiies Control Unit.

4. During flight the generator is cooled by ram air, whilst the hydraulic fluid is passed through a reservoir cooled by fuel flowing to the aircraft engines. Details of the cooling arrangements and the hydraulic systems will be found in the relevant Aircraft Handbook.

DESCRIPTION

Motor-generator assembly

5. The motor-generator assembly (*fig.* 1) consists essentially of the hydraulic motor, oil tank and the generator which are secured together by studs and nuts and are not normally separated except for major servicing. Annular channels are provided around the generator housing, with holes leading to the interior through which air is fed, via funnel attachments which are secured by straps, into the generator for cooling purposes; this arrangment allows the cooling air supply pipes to follow a convenient route, since the funnels may be positioned anywhere over a 210 deg. range around the assembly.

Motor

6. The body of the motor is made in two pieces; the motor housing and the gear housing, both of which are machined from solid duralumin bar. Where possible, excess material is machined away for lightening

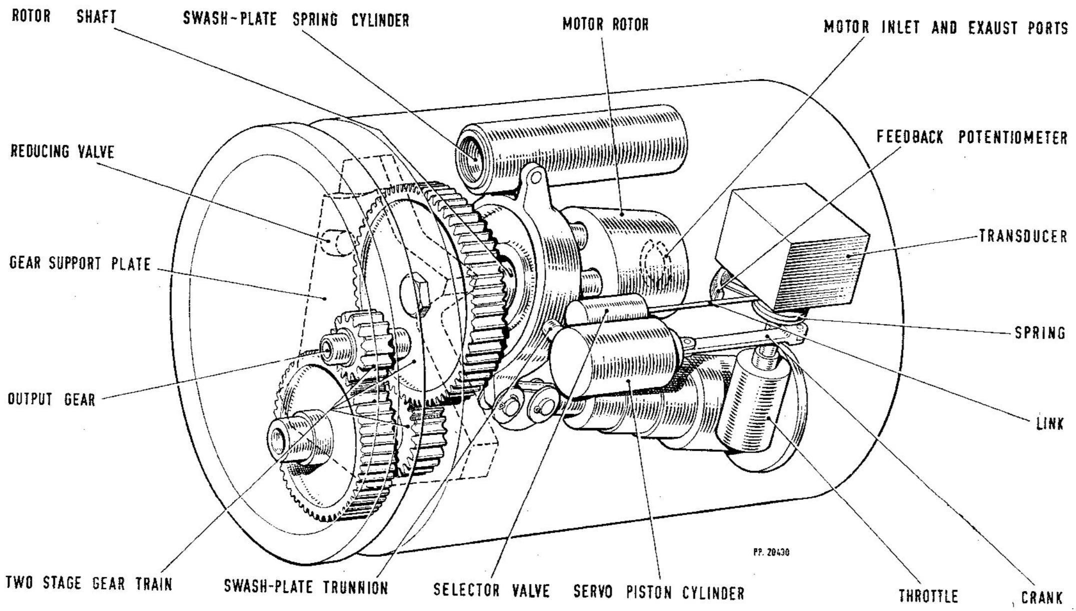


Fig. 2. Hydraulic motor—location of principal items

purposes, e.g., the external grooves and recesses. The ancillary items are arranged within the body as shown diagrammatically in fig. 2, and drillings are made through the motor and gear housing for the passage of hydraulic fluid. Blanking or cover plates seal the openings and enable the drillings to be cleaned and inspected during major overhauls.

7. A filter forms part of the inlet union and consists of a coarse cylindrical gauze filter surrounding a non-ferrous spigot containing a small rod-type magnet; ferrous metallic particles are attracted out of the fluid stream and adhere to circlips on the periphery of the spigot from where they can easily be removed during servicing. From the inlet filter chamber a large drilling leads to a throttle, and a small drilling communicates with a port in a swash-plate actuator housing.

8. The throttle is mounted near the end of the motor that is remote from the generator. It consists of a rotary throttle valve contained within a fixed cylindrical sleeve, the lower edge of the valve being arranged to cover or uncover a pair of circular outlet ports in the upper part of the sleeve as the valve is turned, thus varying the area of the port openings and controlling the fluid flow to the motor. Large drillings are provided between the throttle outlet and the swash-plate motor inlet port; a small drilling also connects the outlets with another port in the swash-plate actuator housing. Four equally-spaced holes in the lower part of the sleeve act as inlet ports for the throttle.

9. A transducer is mounted in a large recess in the motor housing, immediately above the throttle, the transducer spindle and throttle spindle being aligned with each other and inter-connected by a neutrally-tensioned helical wire spring; limited movement of the throttle valve is transmitted via the spring to the transducer, and consequently to a selector valve, and vice-versa. An arc-shaped wire-wound potentiometer is attached to the transducer, and its wiper arm is connected to the throttle valve operating lever; this potentiometer is connected in a rate feedback circuit in the generator control unit. The transducer and potentiometer wiring terminates in a 9-pole plug, the pins being moulded into the plug body to prevent fluid seepage. The transducer recess is sealed by a domed cover plate which is fitted after the initial factory adjustments to the transducer and selector valve mechanism have been made.

10. A schematic diagram to show the general

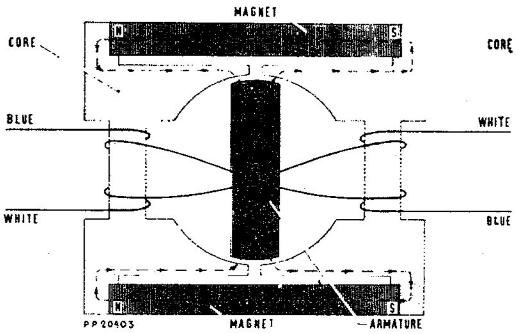


Fig. 3. Schematic diagram of transducer

arrangement of the transducer cores and armature is given in fig. 3. Each core carries two windings which are connected in series as shown; when equal currents are fed through both windings, the armature remains in its normal central position, but if the currents are varied differentially, the armature turns accordingly. The armature is returned to its central position by the flux from a pair of magnets that are situated at the ends of the cores. The armature is supported in small ball bearings housed in the transducer end plates, and its movement is limited to approximately $\pm$ 7 deg., this deflection occurring when the current differential between the two windings is approximately 100 to 120mA. The deflection, which is proportional to the current flowing through the coils, is usually within $\pm$ 3 deg.

11. The selector valve and the associated servo piston are mounted horizontally in the gear housing in line with the transducer and throttle levers, to which they are attached by a wire link and an operating crank respectively. The selector valve housing connects with the motor exhaust port via a tubular transfer dowel and a servo-filter housing. The servo-filter, which is of the edge-type, prevents particles exceeding 25 microns from entering the selector valve housing via the transfer dowel. The multi-land selector valve is reciprocated within its tubular bush, by movement of the transducer armature, to uncover ports in the bush which communicate with the servo-piston cylinder. The servo-piston and its cylinder are quite large in comparison with the selector valve and thus provide considerable power magnification to operate the throttle valve.

12. The swash-plate motor assembly consists essentially of a solid rotor having cylinders inclined outwards around its axis, each cylinder containing a plunger and a compression spring. The spherical outer end of each plunger is 'shod' with a bronze 'slipper' which slides on the operating face of the swash-plate. As the rotor revolves, a port at the inner end of each cylinder aligns in turn with either an arc-shaped inlet port or an arc-shaped exhaust port. These two ports are machined in a flat circular plate which is secured in the motor housing, this plate also acting as an end-thrust bearing for the rotor. The rotor is supported by a large roller bearing around its periphery and a small roller bearing on its output shaft, this latter bearing being housed in the main web of the gear housing which separates the fluid-filled interior of the motor chamber from the gears. A synthetic-rubber lip-seal prevents fluid from passing through the rotor-shaft bearing and into the gear chamber. Drillings within the rotor and through the plungers ensure adequate lubrication of the plunger, swash-plate, and bearings.

13. The swash-plate pivots on integral trunnions which are supported in bearing blocks. The blocks fit in recesses in the motor housing and are held in place when the gear and motor housings are fitted together. A swash-plate control spring is enclosed in a cylindrical tube having projections which fit in a yoke on the top edge of the swash-plate. The spring compression is pre-set by a mush-room-headed stud, the stem of which protrudes through the motor housing and enables adjustment to be made during factory testing. A swash-plate actuator piston is contained within a housing which is secured on the motor housing by four long studs and nuts. Fluid passages to the actuator are provided by stepping the actuator housing so that it fits in a series of three progressively larger bores, a port being situated in each step; ring seals ensure that fluid cannot pass from one step to another when the actuator assembly is in position. One end of the actuator piston is attached by a short crank to the lower edge of the swash-plate; the other end is provided with an adjustable stop to limit the swash-plate at its maximum deflection angle. A blanking plate forms a stop for limiting the minimum swash-plate angle which may be adjusted by fitting shims under the plate.

14. A large drilling connects the motor exhaust port with a chamber containing a pressure maintaining valve; this chamber leads to the motor main return line which terminates at an outlet union containing a non-return valve.

15. The motor housing is spigoted and dowelled into the gear housing, a rubber 'O' ring seal, fitted to a recess in the spigot end of the housing, ensuring a satisfactory seal; these two parts of the motor body are secured together by wire-locked nuts on studs screwed into the motor housing. The gear housing incorporates a flange which locates the oil tank.

16. The main drive gear is splined to the end of the rotor shaft and secured by a bolt and tab-washer. Meshing with this gear is a smaller gear, splined on to a layshaft unit which is supported by two ball bearings, one in the gear housing web, the other in a gear support plate which is fitted inside the gear housing. Integral with the layshaft is a gear wheel which drives an output gear; this output gear is splined internally to accommodate the splined end of the quill shaft that couples the motor to the generator rotor. The quill shaft provides an efficient high-speed universal joint which prevents mechanical stresses being transferred from one item to the other. Stub extensions on each side of the output gear locate in ball bearings, both of which are housed in the gear support plate. A pinion, fitted to the end of the layshaft, drives small gear-type pressure and scavenge pumps via gears on the gear-pump shaft. The pumps are located within the oil tank.

17. Drillings in the gear support plate lead to two brass jets; one is screwed into the gear support plate and aimed at the meshing output gears, and the second into a short extension aimed at the motor output and layshaft gears.

Oil tank

18. The tubular body of the oil tank is of aluminium-alloy, finned for cooling and provided with a tapped hole to accommodate a dipstick.

A brass diaphragm assembly, sealed by an 'O' ring, closes the body at one end, and an aluminium-alloy end plate, also sealed by an 'O' ring, closes the body at the other end. A hollow pillar, located axially through the tank, forms a housing through which the quill shaft passes to connect the hydraulic motor to the generator.

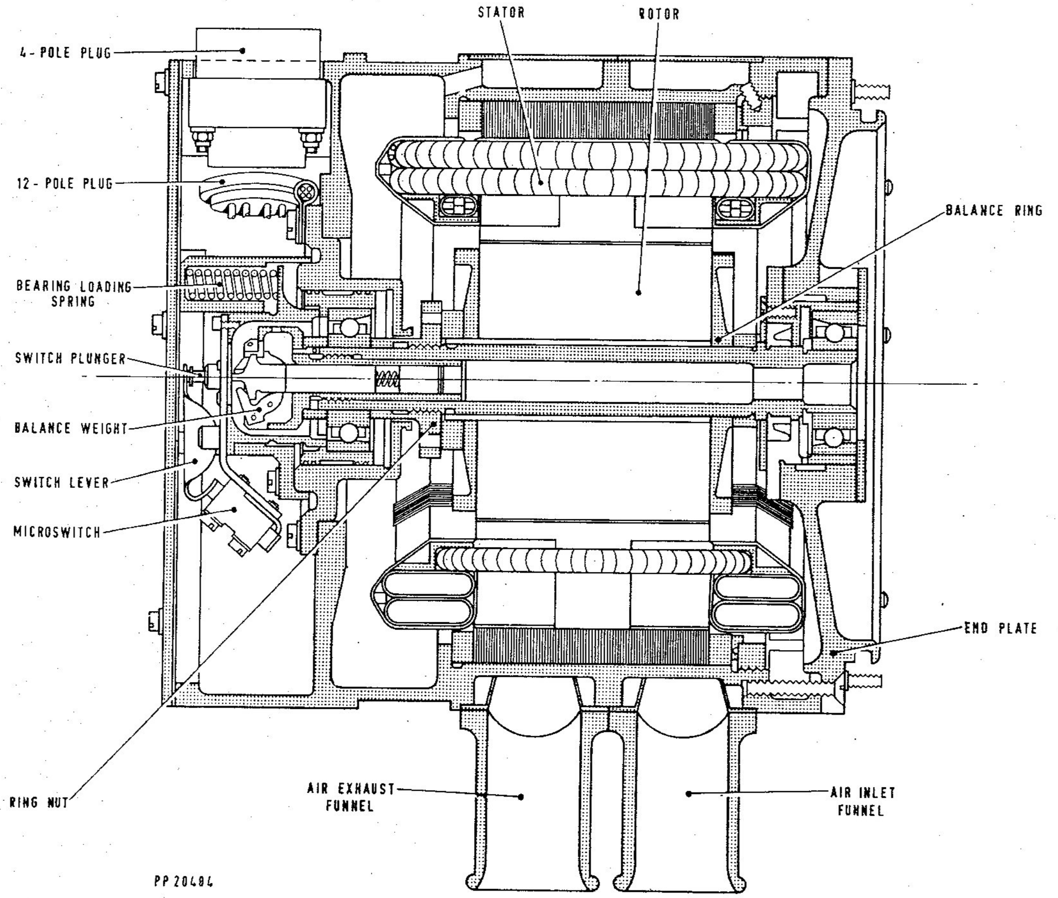


Fig. 4. Sectional view of generator

19. The end plate has a pump unit secured to it by bolts; the pump unit houses a pressure pump which supplies oil via feed pipes and drillings in the end plate to the gear train and bearings, and a scavenge pump which returns the oil from the gear housing to the tank. The output of the pressure pump is governed by a relief valve set to $5\frac{1}{2}$ lb/in^2. The oil tank has a breather valve located in the end plate to equalize pressure between the gear housing and the oil tank.

Generator

20. The generator stator and rotor assemblies (*fig.* 4) are contained within a machined duralumin casing approximately 7 in. dia., similar to that of the hydraulic motor. An end plate at one end of the casing is spigoted to fit into the oil tank, a seal ring on the spigot preventing any fluid leakage at the joint. The end plate houses one generator rotor shaft bearing, the bearing being retained by a race retaining plate, secured by six screws. The other end of the casing is closed by a flat retaining plate which gives access to a compartment formed by an internal web. The web houses the other ball bearing which supports the rotor shaft, and the compartment contains a centrifugal switch mechanism.

21. Two annular grooves are cut around the periphery of the casing and they are covered by straps which terminate in cooling air inlet and exhaust funnels. Twenty-four holes in each annular groove lead into the generator interior. Air, piped into the inlet funnels, therefore, flows around the inlet annular groove, into the generator and past the stator windings, rotor, and rotor bearing, out to the other annular groove and through the exhaust funnel.

22. The stator assembly consists of two pairs of field windings and one pair of output windings which are laid in position around the four internal poles of a stack of circular laminations. The windings are held in place by rings, to which they are bound, and the assembly is impregnated and baked. The stator assembly is secured in the generator casing between two spacer rings, by a large ring nut which is locked by a grub screw. The fly leads from the field windings are fed through the casing web in air-tight glands and terminate in a 12-pole plug. The output winding fly leads are soldered to the pins of a 4-pole plug.

23. The rotor assembly consists of a stack of varnish bonded 6-pole iron laminations, assembled around the tubular steel rotor shaft. The stack is clamped between balance rings by a ring nut screwed on to the threaded end of the rotor shaft; holes are drilled in the balance rings to achieve perfect rotor balance. The end of the rotor shaft which is adjacent to the oil tank is internally splined to receive the quill shaft that couples the generator rotor to the hydraulic motor output gear. The rotor shaft is supported in two angular-contact ball bearings; the bearing at one end of the shaft is secured in its housing by a retaining plate and is lubricated with fluid from one of the feed pipes in the oil tank. Excess fluid drains through a passage in the oil tank into the gear housing sump and is returned to the tank by the scavenge pump. The other rotor shaft bearing fits in a sleeve that slides in the bore of a bearing housing; this housing is secured, by screws, in the centre of the generator casing web. The inner race of the bearing is secured to the rotor shaft but the outer race is loaded by three compression springs, located in a bearing end cover, which press against a flanged switch carrier in contact with the sliding sleeve. The bearing and springs are lubricated with grease.

24. The centrifugal switch mechanism can be seen in fig. 4, the component parts being emphasized for clarity. Screwed to the threaded end of the rotor shaft is a sleeve which carries three small pivoted L-shaped weights on its outer end; the sleeve also secures the inner race of the ball bearings at this end of the rotor shaft. Within the sleeve is a sliding spring-loaded plunger, and in line with this plunger is a short push-rod, one end of which engages with a small pivoted lever; this lever operates the push-button of a small micro switch. When the rotor is stationary the button is depressed by the action of the plunger and spring. As the rotor turns, centrifugal force causes the balance weights to fly out and press the sliding plunger inwards against the spring pressure; the button is therefore released and causes the switch contacts to change-over. The spring pressure is adjusted by shims to ensure that the switch operates when the rotor speed is 23000 $\pm$ 200 rev/min. The three leads from the micro switch terminate at the 12-pole plug. The centrifugal switch is associated with the starting and protective circuits of the generator control unit.

OPERATION

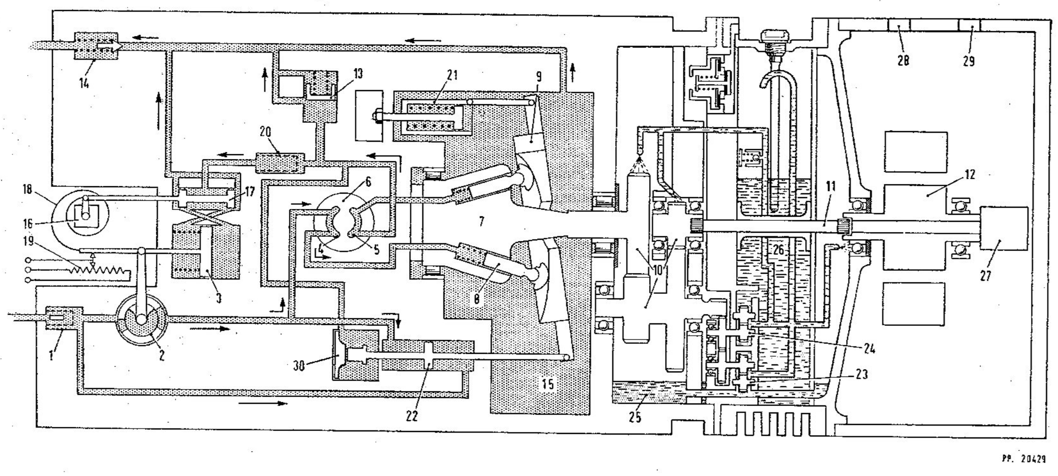
General

25. Operation without cooling air is only permissible for very short periods; for example, the hydraulic fluid will probably reach its maximum permissible temperature of 90 deg. C. in about 1 min from switching on, depending on the amount of fluid in the system. If the fluid only is cooled, the motor-generator can only be operated for about 4·5 min at an ambient temperature of 45 deg. C. or for about 6 min at 22 deg. C. Provision MUST therefore be made for adequate cooling of the fluid, and cooling air for the motor-generator when ground running.

Motor

26. A schematic diagram to show the operation of the hydraulic motor assembly is given in fig. 5. The key beneath the diagram is referred to in the following description by the bracketed figures.

27. Hydraulic fluid at a pressure of between 2650 and 2950 lb/in^2 passes through the inlet filter (1) to the throttle valve (2) which controls the fluid flow to the swash-plate motor. From the throttle, fluid at a pressure of between 1200 and 2400 lb/in^2, depending upon the throttle opening, is fed to the motor. The arc-shaped motor inlet port (4) allows fluid to enter those cylinders of the motor rotor (7) which are aligned, causing the plungers (8) to move outwards and the 'sliding slippers' on the ball-shaped end of the plungers to press against the inclined face of the stationary swash-plate (9). A similar arc-shaped exhaust port (5) is provided so that the plungers are able to expel fluid into



1 INLET FILTER
2 THROTTLE VALVE
3 SERVO PISTON
4 MOTOR INLET PORT
5 MOTOR EXHAUST PORT
6 PORT INSERT
7 MOTOR ROTOR
8 PLUNGER
9 SWASH-PLATE
10 GEARS
11 QUILL SHAFT
12 GENERATOR ROTOR
13 PRESSURE MAINTAINING VALVE
14 NON-RETURN VALVE
15 MOTOR CHAMBER
16 TRANSDUCER
17 SELECTOR VALVE
18 SPRING
19 FEEDBACK POTENTIOMETER
20 SERVO FILTER
21 CONTROL SPRING CYLINDER
22 SWASH-PLATE ACTUATOR
23 SCAVENGE PUMP
24 PRESSURE PUMP
25 OIL SUMP
26 OL TANK
27 CENTRIFUGAL SWITCH
28 COOLING AIR INLET
29 COOLING AIR EXHAUST
30 ADJUSTABLE STOP

Fig. 5. Schematic diagram of motor-generator

the hydraulic system return line. The rotor therefore revolves and attains a normal rotational speed of 3740 rev/min.

28. A step-up ratio of approximately 1:6·41 is obtained by a two-stage gear train (10) to give the generator rotor a speed of 24000 rev/min. The ratio is chosen so that no harmonic difficulties will be introduced by the number of teeth on the gears. The gears are lubricated from two small jets, the fluid being obtained from the self-contained oil tank (26) through the pressure pump (24) and returned by the scavenge pump (23).

29. The fluid expelled through the motor exhaust port flows to the outlet union via the pressure maintaining valve (13). This valve ensures that fluid pressure for the servo system is always available during operation by maintaining a pressure difference of approximately 50 lb/in² between the motor exhaust and the motor return line. The non-return valve (14) in the outlet union, opens when the pressure in the motor return line is approximately 10 lb/in² above that of the system's main return line, thus preventing the gear housing from being flooded with fluid when the motor is stationary. A considerable amount of fluid flows through the rotor cylinders and the lubricating channels to lubricate the plungers, swash-plate 'slippers', rotor bearings, etc., and consequently the motor chamber (15) is always full of fluid. The fluid pressure in this chamber, which is directly connected to the outlet union, is controlled at approximately 10 lb/in² above the pressure in the system's main return line by the non-return valve.

30. There are a number of subsidiary hydraulic circuits within the motor assembly, one of which is the servo-assisted throttle system. The electro-magnetic transducer (16) is not sufficiently powerful to operate the throttle directly; the transducer, therefore, operates a selector valve (17) which admits fluid, tapped from the motor return line, to one side or the other of the servo-piston (3) to which the throttle operating lever is attached. Movement of the transducer armature thus causes the servo piston to open or close the throttle. A torsion spring couples the transducer armature and the throttle so that movement of the throttle in either direction produces a reverse torque on the armature, thus providing a mechanical feedback link. The armature tends to return to its central position, until the armature torque balances the spring torque; the throttle is then held at the required setting by the selector valve. (In a perfect system, the selector valve ports would be fully closed at this condition). To prevent instability due to the delays inherent in a system of this sort, the throttle also operates the wiper of a feedback potentiometer (19) which is connected in a feedback circuit in the control unit.

31. If the throttle opening is small, considerable energy loss, with consequent heating, takes place across the throttle; to avoid this and to maintain a throttle opening as near optimum as possible (approximately half open), the angular setting of the swash-plate is automatically varied. Fluid, tapped from the inlet side of the throttle, is fed to one side of the swash-plate actuator piston, while the other side of the piston is fed with fluid tapped from the throttle outlet. If the pressure difference across the throttle is high, e.g. the throttle is closed to decrease the motor speed, the actuator piston moves to reduce the swash-plate angle; this reduces the mechanical advantage of the motor which will therefore lose speed and enable the throttle opening to be increased. When the motor starts, the throttle is wide open, and the swash-plate control spring housed within the control spring cylinder (21) sets the swash-plate angle at its maximum deflection, thus allowing the normal running speed to be rapidly obtained.

Generator

32. The generator is of the polar inductor type and has a 6-pole rotor revolving within a 4-pole stator assembly which carries the field and output windings. This type of generator has the advantage of having no rotor windings and therefore no slip-rings or commutator. The generator has a high internal impedance, however, which is overcome in the manner described in para. 35.

33. A simplified diagram of the windings, showing the relationship between the stator and rotor poles, is given in fig. 6, from which it can be seen that the magnetic flux due to the field windings also passes through the outlet windings. The three subsidiary sketches (b), (c) and (d) of fig. 6, show the direction of the magnetic lines of force as the rotor revolves, and it is apparent that the flux linkage between the field and output windings is reversed every 30 deg. rotation of the rotor, six complete cycles occurring every revolution. The output frequency of 2400 c/s is obtained when the rotor speed is 24000 rev/min.

34. The field windings comprise two parts, the inner field coil and the outer field coil. These coils are normally energized by the output of the voltage control chassis of the control unit, the input power of which is obtained from the generator output. During operation, the field current is varied as necessary to maintain the desired output voltage, the field current being increased if a greater load causes a drop in output voltage, and vice-versa. For starting purposes, however, the residual magnetism in the stator poles is insufficient to produce an output; a part of the field windings is then energized by the 28V, d.c. aircraft supply until the generator output is sufficient to operate a relay in the control unit. The relay contacts connect both parts of the field in series across the control unit output. For clarity, in fig. 6, the two parts of the field are shown surrounding separate poles of the stator, whereas in practice each part consists of two windings in series, one for each pair of poles. The output windings consist of two coils connected in series as shown in fig. 6.

35. The internal impedance of the generator output windings, being relatively high, necessitates the inclusion of a capacitor in series with the load in the manner customary with inductor generators. The value of the capacitor is chosen to resonate with the generator windings at approximately the output frequency of 2400 c/s, because a series resonant circuit has a low impedance at the resonant frequency. At frequencies

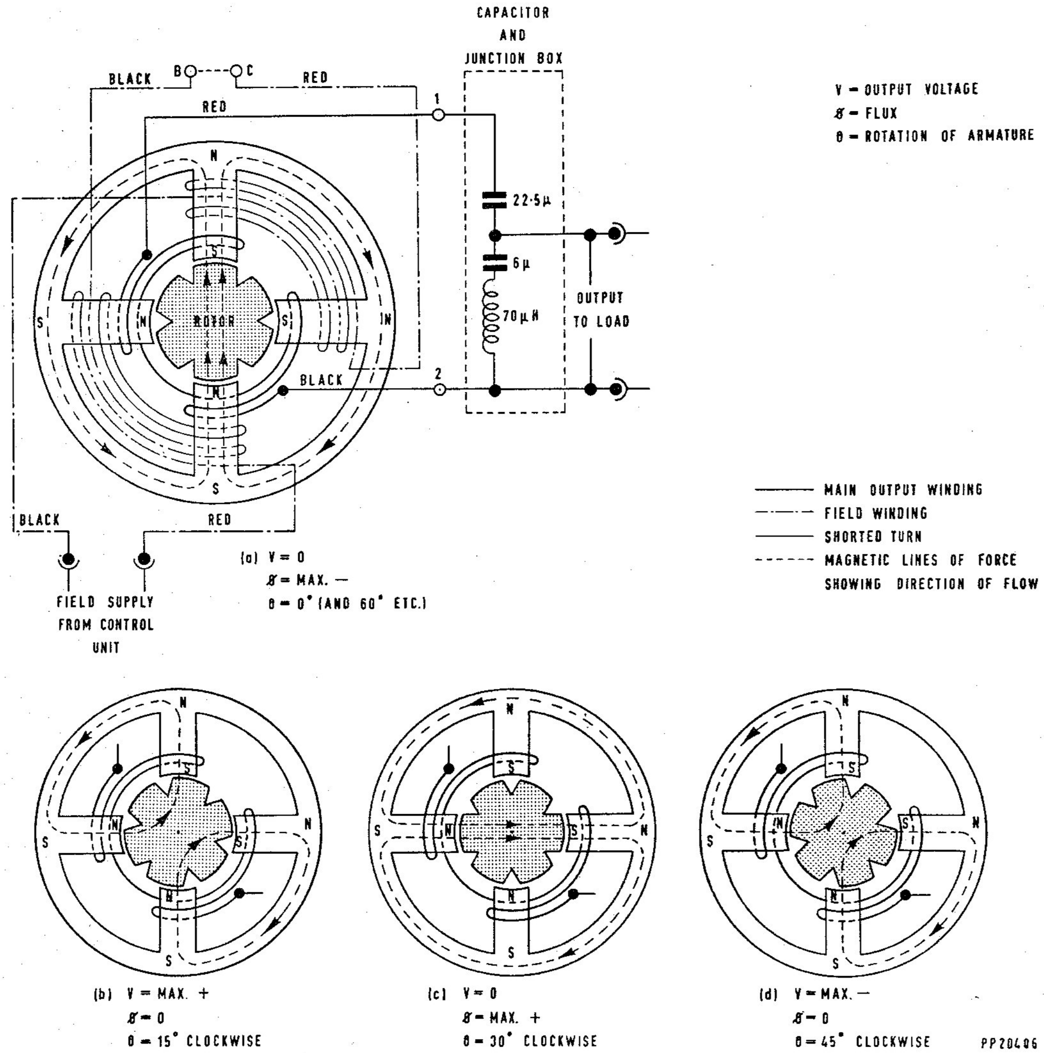


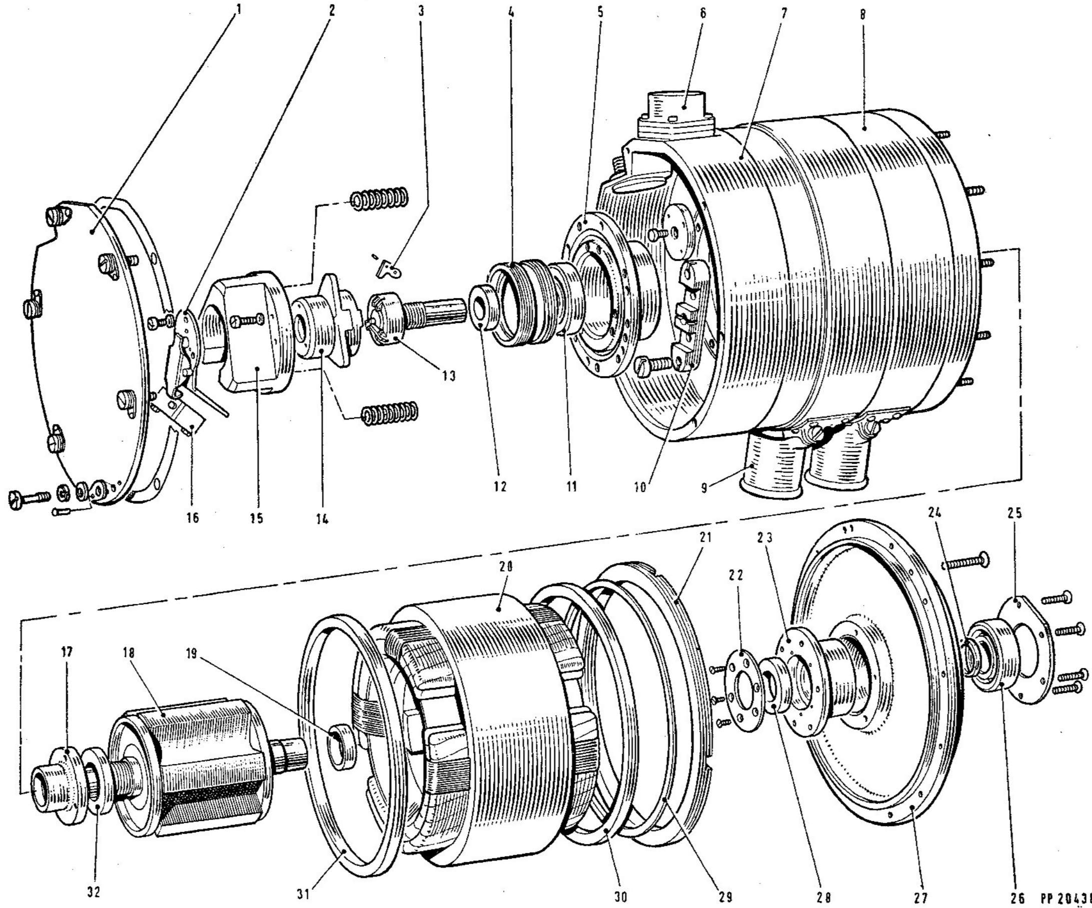
Fig. 6. Schematic diagram of generator

other than the resonant frequency, however, the impedance of this resonant circuit increases, with the result that when non-linear loads are supplied, the harmonic content of the output waveform is increased. A series resonant filter circuit consisting of a capacitor and an inductor is therefore connected across the generator output, as shown in fig. 6, the combination of this filter circuit and the generator presenting a low impedance to the harmonic components of the load current, thus reducing the voltage waveform distortion.

36. When operating, the generator creates considerable heat which must be dissipated to keep the temperature down to an acceptable level. To accomplish this, cooling air is fed through the generator casing, from either a cold air unit or by ram effect from a scoop in the aircraft's fuselage. In the latter instance, ground running is restricted unless an external air supply is available. A single-pole change-over micro switch is operated centrifugally when the generator rotor speed reaches approximately 23000 rev/min. This switch is connected in the protective circuit incorporated in the control unit.

Installation

37. The motor-generator must be positioned so that the marking TOP is always on top



1	COVER PLATE	**17**	ROTOR STACK NUT
2	SWITCH MOUNTING BRACKET	**18**	ROTOR ASSEMBLY
3	BOB WEIGHT	**19**	SPACER
4	BEARING SLEEVE	**20**	STATOR COIL ASSEMBLY
5	REAR BEARING HOUSING	**21**	RING NUT
6	4-POLE PLUG	**22**	LIP SEAL RETAINING PLATE
7	GENERATOR HOUSING	**23**	FRONT BEARING HOUSING
8	COOLING STRAP	**24**	SPACER
9	COOLING FUNNEL	**25**	BEARING RETAINING PLATE
10	TERMINAL BLOCK	**26**	BEARING
11	BEARING	**27**	END PLATE
12	SPACER	**28**	LIP SEAL
13	CARRIER AND STRIKER ASSEMBLY	**29**	STATOR WASHER
14	SWITCH CARRIER	**30**	SPACER
15	SPRING RETAINER	**31**	SPACER
16	MICRO SWITCH	**32**	SPACER

Fig. 7. Exploded view of generator

relative to the aircraft. Sufficient space must always be left around the machine for connecting electrical cables, cooling pipes and oil pipes.

SERVICING

General

38. The motor-generator, type B503-4, should be serviced in accordance with the relevant servicing schedule and the instructions contained in this chapter.

Routine servicing

39. Routine servicing on motor-generators installed in aircraft includes the following security checks:

(1) Examine all securing nuts and bolts for tightness and ensure that the motor-generator is securely attached to its pedestal.

(2) Check the hydraulic connections, the electrical connections and the cooling air attachments for security.

(3) Examine the hydraulic motor housing and oil tank for fluid leakage.

Bay servicing

40. The following servicing can only be accomplished with the motor-generator removed from the aircraft. The oil tank and the hydraulic motor housing should be drained of fluid and the motor-generator placed on a bench mounted pedestal provided with a drip tray.

Cleaning inlet filter unit

41. Clean the inlet filter unit as follows:

(1) Cut the locking wire and remove the nuts that secure the inlet filter unit to the hydraulic motor housing.

(2) Raise the end of the motor-generator so that the inlet filter unit can be withdrawn in a downward direction, thus preventing residue from passing into the motor housing through the filter output port.

(3) Detach the gauze filter from the unit and wash the gauze with carbon tetrachloride, (C.T.C.), or trichlorethylene; dry the gauze with a clean dry air blast.

(4) Carefully remove any deposits from the circlips of the magnet holder, wash the magnet holder, with C.T.C. or trichlorethylene and dry it with a clean dry air blast.

(5) Assemble the gauze filter to the unit.

(6) Examine the inlet filter unit 'O' seal for deterioration and fit a new seal if necessary.

(7) Assemble the inlet filter unit to the hydraulic motor housing and secure it with the retaining nuts. Lock the nuts with 22 s.w.g. wire.

Cleaning servo filter

42. Clean the servo filter as follows:

(1) Cut the locking wire, unscrew the nuts that retain the servo filter and cap and remove the end cap.

(2) Rotate the motor-generator so that the servo filter is at the bottom and withdraw the filter in a downward direction.

(3) Wash the filter thoroughly with C.T.C. or trichlorethylene and dry it with a clean, dry air blast.

(4) Replace the filter, wide end first, in the motor housing.

(5) Examine the end cap 'O' seal for deterioration and fit a new seal if necessary.

(6) Locate the end cap to the motor housing and secure it with the nuts. Lock the nuts with 22 s.w.g. wire.

Renewal of 'O' seals

43. If there are signs of fluid leaks from the oilway or pressure test cover plates, remove the cover plate concerned, examine the 'O' seal and fit a new 'O' seal if necessary. Replace the cover plate, tighten the retaining nuts and lock them with 22 s.w.g. wire. If fluid has leaked at the oil tank-generator joint or the oil tank-gear housing joint, the motor-generator must be separated and the offending 'O' seal renewed.

Dismantling and renewal of components

44. *Motor-generator*—Separate the motor-generator as follows:

(1) Cut the locking wire and remove the nuts that secure the generator, oil tank and hydraulic motor.

(2) Carefully separate the generator from the oil tank, keeping the assemblies in line until the quill shaft is free at one end. Remove the oil tank.

(3) Withdraw the quill shaft and inspect the splines for damage; if the quill shaft is serviceable, discard its 'O' seal and place the shaft in a dust-proof bag until required.

(4) Place the hydraulic motor in a dust-proof bag until required.

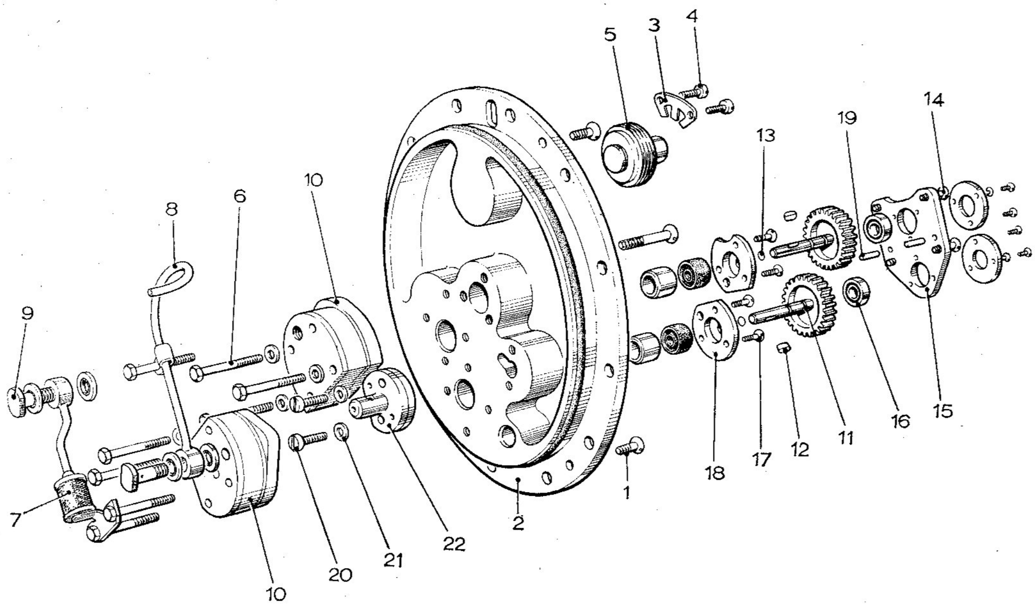


Fig. 7A. End plate components

Note . . .

When a motor and hydraulic control unit (5UB/6838), supplied as a spare, is to be assembled to an existing oil tank and generator it is essential to the correct alignment of the oil pump drive gears, that the oil tank end plate supplied with the new unit is used and the existing end plate discarded. To transfer the oil pumps assembly, relief valve and breather valve to the new end plate refer to fig. 7a and proceed as follows:

(5) Remove the six countersunk screws (1) which secure the end plate (2) to the oil tank main housing. *Note that the three screws grouped at the centre are longer than the three outer screws.*

(6) Withdraw the end plate and O seal from the oil tank.

(7) Remove the locking plate (3) and two screws (4) which retain the breather valve(5). Unscrew and remove the breather valve.

(8) Cut the locking wire and remove the four bolts (6) which secure each pump to the end plate. Note that two of these bolts also secure the oil filter ((7) *not fitted prior to modification No. Elec. A*.434) and one of them secures an oil pipe (8) by means of a P clip. Remove the banjo bolts (9) securing the oil pipes to the pumps. Remove the oil pipes and filter.

(9) Remove each pump cover, body, gears and sandwich piece as a unit (10), leaving the drive shafts (11), each with a key (12), exposed. Remove the keys and remove the shims (13) which control the end float of the drive shafts. Put the key and shims from each pump into a separate bag, marked with the identity of the pump to ensure correct re-assembly.

(10) Turn the end plate over and remove the four countersunk screws (14) which secure the gear support plate (15).

(11) Lift off the gear support plate complete with bearings, (16) pump drive gears and shafts (11).

(12) Remove the three countersunk screws (17) from each seal cover (18) and remove the seal covers.

(13) Remove the two dowels (19) which locate each pump on the end plate.

(14) Put the parts associated with each pump into the bags referred to in (9).

(15) Remove the two cheese-headed screws (20) and washers (21) which retain the relief valve assembly (22) and remove the relief valve assembly.

(16) Discard all seals and gaskets.

(17) Assemble all the parts to the new end plate, fitting new gaskets and seals. Apply Hermetite compound 1310 medium grade (D.T.D.900/4134) between the pump sandwich plates and the end plate. If the pump cover plates, bodies and sandwich plates have become separated, clean off all old jointing compound and apply fresh Hermetite compound 1310 to each joint.

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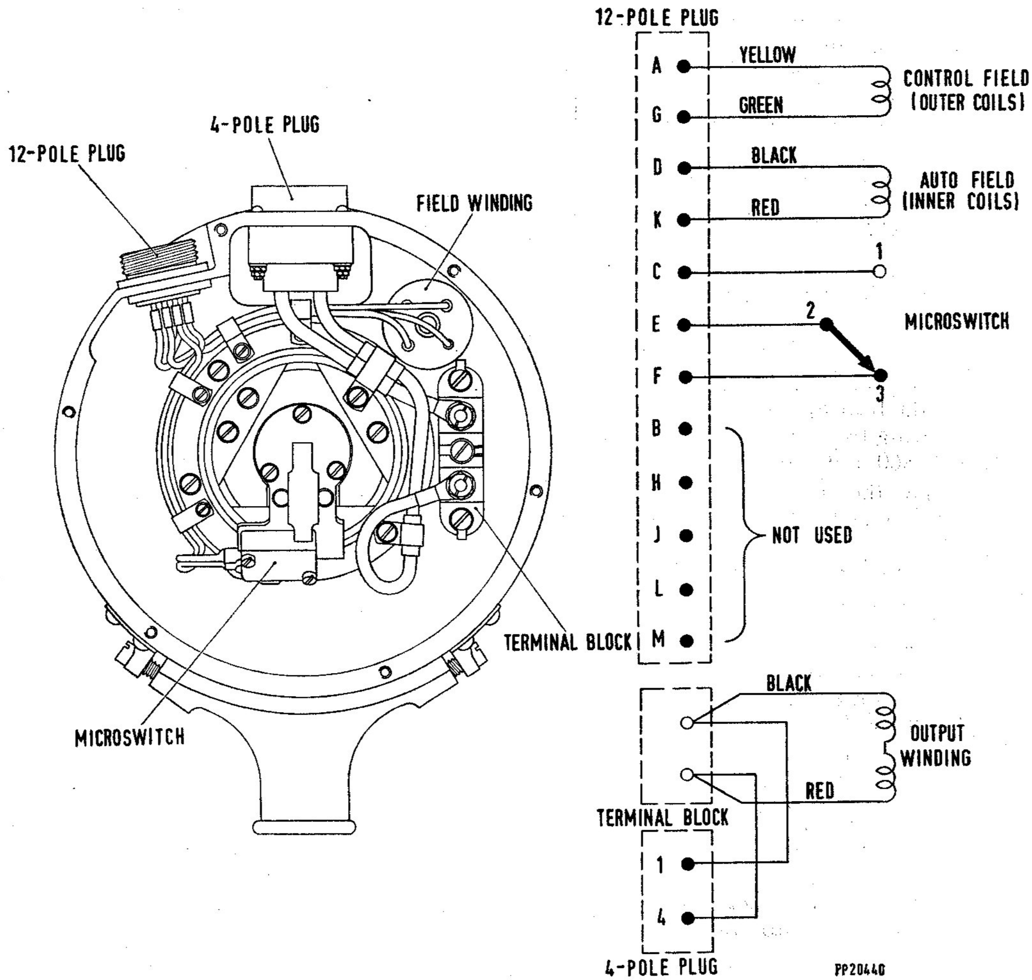


Fig. 8. Schematic diagram of terminal chamber

45. *Generator* (*fig.* 7)—The generator should be dismantled in accordance with the following instructions so that the rotor bearings, lip seal and stator coil assembly may be renewed.

46. *Removal of rotor assembly*—Remove the rotor assembly as follows:—

(1) Cut the locking wire and unscrew the captive screws of the cover plate (1), remove the cover plate and discard the gasket.

(2) Unscrew the three 6BA screws that secure the micro switch mounting bracket (2) to the switch carrier (14) remove the mounting bracket and tape it to the generator housing.

(3) Cut the locking wire and remove the six 4BA screws that secure the rear bearing housing (5) to the inner web of the generator housing.

(4) Unscrew the six 4BA screws that secure the bearing retaining plate (25) and the front bearing housing (23) to the end plate (27).

(5) Screw three long 2BA screws into the extraction holes provided in the rear bearing housing, tighten the screws evenly and withdraw the rotor assembly complete with front and rear bearing housings.

47. *Removal of rotor rear end bearing*—Remove the rear motor bearing as follows:—

(1) Cut the locking wire and remove the six 4BA screws and washers that secure the spring retainer (15) to the rear bearing housing, remove the spring retainer, springs and the switch carrier.

(2) Remove the grub screw from the carrier and striker assembly (13) and, using special tools K4492 and K4495, unscrew and remove the carrier and striker assembly.

(3) Remove the spacer (12) from the rotor shaft.

(4) Withdraw the rear bearing housing and bearing from the rotor shaft using special tool K4465.

(5) Push the bearing, in its sliding sleeve (4), out of the bearing housing and withdraw the bearing from the sleeve using special tool K5860 and a press.

(6) Examine the bearing for reason of failure (e.g. lack of lubrication or normal wear).

48. *Removal of rotor front end bearing*—Remove the front rotor bearing as follows:—

(1) Using special tool K4465, remove the front bearing housing and bearing from the rotor shaft.

(2) Push the bearing (26) out of the housing.

(3) Examine the bearing for reason of failure (e.g. lack of lubrication or normal wear).

49. *Removal of stator coil.*—Remove the stator coil assembly as follows:—

(1) Remove the inlet cooling air funnel attachment.

(2) Unscrew and remove the 6BA grub screw that locks the stator ring nut (21), (located in the cooling air inlet channel and in line with the 4-pole plug (6)).

(3) Identify the stator field connections at the 12-pole plug and unsolder them, remove the cable cleats and undo the cableform binding cord.

(4) Remove the output winding leads from the terminal block (10) and unsolder the lugs from the leads.

(5) Unscrew the 4BA screw that secures the 4-way cable clamp and the 4BA screw that secures the 2-way cable clamp, prise the small ring seals from their seatings so that the stator leads are free. Identify the leads.

(6) Unscrew and remove the ring nut (21) using special tool K3523, remove the stator washer (29) and spacer (30).

(7) Carefully withdraw the stator coil assembly (20) and spacer (31) from the generator housing.

Assembly

50. *Stator coil assembly.*—Fit the stator coil assembly to the generator housing as follows:—

(1) Locate the spacer (31) in the generator housing.

(2) Pass the leads through the appropriate holes in the web of the generator housing and insert the stator coil assembly into the generator housing.

(3) Place the spacer (30) against the stator coil assembly and locate the stator washer (29).

(4) Fit and tighten the ring nut, ensuring that the stator coil assembly does not turn and thus break or strain the leads.

(5) Pull the leads through the web of the generator housing and slide new ring seals on the leads.

(6) Fit the cable clamps to secure the leads and retain them with the 4BA screws. Lock the screws with varnish (V130/1).

(7) Solder the lugs to the output winding leads and solder the field connection leads to the 12-pole plug; connect the output winding leads to the terminal block.

(8) Fit and tighten the grub screw and lock it with varnish (V130/1).

(9) Fit the inlet cooling air funnel attachment.

51. If the hole in the ring nut is not in line with the tapped hole in the generator housing, drill and tap a new hole (0·35 in. deep, total) in the ring nut using the tapped hole in the generator housing to spot the position. If the thread in the tapped hole of the generator housing is damaged, drill and tap a new hole in the housing and ring nut. This must be set at an angle of 60 deg. to the rotor axis so as to engage properly with the ring nut; the hole must not be in the region of the spanner slots in the ring nut, or too near the air holes or stud holes in the generator housing.

52. *Front bearing.*—Fit the front bearing as follows:—

(1) Ensure that the oilways of the front bearing housing and the end plate are clear.

(2) Wash the packing grease from the bearing.

(3) Lubricate the bearing lightly with grease, XG-275.

(4) Locate the spacer (24) in the front bearing housing, press the bearing into the housing with the pressure side of the bearing away from the rotor. The spacer must be free to move with the bearing pressed fully home.

(5) Lubricate a new lip seal with grease, XG-275, and locate it in the front bearing housing with the lip of the seal facing the front end of the generator, fit the seal retaining plate, secure the plate with the six 6 B.A. screws and lock the securing screws by peening.

(6) Lubricate the rotor shaft with hydraulic oil, OM-15 (D.T.D.585), and press the front bearing housing squarely on to the shaft.

(7) Wipe away any surplus grease from the exterior of the bearing housing.

53. *Rear bearing.*—Fit the rear bearing as follows:—

(1) Wash the packing grease from the bearing.

(2) Charge the bearing with approximately 1·5 c.c. grease, XG-275, distributed evenly between inner and outer races.

(3) Apply about 2 c.c. grease, XG-275, to the periphery of the inner end of the bearing housing.

(4) Press the bearing into the sliding sleeve and lubricate the exterior of the sleeve with grease XG-275. Locate the sleeve in the bearing housing ensuring that the pressure side of the bearing is away from the rotor laminations.

(5) Lubricate the rotor shaft with hydraulic oil, OM-15 (D.T.D.585), and press the bearing and housing on to the rotor shaft.

(6) Fit the spacer (12) to the rotor shaft and screw the carrier and striker assembly into the rotor shaft.

(7) Secure the carrier and striker assembly with its grub screw, ensuring that the grub screw engages one of the serrations at the end of the rotor shaft. Lock the grub screw with varnish.

(8) Locate the switch carrier to the rotor shaft.

(9) Charge the three pockets of the spring retainer with grease, XG-275, and insert the springs. Apply grease to the exterior of the switch carrier so as to charge the space between the carrier and the bearing housing when assembled.

(10) Assemble the spring retainer and switch carrier to the front bearing housing ensuring that the lugs of the switch carrier press against the bearing outer race through the gaps in the inner ridge of the sliding sleeve, fit the six 4BA retaining screws.

54. *Rotor to generator housing.*—Fit the rotor to the generator housing as follows:—

(1) Carefully insert the rotor into the generator housing (from the terminal compartment end), and secure the rear bearing housing to the web of the generator housing with the six 4BA screws. Wire-lock the bearing housing screws and the spring retainer screws together.

◄ (2) Check the adjustment of the micro switch (fig. 8A). Locate the switch ► mounting bracket on the switch carrier and secure it with the three 6BA screws; lock the screws.

(3) Locate the end plate over the generator studs, ensuring that the lubricating cut-away (and oil holes) is uppermost. Rotate the end plate until the tapped holes of the front bearing housing are in line with the corresponding holes of the end plate, and temporarily locate the housing.

(4) Fit and tighten the two 2BA screws that secure the end plate to the generator housing.

(5) Locate the front bearing retaining plate with its straight edge aligned with the oil

feed cut-away on the end plate and secure it to the end plate and bearing housing with the six 4BA screws.

(6) Peen the metal of the bearing retaining plate into the screw slots to lock them.

(7) Insert a quill shaft into the rotor shaft and check that the generator can be spun easily, that no fouling occurs, and that there is no play in the bearings.

55. *Motor to generator.*— Assemble the motor to the generator as follows:—

(1) Fit a new 'O' seal to the groove of the generator end plate.

(2) Fit a new 'O' seal to the quill shaft and insert the shaft into the generator.

(3) Fit a new 'O' seal to the groove in the oil tank diaphragm assembly, locate the

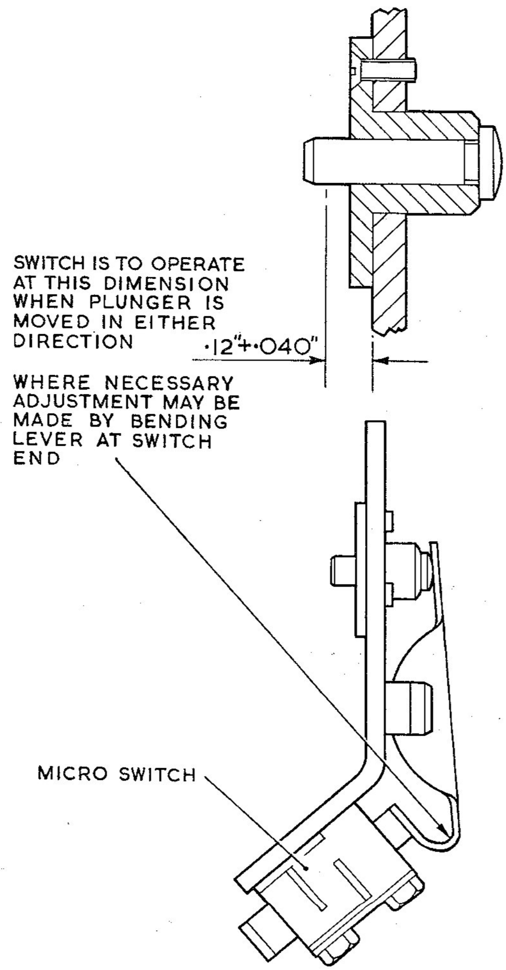


Fig. 8A. Micro switch mounting bracket assembly

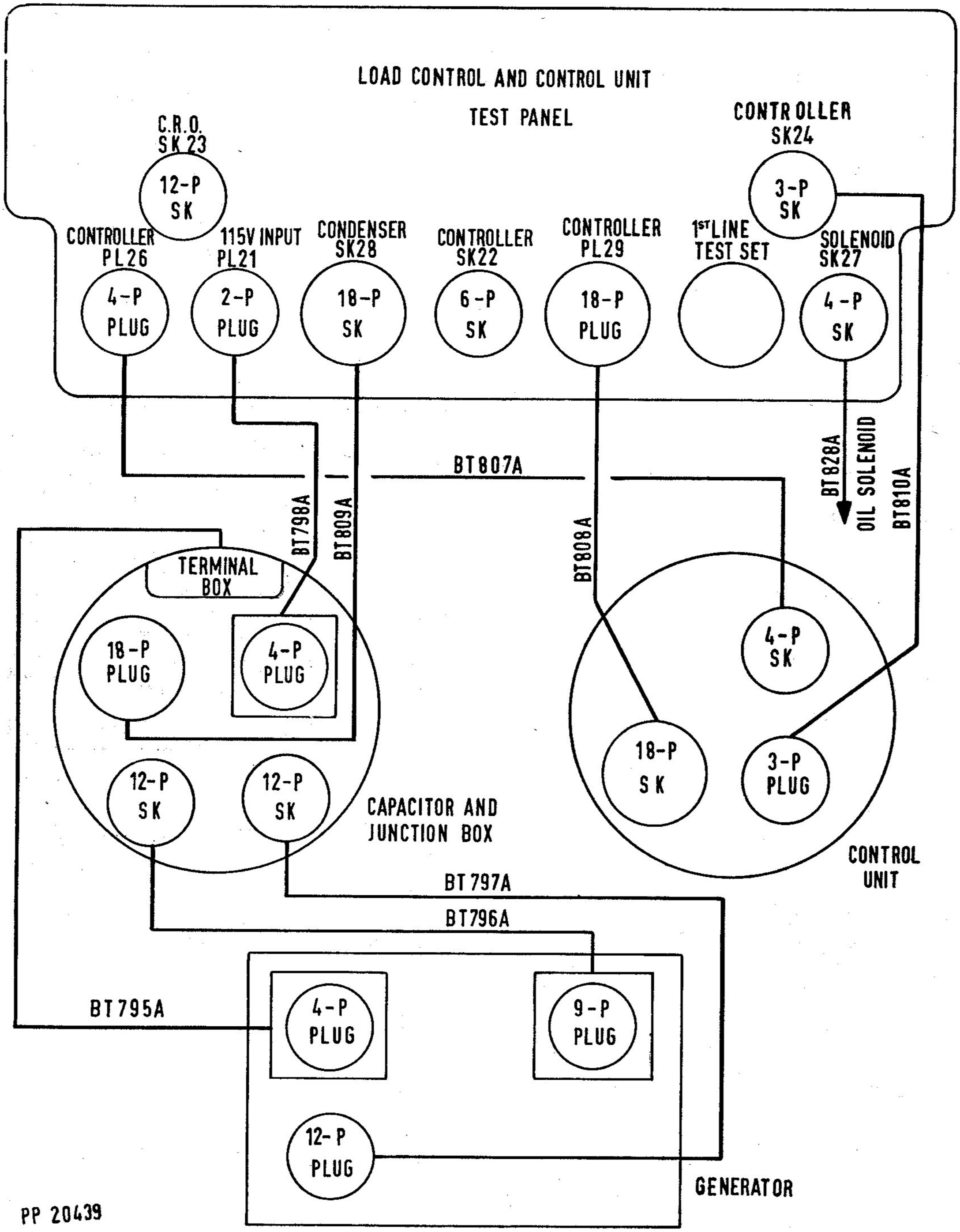
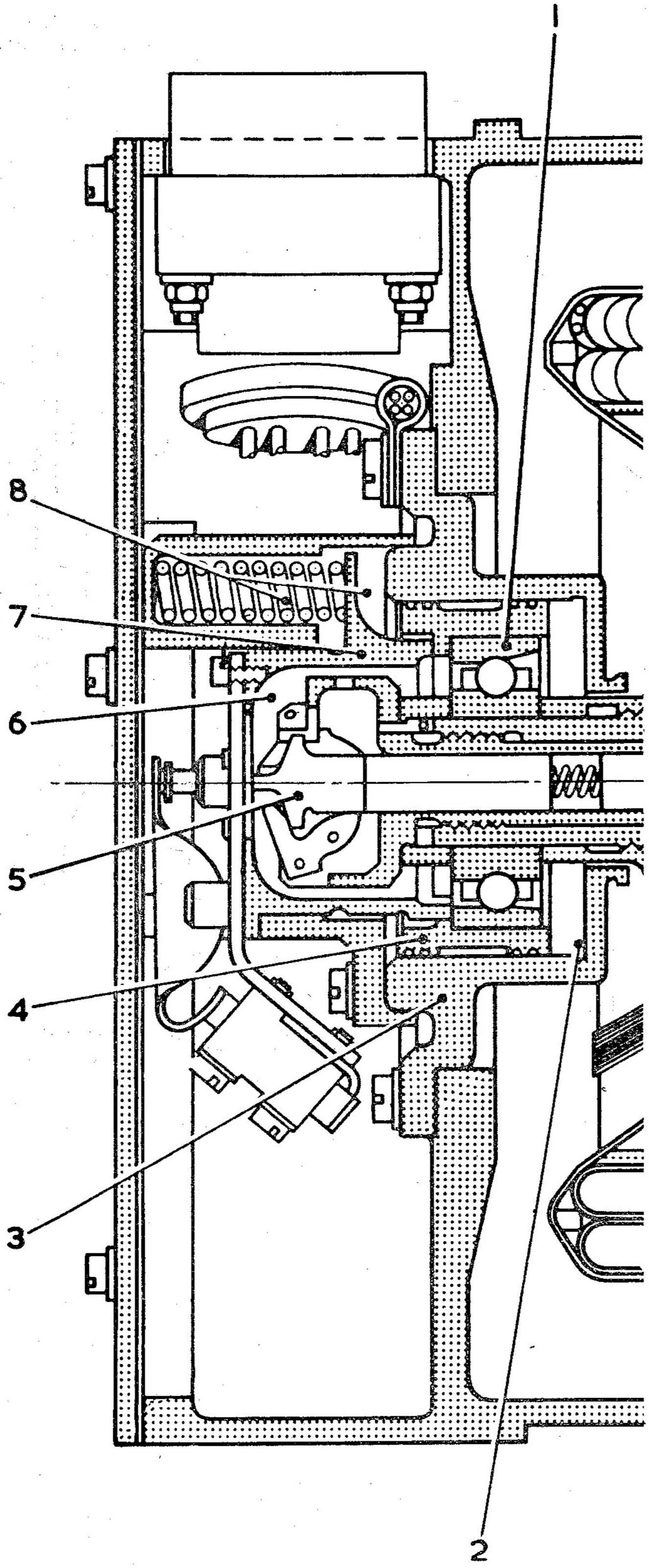


Fig. 9. Connections between generator and test panel, Type BT.950



1 CHARGE THE BEARING WITH APPROXIMATELY 1·5 c.c. GREASE XG–275, DISTRIBUTED EVENLY BETWEEN INNER AND OUTER RACES

2 APPLY ABOUT 2 c.c. GREASE XG–275, TO THE PERIPHERY OF THE INNER END OF THE REAR BEARING HOUSING

3, 4 and 7 GREASE THE MATING SURFACES OF THESE ITEMS AND CHECK THEM FOR EASY SLIDING

5 GREASE LIGHTLY THE SPHERICAL TIP OF THIS ITEM

6 ON INITIAL ASSEMBLY, ENSURE THAT THIS SPACE IS FREE FROM EXCESSIVE GREASE

8 CHARGE THE SPRING POCKETS AND THE SPACE AROUND THE SWITCH CARRIER WITH GREASE, XG–275.

Fig. 10. Grease lubrication of rear bearing assembly

oil tank over the generator studs and carefully locate the spigot of the end plate to the oil tank.

(4) Align the hydraulic motor with the generator and locate the hydraulic motor to the generator.

(5) Fit and tighten the twelve 2BA nuts and washers and lock them with locking wire.

TESTING

General

56. The information contained in para. 56 to para. 97 applies to the testing of the B503–4 generating system, i.e. a.c. generator and its associated control unit and junction box when removed from the aircraft installations they supply. The tests are designed to simulate the service conditions in which the generating system operates.

57. Information relating to the following characteristics of the generating system is obtained during testing:—

(1) Any output frequency deviation from the nominal of 2·4 kc/s.

(2) Any output voltage deviation from the nominal of ◀115▶V R.M.S.

(3) The configuration of the sinusoidal output waveform.

(4) The percentage of harmonic distortion present in the waveform in (3).

(5) The behaviour of the generating system during load changes: i.e. the response of the control unit to frequency changes caused by load transients.

(6) The behaviour of the generating system in varying combinations of inlet pressures, outlet back pressures and loads.

(7) Changes in the magnitude of the generator transducer currents as represented by the control unit magnetic amplifier outputs.

(8) Changes in the magnitude of the generator field currents.

(9) The ability of the control unit to govern the generator output frequency within a specified time after the generator has been 'crash started'.

(10) The magnitude of output currents drawn when the generating system is under load.

58. Should it become apparent during testing that the generator is not being controlled satisfactorily and within the specified time, voltage or frequency limits, the control unit should be tested in accordance with the instructions detailed in A.P.4343B, Vol. 1, Book 2, Sect. 8, Chap. 6.

Hydraulic supplies

59. The B503–4 a.c. generating system is supplied with hydraulic fluid under the required pressures by the H.M.L. Hydraulic Test Bench Ref. No. 4G/6087. Information on this installation is given in A.P.4743. It is essential that all operators who are responsible for testing the B503–4 a.c. generating system should be conversant with the operating instructions relating to this installation in order that subsequent references in the testing procedures to (for example) inlet pressures, back pressures, flow rates and starting and stopping methods may be understood readily.

Starting and stopping generators under test

60. There are two methods of starting and stopping the a.c. generator under tests:—

(1) By means of manual operation of the hydraulic bench inlet control valve.

(2) By means of electrical operation of a solenoid valve on the test bench.

61. The first method is employed when running up the generator initially in order to maintain close control over the generating system being tested: this method is also used when detailed observations of performance under varying conditions are being made. The second method, known as 'crash starting' is used when service conditions are being simulated. In operational practice all starting of a.c. generators is made in 'crash start' conditions. Details of starting procedures are given in para. 79.

Working temperatures

62. The hydraulic fluid supplies must be maintained at a temperature of 70° ± 5° C. When under test the a.c. generator must be cooled by means of dry air supplied at 18 cu. ft./min (approx.).

Test equipment required

63. The following items of test equipment and/or supplies are required when testing B503–4 a.c. generators:—

(1) Test panel type B.T.950, Ref. No. 5G/3187.

(2) H.M.L. Hydraulic Test Bench, Ref. No. 4G/6087.

(3) Capacitor and junction box, Ref. No. 5UC/6114.

(4) Control unit, Ref. No. 5UB/6113.

(5) Flexible hose for hydraulic connections.

(6) Cathode ray oscilloscope, type No. C.T.414, Ref. No. 10S/9431632.

(7) A.C. voltmeter 0–150V, Ref. No. 5QP/25256.

(8) A.C. mains supply at 50–60 c/s 110–250V.

(9) Dry air cooling supply at 18 cu.ft./min (approx.).

(10) Water cooling supply for the hydraulic bench at 10 gal/min (approx.).

(11) Stop watch.

(12) Load unit (air cooled).

Test preparations

64. The following preparations are necessary before the commencement of testing: the order in which the preparations are made is decided by the relevant servicing schedule.

Hydraulic test bench

65. (1) Mount the generator in position on the test bench, securing it with the clamps provided.

(2) Connect the hydraulic high pressure inlet (generator three stud flange) to BENCH MANIFOLD NO. 2.

(3) Connect the hydraulic low pressure outlet (generator two stud flange) to RETURN MANIFOLD.

(4) Connect the motor pressure gauge connection to EXTERNAL PRESSURE TAPPING POINT NO. 1.

(5) Connect the servo pressure tapping to EXTERNAL PRESSURE TAPPING POINT NO. 4.

(6) Connect the dry air supply to the cooling air inlet adapter on the generator.

(7) Connect the necessary electrical power supplies to the test bench.

(8) Connect the cooling water supplies to the oil cooler.

(9) Set the BENCH MANIFOLD SELECTOR in the neutral (central) position.

(10) Set fully open (counter-clockwise).

(a) INCHING CONTROL VALVE.

(b) No. 2 MANIFOLD NEEDLE VALVE ('crash start' solenoid).

(11) Press the START button.

(12) Set the BY-PASS VALVE to LOAD.

(13) Adjust the H.M.L. ELECTRAULIC FLOW VALVE to the required flow (para. 88) as indicated on the ELECTRAULIC FLOW METER.

(14) Set the PRESSURE REGULATOR to 2650 lb/in^2.

(15) Set the BENCH MANIFOLD SELECTOR to the No. 2 position.

Test panel B.T.950

66. (1) Mount the control unit and the capacitor and junction box on the test panel, using the two pairs of band clamps provided.

(2) Make all electrical cable connections as shown in fig. 9.

(3) Perform the setting up instructions contained in A.P.4343S, Vol. 1, Book 2, Sect. 9, Chap. 6.

(4) Switch ON ALTERNATOR START switch.

(5) Check that current and voltage readings appear on Meters C and D respectively, thus proving that the generator automatic field circuit is complete.

(6) Switch OFF ALTERNATOR START switch.

(7) Set the OSCILLATOR RANGE switch to 2100–2700 c/s.

(8) Set ALTERNATOR LOAD to 1000W ON DIRECT.

Testing procedure

Preliminary run-up test

67. This test is performed in order that information of a general nature may be obtained of the generating system as a whole and to establish its suitability for prolonged testing under varying conditions.

68. Run up the a.c. generator as follows:—

(1) Set ALTERNATOR START to ON.

(2) Ensure that no hydraulic back pressure is possible in the motor outlet line.

(3) Start the generator by turning the INCHING CONTROL VALVE in a clockwise direction steadily.

(4) Adjust the PRESSURE REGULATOR to a pressure of 2650 lb/in^2.

69. The generator run up should be controlled in such a manner that the required inlet pressures are achieved in approximately 60 seconds: after 90 seconds the protective circuits in the control unit would operate and cause the bench oil solenoid to close, thus shutting down the generator.

70. During the run up period, observe the following meter indications:—

(1) The reading on METER-C should increase slowly, indicating that generator field current is being drawn.

(2) The reading on METER-A should increase first indicating that transducer current is present: i.e. that the generator throttle is opening.

(3) The reading on METER-B should follow that on METER-A, indicating that the opposing transducer current is present, i.e. that the throttle position is being controlled.

71. After the generating system has obtained a steady state it is necessary to check the output frequency by obtaining a stationary 1 to 1 Lissajous figure on the C.R.T. The figure is obtained by adjusting the outer scale of the OSCILLATOR FREQUENCY control. Any frequency deviation from the nominal of 2·4 kc/s is read as follows:—

(1) By the reading shown on the OSCILLATOR FREQUENCY control outer scale.

(2) By the percentage reading on the FREQUENCY DEVIATION meter.

In no circumstances should the generator be allowed to continue running if the frequency deviation is more than $\pm$ 150 c/s or $\pm$ 6% (approx.).

72. Make the following additional observations:—

(1) Check that the voltmeter is monitoring output voltage.

(2) Check that, at this stage, the HARMONIC DISTORTION meter does not register more than 10%: a quantity in excess of this percentage would indicate that a fault exists in the series resonant circuit, located in the capacitor and junction box.

73. Before proceeding with the generator output tests (Table 1) return the OSCILLATOR RANGE switch to 2330–2470 c/s and set the FREQUENCY DEVIATION RANGE switch to $\pm$ 2%.

A.C. generator output tests

74. The output characteristics of the generator should be measured in terms of the details given in Table 2 while the generator functions in terms of the tests given in Table 1. Each test required that a separate run up be performed in the conditions specified: back pressures should not be applied until the generator has run up.

75. In connection with Table 1 it should be noted that evaluation of the 350W load may be obtained in the following manner:—

(1) Set ALTERNATOR LOAD to 250W ON DIRECT.

(2) Set SELECTOR-A to 2·4 kc/s LOAD (RANGE x100).

(3) Set RANGE-A MILLIAMPS to 300.

(4) Adjust the FINE LOAD CONTROL VARIAC to obtain a current reading on METER-A commensurate with a load of 350W.

TABLE 1
Output test conditions

Test	Inlet pressure lb/in^2	Outlet back pressure lb/in^2	Load watts
1	2650	100	1750
2	2950	35	1750
3	2950	35	1000
4	2950	35	350
5	2650	35	350
6	3100	35	350

TABLE 2
Required results of output tests

Test	Frequency deviation from 2·4 kc/c (See Note 1)	Voltage deviation from ◀115▶V R.M.S.	Harmonic content
1	± 1%	± 1%	
2	± 1%	± 1%	Not greater than 6% (tests 2 to 5)
3	± 1%	± 1%	
4	± 2%	± 2%	
5	± 1%	± 1%	
6	± 2%	± 2%	

Note . . .

(1) *The maximum frequency hunt* (Table 2) *should not exceed + or −12 c/s within a period of* 1 *second.*

(2) *The output frequency may be adjusted by totating the external knob of the potentiometer R.V.* 11 *located on the control unit bulkhead.*

(3) *The output voltage may be adjusted similarly by the use of R.V.* 1 *also located on the control unit bulkhead.*

(4) *If adjustment beyond the ranges provided by R.V.* 11 *and R.V.* 1 *appears to be necessary, the control unit should be withdrawn from service.*

Waveform

76. During the progress of each of the tests specified in Table 1 it is necessary to check the generator output waveform while the generating system operates in the varying conditions detailed. The output waveform may be observed on the C.R.T. by setting the C.R.T. DISPLAY SELECTOR to OUTPUT WAVEFORM. The output display should appear as a series of approximately 5 undistorted sinusodial waveforms of equal amplitude, the permissible level of harmonic distortion (Table 2) being indicated on the HARMONIC DISTORTION METER.

Hydraulic fluid flow test

77. During the progress of the tests detailed in Table 1 it is necessary to measure the rate of flow of hydraulic fluid into the generator motor: this flow should not exceed 220 gal/hr in any condition.

Frequency transient response test

78. This test proves the capability of the control unit to modify the generator throttle position via the generator transducer when sudden increases or decreases in load demands are made, resulting in frequency deviations outside the specified limits. The frequency deviations must be reduced to within the specified limits within a period of 0·5 second. Failure to control frequency transients would result in the removal of d.c. from the bench oil solenoid valve and consequent shutting down of the generating system.

79. The pre-conditions for conducting frequency transient tests, with increased load, are as follows:—

(1) Follow the setting up instructions contained in A.P.4343S, Vol. 1, Book 2, Sect. 9, Chap. 6.

(2) Ensure that no hydraulic back pressure is possible in the motor outlet line.

(3) Run up the generator (para. 67) to an inlet pressure of 2650 lb/in² and on a load of 1000W ON DIRECT.

(4) Select an additional load of 500W ON AUTO.

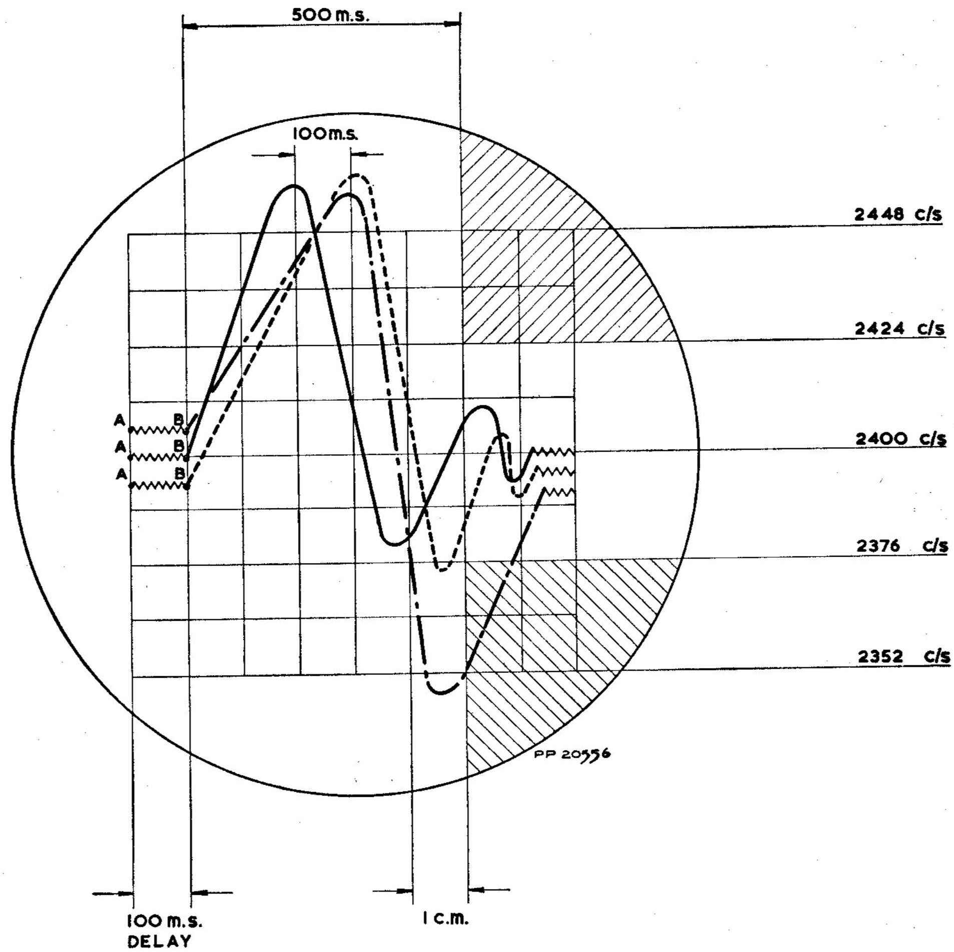
(5) Set the SET AUTO DELAY control to its approximate mid position.

(6) Set the AUTO MAKE/RESET/AUTO BREAK switch to AUTO MAKE.

80. Perform the frequency transient response tests with increased load (from 1000W to 1500W) as follows:—

(1) Operate the INITIATE AUTO LOAD CHANGE switch.

(2) Observe that the oscilloscope (approximately) straight line trace breaks into oscillations after the preset delay and subsequently returns to the (approximately) straight line, which event marks the reduction of the frequency transient to within specification limits.



KEY

A — TRIGGER POINT

B — LOAD CHANGE POINT

———————— IDEAL IMAGE

- - - - - - - - - - TYPICAL IMAGE

——— - ——— - ——— UNACCEPTABLE IMAGE

Fig. 11. Transient response—Oscilloscope display

(3) Obtain a presentation of a complete transient event on the oscilloscope by completing as necessary the following switching sequence in conjunction with operation of the SET AUTO DELAY control:—

(*a*) Return the INITIATE AUTO LOAD CHANGE switch to OFF.

(*b*) Reset the AUTO MAKE/RESET/AUTO BREAK switch.

(*c*) Operate the INITIATE AUTO LOAD CHANGE switch.

(4) Check that, during frequency transient tests, the frequency returns to within the specified limits (2·4 kc/s ± 24 c/s) within 0·5 second using the time scale of the calibrated oscilloscope (Fig. 11).

81. For decreased load frequency transient response tests (from 1500W to 1000W) the procedure is identical with that for increased load transient tests with the important exception that the AUTO MAKE/RESET/AUTO BREAK switch is set to AUTO BREAK, the ON AUTO load of 500W being subtracted from the total load of 1500W imposed by the load switch settings.

Crash start test

82. This test proves the capability of the generating system to contain within a predetermined period the effects of instantaneous hydraulic oil pressure in the motor generator, thus simulating the conditions to be met in operational service (para. 71 and 72).

83. To make a 'crash start' test the following operations are necessary:—

(1) Run up the generator as in para. 79 to a pressure of 2650 lb/in² using a load of 1750W ON DIRECT.

Note . . .

In no circumstances should any back pressures exist in the hydraulic system during 'crash start' tests.

(2) Obtain a stationary 1 to 1 Lissajous figure as in para. 71 and ensure that the output frequency is at 2·4 kc/s ± 1%.

(3) Stop the generator by operating NO. 2 MANIFOLD NEEDLE VALVE on the test bench.

(4) Set the ALTERNATOR START switch to OFF.

(5) Return the NO. 2 MANIFOLD NEEDLE VALVE to its previous position.

(6) Perform the following operations simultaneously:—

(*a*) Set the ALTERNATOR START switch to ON.

(*b*) Start the stop watch.

84. A satisfactory 'crash start' should result in the C.R.T. Lissajous figure display returning to a stationary position within 9 seconds. The crash start test should be repeated three times at a load of 1750W ON DIRECT.

85. A further three 'crash start' tests should be made, using a load of 550W ON DIRECT. The load of 550W may be obtained by adapting the instructions contained in para. 86 to this parameter.

Generator load current test

86. The magnitude of the generator load feed back currents is measured in the following manner during a 'crash start' test:—

(1) Ensure that the RANGE-A MILLIAMPS switch is set to 300.

(2) Set the SELECTOR-A switch to 2·4 kc/s (RANGE X100).

(3) Measure the load current by observing METER-A. On a load of 1750W the reading should be 14·9A and on a load of 550W, 4·6A.

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