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Chapter 20

AIR TURBINE DRIVEN ALTERNATOR, TYPE ATDE.202

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Turbo-alternator, Type ATDE.202	**Ref. No. 5UA/7154**
Alternator details	
Main winding	*200V, 3-phase 400 c/s star connected*
Auxiliary winding	*30V, 3-phase, 400 c/s, delta connected*
Output power	*15kVA at 0·8 p.f.*
Operating conditions	
Operating speed	*2400 rev/min ± 2 per cent*
Frequency	*400 c/s*
Limiting speed	*28200 ± 600 rev/min*
Frequency	*470 ± 10 c/s*
Brush grade	*K.C.E.G.11*
New brush length	*0·8 in.*
Minimum brush length (on shortest side)	◄*0·6 in.*►
Air inlet temperature (max.)	*340°C*
Air inlet pressure (max.)	*145 lb/in²*
Rotation (viewed from turbine end)	*Clockwise*
Lubrication	
Oil	*OX-38*
Oil capacity (turbo-alternator)	*5 pints*
Oil capacity (accumulator)	*0·3 pints*
Approximate dimensions	
Length overall	*22 in.*
Height overall	*18·5 in.*
Width overall	*13·5 in.*
Weight (dry)	*112 lb.*

Introduction

1. The turbo-alternator is of unit construction, the alternator rotor being driven direct by the air turbine from air supplied by the compressor of the aircraft gas turbine. Provision has been made for cooling air to be introduced to isolate thermally the alternator from the turbine.

2. Speed control and, therefore, alternator output frequency is effected by a self-contained, hydraulically-operated governing system. Oil for the system and for the lubrication of bearings and gears is contained in a sump formed in the lower portion of the alternator main casing. The governor unit, a hydraulic accumulator for inverted flight and a filter are also accommodated in the alternator main casing.

3. The turbo-alternator consists primarily of the turbine, alternator and governor unit. The turbine and the alternator produce the power and the governor unit, which is driven

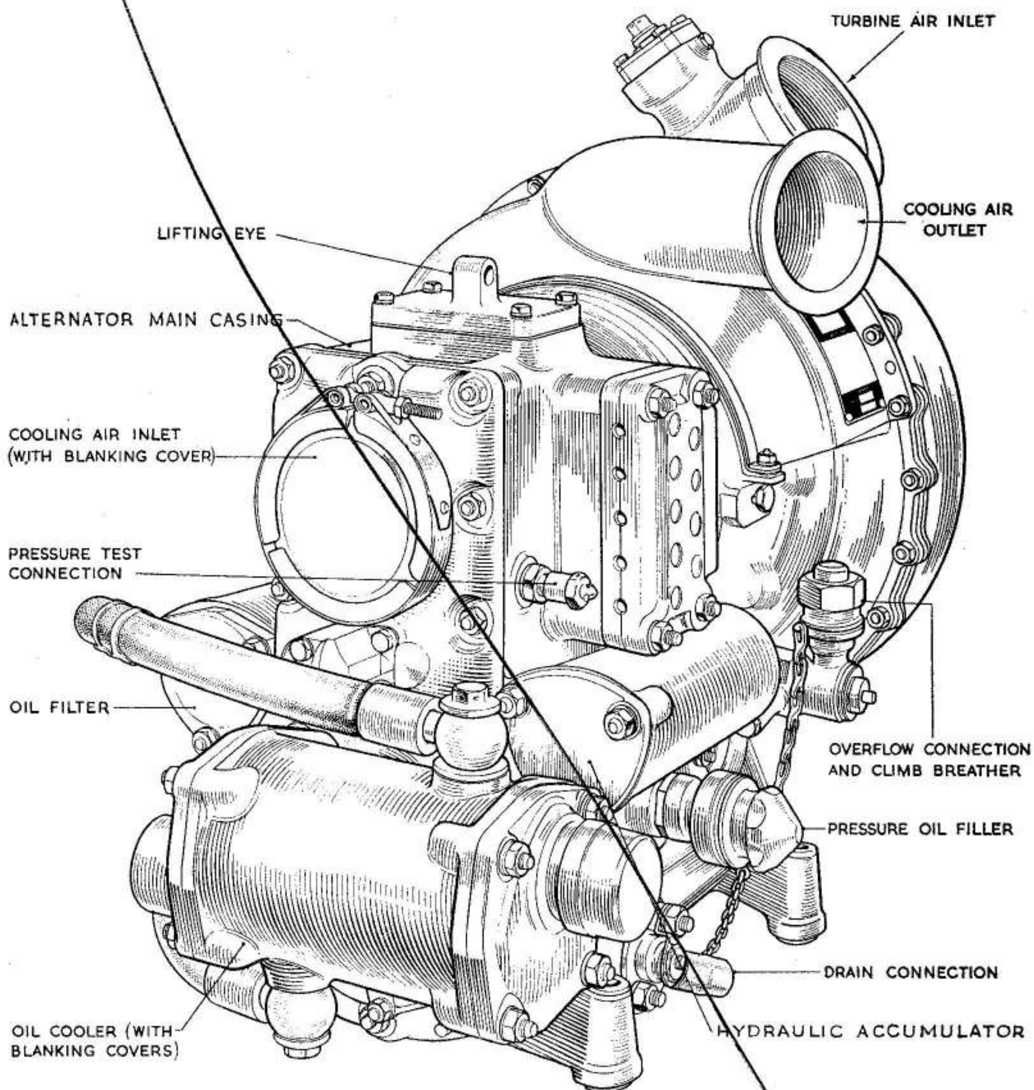


Fig. 1. Turbo-alternator, Type ATDE.202 (alternator end)

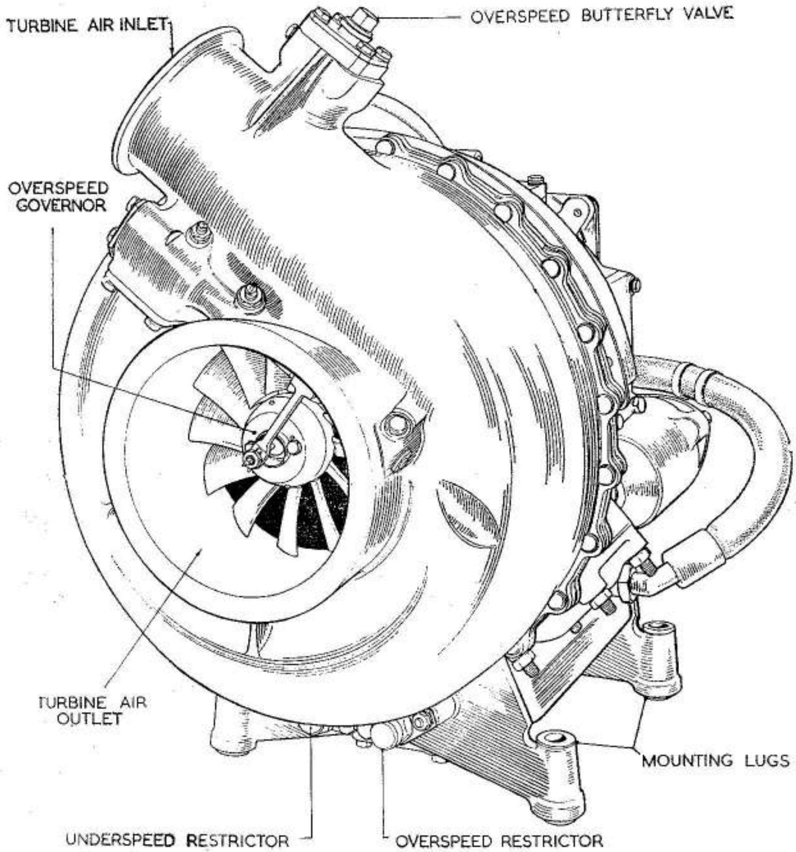


Fig. 2. Turbo-alternator, Type ATDE.202 (turbine end)

through a reduction gear (0·256 : 1) from the pinion end of the rotor shaft, controls the speed of the turbine and the alternator.

DESCRIPTION

General

4. The turbo-alternator comprises the following major groups:—alternator main casing, rotor, turbine, idler gear, reduction gear cover and governor unit.

5. The turbine wheel is mounted on the rotor shaft and a pinion on this shaft drives the governor unit through a reduction gear. The hydraulic system is operated by oil supplied by two gear-type pumps. The governor unit is mechanically linked to nozzle vanes which control the supply of air to the turbine wheel.

Alternator main casing group

6. This group consists of a main casing, alternator stator, brush gear, hydraulic accumulator, oil filter, oil filler and oil level indicator.

7. The stator and brush gear are housed in the upper portion of the main casing whilst the lower part, which forms the oil sump, accommodates the governor unit. The casing is externally finned in the region of the sump to dissipate heat. One end face of the casing receives the reduction gear cover, the other

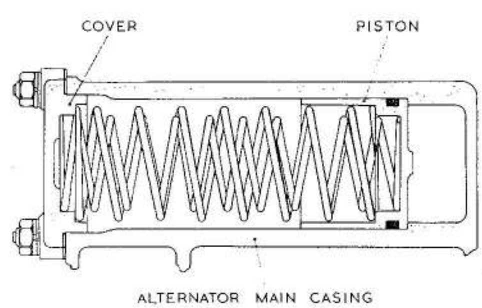


Fig. 3. Hydraulic accumulator

end face the turbine group. Two similar bosses formed one on each side of the main casing provide the housings for the oil filter assembly and the hydraulic accumulator. The pressure oil filler, drain connection and oil level indicator are all positioned on that side of the casing, which contains the hydraulic accumulator.

8. The sump drain connection consists of a mushroom-type valve actuated by a valve drain bolt with left-hand external thread so that turning the bolt in a counter-clockwise direction opens the drain. It is secured in the closed position by a locking plate attached to a casing stud.

9. The hydraulic accumulator (*fig.* 3) consists of a piston with a single sealing ring, spring-loaded towards the end of the cylinder which is connected to the low pressure oil supply. At this end of the cylinder, a step acts as the piston stop. The cover at the opposite end of the cylinder is recessed on the inside to locate the two coil springs which load the piston. The purpose of the hydraulic accumulator is to maintain an adequate supply of oil to the high pressure pump in the event of the low pressure pump being temporarily starved under negative-g conditions.

10. The oil filter assembly (*fig.* 4) is located at one end by an insert in the casing while the opposite end bears against the filter cover which retains it in position. An air transfer bobbin fitted through the filter assembly ensures a balance of air pressure and, therefore, an even oil level in the sump at both ends of the governor unit. An oil seal is fitted to one end of the bobbin and the opposite end of the bobbin fits through a seal retained in the filter cover.

11. The pressure oil filler is a Lockhead-Avery type self-sealing coupling with blanking cap. To avoid the possibility of the cap being mislaid it is connected by a short chain to an adjacent stud on the oil level indicator.

12. The oil level indicator body locates with an aperture in the wall of the main casing sump at normal oil level which may be viewed through a toughened glass window against an indicator plate. The latter has two graduations, the lower marked refill and the higher full-cold. An overflow connection, consisting of a union body with a stack pipe attached to one end, is screwed into the indicator body so that the height of the stack pipe is fractionally below the correct sump oil level. The outer threaded portion of the union body is fitted with a blanking cap. When filling the sump the blanking cap is removed and oil is pumped in through the pressure filler until it overflows from this connection.

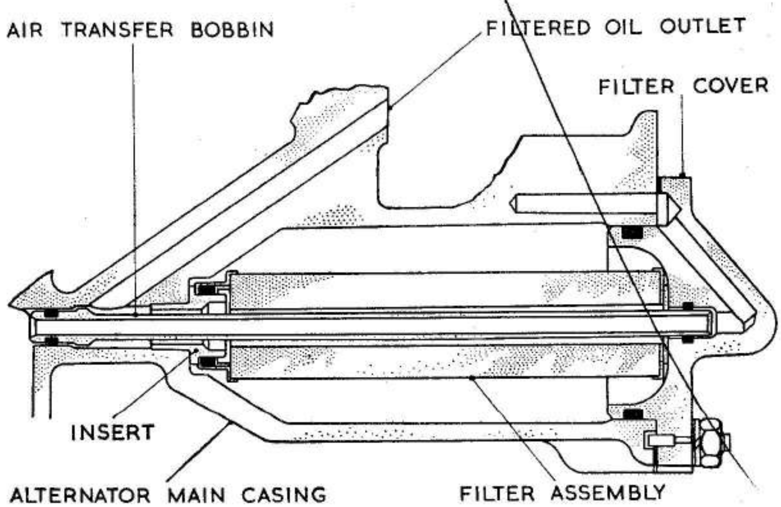


Fig. 4. Oil filter

13. Adjustable overspeed and underspeed restrictors are positioned at the turbine end of the main casing sump to restrict the oil displaced by the integrating piston of the governor unit. Inter-connection between the externally mounted restrictors and the governor unit, which is contained within the sump, is via transfer bobbins each fitted with a sealing ring at either end. These restrictors are initially set during rig test to ensure optimum stability of the governing system and should not normally require further adjustment in service.

14. The stator laminations are held together by a spun-over, outer metal cup. The windings are insulated from the stampings and impregnated with insulating materials. Three concentric rows of cooling slots pass through the outer portion of the stator pack and these are connected by metal spinnings at each face of the pack so that the cooling air enters the outer row, passes back along the middle row and leaves by the inner row.

15. Access to the alternator brush gear is obtained by removing two brush block cover plates from the main casing. The upper brush block cover incorporates a lifting eye and both brush block covers are fitted with insulators. The brushes are hexagonal in section and are housed in pairs, in two brush blocks. The two brush gear assemblies are used to carry the total excitation current.

Rotor group

16. This group consists of a the rotor assembly, overspeed governor assembly and the turbine exducer and wheel assembly. The rotor is of the 2-pole cylindrical type and the shaft runs in a ball bearing at the turbine wheel end and in a roller bearing at the opposite end. The alternator rotor and slip-ring assembly is integral with the shaft which is dynamically balanced after winding; further balancing is effected after the turbine wheel is fitted. Adjacent to the slipring are a stainless steel distance piece, inner race of the roller bearing and an helical pinion, all of which are secured on the shaft by a ring nut and cup-washer. The pinion is keyed to the shaft, which is sealed at this end by a spring bobbin.

17. The turbine exducer and turbine wheel each have thirteen blades. Both components are internally splined and are together retained on the rotor shaft splines by the governor weight carrier of the overspeed governor assembly which is screwed into the rotor shaft.

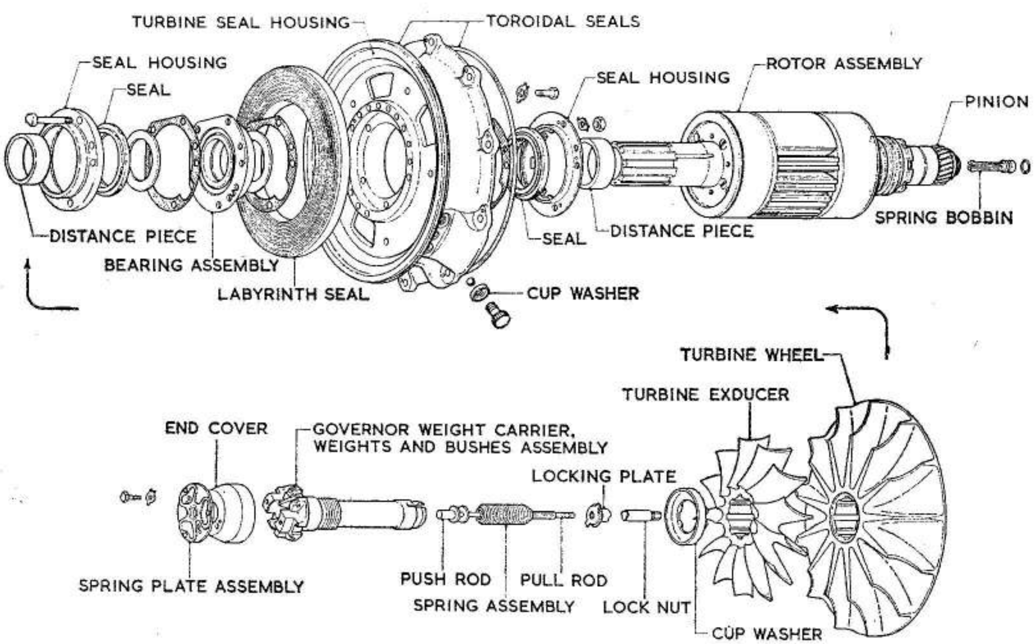


Fig. 5. Rotor assembly

18. The ball bearing assembly, with a housed seal and a gasket on each side fits into the turbine seal housing and is retained by five D-headed bolts with nuts, locked by tabwashers. At the bottom of the seal housing are three plugs, each of which retains a ball in a passage in the housing. During inverted flight the balls move to opposite ends of the passages and close the oilways leading from the sump, thus preventing loss of oil which would result in failure of the governor unit due to oil starvation.

19. A labyrinth seal, to limit the flow of hot air from the turbine to the alternator, is fitted at the rear of the turbine wheel and is secured to the turbine seal housing by five bolts.

20. The overspeed governor assembly is a mechanical device operated by fly weights and closes a butterfly valve in the inlet of the turbine volute in the event of an accidental overspeed. The assembly is housed in the turbine end of the rotor shaft. Two spring-loaded fly weights each oscillates on a pin in the governor weight carrier and the toes of the weights engage with the integral collar of a pushrod attached to one end of a tension spring, contained within the governor weight carrier. A pullrod at the opposite end of the spring is retained by a serrated locking plate which engages with a dogged locknut. The locking plate locates in slots in the end of the governor weight carrier and correct loading of the spring is achieved by adjustment of the locknut. The outer end of the pushrod is supported in a bush, flexibly mounted in a spring plate secured together with the end cover to the governor weight carrier.

Turbine group

21. This group primarily consists of a torus, lever and brush assembly, part of the butterfly valve' mechanism and the nozzle vane setting assembly; the two assemblies are bolted to the alternator main casing. Shims fitted between the nozzle vane housing and alternator main casing ensure correct clearance between the nozzle vanes and the turbine wheel.

22. The torus, which surrounds the turbine exducer, houses two bushes for the spindle operating the butterfly valve mechanism. A lever, pinned to centre of the spindle, has an adjusting screw which contacts the pushrod of the overspeed governor assembly. A spring-loaded cam lever assembly at the outer end of the spindle engages with a cut-away sector in the head of the butterfly shaft to retain the valve in the normal open position.

23. The butterfly valve is located by a master serration on its shaft, which is mounted in two ball bearings housed in the torus inlet. A torsion spring loads the valve towards the closed position so that when the cam lever is disengaged from the head of the shaft by action of the overspeed governor, the valve is rapidly closed.

24. The nozzle vane housing has twenty-five bearing housing assemblies, each of which is retained by a taper pin. The bearing housing assemblies incorporate two ball bearings for the nozzle vane shaft. A lever assembly on each shaft is fitted with a monel rivet which engages with a slot in an actuating ring. A larger slot in the ring engages with an actuating crank shaft which transfers movement of the governor servo piston to the ring and hence to the nozzle vanes. Two adjusting screws permit the correct positioning of the crank. A slotted support ring surrounds the nozzle vanes to maintain the correct working clearance of the vanes.

Idler gear group

25. This group consists of an helical idler gear fitted with an oil deflector and runs in two ball bearings, one housed in the main casing and the other in the reduction gear cover.

Reduction gear cover group

26. The reduction gear cover is secured on the studded end face of the main casing and is located by two hollow dowels. The bearing housing for one ball bearing of the idler gear group is accommodated in a bore in the inner side of the cover. On the outer side of the cover is bolted a breather connection which also retains the idler gear shaft oil seal in position.

27. An oil trap and key assembly and an oil filter assembly surround the driver gear of the governor unit and are retained in position by the oil cooler assembly.

28. A removable cover plate and seal in alignment with the end of the rotor shaft

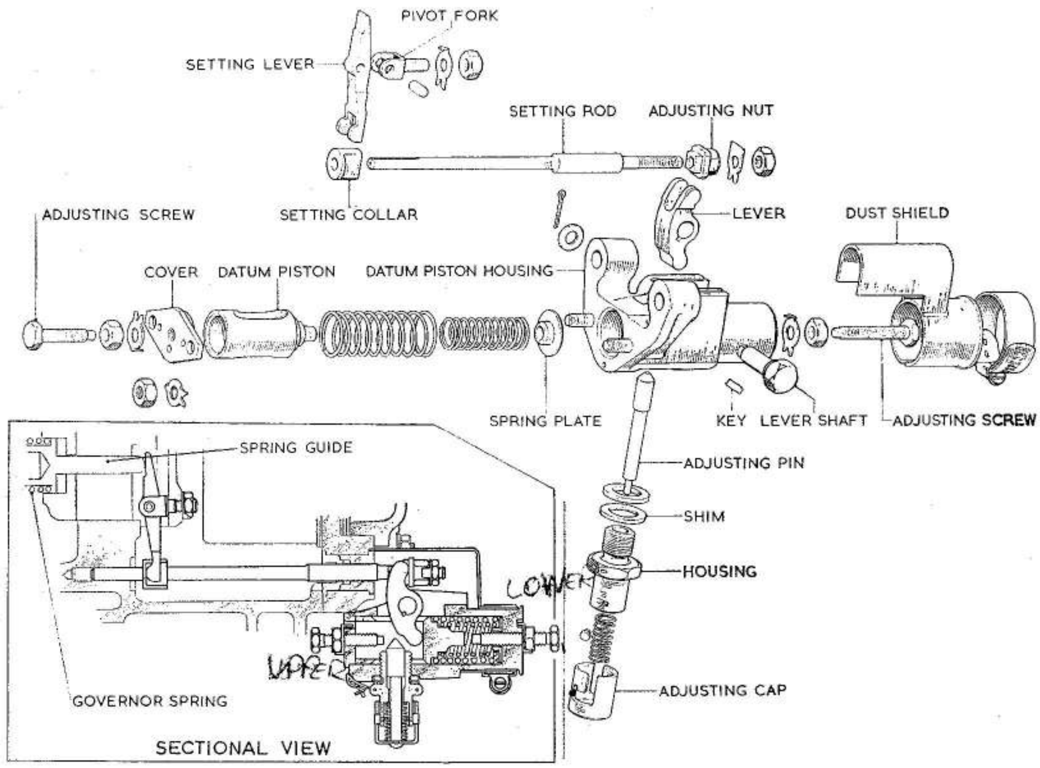


Fig. 6. Governor manual control

provides access to the spring bobbin which blanks off this end of the shaft. Removal of the bobbin is necessary when adjustment of the overspeed governor is required.

Governor unit group

29. The governor unit is fitted in the lower part of the alternator main casing and is driven from the rotor shaft through a train of three helical gears. The unit provides a pre-set constant control of the air turbine alternator output frequency at the varying conditions of applied loads and inlet air pressures.

30. The governor casing comprises three assemblies, the main, pump and bottom casing assemblies. These are bolted together and embody bushes for the idler and driver gear shafts of the high and low pressure oil pumps.

31. The governor main casing houses the governor weights and the high pressure relief valve. To this casing is secured a valve housing and the pump casing, both of which are located by dowels.

32. The pump casing has oilways and pockets for the idler and driver gears or the high pressure pump and houses the non-return valve, low pressure relief valve and bleed valve.

33. The bottom casing has oilways and pockets for the idler and driver gears of the low pressure pump.

34. The four governor weights are fitted on a driving plate secured to the end of the drive shaft. Each weight hinges on a pin and when the weights move outwards, under centrifugal force, the toes press against a ball bearing housing which, together with the ball bearing, is secured to the control lever assembly. A ball pin at one end of the control lever engages with the socket end of the piston valve. At the opposite end of the control lever an adjustment screw contacts the spring seat of the governor spring fitted over a spring guide which bears on the setting lever (*fig.* 6) of the governor manual control. The control lever pivots on a pin in two small ball bearings fitted to a fixed lever support bracket; the setting lever pivots on a pin in a pivot fork secured to the bottom casing. The end of the setting lever connects with a collar on the setting control rod the adjustment nut of which engages the forked lever of the governor manual test control.

35. The bleed valve is contained in a valve seat pressed into the pump casing. Adjustment shims for the valve spring are fitted on the valve stop and the components are retained in the valve seat by a spring ring. Oil bled from the high pressure pump returns to the sump.

36. The low pressure relief valve is positioned in the outlet from the low pressure pump in the pump casing. This piston type valve relieves at 40 lb/in² and allows surplus oil to return to the sump.

37. The high pressure relief valve is also fitted in the pump casing and consists of a spring-loaded, flanged slide valve in a valve housing. The housing bore and the portion of the valve which operates in it, are case hardened. Adjustment shims are fitted between the spring and the valve flange and the valve is set to relieve at a pressure of 340 lb/in².

38. A non-return valve assembly, consisting of a disc-type valve and seat pressed into a valve body with two sealing rings, is housed in the pump body. The valve is retained on the seat by a spring on a guide which is secured in the body by a pin. Six holes in the guide flange permit oil to pass when the valve opens. The valve is fitted between the oil filter and high pressure pump inlet and relieves at a pressure of 5 lb/in².

39. The clogged filter by-pass valve is a ball type valve, spring-loaded to 20 lb/in² and is positioned in the pump and bottom casings. If the hydraulic oil pressure rises due to the filter being clogged, the valve opens and unfiltered oil is allowed to pass into the hydraulic circuit to maintain normal operation.

40. The low pressure gear-type oil pump in the bottom casing delivers 14 lb. of oil per minute at 6150 rev/min to the high pressure pump to the low pressure side of the integrating piston and to the oil jets for lubrication of rotating components.

41. The high pressure pump is also a gear-type pump, it is contained in the pump casing and delivers high pressure oil to the piston valve.

42. The piston valve, together with the sleeve housing and liner assembly (follow-up sleeve) and the servo and integrating pistons are all accommodated in the valve housing. Two transfer bobbins, each fitted with two sealing rings, connect oilways in the housing with the underspeed and overspeed restrictors in the alternator main casing. The piston valve engages with the governor control arm and the sleeve housing connects with the differential lever through a trunnion.

43. The spring-loaded servo piston is enclosed in the valve housing between a valve cover and a seal housing. Twin ball bearings on one end of the piston engage in a slot in the actuating crank through which movement of the piston is transmitted to the actuating ring and nozzle vane. A trunnion on the opposite end of the piston engages with the differential lever.

44. The integrating piston operates in a liner in the valve housing which is enclosed by a similar cover. The piston engages with the differential lever through a trunnion. Adjustment shims positioned between the cover and the housing ensure that the sleeve housing is centralized (that is, in the on-speed position) with the servo piston at the end of its stroke (nozzle vanes open) in order to prevent excessive speed during start-up.

Governor manual control

45. A manually adjustable, spring-loaded datum piston is enclosed in a housing secured to the reduction gear cover. The housing and piston are slotted to accept a forked lever keyed to a short shaft through the housing. The shaft can be turned to adjust the lever position. An adjustment screw acting as a lower datum stop (374 c/s) for the governor manual test control is fitted in the end of the datum housing. A similar screw, which acts as a lever stop during test check of the overspeed governor, is fitted in the cover attached to the opposite end of the datum housing.

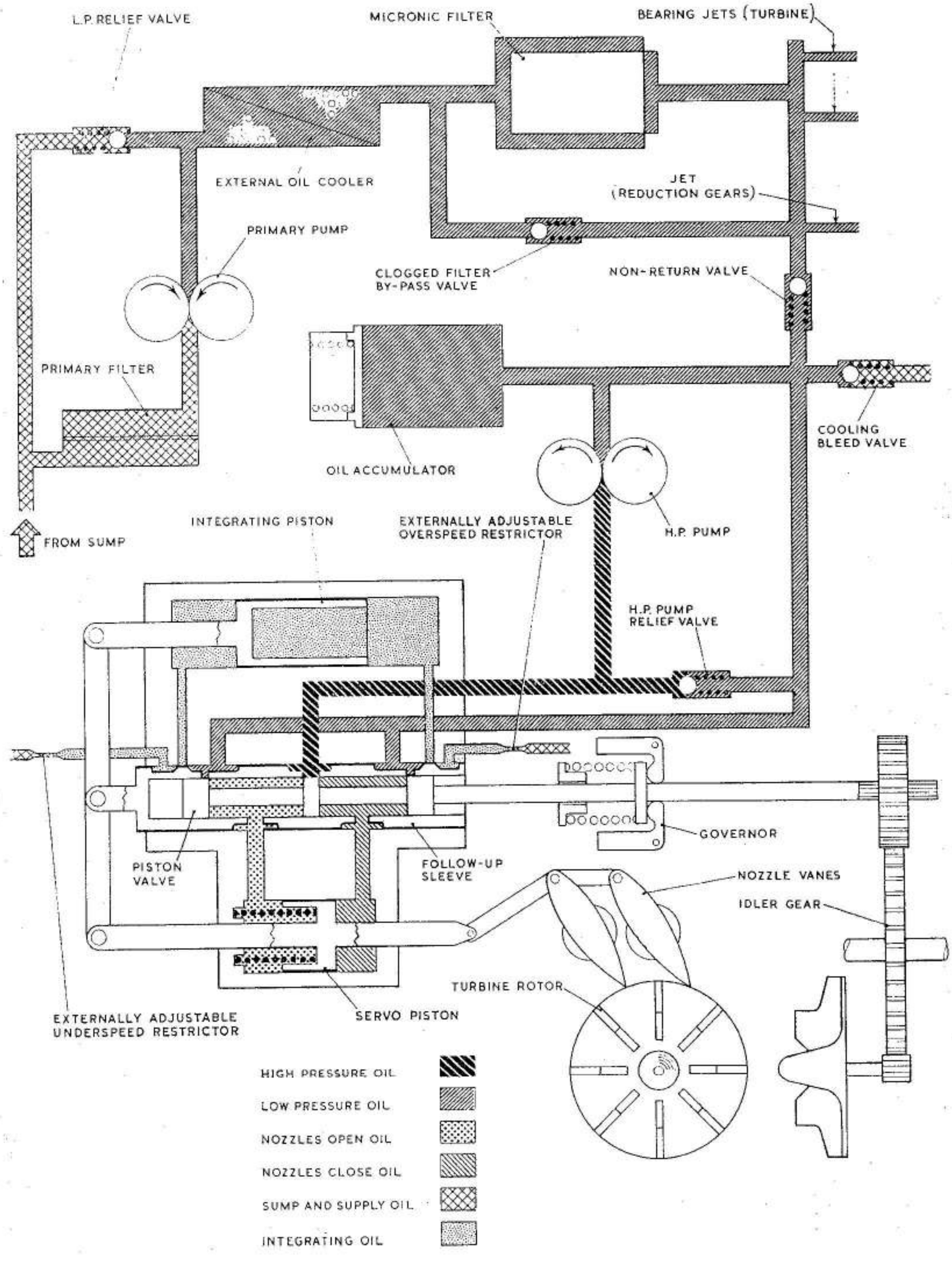


Fig. 7. Hydraulic circuit diagram

46. An overspeed adjuster assembly fitted to the datum piston housing, consists of a spring-loaded adjusting pin which acts as a lever upper datum stop (470 c/s) for the governor manual test control. The adjusting pin is riveted to a bayonet type adjusting cap which provides a quick and easy release to the upper datum stop, thus enabling operational tests on the overspeed governor to be performed.

Oil cooler assembly

47. This consists of a housing with inlet and outlet oil connections, an oil cooler and two air hose connections. The hose connections retain the oil cooler in the housing and receive air pipes (not supplied with the turbo-alternator) for the cooling air flow through the unit.

Gravity filler and climb breather

48. This assembly is secured by a banjo bolt to the main casing. It is used for gravity oil filling when pressure filling facilities are not available. During climb a spring-loaded ball valve is lifted from its seat by the weight of a plunger and allows sump breathing to atmosphere.

Insulator blanket

49. This heat shield (not illustrated) surrounds the turbine-end of the turbo-alternator. It consists of insulating material sandwiched between two sheets of metal which are wired together at four points. It is not secured to the turbo-alternator.

PRINCIPLES OF OPERATION

50. Air, tapped from the last stage of the aircraft gas turbine compressors, enters the annular chamber of the turbine tangentially and passes between the nozzle vanes to strike the turbine wheel at high velocity. Energy is thus transferred from the air stream to the turbine wheel, which rotates at high speeds. The air then exhausts to atmosphere through the outlet duct via an exducer which consists of a number of vanes in line with those of the turbine wheel; this gives axial velocity to the air stream as it discharges and thus reduces turbulence.

51. The speed of the turbine is controlled by a hydraulic governor which incorporates a mechanical reset feature and has a sensing element consisting of four spring-loaded governor weights. In response to changes in speed due to changes of electrical load, the centrifugal force of the governor weights will overcome, or be overcome by, the loading of the governor spring. This causes a piston valve to move and direct high pressure oil to the appropriate side of a servo piston. Movement of the servo piston and associated linkage varies the area between the nozzle vanes and tends to restore the speed of the turbo-alternator to its initial value. The piston valve moves in a follow-up sleeve, the movement of which is controlled by the servo-piston and by an integrating piston. These are mechanically connected to the servo piston as shown in fig. 7 and their purpose is to apply the appropriate amount of phase advance and damping to ensure the optimum stability of the governing system.

52. If the speed of the turbine falls, the loading of the governor spring will exceed the governor weight force and cause the piston valve to move to the right (diagram B in fig. 8). In this position the valve directs high pressure oil to the left-hand side of the servo piston and connects the opposite side to the low pressure oil system. Consequently the servo piston moves to the right, regulating the nozzle vanes to allow a greater air flow to the blades of the turbine wheel and so increasing its speed (diagram C in fig. 9).

53. Concurrently with the movement of the servo piston the follow-up sleeve moves to the right, through the mechanical linkage, and in following the movement of the piston valve it tends to restrict the flow of high pressure oil to the servo piston. This movement of the sleeve also directs low pressure oil to the right-hand side of the integrating piston and connects the opposite side with a return outlet to the sump via an adjustable restrictor. The integrating piston thus moves towards the left, its rate of movement being dependent on the setting of the restrictor.

54. With the increase in speed of the turbine, the governor weight force increases, overcoming the loading of the spring and moving the piston valve back towards its original position. As the integrating piston moves towards the left, the follow-up sleeve, through the linkage, also moves back towards its original position. Adjustment of the underspeed restrictor is made so that the sleeve reaches its original datum position coincident with the piston valve. The oil ports are now blanked off and an on-speed

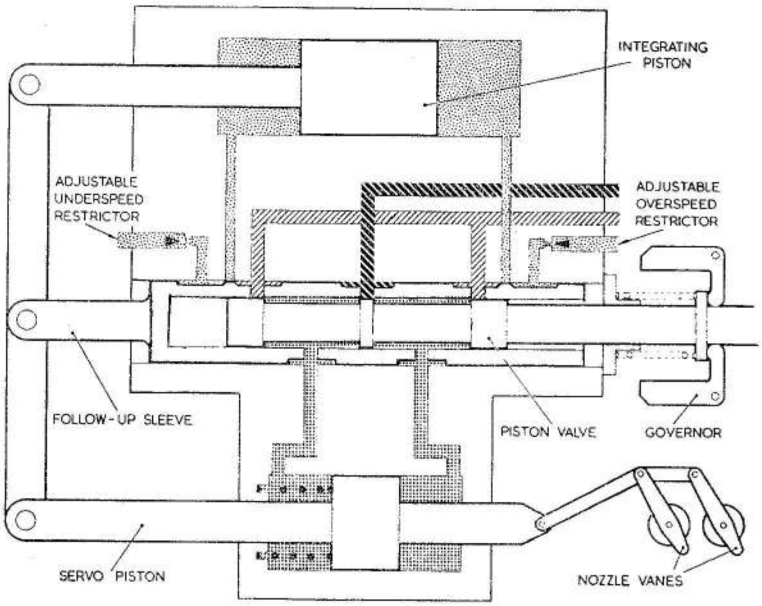
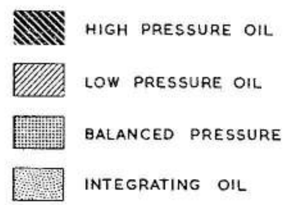


DIAGRAM A

On-speed condition- Average load



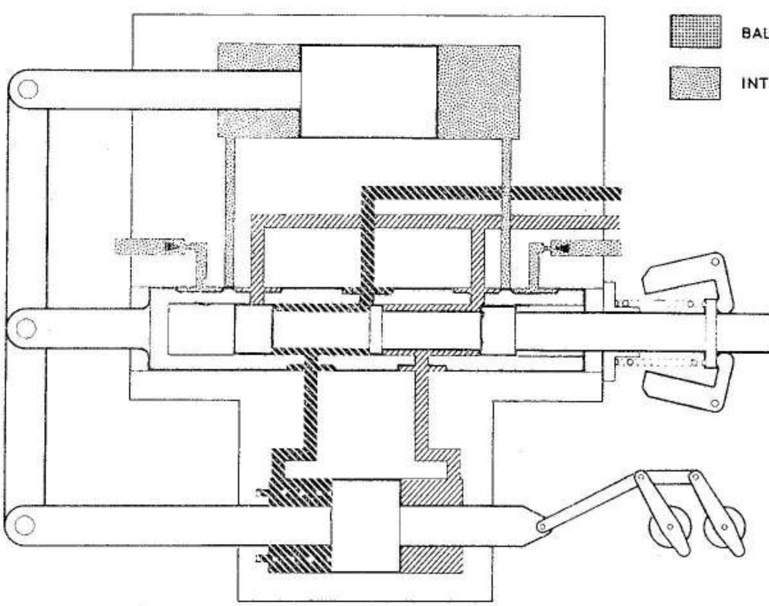


DIAGRAM B

Turbine speed falling- Piston valve moving to right

Fig. 8. Functional diagrams

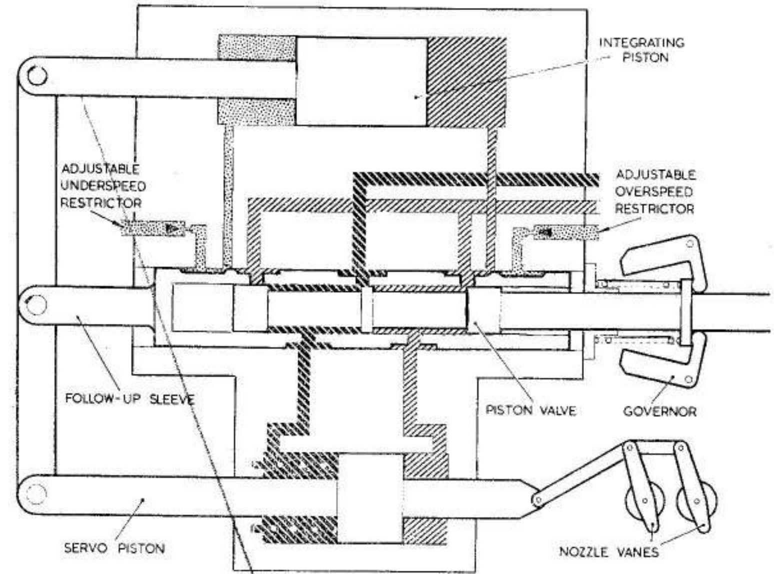


DIAGRAM C

Servo piston moving to right – Nozzle vanes opening
Follow-up sleeve moving to right

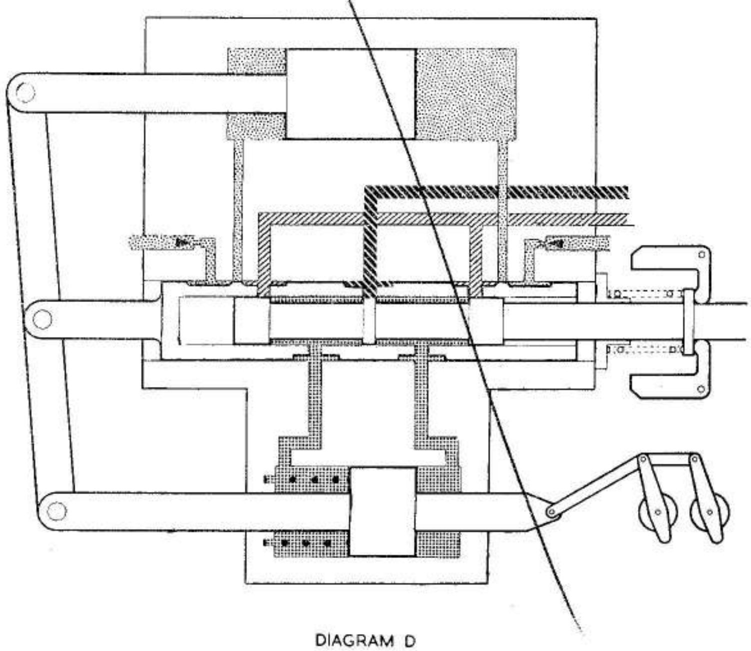


DIAGRAM D

Integrating piston moved to left – Follow-up sleeve and piston valve returned to original datum giving on-speed condition with increased nozzle vane opening

Fig. 9. Functional diagrams

condition is thus attained with the servo and integrating pistons reset (diagram D in fig. 9) giving increased air flow to the turbine proportional to the increased applied load.

55. The foregoing operations do not take place in sequence, they occur concurrently. The governing system is responsive to both varying conditions of load and air flow.

56. If the speed of the turbine increases, the centrifugal force of the governor weights will overcome the loading of the governor spring causing the piston valve to move towards the left. The governor unit now functions in exactly the reverse manner to that already described, in order to restore the on-speed conditions. The servo and integrating pistons will be reset to reduce the area between the nozzle vanes in order to effect the requisite decrease in turbine speed.

Overspeed governor

57. Accidental overspeeding is prevented by the action of an overspeed governor at the turbine end of the rotor shaft. Should the turbine speed tend to exceed a given safety figure, the overspeed governor operates a shut-down valve in the inlet pipe to the turbine and cuts off the air supply. This operation is irrevocable in flight and consequently, manual re-setting is necessary; this can only be done when the turbine is stationary.

Cooling

58. Cooling air for the turbo-alternator is obtained during flight by ducting ram air in parallel through the alternator and oil cooler and finally discharging it overboard.

59. Under conditions where little or no ram air is available, a cooling flow is induced by an ejector (not part of the turbo-alternator) which obtains its primary air from the main air supply to the turbine. The cooling air is admitted to the alternator case at the opposite end to the turbine and after passing over the slip rings and brush gear divides into two flows; one flow passes over the surface of the rotor through the air gap and the other makes a three-pass labyrinth passage through the stator. Downstream of the alternator the two flows combine and pass over the back-plate of the turbine before leaving, thereby preventing convective heat transfer from the turbine to the alternator.

60. Cooling of the oil is effected by an external cross-flow tubular type oil cooler attached to the alternator main casing. The oil makes a single pass across the tubes, which are fitted with baffles in the leaders, to provide a three-pass labyrinth passage for the air.

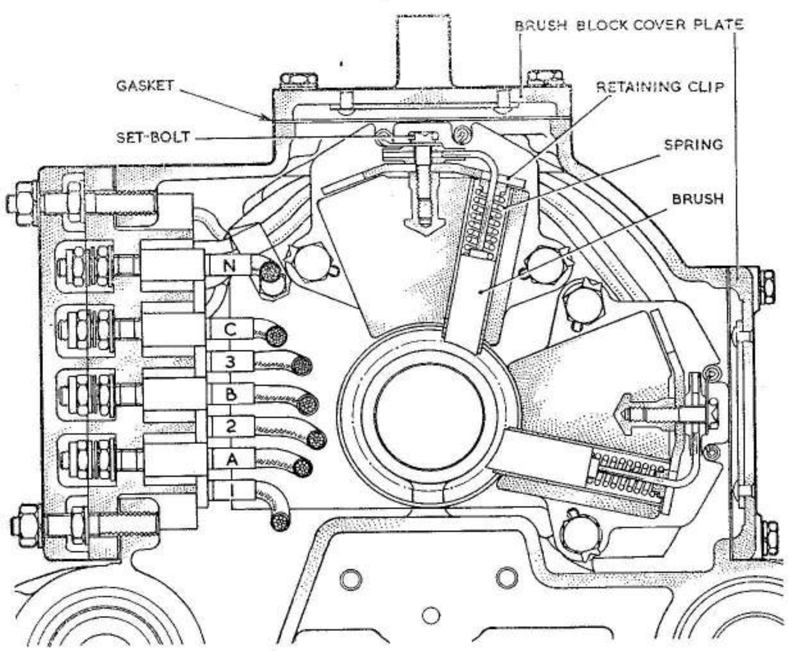


Fig. 10. Part section of alternator casing showing brush assembly

Lubrication

61. Filtered oil from the sump passes through a low pressure gear-type pump, the output of which is divided. One supply is used for lubrication of the gears and bearings and the other is delivered to the high pressure gear type pump which supplies oil for operating the governor unit. Both oil pumps are contained in the governor unit and each incorporates a relief valve in its circuit. All rotating parts are lubricated by oil passed through jets which are protected from clogging by dirt traps. Should the oil filter become clogged, the oil passes through a by-pass valve so that the system will continue to operate using unfiltered oil.

62. Ventilation of the sump to permit breathing without loss of oil is achieved by the incorporation of a centrifugal breather, which is unaffected by aircraft altitude.

63. A hydraulic accumulator is fitted in the return side of the governor unit oil circuit to maintain an adequate supply of oil to the high pressure pump in the event of the primary pump being temporarily starved during inverted flight.

SERVICING

General

64. The servicing detailed in paras. 66 to 71 is applicable when the turbo-alternator is installed in the aircraft, the operations should take place at the periods specified in the relevant Servicing Schedule. Information on testing when installed will be found in the aircraft Air Publication.

65. The instructions detailed in paras. 72 to 78 cover the testing and adjusting of the turbo-alternator when not installed. The tests should be performed with the turbo-alternator fitted on the A.T.A. Test Trolley Mk. 1A (Ref. No.   ). A description of the test trolley together with instructions for fitting the turbo-alternator and the procedures to be adopted for starting and running is given in A.P.4343V, Vol. 1, Book 2, Sect. 2.

Checking the oil level and refilling

66. (1) Check the oil level in the sump through the sight glass of the visual indicator, which is marked FULL and REFILL.

(2) Before topping-up ensure that the oil to be added is to the same specification as that already contained in the sump.

(3) To replenish the oil, remove the blanking cap from the self-sealing coupling and connect up the hose of the oil replenishment trolley.

(4) Pump oil through the self-sealing coupling until the FULL mark is reached as indicated through the sight glass.

(5) When the oil has reached this level, refit the blanking cap to the overflow connection. Run the engine to circulate the oil in the unit and top up the sump as necessary.

(6) When pressure filling facilities are not available, remove the plug from the overflow connection and climb breather group, which is situated adjacent to the oil indicator and pour oil into the sump until it reaches the FULL mark as before. When the FULL mark is reached, fit and tighten the plug. Run the engine as in (5) then remove the plug and top up as necessary. Refit and wire-lock the plug.

Draining and flushing

67. (1) Attach a suitable length of ½ in. bore hose to the drain connection at the base of the sump.

(2) Slacken the nut which secures the valve locking plate and move the plate clear of the valve hexagon.

(3) Using a suitable box spanner, turn the valve drain bolt in a counter-clockwise direction to allow the oil to run freely from the drain pipe.

(4) Flush the sump by pumping clean oil into the sump until the oil flowing from the drain appears to be quite clean.

(5) Close the valve by turning in a clockwise direction. When tight, refit the locking plate and nut.

(6) Refill the sump to the FULL mark as in para. 66.

Checking the oil pressure

68. (1) Unlock and remove the outer sleeve and nipple plug from the pressure test connection adjacent to the terminal block.

RESTRICTED

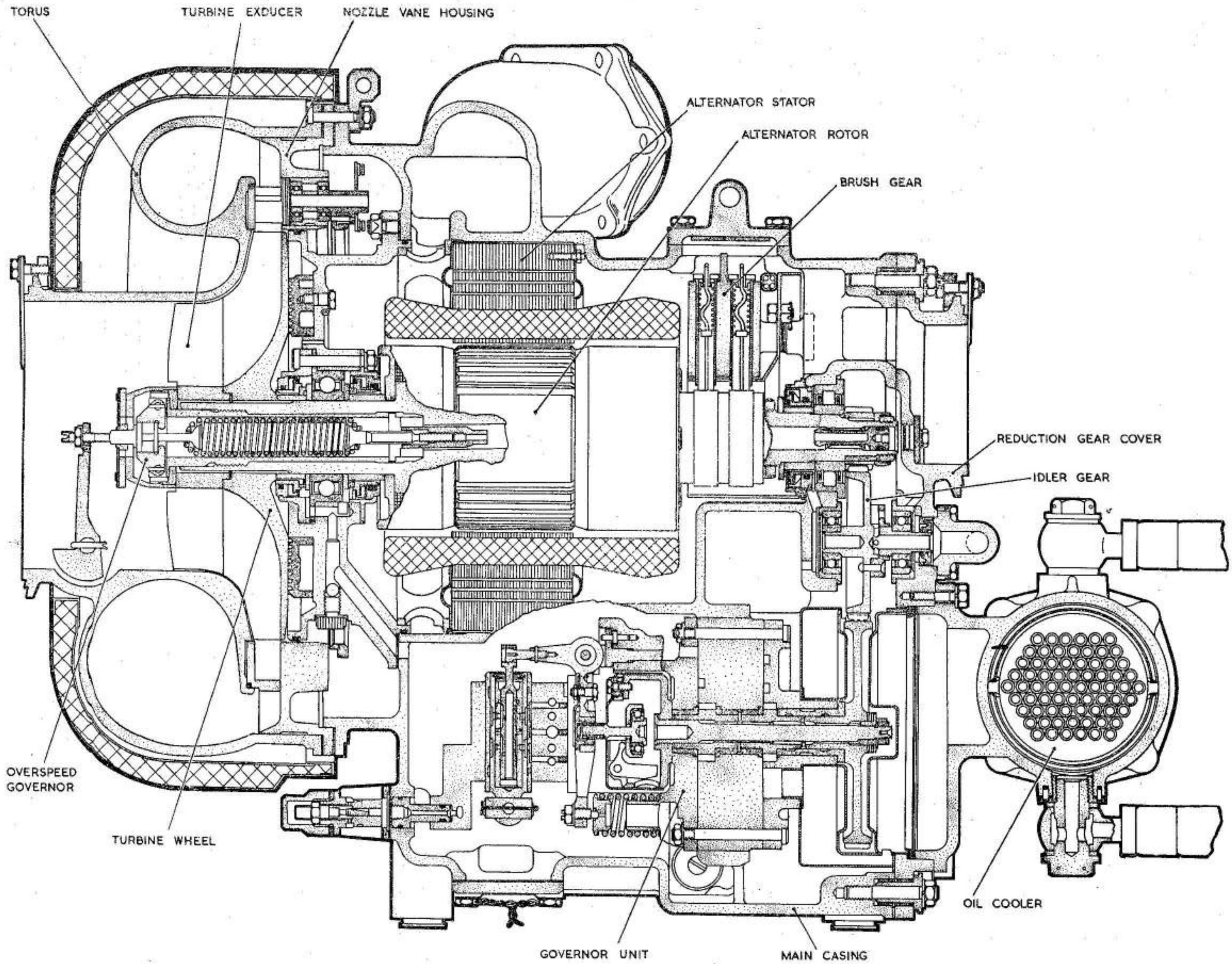


Fig. 11. Sectional view of turbo-alternator

(2) Connect up a suitable pipeline ($\frac{1}{8}$ in. B.S.P. union nut) and a pressure gauge graduated from 0 to 100 lb/in².

(3) Run the engine to ensure a governed turbo-alternator speed of 23800 to 24200 rev/min. The oil pressure must not fall below 35 lb/in².

Note . . .

If the oil pressure falls below 35 lb/in² it will render the turbo-alternator unserviceable and it must be replaced by a serviceable unit.

(4) When satisfactory results have been obtained, remove the pressure gauge and pipe, refit the nipple plug and outer sleeve, tighten and wire-lock.

Removing and renewing the oil filter

69. (1) Remove the three nuts securing the filter cover, which is situated to the left of the oil filler, and withdraw the filter.

(2) Fit the new filter, leaving the perforated parchment covering in position, as this is not a transport item. When inserting the filter ensure that the seals are not damaged in the process.

(3) Fit the filter cover and secure with three $\frac{1}{4}$ in. U.N.F. nuts, plain and spring washers.

Checking wear on the brushes

70. (1) Remove the brush block cover plate at the top of the unit (*fig.* 10).

(2) Untab and unscrew the setbolt which secures the retaining clip for the brush spring.

Note . . .

When the setbolt is removed, the clip is free and great care must be taken to ensure that the brush spring does not cause the loose clip to slide off.

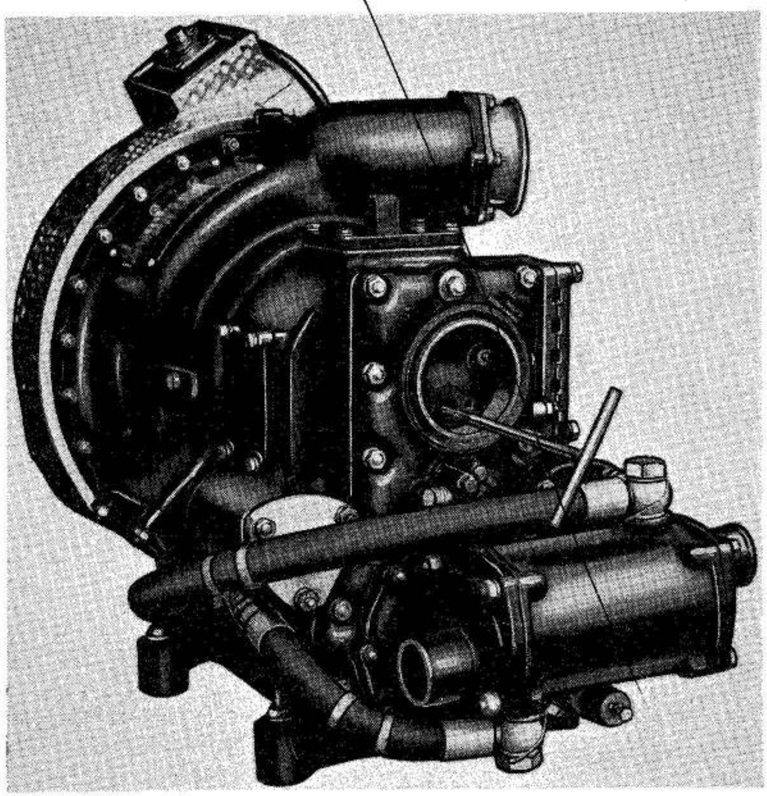


Fig. 12. Overspeed trip adjustment

(3) Withdraw each brush in turn and check the length of the short side. If this is less than 0·3 in., renew the brush.

(4) When refitting the brush, first fit it to the retaining clip, then pull the pigtail to compress the spring, lower into position and secure with setbolt and tabwasher.

Note . . .

It is essential that the brushes are refitted into their original positions.

(5) Fit the top brush cover plate ensuring that a serviceable gasket is first positioned on the studs. Remove the side cover plate and proceed as in sub-paras. 2-4.

(6) Refit the side cover plate.

General checks

71. (1) Check the security of the mounting bolts.

(2) Check the security of all electrical, hydraulic and pneumatic connections.

Testing

Frequency

72. With the turbo-alternator running, check that the frequency is 400 c/s. Operate switches C, D, E and F on the test trolley, switching on and off loads in suitable increments up to full load. Check that the frequency remains stable. Switch on and off a load of 9kW, the frequency should remain at 400 ± 6 c/s. Under steady state conditions, hunting of the frequency should not exceed 4 c/s total.

Note . . .

The maximum continuous load with the turbo-alternator driven by the test trolley is 9 *kW. The* 0·8 *p.f. loading should only be used with* 12 *kW of load selected and switch D on the test trolley should be set at* 6 *kW. The duration under this condition should not exceed* 30 *seconds.*

Overspeed trip

73. Withdraw the overfrequency adjusting cap on the governor manual control. Attach a suitable spanner to the manual speed control and depress slowly and evenly, until the overspeed trip operates. This should occur at 470 ± 10 c/s. Allow the manual speed control to return to its normal position, and return the overfrequency stop adjusting cap to its upper datum limiting position. Close the drive air control valve on the test trolley and reset the overspeed trip by turning the reset counter-clockwise through 90 degrees.

Alternator

74. With the machine running, check the no-load rotor current, this should be approximately 9·5 amperes. Select a load of 7·5 kW, and check that the maximum voltage unbalance does not exceed 3 volts.

75. Using a 500V insulation resistance tester, measure the insulation resistance between the stator windings and the frame, and between the star and delta windings. The minimum permissible reading should be not less than 5 megohms. Using a 250V insulation resistance tester, measure the insulation resistance between the rotor and the frame. The minimum permissible reading should be not less than 0·5 megohms.

Adjusting

Frequency datum

76. Remove the dust shield from the governor extension shaft (*fig.* 6) this is held on by the jubilee clip on the mechanical limit box. Unfasten the lock-washer and nut on the end of the governor extension shaft.

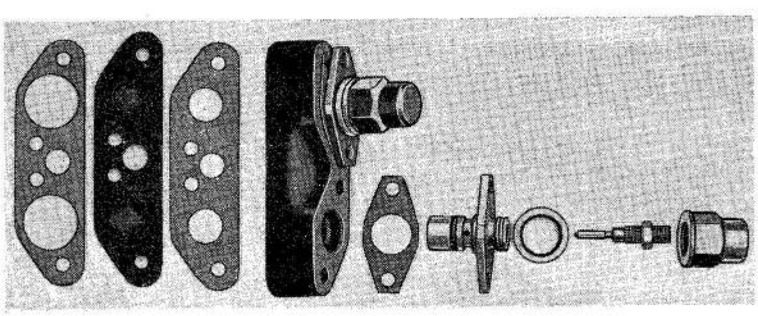


Fig. 13. Bleed-block assembly dismantled

Carefully pull out the shaft against the spring tension sufficient to expose the squared adjusting nut from under the forked lever. Turn the adjusting nut clockwise to raise, or counter-clockwise, to lower the datum; turning one flat will alter the frequency by approximately 3 c/s.

Overspeed trip

77. Remove the rotor shaft end cover located in the cooling air inlet. Remove the oil seal in the rotor shaft by inserting a 10UNF screw and exerting a steady pull on the seal. Using a long 4 B.A. socket spanner located on the adjusting nut down the centre of the shaft, turn the adjuster clockwise to increase trip value, and counter-clockwise to decrease trip value. Turning one notch moves the trip value by approximately 2·5 c/s. After adjusting, replace the rotor shaft oil seal and cover. The trip should be operated at least once before taking a final frequency reading in order to settle the mechanism.

Note . . .

Ensure that excessive end load is not applied on the adjuster nut, as this may result in displacement of the balance weights.

Governor stability

78. In the event of an unstable governor, poor frequency response, or a frequency datum shift, the bleed-block assembly, housing the overspeed and underspeed restrictors should be removed for cleaning. Scrupulous cleanliness should be observed throughout the following operations.

(1) Drain the oil (para. 67 refers).

(2) Locate the bleed-block assembly which is fitted under the torus (*fig.* 2).

(3) Remove the cap nuts and the four fixing nuts, and withdraw the bleed-block from the mounting studs taking care not to damage the gaskets.

(4) Blow out the oilways and filters with clean dry compressed air.

(5) Refit bleed-block, securing nuts and cap-nuts.

(6) Refill with oil (para. 66 refers).

(7) Test for stability and response of the governor as detailed in para. 72.

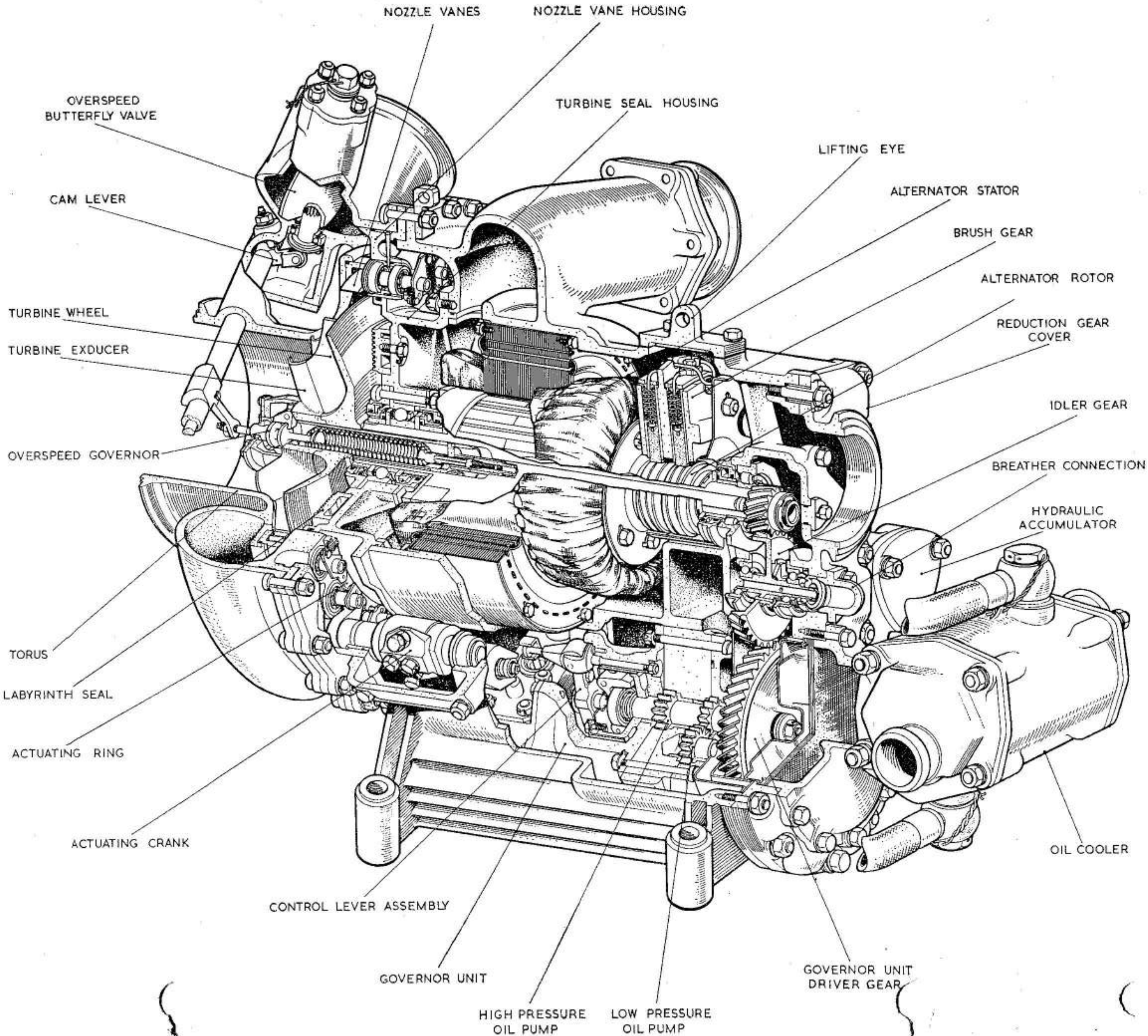


Fig. 14. Pictorial section of turbo-alternator

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