Now 113B-0127-1

Chapter 2

MOTOR-GENERATOR, DE HAVILLAND, B.504 SERIES

LIST OF CONTENTS

	Para.
Introduction	1
Description	
Motor—generator assembly	5
Hydraulic motor	6
Generator	19
Operation	
General	24
Hydraulic motor	25
Generator	33
Installation	38
Servicing	
General	39
Routine servicing	40
Bay servicing	41
Cleaning inlet filter unit	42
Cleaning servo filter	43
Renewal of 'O' seals	44
Dismantling and renewal of components	
Motor-generator	45
Hydraulic motor	
Gear support plate	46
Gear housing	47
Servo cylinder	48
Selector valve sleeve	49
Lip seal and bearing	50
Swashplate spring sleeve	51
Swashplate	52
Motor rotor assembly	53
Actuator cylinder	54
Throttle valve sleeve	55
Transducer	56
9-pole plug	57
Servo filter	58
Inlet filter body	59
Non-return valve	60
Pressure maintaining valve	61
Generator	
12-pole connector	62
4-pole plug	63
Removal of rotor assembly	64
Removal of rotor bearing (rear end)	65
Removal of rotor bearing (front end)	66
Removal of stator coil	67
Assembly	
Stator coil assembly	68
Front bearing	69
Rear bearing	70
Rotor to generator housing	71
4-pole plug	72
12-pole connector	73
Cover plate	74
Hydraulic motor	
Pressure maintaining valve	77
Non-return valve	78
Inlet filter body	79
Servo filter	80
9-pole plug	81
Transducer	82
Throttle valve assembly	83
Actuator cylinder	84
Motor rotor assembly	85
Swashplate spring sleeve	86
Swashplate angle adjustment	87
Gear housing	88
Gear housing to motor housing	89
Gear support plate to gear housing	90
Motor to generator	91
Testing	
General	92
◀ *Hydraulic supplies*	96
Starting and stopping a.c. generators under test	97
Working temperatures	99
Test equipment required	100
Test preparations	
General	101
Preparations for testing B.504A generators	102
Preparations for testing B.504B and C generators	103
Testing procedure	
Preliminary run-up test	105
B.504 series generator output tests	113
Waveform test	115
Hydraulic fluid flow test	116
Frequency transient response test	117
'Crash' start TEST	121
Generator load current test	125 ▶
Interchangeability of B504B and B504C Motor-Generators	126

LIST OF ILLUSTRATIONS

	Fig.		Fig.
Motor—generator assembly—B.504 series	1	*Wiring diagram of 9-pole plug-transducer*	9
Motor (location of principal items) ...	2	*Interconnections between generator and test panel*	10
Transducer (schematic diagram)	3	*Transient response—oscilloscope display*	10*A*
Sectional view of generator	4	*Components affecting interchangeability of generators B504B and B504C* ...	10*B*
Motor and generator (schematic diagram)	5	*Grease lubrication of rear bearing assembly*	10*C*
Generator (schematic diagram)	6	*Gear housing (exploded view)*	11
Generator (exploded view)	7	*Hydraulic motor (exploded view)* ...	12
Micro switch mounting bracket assembly	7A		
Schematic diagram of terminal chamber	8		

LEADING PARTICULARS

Motor-generator assembly, type B504A	*Ref. No. 5UB/6634*
Motor-generator assembly, type B504B	*Ref. No. 5UB/6635*
Motor-generator assembly, type B504C	*Ref. No. 5UB/6636*
Overall length...	17 *inches*
Overall height, including pedestal	8 *inches*
Maximum width over inlet and exhaust funnels	9 *inches*
Fixing holes	8 *clearance holes for* $\frac{1}{4}$ *in. studs*
Fixing centres—inner holes	5·3 × 5·5 *inches*
Fixing centres—outer holes	5·3 × 10·1 *inches*
Generator output voltage and frequency ...	115–118*V. a.c. (r.m.s.) at* 2400 *c/s*
Output voltage and frequency variations ...	±1%—750*W to maximum output* ±2%—375*W to* 750*W*
Maximum output voltage on no-load	138*V a.c. (r.m.s.)*
Rated power output	3·0 *kW at* 0·95 *PF. (Continuous)*
Recovery time after load change (frequency)	0·5 *sec.*

Hydraulic motor

Hydraulic supply pressure	2650–2950 *lb/in² at unit*
Hydraulic main return line pressure	100 *lb/in² maximum*
Scavenge pump back pressure	50 *lb/in² maximum*
Hydraulic fluid minimum flow	5·4 *gallons per minute*
Hydraulic fluid temperature range	10–80° *C. for specified output*
Hydraulic fluid	*D.T.D.* 585 (*OM*-15, *Ref. No.* 34*B*/9100572)

Introduction

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

2. The generator is driven by a specially designed hydraulic motor, the two 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.4343B, Vol.* 1, *Book* 2, *Sect.* 8, *Chap.* 6) and a Capacitor and Junction Box. Type B700–2 (*A.P.4343B, Vol.* 1, *Book* 2, *Sect.* 8, *Chap.* 7). The types B504A, B and C differ only in the positioning of the generator to the hydraulic motor. This is accomplished by rotating the generator so that the 12-pole connector assumes a different position relative to the motor, the type B504A being 7·5 deg. from 'top' whilst the types B504B and B504C are positioned 67·5 deg. and 247·5 deg. from 'top' respectively (para. 113).

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 in². The motor is maintained at a constant speed by regulating 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. Constant output voltage is provided by the voltage control circuit contained in the 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 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. Air is fed, via funnel attachments secured by straps, through these channels into the generator for cooling purposes; this arrangement allows the cooling air supply pipes to follow a convenient route, since the funnels may be positioned anywhere over a 210 deg. range round the assembly.

Hydraulic 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 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, as necessary. Blanking or cover plates seal the openings and enable the drillings to be cleaned and inspected during major servicing.

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.

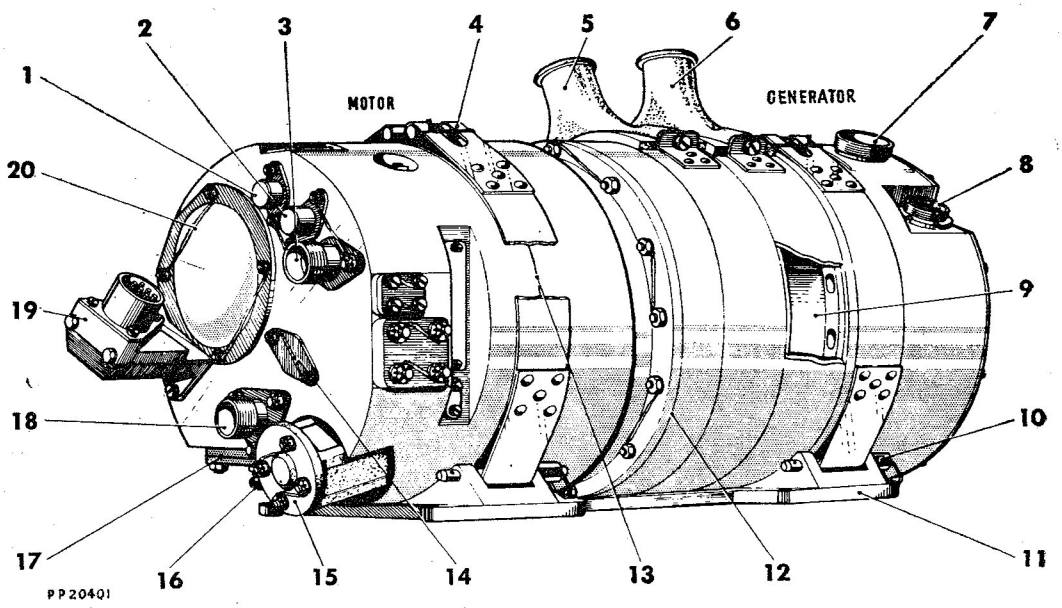
8. From the inlet filter chamber a large drilling leads to a throttle, and a small drilling communicates with a port in a swashplate actuator housing.

9. The throttle is mounted near the end of the motor 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 swashplate motor inlet port; a small drilling also connects the outlets with another port in the swashplate actuator housing. Four equally-spaced holes in the lower part of the sleeve act as inlet ports for the throttle.

10. 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 interconnected 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 velocity 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.

11. A schematic diagram to show the general 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 ± 7 deg., this deflection occurring when the current differential between the two windings is approximately 100 to 120 mA. The deflection, which is proportional to the current flowing through the coils, is usually within ± 3 deg.

12. The selector valve and the associated



1 SERVO FILTER PLATE
2 SWASHPLATE SPRING ADJUSTER COVER PLATE
3 OUTLET AND NON-RETURN VALVE
4 SECURING STRAP
5 COOLING AIR INLET FUNNEL
6 COOLING AIR EXHAUST FUNNEL
7 4-POLE PLUG
8 12-POLE PLUG
9 ANNULAR GROOVE WITH HOLES TO INTERIOR FOR GENERATOR COOLING
10 QUICK RELEASE PIN
11 PEDESTAL
12 JOINT BETWEEN MOTOR AND GENERATOR
13 JOINT BETWEEN MOTOR AND GEAR HOUSING
14 DASHPOT FILTER COVER PLATE
15 DASHPOT AT END OF ACTUATOR
16 SCAVENGE OIL PIPE CONNECTION
17 THROTTLE COVER PLATE
18 INLET AND INLET FILTER
19 9-POLE PLUG
20 TRANSDUCER CHAMBER COVER PLATE

Fig. 1. Motor–generator assembly—B.504 series

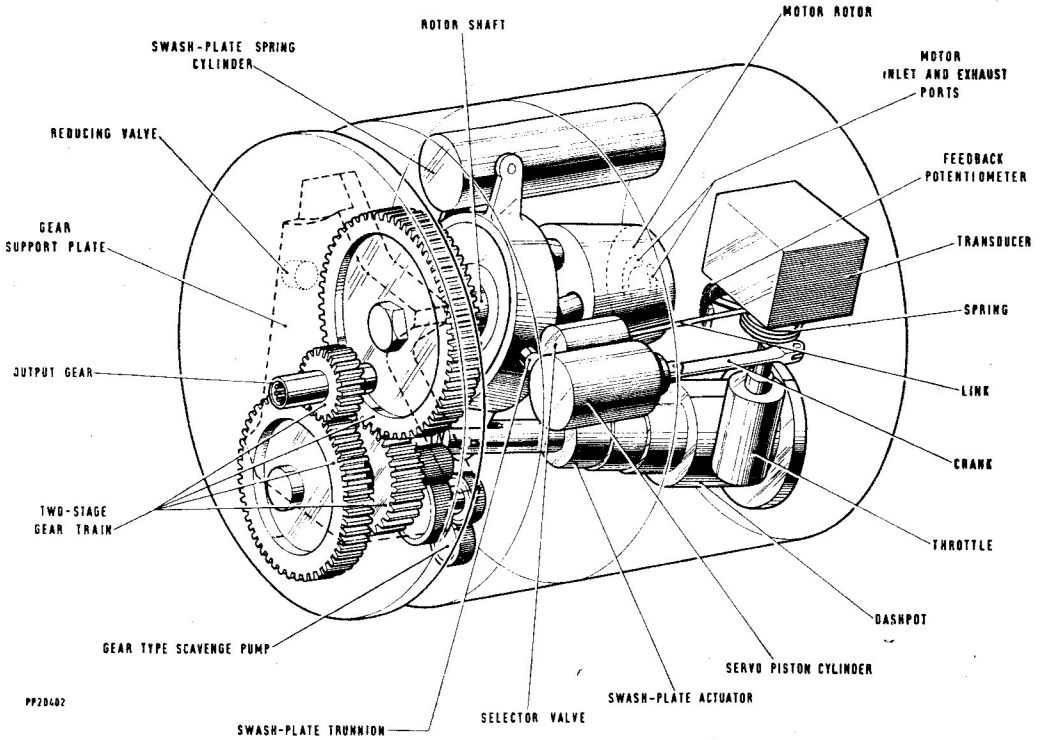


Fig. 2. Motor (location of principal items)

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

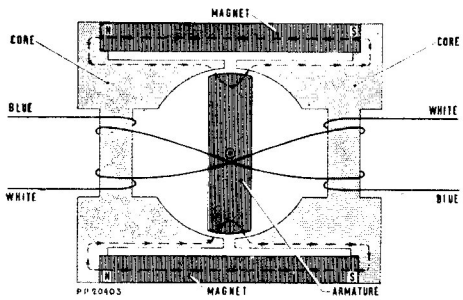


Fig. 3. Transducer (schematic diagram)

dowel and a servo-filter housing. The servo filter, which is of the edge-type, prevents particles exceeding 0·001 in. 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.

13. The swashplate motor assembly consists essentially of a solid rotor having five cylinders inclined outwards around its axis, each cylinder containing a plunger and a compression spring. The spherical outer end of each plunger is fitted with a bronze 'slipper' which slides on the operating face of the swashplate. As the rotor revolves, a port at the inner end of each cylinder is aligned 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, swashplate, and bearings.

14. The swashplate 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 swashplate control spring is enclosed in a cylindrical tube having projections which fit in a yoke on the top edge of the swashplate. The spring compression is preset by a mushroom-headed stud, the stem of which protrudes through the motor housing and enables adjustment to be made during factory testing. A swashplate actuator piston is contained within a housing which is secured on the motor housing by four long studs and nuts.

The actuator housing also incorporates a dash pot with a spring-loaded piston; this piston has a non-return valve and a restricted orifice. That part of the actuator housing which includes the dashpot is connected with the motor exhaust port via small drillings and a dashpot filter; the filter consists of a short perforated tube across the end of which is brazed a fine gauze disc. Fluid passages to the actuator and dashpot pistons 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 swashplate; the other end is provided with an adjustable stop to limit the swashplate at its maximum deflection angle. The dashpot cover forms a stop for limiting the minimum swashplate angle which may be adjusted by fitting shims under the cover.

15. 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.

16. 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 to which the generator casing is attached.

17. The main drive gear is splined to the end of the rotor shaft and secured by a bolt and tabwasher. 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 short 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 a gear support plate. A pinion, fitted to the end of the layshaft, drives a small gear-type scavenge pump via a gear on one of the gear-pump shafts. The pump is located in a compartment at the bottom of the gear housing and a small drilling leads from the scavenge pump to a union which is screwed into the motor housing.

18. The gear support plate also houses a pressure reducing valve; this valve consists of a ported spring-loaded sleeve, operating within a fixed ported sleeve such that the area of the control ports is reduced if the fluid inlet pressure increases and vice versa. The inlet side of the reducing valve is connected, by drillings, to the tubular transfer dowel situated in the line from the motor exhaust port to the selector valve. The fluid outlet pressure from the reducing valve is pre-set by an adjustable spring stop, which can only be adjusted when the generator is detached from the motor. From the valve outlet, drillings in the gear support plate lead to three brass jets; one is screwed into the gear support plate and aimed at the meshing output gears, the second into a short extension aimed at the motor output and layshaft gears, and the third in the outer face of the gear support plate and extending outwards towards the ball bearing which supports the driven end of the generator rotor shaft.

Generator

19. The generator stator and rotor assemblies

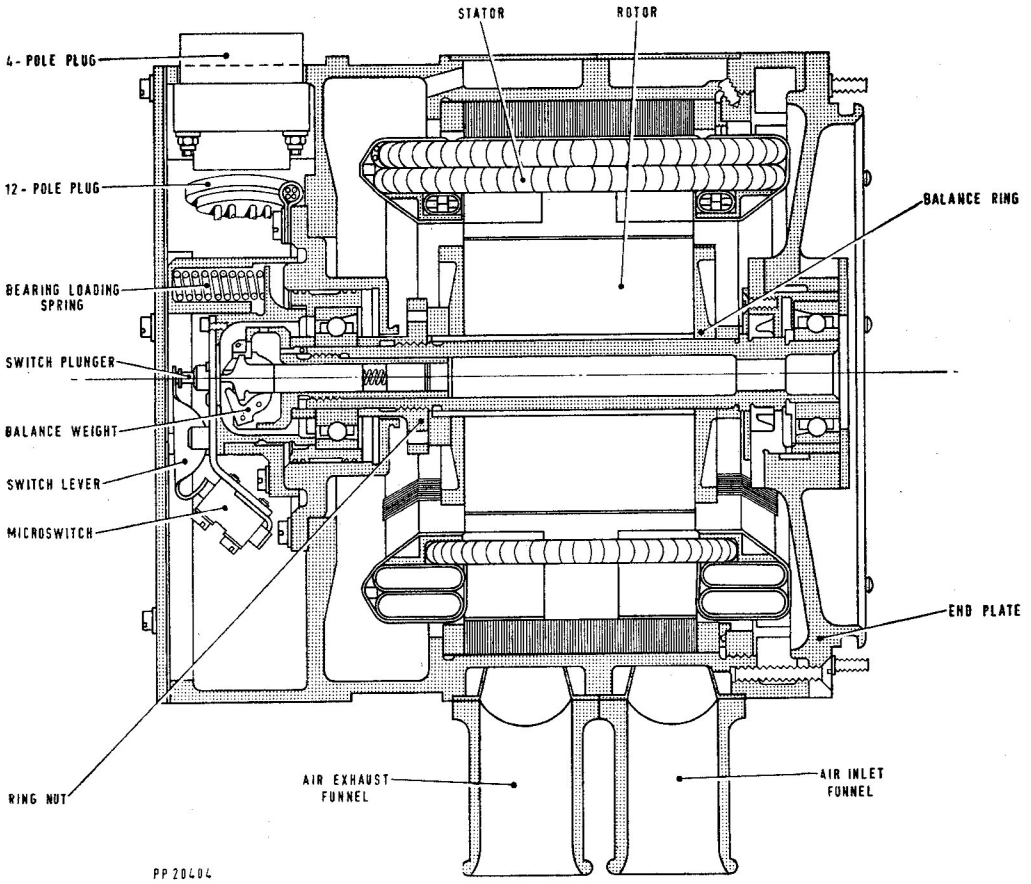


Fig. 4. Sectional view of generator

(*fig.* 4) are contained within a machined duralumin casing approximately 7 in. dia., similar to that of the hydraulic motor. An end plate, at the motor end of the casing, is spigoted to fit into the motor gear housing, a seal ring on the spigot preventing any fluid leakage at the joint. The end plate houses the generator rotor shaft bearing at the motor end, the bearing being retained by a race retaining plate, secured by six screws. The race retaining plate facilitates the changing of a type B504B generator to a type B504C or vice versa by the removal of the six securing screws and rotation of the plate through 180 deg. 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.

20. 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 funnel, 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.

21. 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 airtight glands and terminate at a 12-pole plug. The output winding fly leads are soldered to the pins of a 4-pole plug.

22. The rotor assembly consists of a stack of six-pole laminations, assembled around the tubular steel rotor shaft. The laminations are 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 hydraulic motor 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 the motor end of the shaft is secured in its housing by a retaining plate and is lubricated with fluid from one of the jets in the motor gear housing. Excess fluid drains into the gear housing sump and a lip seal prevents the ingress of fluid to the generator interior. 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.

23. 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 bearing 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.

Key to Fig. 5
Motor—generator (schematic diagram)

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 SWASHPLATE
10 GEAR TRAIN
11 QUILL SHAFT
12 GENERATOR ROTOR
13 RESTRICTOR
14 PRESSURE MAINTAINING VALVE
15 NON-RETURN VALVE
16 MOTOR CHAMBER
17 TRANSDUCER
18 SELECTOR VALVE
19 SPRING
20 F/B POTENTIOMETER
21 SERVO FILTER
22 PRESSURE REDUCING VALVE
23 CONTROL SPRING
24 SWASHPLATE ACTUATOR PISTON
25 DASHPOT PISTON
26 NON-RETURN VALVE
27 DASHPOT FILTER
28 SCAVENGE PUMP
29 GEAR LAYSHAFT
30 OIL SUMP
31 CENTRIFUGAL SWITCH
32 COOLING AIR INLET
33 COOLING AIR EXHAUST

OPERATION

General

24. 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 etc. If the fluid only is cooled, the motor generator can only be operated for

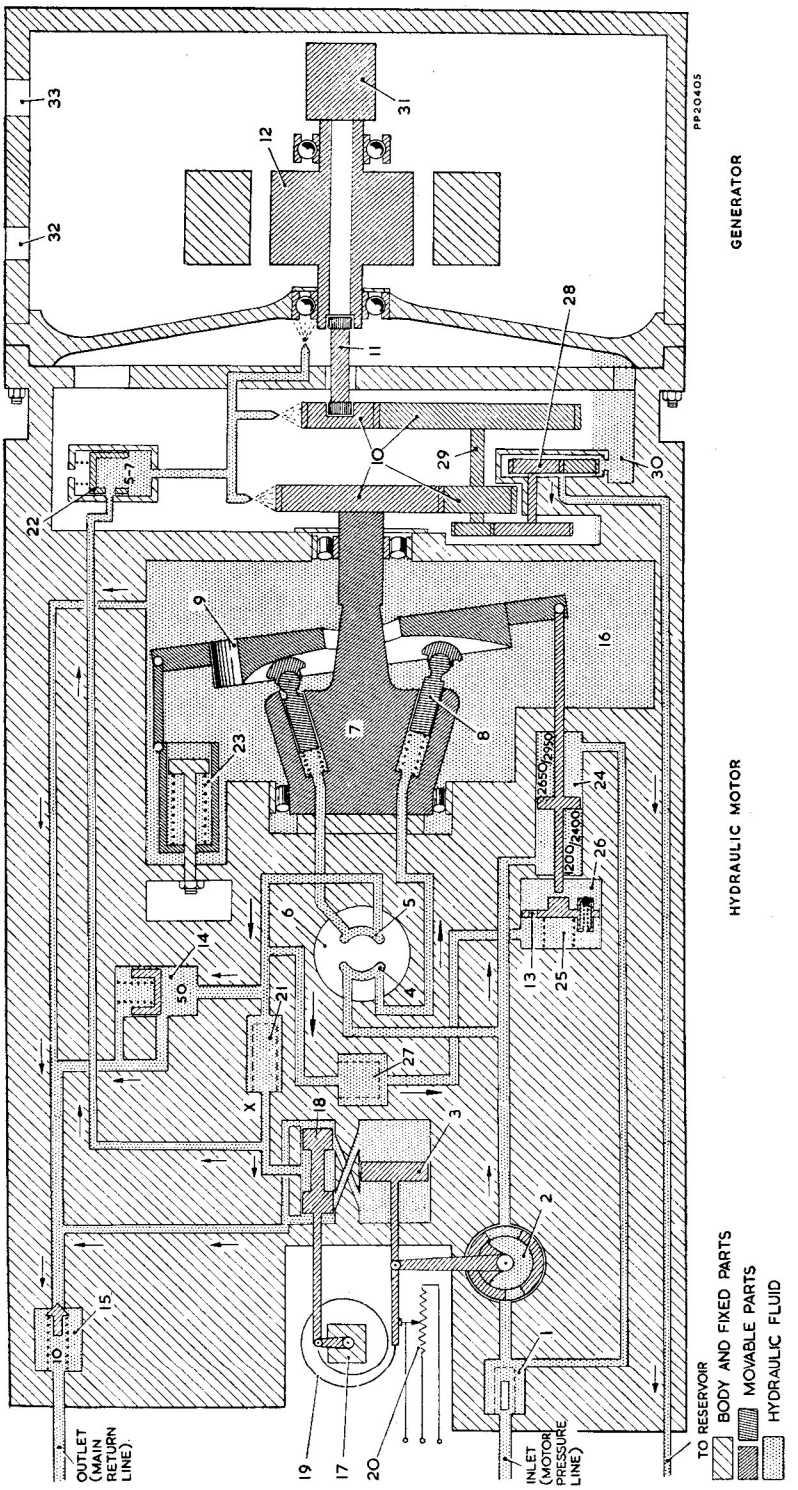


Fig. 5. Motor and generator (schematic diagram)

about 4·5 mins 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.*

Hydraulic Motor

25. A schematic diagram to show the operation of the hydraulic motor assembly is given in *fig.* 5, which also shows the generator attached to the driving end of the motor. The key adjacent to the diagram is referred to in the following description by the bracketed figures. The numbers within the valves etc. represent fluid pressure or pressure drops at the particular points; for full details see the text reference.

26. 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 swashplate 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 ends of the plungers to press against the inclined face of the stationary swashplate (9). A similar arc-shaped exhaust port (5) is provided so that the plungers are able to expel fluid into the hydraulic system return line. The rotor therefore revolves and attains a normal rotational speed of 4470 rev/min.

27. A step-up ratio of approximately 1 : 5·36 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, and to prevent mechanical losses due to turbulence, this fluid is returned direct to the hydraulic reservoir by the small scavenge pump (28). Air is unavoidably included with the scavenged fluid by the action of the pump; the scavenged fluid is, therefore, returned separately to reduce the likelihood of the air causing frothing of the fluid in the main return system.

28. The fluid expelled through the motor exhaust port flows to the outlet union via the pressure maintaining valve (14). This valve ensures that fluid pressure for the servo system is always available during operation by maintaining a pressure difference of approximately 50 lb/in^2. between the motor exhaust and the motor return line. The non-return valve (15) in the outlet union, which opens when the pressure in the motor return line is approximately 10 lb/in^2 above that of the system's main return line, prevents the gearbox from being flooded with reservoir fluid whilst the motor and scavenge pumps are stationary. A considerable amount of fluid flows through the rotor cylinders and the lubricating channels to lubricate the plungers, swashplate 'slippers', rotor bearings, etc., and consequently the motor chamber (16) 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/in^2 above the pressure in the system's main return line bythe non-return valve.

29. 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 (17) is not sufficiently powerful to operate the throttle directly; the transducer, therefore, operates a selector valve (18) 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 (20) which is connected in a feedback circuit in the control unit.

30. Another tapping from the motor return line provides fluid for lubrication purposes in the gear chamber. A small pressure reducing valve (22) within the gear support plate feeds the fluid at a pressure of between 5 and 7 lb/in^2 to three jets, two of which direct fluid on to the gears, the other directing fluid on to the ball bearing at the motor end of the generator rotor.

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 swashplate is automatically varied. Fluid, tapped from the inlet side of the throttle, is fed to one side of the swashplate actuator piston (24), 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 swashplate 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 swashplate control spring housed within the control spring cylinder (23) sets the swashplate angle at its maximum deflection, thus allowing the normal running speed to be rapidly obtained.

32. It is essential that the swashplate control system should operate smoothly and slowly, particularly in the event of a sudden drop in load causing a rapid closure of the throttle to prevent overspeeding. Movement of the actuator piston, to reduce the angular setting of the swashplate, is heavily damped because this movement can only take place at a rate determined by the fluid flow through the restrictor (13) in the spring-loaded piston housed in the dashpot (25). The actuator piston can move rapidly in the other direction, however, because the dashpot piston presses against the actuator piston rod and the non-return valve (26) allows fluid to pass easily from one side of the dashpot piston to the other. The fluid supply to the dashpot is obtained from the motor exhaust line via the dashpot filter (27).

Generator

33. The generator is of the polar inductor type having a six-pole rotor revolving within a four-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 later.

34. 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 output 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 revoltuion. The output frequency of 2400 c/s is obtained when the rotor speed is 24000 rev/min.

35. 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.

36. 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 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

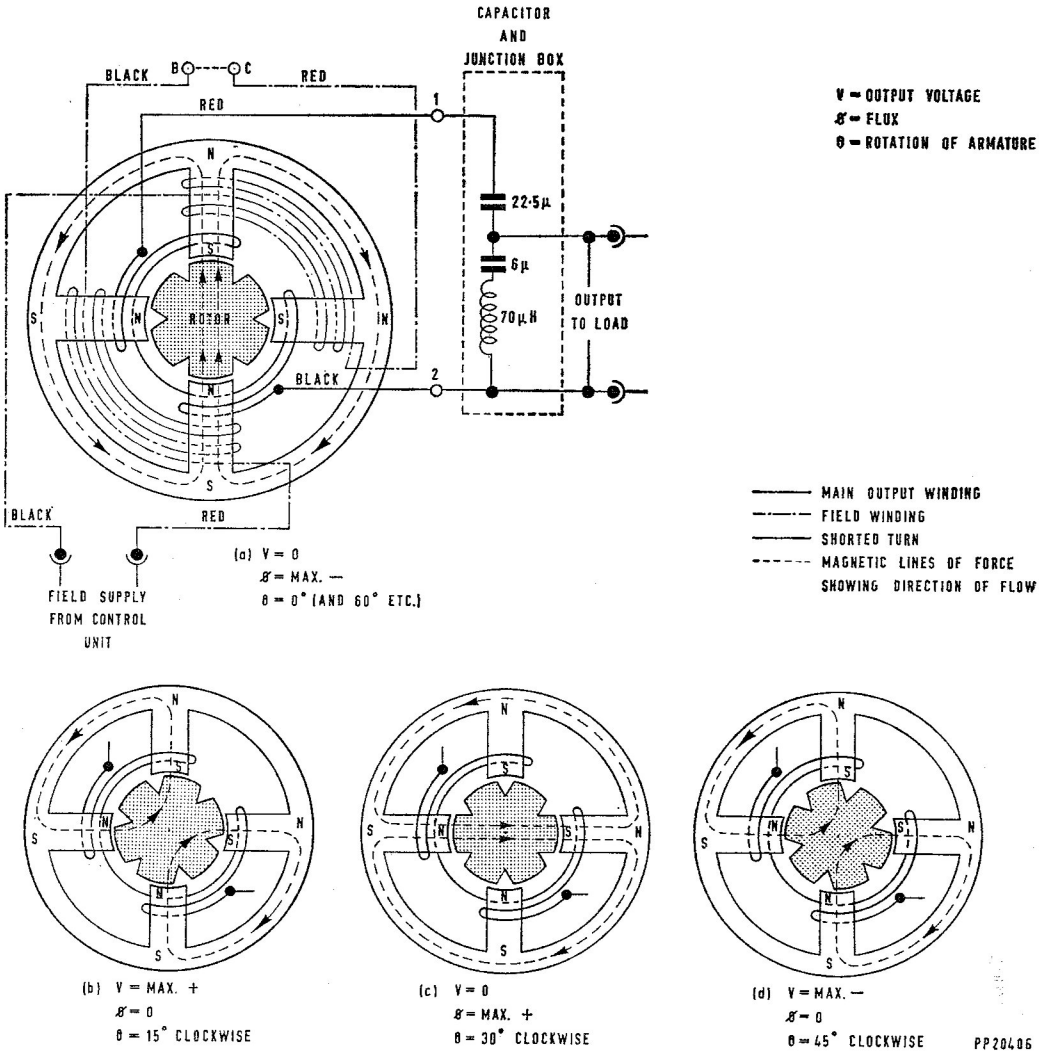


Fig. 6. Generator (schematic diagram)

a low impedance to the harmonic components of the load current, thus reducing the voltage waveform distortion.

37. 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, the air being provided by 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 cooling 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

38. The motor-generator is held on its pedestal by securing straps (*fig.* 1), fitted with quick release screws and it is therefore possible to index it through a maximum angle of 210 deg. However, care must be taken to see that the marking TOP is always on top relative to the aircraft. The dimensions of fixing holes and centres are given in Leading Particulars. Sufficient space must always be left around the machine for connecting electrical cables, cooling pipes and oil pipes.

SERVICING

General

39. Motor-generators of the B504 series should be serviced in accordance with the relevant aircraft and bay servicing schedules and the instructions contained in this chapter.

Routine servicing

40. Routine servicing of motor-generators installed in aircraft consists of 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 for fluid leakage.

Bay servicing

41. The following servicing can only be accomplished with the motor-generator removed from the aircraft. 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

42. Clean the inlet filter unit as follows:—

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

(2) Raise the end of the motor-generator so that the inlet filter body and 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 outer 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) Fit a new 'O' seal to the inlet filter body.

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

Cleaning servo filter

43. Clean the servo filter as follows:—

(1) Cut the locking wire, unscrew the nuts that retain the servo filter end 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) Fit a new 'O' seal to the end cap.

(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

44. If there are signs of fluid leaks from the oilway or pressure test cover plate, 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 main joint, the motor-generator must be separated and the offending 'O' seal renewed.

Dismantling and Renewal of Components

Motor-generator

45. Separate the motor-generator as follows:—

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

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

(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.

Hydraulic motor

46. *Gear support plate* (*fig.* 11). Remove and dismantle the gear support plate as follows:—

(1) Cut the locking wire and remove the slotted nuts from the two studs of the gear support plate (11), extract the split pin and remove the slotted nut from the bolt of the gear support plate, and, using special tool B.T.1870, withdraw the gear support plate from the gear housing (16).

(2) Remove the three 4 BA screws that secure the layshaft bearing housing (47) to the gear support plate and withdraw the housing.

(3) Remove the layshaft (39) from the gear support plate.

(4) Remove the bearing (36), layshaft pinion (37), and the bearing (46) from the layshaft.

(5) Remove the circlips (1) and (42) that retain the generator pinion bearings (43) and (45) in the bearing sleeve (2) and press out the bearings and the generator pinion (44).

(6) Remove locking wire and the two 4BA screws that retain the pressure reducing valve body assembly (7) and withdraw the assembly.

(7) Unlock the tabwashers, unscrew the two 4BA screws that secure the jet pedestal (41) and remove the pedestal.

(8) Unlock the tabwasher and remove the lubricating jet extension (10).

(9) Remove the lubricating jet (12) using special tool B.T.1050.

47. *Gear housing* (*fig.* 7). Separate the gear housing from the hydraulic motor as follows:—

(1) Unlock the tabwasher, and, holding the motor gear (13) with special tool B.T.2046, unscrew the retaining bolt and withdraw the motor gear using special tool B.T.1873.

(2) Cut the locking wire, and, using special tool B.T.1876 remove the six 1/4 B.S.F. nuts that secure the gear housing to the hydraulic motor housing.

(3) Unlock the tabwasher and remove the two 4BA screws that secure the selector valve cover, screw a 4BA screw into the central extractor hole, remove the selector valve cover and discard the 'O' seal.

(4) Slacken off the selector valve locking screw in the transducer lever, screw the selector valve (25) through the transducer lever from the hydraulic motor end and withdraw the valve.

(5) Extract the split pins from the clevis pin in the throttle lever assembly (81 *fig.* 12) and remove the clevis pin and washer.

(6) Using special tool B.T.1872, separate the gear housing from the hydraulic motor housing. Discard the 'O' seal (76 *fig.* 12).

(7) Unlock the tabwasher and remove the 4BA nut that retains the scavenge pump input gear (30), and remove the gear.

(8) Unlock the tabwashers and remove the four 4BA screws that secure the scavenge pump body (32), withdraw the transfer pipe and remove the scavenge pump by tapping the dowels on the underside of the pump body.

(9) Remove the pump backplate (35), gears, and ball race (31).

48. *Servo cylinder* (*fig.* 11). Remove the servo cylinder as follows:—

(1) Unscrew the five 4BA screws that retain the servo cylinder (19), withdraw the cylinder using special tool B.T.2047; discard the 'O' seals.

(2) Extract the split pin from the clevis pin that connects the servo link (20) to the servo piston (17), withdraw the pin, remove the servo link and withdraw the servo piston and spring.

(3) Withdraw the transfer tube (24) and discard the 'O' seals.

49. *Selector valve sleeve* (*fig.* 11). Remove the selector valve sleeve as follows:—

(1) Remove the two 4BA screws that retain the selector valve sleeve (26) and withdraw the sleeve.

50. *Lip seal and bearing* (*fig.* 11). Remove the lip seal and bearing as follows:—

(1) Unscrew the four 4BA screws that secure the lip seal retaining plate (14).

(2) Unscrew the three 4BA screws that secure the race retaining plate (22).

(3) Press the bearing (21), lip seal (15) and lip seal retaining plate out of the gear housing.

51. *Swashplate spring sleeve* (*fig.* 11 *and* 12). Remove the swashplate spring sleeve as follows:—

(1) Remove the sealing sleeve (28, *fig.* 11) and discard the 'O' seals (27 and 29 *fig.* 11).

(2) Cut the locking wire and remove the two 2BA slotted nuts that secure the swashplate spring cover (24 *fig.* 12), remove the cover and discard the 'O' seal (23 *fig.* 12).

(3) Unlock the tabwasher and remove the nut and locknut of the swashplate spring rod (1 *fig.* 12).

(4) Withdraw the swashplate spring sleeve (6 *fig.* 12), sleeve washer (4 *fig.* 12) and spring rod.

52. *Swashplate* (*fig.* 12). Remove the swashplate as follows:—

(1) Extract the split pin and remove the clevis pin of the swashplate link (93) and remove the link.

(2) Unlock the tabwasher and unscrew the 4BA screw used to secure each swashplate trunnion (91) and remove the swashplate (92).

53. *Motor rotor assembly* (*fig.* 12). Remove the motor rotor assembly as follows:—

(1) Withdraw the motor rotor assembly (84).

(2) Unlock the tabwashers and remove the three 4BA screws that secure the bearing retaining sleeve (90) and remove the sleeve.

(3) Withdraw the motor bearing.

(4) Remove the two 4BA screws that secure the port insert retaining plate (78) and remove the retaining plate and the port insert (77).

54. *Actuator cylinder* (*fig.* 12). Remove the actuator cylinder as follows:—

(1) Cut the locking wire and remove the four 2BA slotted nuts and plain washers that retain the actuator cylinder cover (46), remove the cover and the shims (47) and (48), discard the 'O' seal (51).

(2) Withdraw the actuator cylinder (62) and discard the 'O' seals (63), (64) and split ring (66).

(3) Hold the actuator piston stop (44) using special tool B.T.2048 and remove the thimble nut (43).

(4) Unlock the tabwasher and remove the retaining screw (45).

(5) Withdraw the 'O' seal housing (52) and the actuator piston (54) from the cylinder and discard the 'O' seal (53).

55. *Throttle valve sleeve* (*fig.* 12). Remove the throttle valve sleeve as follows:—

(1) Cut the locking wire and remove the four 1/4 B.S.F. slotted nuts and plain washers that secure the throttle sleeve plug (73), remove the plug and discard the 'O' seal (72).

(2) Remove the two 4BA screws that retain the throttle valve sleeve (68).

(3) Remove the throttle valve lever lock pin (79).

(4) Disconnect the spring from the throttle lever assembly (81), withdraw the throttle valve sleeve and discard the 'O' seals (74). Remove the throttle lever.

56. *Transducer* (*fig.* 12). Remove the transducer as follows:—

(1) Unlock the tabwasher and remove the three 4BA screws that secure the transducer (83) and withdraw the tranducer.

(2) Identify the electrical connections to the transducer and carefully unsolder them.

57. *9-pole plug* (*fig.* 12). Remove the 9-pole plug as follows:—

(1) Cut the locking wire and remove the three 4BA screws that secure the 9-pole plug to the motor housing.

(2) Carefully unsolder the connection to the bus bar wiper arm.

(3) Remove the cable cleats and withdraw the plug and cables. Discard the 'O' seal (61).

58. *Servo filter* (*fig.* 12). Remove the filter as follows:—

(1) Cut the locking wire and remove the two 2BA slotted nuts that secure the end cap (27).

(2) Remove the end cap, discard the 'O' seal (26) and withdraw the servo filter (25).

59. *Inlet filter body* (*fig.* 12). Remove the inlet filter body as follows:

(1) Cut the locking wire and remove the three 1/4 B.S.F. slotted nuts that retain the inlet filter body (36)

(2) Remove the earthing terminal, withdraw the body from the motor housing and discard the 'O' seal (37).

60. *Non-return valve* (*fig.* 12). Remove the return valve as follows:—

(1) Cut the locking wire and remove the 1/4 B.S.F. screws that secure the non-return valve body (32), remove the body and discard the 'O' seal.

(2) Remove the screws of the non-return valve body and withdraw the sealing washer, bobbin, spring seat (31) and spring.

61. *Pressure maintaining valve* (*fig.* 12). Remove the pressure maintaining valve as follows:—

(1) Cut the locking wire and remove the four 4BA screws that retain the valve plug (7). Remove the plug and discard the 'O' seal (8).

(2) Withdraw the spring (9), valve body (12), pressure maintaining valve (11) and the shims (10). Retain the shims but discard the 'O' seals (15) and (16).

Generator

62. *12-pole connector* (*fig.* 7). Remove the 12-pole connector as follows:—

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

(2) Unscrew and remove the lock-ring from the 12-pole connector, withdraw the connector, identify the electrical connections and unsolder them.

63. *4-pole plug* (*fig.* 7). Remove the 4-pole plug as follows:—

(1) Remove the four 6BA bolts and stiff-nuts that secure the 4-pole plug (6), withdraw the connector, identify the leads and unsolder the connections. Discard the gasket.

(2) Remove the cable cleats and disconnect the leads from the terminal block (10).

64. *Removal of rotor assembly* (*fig.* 7). Remove the rotor assembly as follows:—

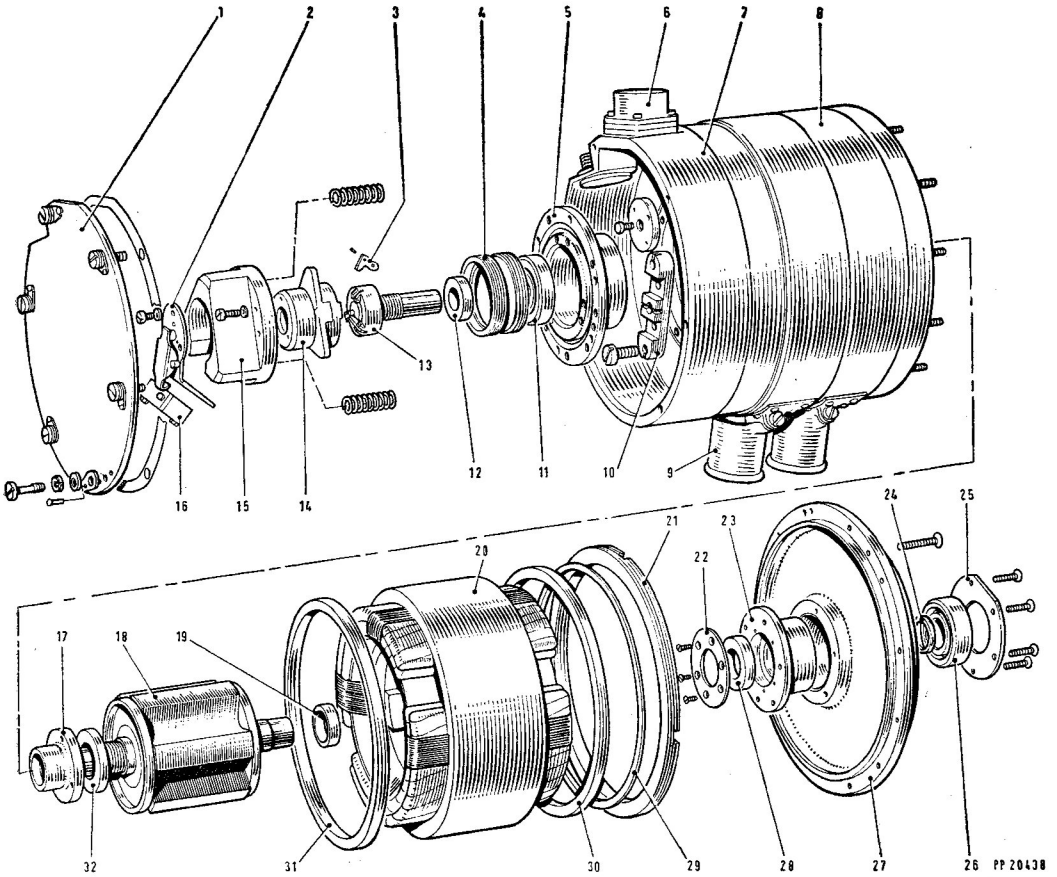
(1) Cut the locking wire and unscrew the captive screws of the cover plate (1), remove the cover plate and discard the gasket.

(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 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



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

Fig. 7. Generator (exploded view)

housing, tighten the screws evenly and withdraw the rotor assembly complete with front and rear bearing housings.

65. *Removal of rotor bearing (rear end) (fig. 7).* Remove the rear rotor 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 tool B.T.1868, 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 tools B.T.2053 and B.T.2054.

(5) Push the bearing, in its sliding sleeve (4), out of the bearing housing and withdraw the bearing from the sleeve using special tool B.T.2052 and a press.

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

66. *Removal of rotor bearing (front end.)* Remove the front rotor bearing as follows:—

(1) Using special tools B.T.2053 and B.T.2054 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).

67. *Removal of stator coil (fig. 7).* Remove 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).

(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 clamps, 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 B.T.1866, remove the stator washer (29) and spacer ring (30).

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

Assembly

68. *Stator coil assembly (fig. 7).* 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 ring (30) against the stator coil assembly and locate the stator washer (29).

(4) Fit and tighten the ring nut using special tool B.T.1866, ensuring that the stator coil assembly does not turn and thus break or strain the leads.

(5) Position special tool B.T.1865, pull the leads through the web of the generator housing and slide new ring seals on to 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 connections 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.

Note . . .

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. Use the tapped hole in the generator housing to spot the position, and use special tool B.T.2055, with one 2BA stud removed. 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.

69. *Front bearing* (fig. 7). Fit the front bearing as follows:—

(1) Ensure that the oilways of the front bearing housing (23) and the end plate (27) are clear.

(2) Wash the packing grease from the bearing.

(3) Lubricate the bearing with hydraulic oil, OM-15 (D.T.D.585).

(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 XG275 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 6BA 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.

70. *Rear bearing* (fig. 7). 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 rear 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 (13) to 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 the items are 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.

71. *Rotor to generator housing* (fig. 7). 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

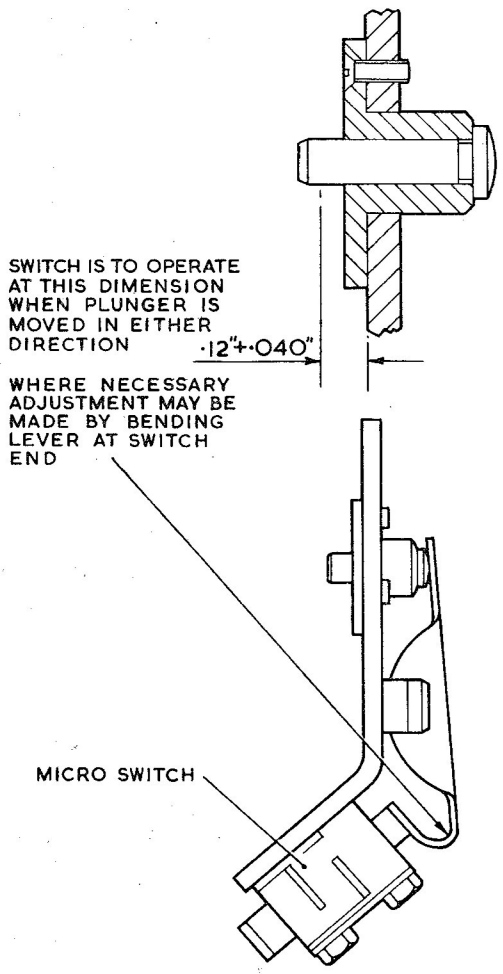


Fig. 7A. Micro switch mounting bracket assembly

generator housing with the six 4BA screws. Wirelock the bearing housing and spring retainer screws together.

(2) ◄ Check the adjustment of the micro switch (fig. 7A). ► Locate the switch mounting bracket to 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) are 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.

Note . . .

For motor-generators 504B and C, care must be taken to fit the bearing retaining plate with its tongue aligned with the etched B or C (as appropriate) on the end plate.

72. *4-pole plug* (fig. 7). Fit the 4-pole plug as follows:—

(1) Carefully solder the electrical connections to the 4-pole plug, locate a new gasket and secure the plug to the generator housing with the bolts and stiffnuts.

(2) Connect the leads to the terminal block.

(3) Secure the leads with the cleats and lock the cleat securing screws with enamel, air drying, scarlet.

73. *12-pole connector* (fig. 7). Fit the 12-pole connector as follows:—

(1) Carefully solder the electrical connections to the 12-pole connector, insert the connector into its aperture in the generator housing and secure the connector with its lock ring.

74. *Cover plate* (fig. 7). Position a new gasket to the end face of the generator housing, locate the cover plate and secure it with the securing screws. Lock the screws with 22 s.w.g. wire.

75. Peen the metal of the bearing retaining plate into the screw slots to lock them.

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

Hydraulic motor

77. *Pressure maintaining valve* (fig. 12). Fit the pressure maintaining valve as follows:—

(1) Assemble the shims to the pressure maintaining valve (11) and insert the valve and spring (9) into the valve body (12).

(2) Fit a new "O" seal to the spigot of the valve plug (7) and two new "O" seals to the valve body.

(3) Insert the valve body and valve plug into the motor housing and retain the valve plug with the four 4BA screws. Lock the screws with 22 s.w.g. wire.

78. *Non-return valve* (fig. 12). Fit the non-return valve as follows:—

(1) Assemble the bobbin and sealing washer and insert the assembly, spring seat (31) and spring (33) into the non-return valve body.

(2) Fit two new "O" seals (28) and (30) to the valve seat body (29) and secure the valve seat body to the non-return valve body with the two 2BA screws.

(3) Locate the spigot of the non-return valve assembly to the motor housing and secure it with the two $\frac{1}{4}$ in. B.S.F. nuts.

79. *Inlet filter body* (fig 12). Fit the inlet filter unit and inlet filter body as follows:—

(1) Locate a new "O" seal to the inlet filter body (36).

(2) Insert the inlet filter unit (41) and the inlet filter body into the housing, locate the earthing tag and secure the body with the three washers and $\frac{1}{4}$ in. B.S.F. slotted nuts. Lock the nuts with 22 s.w.g. wire.

80. *Servo filter* (fig. 12). Fit the servo filter as follows:—

(1) Locate the servo filter (25) into its housing.

(2) Fit a new "O" seal to the end cap (27), assemble the end cap to the motor housing.

(*Continued overleaf*)

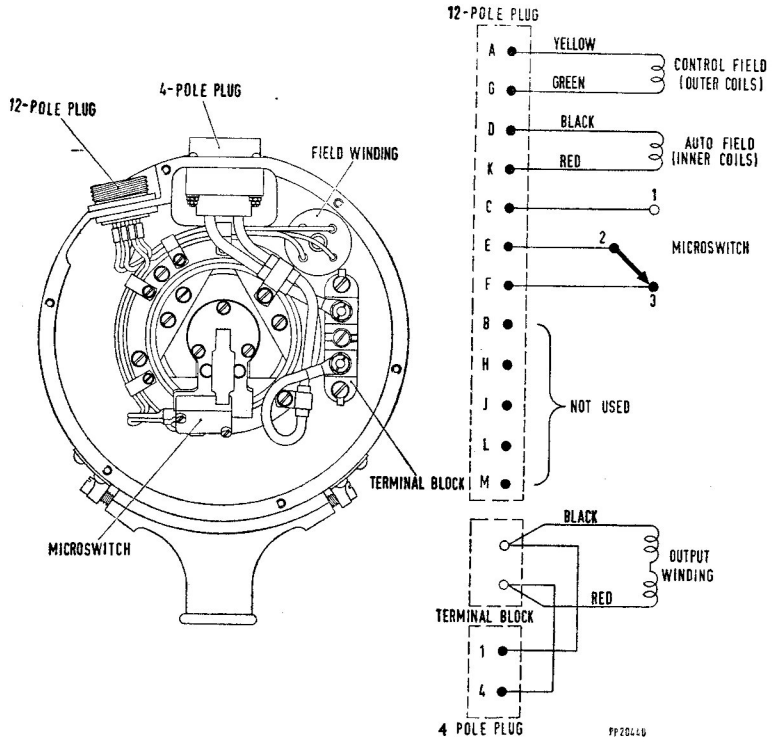


Fig. 8. Schematic diagram of terminal chamber

and secure it with the two washers and 2BA slotted nuts. Lock the nuts with 22 s.w.g. wire.

81. *9-pole plug* (*fig.* 12). Fit the 9-pole plug as follows:—

(1) Locate a new 'O' seal to the spigot of the plug adapter for the B504 A or to the spigot of the plug for the B504 B and C motor-generators.

(2) Thread the cable loom through the transducer chamber, locate the plug or plug adapter in the motor housing and secure it with the three 4 BA screws. Lock the screws with 22 s.w.g. wire.

(3) Fit the cable cleats over the cable loom and tighten the securing screws.

(4) Carefully solder the lead from the plug to the bus bar wiper tag.

82. *Transducer* (*fig.* 12). Fit the transducer as follows:—

(1) Connect the leads of the 9-pole plug to the transducer tag board as shown in *fig.* 9.

(2) Fit the lever to the transducer with the spring.

(3) Position the transducer and fit the three 4 BA screws but do not tighten them at this stage.

83. *Throttle valve assembly* (*fig.* 12). Fit the throttle valve assembly as follows:—

(1) Assemble four new 'O' seals to the throttle valve sleeve (68), and assemble the sleeve into the motor housing.

(2) Assemble the spacer (70) and bearing (69) to the throttle valve; insert the throttle valve (71) into the sleeve so that the stem of the throttle valve passes through the throttle lever and then secure the valve with the lock-pin.

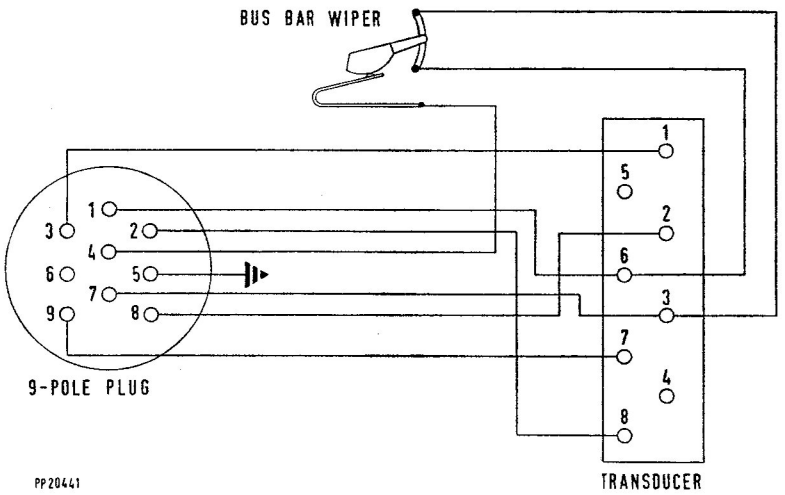


Fig. 9. Wiring diagram of 9-pole plug-transducer

(3) Secure the throttle valve sleeve with the two 4 BA screws.

(4) Tighten the transducer securing screws, ensuring that the contact of the throttle lever wiper arm tracks centrally on the potentiometer and that the bus bar wiper tracks centrally on the throttle valve lever assembly. Lock the transducer securing screws.

(5) Using a spring balance, check that the tension of the wiper arm to the potentiometer is 20 to 30 grammes.

84. *Actuator cylinder* (*fig.* 12). Assemble and fit the actuator cylinder as follows:—

(1) Fit four new 'O' seals (63) to the actuator cylinder (62), fit the rubber and nylon seal in the narrow end of the actuator cylinder.

(2) Locate a new 'O' seal to the external groove of the 'O' seal housing (52) and the rubber and nylon seals to the inside of the 'O' seal housing. Assemble the housing to the threaded end of the actuator piston (54).

(3) Insert the actuator piston into the actuator cylinder.

(4) Fit the tabwasher and the retaining screw (45), tighten the retaining screw and lock it with the tabwasher, ensuring that the tabs are central to the flats of the retaining screws.

(5) Fit the actuator piston stop (44), tabwashers and thimble nut but do not tighten the thimble nut at this stage.

(6) Insert the actuator cylinder into the motor housing and secure it with the nuts and washers. Connect the swashplate link (93) to the actuator piston with the clevis pin, washers and split pin.

85. *Motor rotor assembly* (*fig.* 12). Fit the motor rotor assembly as follows:—

(1) Locate the port insert (77) ensuring that its top is parallel with the datum face and its cut-out fitting around the locating pin. Fit the port insert retaining plate (78) and secure the plate with the two 4 BA screws. Lock the screws by peening.

(2) Insert the motor bearing into the motor housing, locate the bearing retaining sleeve and secure it with the three 4 BA screws and tabwashers. Lock the tabwashers ensuring that the tabs are central on the flats of the screws.

(3) Ensure that the piston and pad assemblies (89) are in their correct numbered positions relative to the rotor.

(4) Using special tool B.T.2049 insert the motor rotor assembly into the motor housing, making contact with the port insert.

(5) Position the swashplate trunnions (91)

on the swashplate journals, assemble the swashplate (92) to the motor housing and secure each trunnion with the 4 BA screw and tabwasher.

(6) Connect the swashplate to the swashplate link with the clevis pin, washers and split pin.

86. *Swashplate spring sleeve* (*fig.* 12). Assemble and fit the swashplate spring sleeve as follows:—

(1) Assemble the spring sleeve bush (2), spring (3) spring rod washer (4) and the swashplate spring rod (1) to the spring sleeve (6).

(2) Insert the assembly into the motor housing, passing the rod through the bush in the motor housing.

(3) Fit the spherical washer, thin nut, tabwasher and plain nut to the actuator spring rod and then screw down the nuts.

87. *Swashplate angle adjustment* (*fig.* 12). Adjust the angle of the swashplate as follows:—

(1) Move the actuator piston to the limit of its travel giving maximum swashplate angle, measure the angle of the swashplate in relation to the motor housing/gear housing joint face using a protractor. Adjust the angle to 15 deg. by means of the actuator piston stop (44). When the correct angle is obtained, tighten the actuator piston stop and lock it with the tabwasher and the thimble nut (43).

(2) Locate the actuator cylinder cover (46) and temporarily secure it. Move the actuator piston to the forward end of its travel (i.e. with the thimle nut abutting the boss of the actuator cylinder cover) and measure the minimum swashplate angle.

(3) Adjust the minimum swashplate angle to 8 deg. by shims (47) located between the actuator cylinder face and the actuator cylinder cover.

(4) When the correct angle has been achieved, remove the actuator cylinder cover, locate a new 'O' seal (51), assemble the actuator cylinder cover to the actuator cylinder and secure it with the nuts and washers. Lock the nuts with 22 s.w.g. wire.

(5) Set the swashplate at its maximum angle and adjust on the swashplate spring rod until the head of the spring rod (1) is 0·125 in below the face of the swashplate spring sleeve (6). Tighten the plain nut onto the thin nut ensuring that the thin nut does not move in relation to the spring rod. Lock the nuts with the tabwasher.

(6) Fit a new 'O' seal (23) to the swashplate spring cover (24), locate the cover and secure it with the washers and nuts. Lock the nuts with 22 s.w.g. wire.

88. *Gear housing* (*fig.* 11). Assemble the gear housing as follows:—

(1) Insert the selector valve sleeve (26) into the gear housing and secure it with the two 4 BA screws. Lock the screws by peening.

(2) Insert the servo piston (17) and spring into the servo cylinder (19), connect the servo link (20) to the servo piston with the clevis pin ensuring that a washer is placed under the head of the pin. Lock the clevis pin with a new split pin.

(3) Fit two new 'O' seals to the servo cylinder, insert the cylinder into the gear housing and secure it with the five 4BA screws. Lock the screws by peening.

(4) Fit the bearing (31) into the scavenge pump body (32) and retain the bearing by peening over the pump body by inserting a centre punch through the holes provided and tapping lightly.

(5) Support the inner race of the bearing and fit the shaft pump drive gear into the bearing.

(6) Locate the idler gear and fit the pump plate.

(7) Insert the scavenge pump into the gear housing, locate the transfer pipe and secure the assembly with the two tabwashers and four screws. Lock the screws with the tabwashers.

(8) Insert the key into its slot in the shaft of the pump drive gear; fit the scavenge pump input gear (30) to the shaft and secure the gear with the tabwasher and nut. Lock the tabwasher to the input gear and nut.

(9) Revolve the scavenge pump to ensure that it operates freely. If the pump does not revolve freely, a gentle tap with a soft drift at either end of the drive gear shaft should rectify this. The hidden end of the drive gear is accessible by inserting a 0·125 in. drift through the hole in the bronze segment on the inside of the gear housing.

(10) Fit four new 'O' seals to the transfer tube (24) and insert the transfer tube into the gear housing.

(11) Fit two new 'O' seals to the sealing sleeve (28) and locate the sleeve around the scavenge pump.

89. *Gear housing to motor housing* (*fig.* 11). Assemble the gear housing to the motor housing as follows:—

(1) Fit a new 'O' seal to the groove of the motor housing.

(2) Locate the gear housing to the motor housing ensuring that the servo link does not foul.

(3) Press the gear housing into the motor housing until the six securing nuts and washers can be fitted. Tighten the nuts evenly and when fully tightened, lock them together with 22 s.w.g. wire.

(4) Press the roller bearing (21) into its housing. Locate the lip seal (15) ensuring that the open end of the lip seal faces the motor housing. Position the lip seal and retaining plate and secure in position with the four screws. Lock the screws by peening metal into the slots.

(5) Connect the servo link (20) to the throttle lever with the clevis pin, ensuring that a plain washer is placed beneath the head of the pin. Secure the clevis pin with a new split pin.

(6) Insert the selector valve assembly (25) into the selector valve sleeve and screw the threaded end of the assembly into the tapped hole in the transducer lever. Adjust the selector valve and the throttle valve to their mid-positions and tighten the set screws on the transducer lever.

(7) Fit a new 'O' seal to the selector valve cap, position the cap and secure it with the the two screws and tabwashers. Lock the screws with the tabwashers.

(8) Locate the motor gear and secure it with the bolt and tabwasher. Lock the bolt with the tabwasher.

(9) Fit a new 'O' seal to the transducer chamber cover, position the cover and retain it with four screws and washers.

90. *Gear support plate to gear housing* (*fig.* 11). Assemble the gear support plate to the gear housing as follows:—

(1) Fit the generator pinion and lubricating jet and peen to lock, using special tools B.T.2050 and B.T.2051 respectively.

(2) Fit the bearings (43) and (45) to the generator pinion (44).

(3) Locate the circlip (42) into its groove in the pinion housing.

(4) Press the pinion and bearings into the pinion housing ensuring that the chamfered ends of the internal splines of the pinion face the generator. Retain the assembly with the circlip (1).

(5) Assemble the layshaft pinion (37) to the layshaft and fit the layshaft bearings (36) and (46).

(6) Position the layshaft assembly to the gear support plate and press the layshaft bearing housing (47) into the gear support plate and over the layshaft bearing (46). Secure the bearing housing with three screws and lock the screws by peening metal into the slots.

(7) Fit two new 'O' seals to the pressure reducing valve assembly, locate the assembly into the gear support plate and retain the assembly with the two screws. Lock the screws with 22 s.w.g. wire.

(8) Fit a new 'O' seal to the jet pedestal (41), position the pedestal and secure it with the two screws locked with tabwashers.

(9) Assemble the gear support plate to the gear housing ensuring correct entry of the

transfer tube and dowel, and correct meshing of gears. Carefully press the gear support plate home and secure it with two nuts locked by 22 s.w.g. wire and a bolt and nut locked by a split pin.

(10) Ensure that the gears revolve freely. If the gears do not revolve freely, lightly tap the end of the layshaft with a soft drift.

(11) Check the clearance between the rotor stop (4) and the motor gear retaining bolt. There must be a clearance of 0·002 in. to ensure the correct end float of the rotor assembly. The clearance may be adjusted by shims (5) placed between the rotor stop and the gear support plate.

(12) Fit the generator lubricating jet and jet extension (10) and lock it with the tabwasher.

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

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

(2) Align the motor with the generator, ensuring that the generator is correctly positioned relative to the mark TOP on the motor housing, fit the twelve 2 BA nuts and washers, tighten the nuts evenly and lock them with 22 s.w.g. wire.

TESTING

General

92. The information contained in para. 105 to para. 125 applies to the testing of B504A, B and C generating systems, i.e. a.c. generators and their associated control units and junction boxes, when removed from the aircraft installations they supply. The tests are designed to simulate the service conditions in which the generating systems operate.

93. Information relating to the following characteristics of generating systems 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 117V r.m.s.

(3) The configuration of the sinusoidal output waveform.

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

(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 is 'crash started'.

(10) The efficiency of the generator scavenge pump.

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

94. 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 separately in accordance with the instructions detailed in A.P.4343B, Vol. 1, Book 2, Sect. 8, Chap. 6.

95. Operators should follow, during testing the sequence of operations laid down in the relevant servicing schedules in conjunction with which the information contained in the current section of this chapter should be read.

Hydraulic supplies

96. The B504A generating system (R.A.F.) is supplied with hydraulic fluid under the required pressures by the H.M.L. Hydraulic Test Bench Ref. No. 4G/6087. The B504B and C generating systems are supplied by the H.M.L. test rig (Hydraulic Bench Supply) Ref. No. 10S/17252. Information on both these installations is given in A.P.4743. It is essential that all operators who are responible for testing the B504 series of a.c. generating system should be conversant with the operating instructions relating to these installations in order that subsequent references

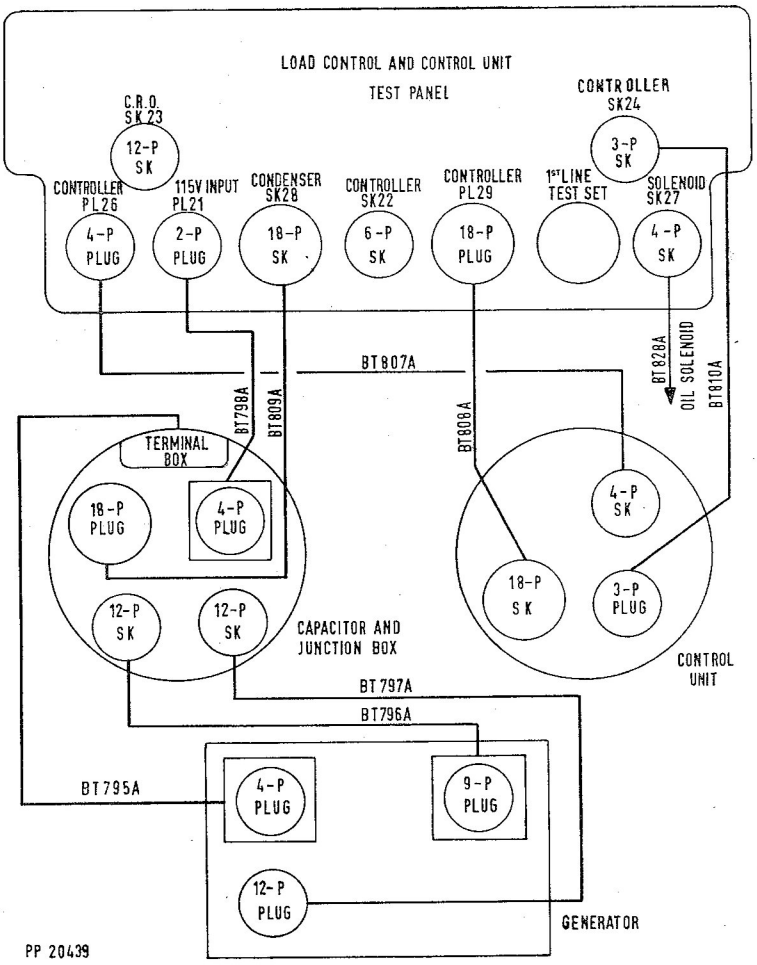


Fig. 10. Interconnections between generator and test panel

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 a.c. generators under test

97. There are two methods of starting and stopping the a.c. generators under test:—

(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.

98. 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. 105 to 108.

Working temperatures

99. 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

100. The following items of test equipment

and/or supplies are required when testing the B504 series 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 (R.A.F.).

(3) H.M.L. test rig (Hydraulic Bench Supply) a.c. Type 6664, Ref. No. 10S/17252 (R.N.).

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

(5) Control Unit Ref. No. 5UB/6113.

(6) Flexible hose for hydraulic connections.

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

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

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

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

(11) Water cooling supply for hydraulic test benches at 10 gal/min (approx.).

(12) Sea water cooling supply, 3–4 gal/min at 40–100 lb/in² (R.N., as necessary).

(13) Oil pressure gauge 0–50 lb/in².

(14) Oil measuring container(s).

(15) Regulating valve.

(16) Stop watch.

(17) Load unit (air or water cooled).

Test preparations

General

101. The preparations necessary for testing vary according to the type of a.c. generator being tested and therefore the type B504A test preparations are separated from those necessary for Types B504B and C. Where preparations are common to all three types details are given under a common heading: the order in which the preparations are made is decided by the relevant servicing schedule.

Preparations for testing B504A generators

102. The following operations should be performed:—

(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 scavenge return connection to drain via a pressure gauge (0–50 lb/in².) with the regulating valve connected into the line downstream of the pressure gauge to give the required scavenge pump back pressure (para. 112): ensure that the regulating valve is fully OPEN.

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

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

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

(10) Set the BENCH MANIFOLD SELECTOR to the neutral (central) position.

(11) Set fully open (counter-clockwise:—

(*a*) INCHING CONTROL VALVE.

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

(12) Press the START button.

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

(14) Adjust the H.M.L. ELECTRAULIC FLOW VALVE to the required flow para. 116) as indicated on the ELECTRAULIC FLOW METER.

(15) Set the PRESSURE REGULATOR to 2650 lb/in².

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

Preparations for testing B504B and C generators

103. The following operations should be performed:—

(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 AUX SUPPLY MANIFOLD.

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

(4) Connect the motor pressure gauge connection to EXTERNAL PRESSURE TAPPING POINT NO. 3.

(5) Connect the servo pressure tapping to EXTERNAL PRESSURE TAPPING POINT NO. 1.

(6) Connect the scavenge return connection to a measuring container via the EXTERNAL TAPPING NO. 2 pressure gauge with the regulating valve connected into the line downstream of the pressure gauge to give the required back pressure (para. 112); ensure that the regulating valve is fully OPEN.

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

(8) Connect the electrical power supplies to the test bench.

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

(10) Close the following test bench valves by turnng them fully counter-clockwise:—

(*a*) BENCH MANIFOLD SUPPLY METERING VALVE.

(*b*) AUXILIARY SUPPLY MANIFOLD METERING VALVE.

(*c*) BENCH MANIFOLD UNLOADING VALVE.

(*d*) AUXILIARY SUPPLY MANIFOLD UNLOADING VALVE.

(11) Open the AUXILIARY RETURN LINE PRESSURE CONTROL valve by turning it fully counter-clockwise.

(12) Set the BENCH MANIFOLD PRESSURE VALVE to HIGH PRESSURE 0–3000.

(13) Switch on the a.c. electrical supply.

(14) Switch on:—

(*a*) COOLING WATER CONTROL SWITCH.

(*b*) HEATER CONTROL SWITCH.

(15) Start the test bench motor by pressing MOTOR ON/OFF SWITCH.

(16) Press and hold down the BY-PASS OPERATING SWITCH until the GENERAL SERVICES SUPPLY meter indicates a pressure of 3000 lb/in^2 and then release it.

104. The following operations should be performed and are common to all three types of generating systems:—

(1) Mount the control unit and the capacitor and junction box on the test console B.T.950, using the two pairs of band clamps provided.

(2) Make all electrical cable connections as shown in fig. 10.

(3) Perform the setting up instruction 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

105. This test is made to obtain information of a general nature on the generating system as a whole and to establish its suitability for prolonged testing under varying conditions.

106. Run up the B504A a.c. generator as follows:—

(1) Set ALTERNATOR START to ON.

(2) Ensure that no artificial hydraulic back pressures are possible in the hydraulic system, i.e. in the scavenge pump and motor return lines.

(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.

107. Run up the B504B and C a.c. generators as follows:—

(1) Set ALTERNATOR START to ON.

(2) Ensure that no artificial back pressures are possible in the hydraulic system, i.e. in the scavenge pump and motor return lines.

(3) Start the generator by turning the AUXILIARY SUPPLY MANIFOLD METERING VALVE in a counter-clockwise direction steadily.

(4) Continue (3) until the AUX MANIFOLD SUPPLY meter indicates a pressure of 2650 lb/in².

108. 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.

109. During the generator 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.

110. After the generating system has attained 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 ± 150 c/s or ± 6% (approx.).

111. 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 in the series resonant circuit, located in the capacitor and junction box, exists.

112. Before proceeding with the generator output tests (Table 1) perform the following operations:—

(1) Return the OSCILLATOR RANGE switch to 2330–2470 c/s.

(2) Set the FREQUENCY DEVIATION RANGE switch to ± 2%.

(3) Impose a back pressure of 35 lb/in² on the return hydraulic line of the scavenge pump.

B504 series generator output tests

113. 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 requires that a separate run up is made under the conditions specified: back pressures should not be applied until the generator has run up.

114. 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.

Note . . .

(1) *The maximum frequency hunt (Table 2) should not exceed ± 12 c/s within a periodicity of 1 second.*

(2) *The output frequency may be adjusted by rotating 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.*

TABLE 1

Output test conditions

Test	Inlet pressure lb/in²	Outlet back pressure lb/in²	Load (watts)
1	2650	100	3000
2	2950	35	3000
3	2950	35	1000
4	2950	35	350
5	2650	35	350

TABLE 2

Required results of output tests

Test	Frequency deviation from 2·4 kc/s (See Note 1)	Voltage deviation from 117V R.M.S.	Harmonic content
1	± 1%	± 1%	
2	± 1%	± 1%	Not greater than 6%
3	± 1%	± 1%	
4	± 2%	± 2%	
5	± 2%	± 2%	

Waveform test

115. 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 five undistorted sinusoidal waveforms of equal amplitude, the permissible level of harmonic distortion (Table 2) being indicated on the HARMONIC DISTORTION METER.

Hydraulic fluid flow test

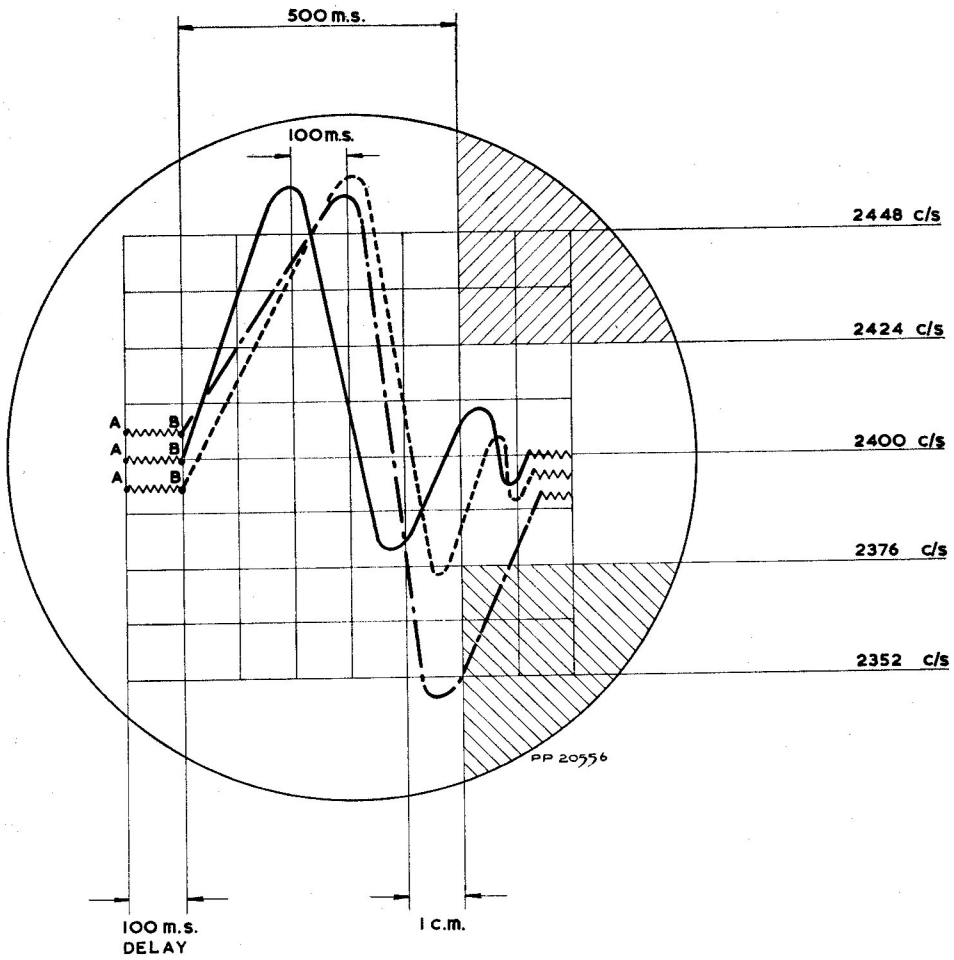
116. During the progress of the tests specified in Table 1 it is necessary to measure the rate of flow of hydraulic fluid. These measurements, made by using measuring containers for scavenge pump outputs or the relevant indicators for the generator motor inputs are the following:—

(1) Motor inlet fluid flow: this flow should be at the rate of not greater than 300 gal/hr in any combination of conditions.

(2) Scavenge pump fluid return flow: this flow should be at a rate of not less than 1·5 gal/hr.

Frequency transient response test

117. 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. These 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.



KEY

A — TRIGGER POINT

B — LOAD CHANGE POINT

——————— IDEAL IMAGE

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

——— · ——— · ——— UNACCEPTABLE IMAGE

Fig. 10A. Transient response—Oscilloscope display

118. The pre-conditions for making 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 artificial back pressures are possible in the hydraulic system, i.e. in the scavenge pump and motor return lines.

(3) Run up the generator (para. 106–108) 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.

119. Conduct 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.

(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 INITIATE AUTO LOAD 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. 10A).

120. For decreased load frequency transient response tests (from 1500W to 1000W) the procedure is identical with that for increased load transient response 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

121. This test proves the capability of the generating system to contain within a pre-determined period the effects of instantaneous hydraulic oil pressure in the motor generator, thus simulating the conditions to be met in operational service (para. 97 and 98).

122. To perform a 'crash start' test the following operations are necessary:—

(1) Run up the generator manually as in para. 106 and/or 107, to a pressure of 2650 lb/in² using a load of 3000W ON DIRECT.

Note . . .

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

(2) Obtain a stationary 1 to 1 Lissajous figure as in para. 110 and ensure that the output frequency is at 2·4 kc/s ± 1%.

(3) Stop the generator by operating the relevant test bench switch, i.e. one or other of:—

(*a*) No. 2 MANIFOLD NEEDLE VALVE (B504A generators, R.A.F.).

(*b*) AUXILIARY MANIFOLD SOLENOID SWITCH (B504B and C generators, R.N.).

(4) Set the ALTERNATOR START switch to OFF.

(5) Return the relevant test bench solenoid switch to its previous position.

(6) Perform the following operations simultaneously:—

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

(*b*) Start the stop watch.

123. A satisfactory 'crash start' should result in the C.R.T. Lissajous figure display returning to a stationary position within a period of 9 seconds. The 'crash start' test should be repeated three times to a load of 3000W ON DIRECT.

124. A further three 'crash start' tests should be made, using a load of 1000W ON DIRECT.

Generator load current test

125. 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 MILLIAMP 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 3000W the reading should be 25·6A and on a load of 1000W, 8·5A.

INTERCHANGEABILITY OF TYPES B.504B and B.504C MOTOR-GENERATORS

126. *General.* Types B.504B and B.504C motor-generators differ in that the generators are fitted in different positions relative to the hydraulic motor. When it is necessary for one type to be converted to the other, it is essential that the front bearing retaining plate is correctly aligned with the oil jet on the gear support plate in accordance with the procedure detailed in para. 127 to 131. If this is not done, the bearing will be starved of lubrication and it is also possible for the jet to suffer physical damage.

127. *Separation of generator from motor.* Remove the locking wire and the twelve nuts securing the two assemblies and lift the generator from the motor. If separation is difficult, three of the nuts should be replaced 120 deg apart and suitable distance pieces inserted between them and the motor casing. The nuts should then be unscrewed evenly so as to force the two assemblies apart.

128. *Repositioning generators Post-Mod. Elec. A/226.* Remove the six screws securing the front bearing retaining plate and turn the plate through 180 deg. so that its tongue is aligned with the etched B or C as appropriate on the end plate. Replace the retaining plate and secure it with the six screws which should be locked by peening.

129. *Repositioning generators Pre-Mod. Elec. A/226.* Remove the two countersunk screws securing the end plate, remove the end plate, turn it through 180 deg. and replace it securing with the two countersunk screws.

130. *Refitting generator to motor.* The generator should be replaced so that the milled flat on the bearing retaining plate is correctly aligned with the lubrication jet on the gear support plate of the motor. In this

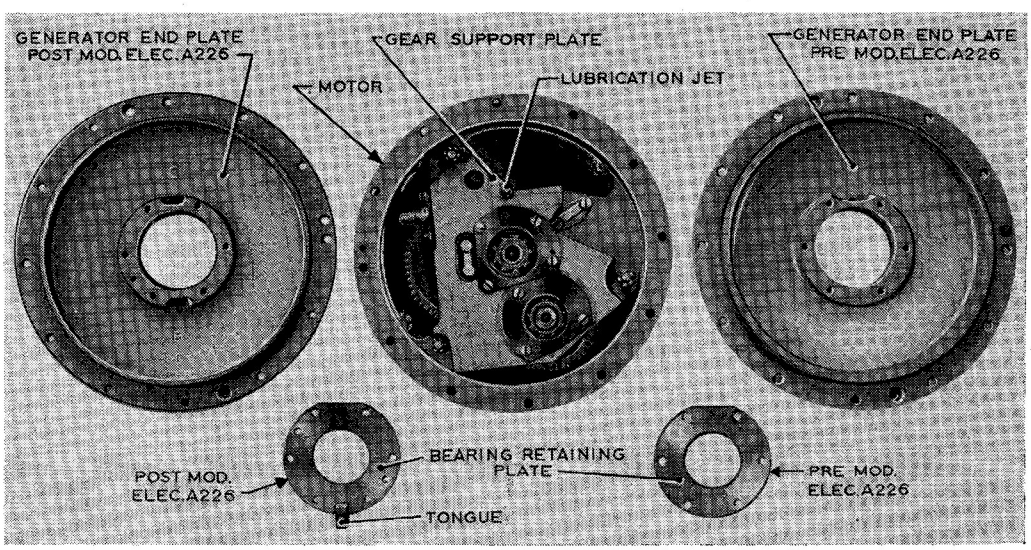
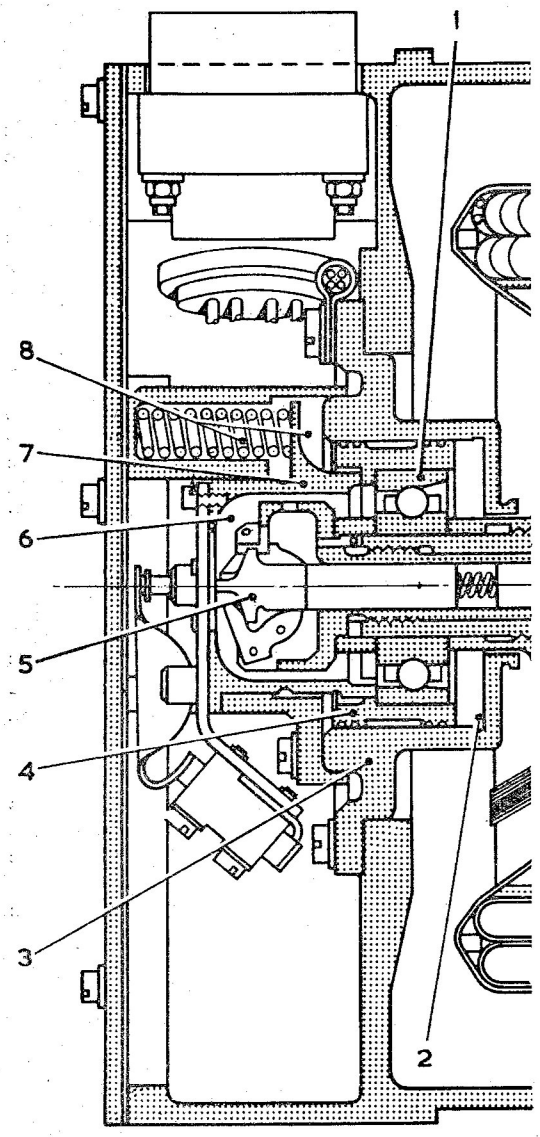


Fig. 10B. Components affecting interchangeability of generators (B.504 B & C)



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. 10C. Grease lubrication of rear bearing assembly

position the 12-pole connector on the generator will be displaced 67½ deg. from the TOP marking on the hydraulic motor for the Type B.504B machines and 247½ deg. for the Type B.504C.

Note . . .

Whenever the generator is separated from the motor, precautions should be taken to prevent the lubricating oil jet being obstructed by dirt or foreign matter. In no circumstances should the generator be fitted to the motor without ensuring that the lubricating jet is aligned correctly with the flat on the bearing retaining plate.

131. The twelve securing nuts and their washers should be replaced and after the nuts have been tightened evenly they should be wire-locked. Where necessary the Type number should be painted over and the correct number substituted using opaque lacquer (Ref. No. 33B/809).

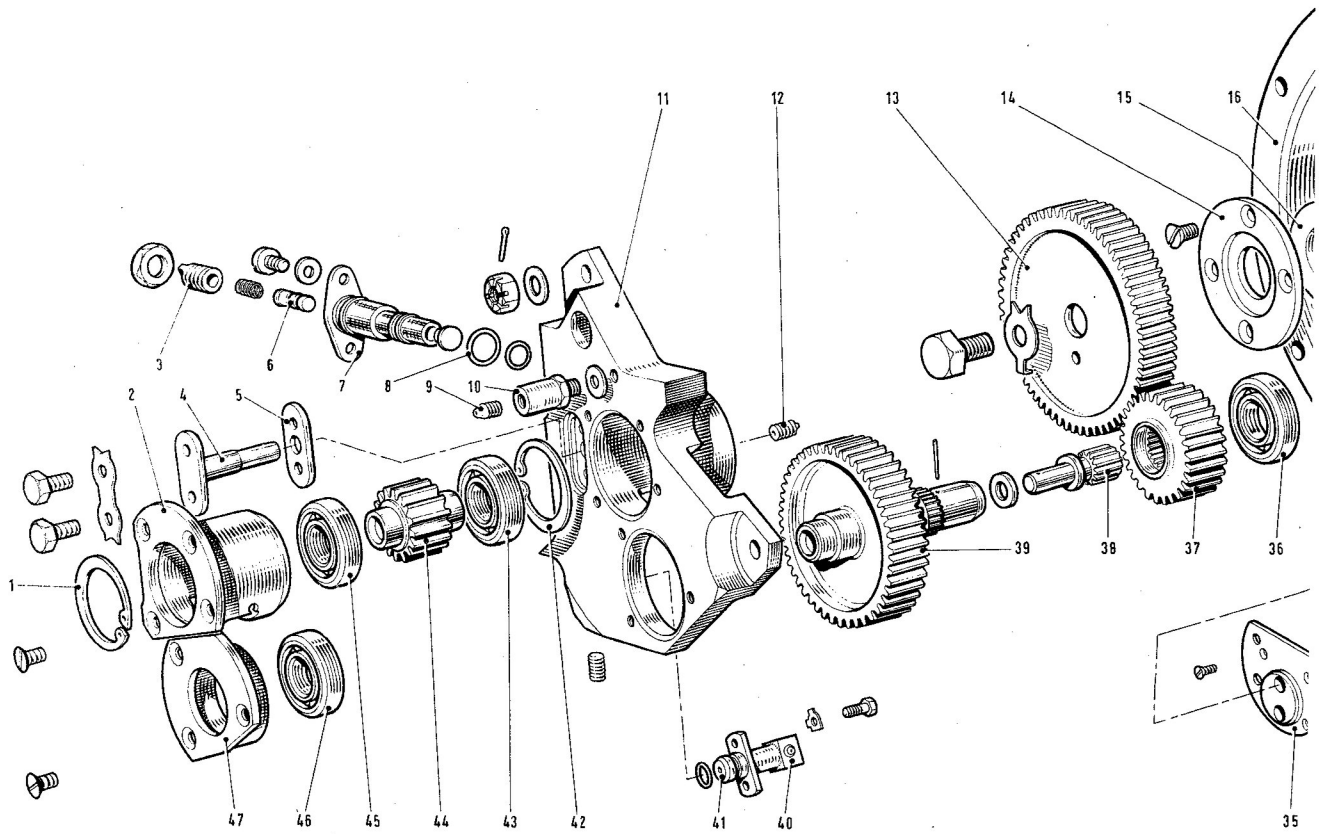


Fig.11

Gear Housing (exploded view

RESTRICTED

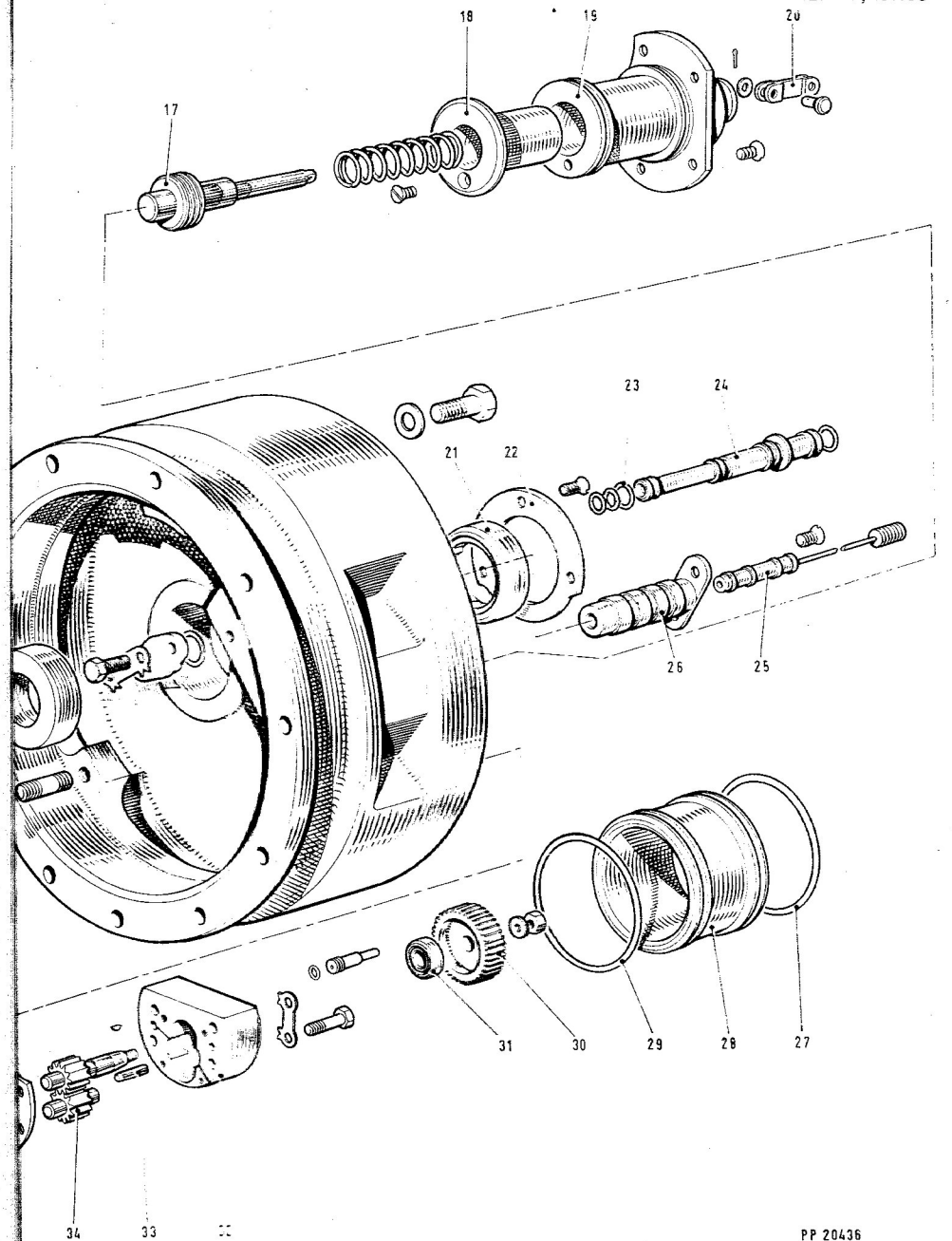


Fig.11

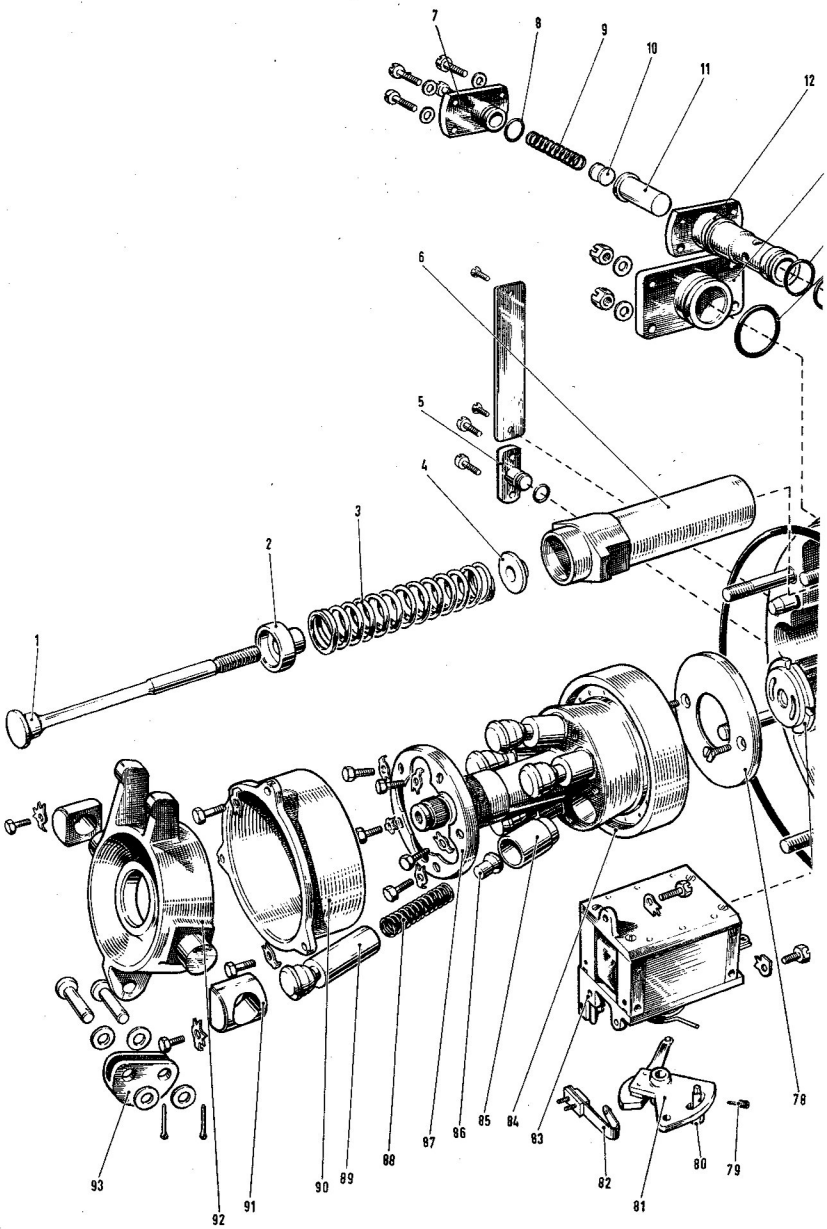


Fig.12

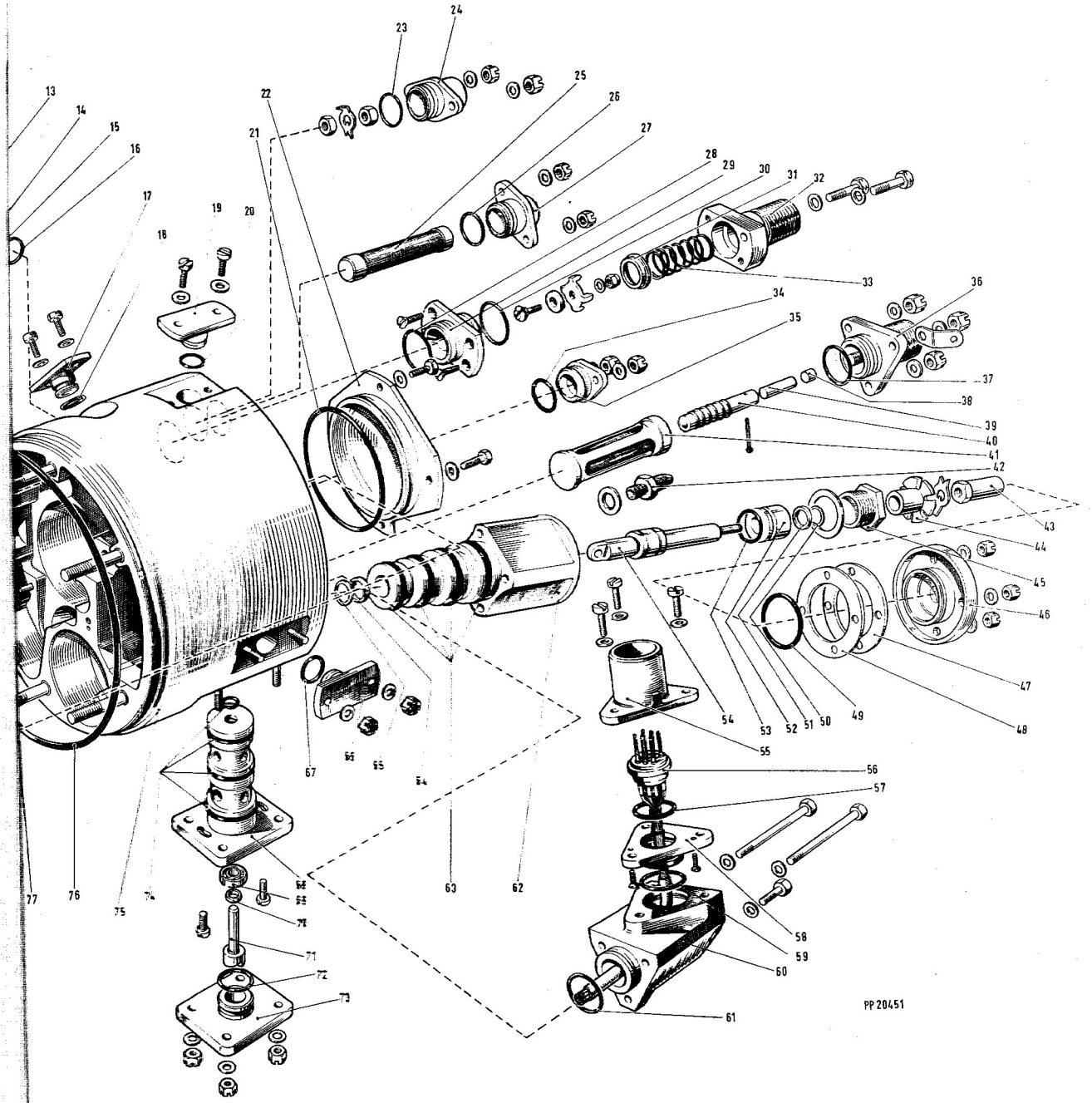


Fig.12

Hydraulic Motor (exploded view)