FOREWORD.

This book has been compiled at the ROVER GAS TURBINE SERVICE SCHOOL for use by those who attend a course, and contains sufficient information to enable them to retain the more essential data imparted during the course, and that which will be the most use to them when operating or servicing ROVER GAS TURBINE POWER PLANTS.

Whilst every care has been taken to ensure that it is up to date, it will be appreciated that continuous development and constantly changing operating conditions, may render it necessary to make alterations from time to time. NO AMENDMENTS will be forwarded, therefore all subsequent modifications that are introduced concerning the engine, will be the student's responsibility.

These notes, therefore, are not intended as a manual on the subject, but are issued as a guide and a valuable contribution to the lectures and instruction given at the ROVER COMPANY'S - GAS TURBINE SERVICE TRAINING SCHOOL.

These notes should be checked frequently with current information in the Official Maintenance and Overhaul Manual, A.P.'s A.M.O's or A.R.B. publications.

Hours of Attendance

Mondays to Fridays

The following class times must be observed.

Morning 9.0.a.m. - 10.15.a.m. - 10.30.a.m. - 11.45.a.m.

Afternoon 1.30.p.m. - 3. 0 p.m. - 3.15.p.m. - 4. 30.p.m.

No Change in these times can be allowed without permission of the School Management.

ROVER A.A.P.P/ARGOSY 660. MK.10201

COURSE NOTES (For reference only)

LEADING PARTICULARS

Description:-	A 1S/60 Turbine engine driving a D.C.Generator, Hydraulic Pump and air pump, through a suitable auxiliaries drive Gearbox.
Compressor:-	Single stage centrifugal.
Shaft.	Single
Turbine Rotor	Single stage
Combustion Chamber:-	Rover, single can, reverse flow. Simplex type burner with air assistance.
Reduction Gearbox:-	Counter shaft type.
Air Mass flow:-	1.43 lb/sec. at 1.C.A.N. conditions.
Air Pressure ratio:-	2.95 at 1.C.A.N. conditions.

RATIOS:-

Drive pinion	3.181
Blower unit	3.181
Generator	10.342
Hydraulic Pump	15.380

FUEL SYSTEM

Fuel Pump	Rover MK. VIII
Burner	Lucas SCH 9063
Temperature Control	Rover Pt.No. 423935
Air Pump	Lucas SCH. 5303
Fuel	See operating limitation.

Oil System

Type	Wet sump, pressure & splash
Oil	See operating limitations
Sump Capacity	4½ PINTS.
Total Engine Capacity	5 PINTS approx.

STARTING SYSTEM — Through generator from aircraft batteries.

Igniter Plug. — KLG. RH.231/6

MAX J.P.T LIMITATIONS.

660°C	FOR 5 MINS
640°C	" 1 HR.
630°C	CONTINUOUS.

NORMAL TEMP. 380°C - 420°C OFF LOAD.

OVER

LEADING PARTICULARS (Cont'd)

GENERATOR

Type:-	Rotax B.3503/L
Output:-	9 KW. 28 Volt D.C.
Speed:-	4512 REV/MIN.

HYDRAULIC PUMP

Type:-	Integral 180 MK.42.
Output:-	5.5. Galls/Min at 2600 P.S.l.
Speed	3034 REVS/MIN.

OVERALL DIMENSIONS

LENGTH.	49.437 ins.
WIDTH.	27.875 ins.
DEPTH.	29.280 ins.

WEIGHT.

SEE ACCEPTANCE LIMITS.

MISCELLANEOUS EQUIPMENT

Burner Actuator	Rotax C.5524/1
Axial Flow Blower Unit	Plannair 5-PL-302-476.
Oil Cooler	Morris-Motors/Rover Pt. No. 421830
Oil Pressure Switch	Smith's 1001/1PG.
Exhaust Thermocouple	" F1079/12
Hours Counter	Cass & Phillips JC.16
Starts Counter	Counting Instruments 52/4/B29
Fire Detector Element	Graviner MK.II Ref. 5CZ/5836
Detector Head	Graviner D.900 Ref. 5CZ/5222

INTRODUCTION

Basically the motive power is provided by a Rover single shaft Gas Turbine engine of 60 B.H.P. which drives a 9KW.24 volt D.C. Rotax generator, an Integral 180 type Hydraulic pump, a Lucas motorised air pump and a Rover MK.VIII fuel pump through an auxiliary gearbox integral with the engine auxiliaries mounting plate.
The generator is used as a starter motor from the aircraft batteries via a swiching unit to start the Gas Turbine engine.

The principle operational function therefore, is

(1) To provide hydraulic pressure for ground operation for rear loading doors and all ground servicing.
(2) D.C. Electrical Power for main engine starting.

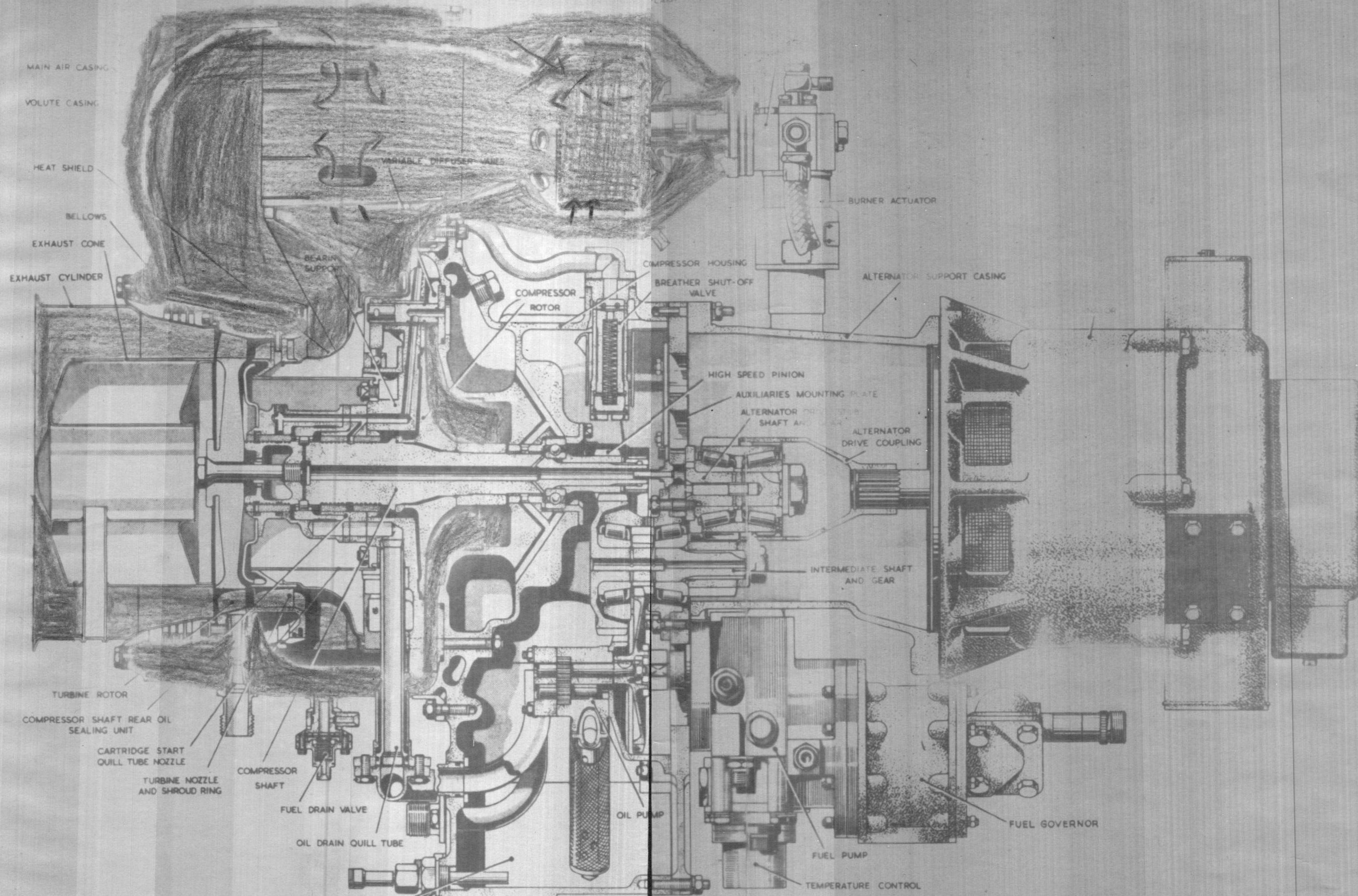
(3) A secondary function is to provide hydraulic pressure and electrical power for emergency operation of the rear loading doors in flight.

The engine complete with its auxiliaries is suspended by its side-ways facing air intakes within a fabricated stainless steel hoop which, in addition to being the main structional member of the power plant, also serves as the engine air intake ducting and provides a mounting for input and output of the engine driven auxiliaries.
Two stainless steel covers secured to the mounting hoop by locking peg fasteners completely enclose the engine unit to form a fireproof box.

Basically the engine consists of a single sided centrifugal aluminium alloy compressor, driven by a single stage axial Turbine of Nimonic steel mounted on a common shaft supported by two bearings, one roller bearing at the rear end of the shaft and one ball bearing at the front end of the shaft.

Air is admitted from the underside of the power plant and ducted through side intakes to the compressor rotor where it compressed and passed to the single reverse flow combustion chamber.
Fuel is injected by a Lucas air assisted Simplex burner, and the resultant mixture is initially ignited by an igniter plug fitted in the side of the combustion chamber.
Combustion gases pass from the chamber downwards through a volute to a fixed nozzle ring assembly which directs them against the blades of the Turbine rotor.
The combustion gases are then exhausted to atmosphere through a fabricated exhaust cone and cylinder assembly via the jet pipe and shroud attached to the rear panel.

The auxiliaries mounting plate and gearbox on the front end of the engine provide a mounting for all the engine driven auxiliaries.
The fuel pump, hydraulic pump generator and blower unit are secured to the gearbox cover whilst the oil pump is carried on the rear face of the auxiliaries mounting plate.
All five units are driven from high speed pinion on the compressor shaft by a train of nine helical spur gears secured to the auxiliaries mounting plate.



FS/2A

Fig. 2A. Sectioned view of engine (starboard side) showing alternator and support casing fitted

924 6 2400 30887 1/5 HD. CO. LTD.

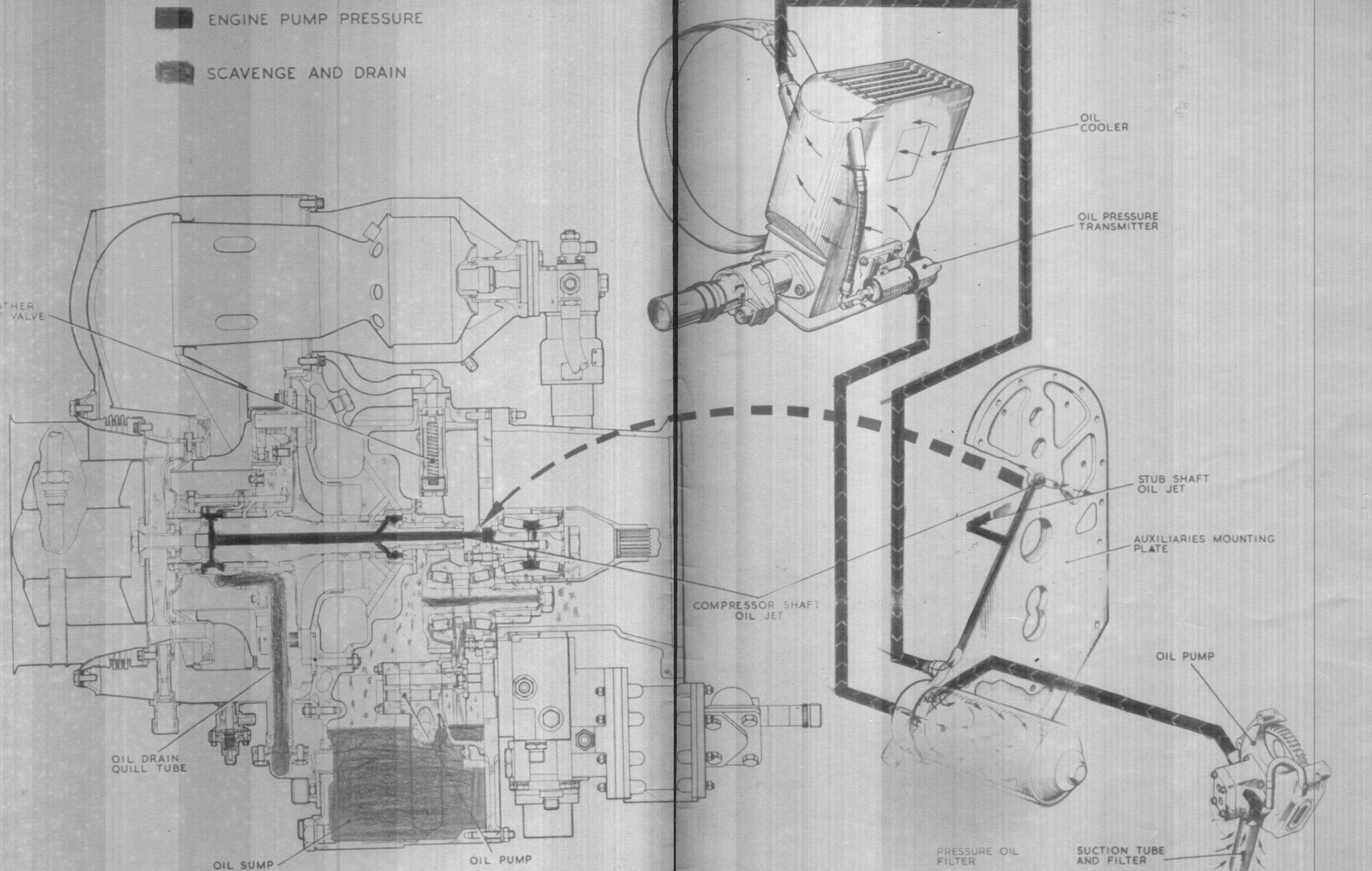


Fig.5 Oil system diagram

(A.L.3, Jan. 58)

258064 4529 250 2/58 8814 Gp 979

THE FUEL SYSTEM :- Consisting of a Rover MK.VIII Multi-piston pump and governor, a temperature control unit, a Lucas air assisted burner and a motorised air pump, is designed to control the supply of fuel to the engine at one pre-determined speed, and does not therefore require a throttle valve. The fuel flow is automatically metered by the governor and temperature control units. A high pressure air tapping from the compressor side of the engine to the burner, supplemented during starting, by the motorised air pump, ensures good atomisation down to very low fuel flows. The supply to the fuel pump is taken from the aircraft fuel tank via a booster pump in the aircraft.

ENGINE LUBRICATION:- is provided by a gear type pressure pump which draws its supply from the oil sump formed by the lower half of the compressor casing. The sump is equipped with an immersion heater and thermostat, to assist starting at extreme temperatures. The engine oil cooler and generator are supplied with cold air, ducted from the mounting hoop via a high efficiency blower unit driven through the auxiliaries drive gearbox.

FIRE PREVENTION:- is provided by a graviner fire wire detection system, which discharges the contents of a 6 lbs. Methyl Bromide bottle, mounted in the aircraft into the auxiliary power plant Nacelle, through two nozzles in the mounting hoop.

CONTRUCTION

The principle rotating parts of the engine unit, consists of a single-sided centrifugal compressor rotor, machined from a solid billet of aluminium alloy, a single stage axial turbine rotor of Nimonic steel mounted on a common shaft of Nickel Chrome Molyb steel, and located in two bearings, one roller and one ball bearing.

Power is transmitted through the High speed Power Take off Pinion mounted on the front end of the shaft,
The front bearing is supported by the compressor housing, which is an alum. alloy casting, enclosing the compressor rotor and fixed diffuser vanes.
The casting forms two side air intake passages, leading to the compressor rotor, and the base is utilized as the engine oil sump. An oil breather pipe connected to the top face of the housing, contains a gravity shut-off valve, to prevent loss if oil during inverted flight.
The rear end of the compressor shaft is supported by a roller bearing situated between two Labyrinth seals. The seals and rear bearing are secured by through bolts to the rear face of the bearing housing support plate.
The support plate is an alum. alloy casting bolted to the rear face of the compressor housing, immediately behind the compressor housing, and spaced from it by the fixed diffuser vanes.
The rear face of the support plate carries the heat shield, turbine nozzle and shroud ring assembly. The heat shield retained by the support plate mounting bolts, completely encloses the compressor shaft, Labyrinth seals and rear bearing, whilst the turbine nozzle and shroud ring assembly forms the turbine discharge nozzles.

In addition, the heat shield forms part of the inner wall of the Nimonic alloy volute casing, which serves to duct the gases from the combustion chamber to the discharge nozzles.
The nozzle and shroud ring assembly and volute, are surrounded by the fabricated stainless steel main air casing, and bolted to the rear of the compressor housing.
A flexible steel bellows assembly, inserted between the nozzle and shroud ring assembly, and main air casing, allows for differential expansion between the two assemblies.
Flanges on the front & rear of the main air casing, carry the combustion chamber, outer air casing and exhaust cone respectively.
Enclosing the front end of the compressor housing, is the alum. alloy auxiliaries drive gearbox and cover.

ROTATING PARTS ASSEMBLY

The compressor shaft is machined from nickel chrome molybdenum steel, and is the main rotating shaft of the engine. It supports both the compressor and the Turbine rotor.
A series of fine grooves is machined around the surface of the shaft to form part of the Labyrinth sealing system for the rear bearing.
In addition, eight spigots are machined around the central portion of the shaft to locate the compressor rotor, whilst the forward end is machined and threaded to take the high speed pinion and its nut.
The centre of the shaft is drilled end to end, and is utilized as an oil duct. Two sets of radial drillings are provided to feed the front and rear bearings.
The single sided compressor rotor consists of two units. (a) The rotor Disc. (b) Rotating Guide Vanes. The alloy disc has seventeen straight vanes machined radially on one face, and a locating collar on the reverse face.
The rotating guide vanes are formed by a steel hub, having seventeen curved radial vanes machined around its circumference, and strengthened by an outer ring welded to the vane tips.
The two units are relatively aligned on a special Jig and shrunk onto the compressor shaft. The collar on the rotor disc locating with the eight spigots on the shaft.
Spigotted to the rear end of the shaft is the Nimonic Steel Turbine rotor, having thirty one blades machined around the periphery of the main disc which is secured to the shaft by a special steel bolt.
To minimise heat transfer from the rotor blades, and to prevent local distortion at running temperature, the end of the shaft is counterbored leaving only a central boss into which the securing bolt is threaded.
In addition, the only contact between the bolt & the rotor is a line contact at the bolt head, the diameter of the bolt shank being reduced below the diameter of the hole of the rotor.
An angular contact high speed ball bearing assembly locates the front of the compressor shaft and serves to absorb any slight axial thrust.
The rear bearing, immediately behind the Turbine rotor consists of 13¼ Diamter rollers, running in a channel formed on the shaft. The

outer race forms a part of the compressor shaft sealing unit. The complete rotating parts assembly is statically and dynamically balanced to within .002/in/ozs. Provision being made on the Turbine blades and compressor rotor face for removeal of material. With the exception of the ball bearing, individual replacement parts cannot be fitted.

COMPRESSOR HOUSING.

The cast alum. alloy casing forms thetwo side air intakes, the locating hub for the compressor rotor and the engine oil sump. The oil sump side cover plate is formed by the mounting plate of an electric oil immersion heater, whilst two unions provide inlet & overflow tappings for the pressure re-oiling system. The boss in the centre of the housing is couterbored to take the light alloy front labyrinth oil seal and the compressor shaft front bearing, which is retained by a steel ring secured to the housing by 6 studs, tabwashers and nuts. Shims are fitted between the compressor housing and the rear face of the oil seal flange to adjust the compressor shaft position, whilst a second set of shims between the rear face of the securing ring and compressor housing, provides ajustment for bearing lip. Two drillings through the housing boss conducts air to the labyrinth seal from an annular reservoir cast in the thickness of the housing.

BEARING HOUSING SUPPORT PLATE

The alum. alloy support plate is secured to the rear face of the compressor housing by 9 bolts, tabwashers & nuts. This plate carries the fixed diffuser vanes. Eight studs on the rear face of the plate provide attachment for the turbine nozzle and shroud ring assembly, whilst six tapped holes take the long set bolts securing the compressor shaft rear oil sealing components. A series of drillings radially and axially through the plate communicate with the compressor shaft sealing unit and compressor housing to form part of the sealing and cooling system. Two of these drillings, drain surplus oil from the rear bearing to a point in the bottom of the support plate boss, where the oil drain quill tube is inserted.

COMPRESSOR SHAFT REAR OIL SEALING UNIT

The sealing unit consists of the compressor shaft inner & outer seals and the rear bearing outer race.
To ensure that these components are assembled in their correct angular relationship, the securing holes are irregularly spaced.
The outer seal consists of a steel housing containing a carbon bush having two rings of radial drillings aligned with two channels in the housing.
When assembled in the engine, the bush mates with a series of fine grooves on the rear of the compressor shaft to form a Labyrinth seal, and the drillings in the bush are aligned with two wider grooves on the shaft.
The inner seal housing contains two carbon bushes which mate with a further series of fine grooves on the compressor shaft to form the inner Labyrinth seal, whilst the gap between these two bushes coincides with a wide groove on the compressor shaft.
A series of drillings through the sealing unit serve as cooling and sealing air passages their exact purpose being explained later in these notes.
Sandwiched between the inner & outer seal housings is the securing flange of the flexible outer race for the compressor shaft rear bearing.
Although the outer race and its securing flange are formed as one unit, they are only connected by eight narrow struts. This method allows sufficient flexibility in the bearing to damp out resonant frequency in the compressor shaft.
In order that oil from the rear of the bearing may pass forward and into the drain holes formed in the bottom of the sealing unit, Thirty Two small diameter holes are drilled horizontally through the race.
The steel Turbine rotor cooling disc attached to the rear face of the outer seal housing by the sealing unit securing bolts, acts as a heat deflector for the turbine rotor, and protects the sealing unit.
Provision is made for cooling air from the compressor to be blown into the space between the rotor disc and cooling disc.
Steel shims fitted between the cooling disc and the outer seal housing provide adjustment for the clearance between the cooling disc and Turbine rotor.

TURBINE NOZZLE & SHROUD RING ASSEMBLY

The Turbine discharge nozzles are formed by 21 vanes on a forged alloy steel ring welded to an extension tube and secured to the rear face of the bearing housing support plate by 8 studs, Tabwashers and nuts.
Steel shims are interposed at the securing face to provide adjustment of the clearance between the Turbine rotor tips and the shroud ring.
The shroud ring surrounds the nozzle vanes and is secured by a hollow peg to each vane.
To assist the gas flow into the Turbine rotor, the front end of the shroud ring is bell-mouthed at its junction with the volute. The grooves cut into the circumference of the bell-mouthed end act as a seal, preventing the air in the main gas casing from entering and mixing with the hot gas in the volute.

HEAT SHIELD

The shield is fabricated from Nimonic steel sheet, and is secured to the rear face of the bearing housing support plate, by nine fixing bolts.

The shield forms the continuation of the volute casing, although separated from it by an air gap.
Cooling air from the main air casing passes through the nozzle hollow pegs and flows between the heat shield and the nozzle and shroud ring extension tube, to protect the compressor shaft seals.
This air is fed back into the main gas stream via a ring of holes in the heat shield behind the volute flange.

VOLUTE CASING.

Fabricated from Nimonic steel sheet, and forms a duct for the combustion gases from the combustion chamber to the nozzle and shroud ring.

COMBUSTION CHAMBER.

Single chamber consists of an outer air casing enclosing a necked flame tube. Both components are fabricated from Nimonic steel, and is attached to main air casing by Twelve cap screws and springwashers.
Secured to a welded boss on the upper side of the air casing by two set bolts and tabwashers, is the Suspension Plug, housing the electrical igniter plug.
A drain union, welded to the bottom of the casing, conveys any accumulation of fuel via a pipe to the drain valve on the main air casing.
The Simplex burner, with its electrical actuator is secured to the front face of the casting and the outside flange of the flame tube locating sleeve by four (4) wire locked set bolts.
The necked flame tube is located centrally within the casing by Three (3) support brackets, and is a sliding fit in the flame tube locating sleeve, at its head, and into the volute casing at its rear end.
The airflow is stabilized as it passes around the outside of the flame tube by four anti-swirl vanes welded to the flame tube head.
Three rings of holes in the flame tube head, and two rings of holes in the locating sleeve, form the primary air intake holes.
The cylindrical section of the flame tube forward to the neck, has six staggered rings of holes to allow the passage of primary air for cooling of the skin, and also contain the locating sleeve through which the igniter plug is inserted.
Inserted round the neck of the flame tube are the seven tubular vortex jets which admit and direct a further supply of primary air to create turbulance in the burning region.
To reduce the temperature of the burning gases still further, dilution air is admitted through four large elongated holes around the rear section of the flame tube.

MAIN AIR CASING

This casing is fabricated from stainless steel sheet and is attached to the rear of the compressor housing by Twenty Three (23) studs, springwashers and nuts, and completely encloses the rear half of the engine.
In addition, the lower side of the casing supports a welded mounting boss for the fuel drain valve, the pipe and flange for the drain quill tube.
The fuel drain valve contains a spring loaded stainless steel diaphram.
When the engine is not running, spring pressure prevents the diaphram from seating and allows any fuel which may have accumulated in the main air casing to escape through a central drilling in the valve housing, and four holes around the edge of the diaphram disc to an avica pipe connected with the power plant bottom panel.

Once the engine is running, an air pressure of apprx. 2 lb/in^2 in the main air casing is sufficient to force the diaphram on to its seat, thus sealing the valve and preventing loss of compressed air.

BELLOWS ASSEMBLY

To avoid distortion of the main air casing due to expansion of the Turbine nozzle and shroud ring assembly, a flexible steel corrugated cylinder is placed between the two components. The bellows is secured to the rear flange of the main air casing by Twenty Three set bolts, one stud and nut and twenty Four springwashers, and to the nozzle & shroud ring by Twelve wire locked set bolts.

EXHAUST CONE & CYLINDER ASSEMBLY

The fabricated stainless steel exhaust cone is secured to the rear flange of the main air casing by the Twenty Three set bolts, one stud & nut and Twenty Four speingwashers which hold the flexible bellows, and has an included cone angle of 24° to match the tip angle of the Turbine rotor blades.
One thermocouple boss and the sole plate for the temperature control mercury boiler, are welded around the support flange of the exhaust cone.

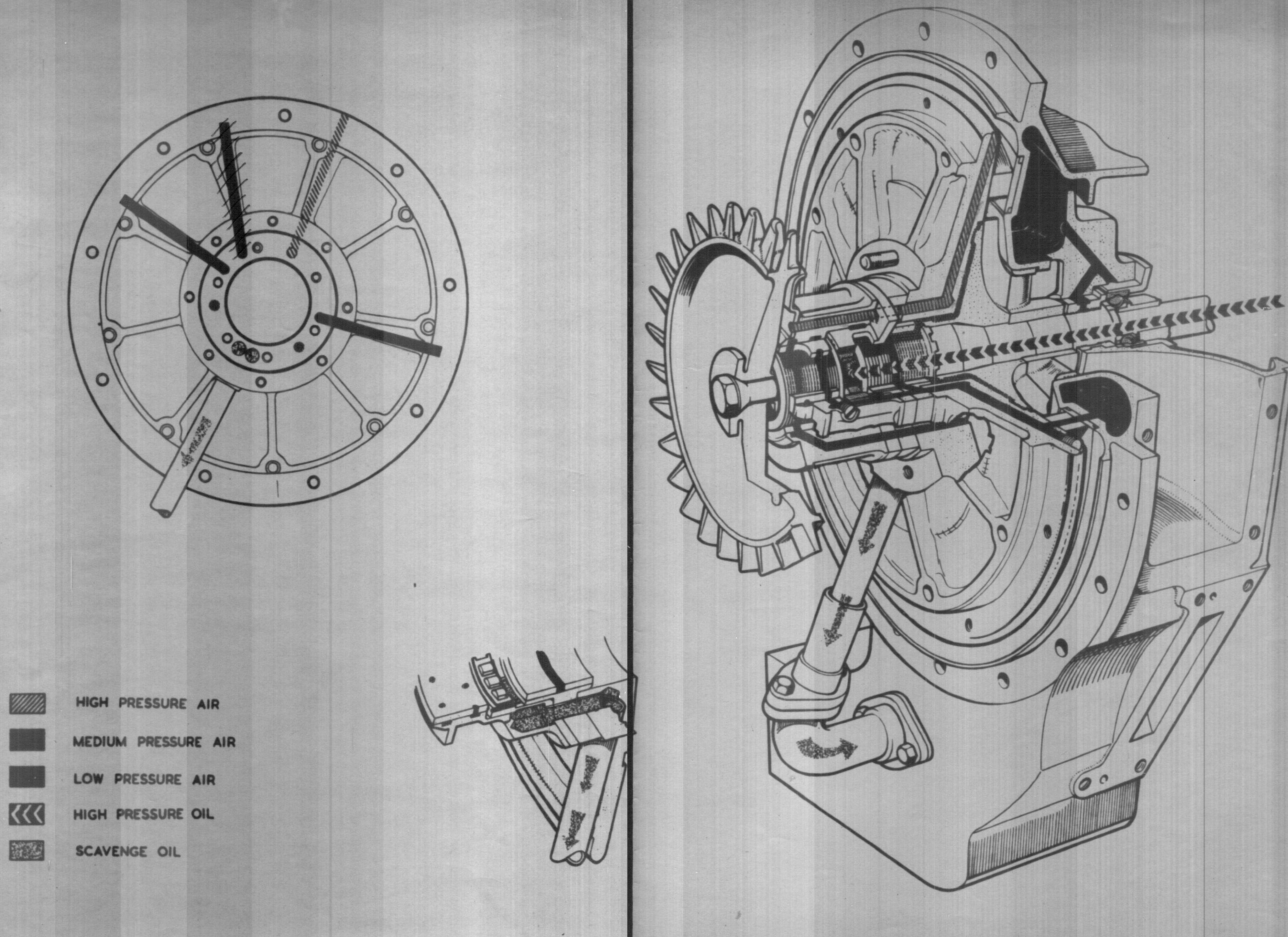


FIG.6 COMPRESSOR SHAFT SEALING AND COOLING AIR

LUBRICATION SYSTEM

Oil Type   Ox.38.   DERD. 2487.   NATO Code 0-149

Oil Pressure   WARNING LIGHT

The engine lubrication is of the wet sump principle, and is provided by a gear type pressure pump, which takes its supply via a suction tube and wire mesh filter from the oil sump, formed in the base of the compressor housing.
From the oil pump, the oil flows via a duct in the pump mounting plate to the internal feed duct in the auxiliaries mounting case past a relief valve, to the annular space in the top of the filter mounting cup.
It then passes down the outside of the filter element through it, into the central passage and up the central boss in the cup. By-passing a second relief valve, inserted at this point, the oil flows from the filter head through a non-return valve at the base of the auxiliary plate to the cooler, via a flexible pipe and returning, also via a flexible pipe to the union at the outside edge of the auxiliary plate beneath the hydraulic pump mounting face.
Pressure oil flows up a duct in the auxiliary plate, a tapping taken off to lubricate the hydraulic pump driving gear bearings. A second tapping at the generator drive gear location, serves to duct oil to the drive gear bearings, proceeding along the duct to an oil jet on the auxiliary plate inner face, where it projects into the open end of the compressor shaft.
Extending across the auxiliary plate, the oilway leads to the idler gear bearings, and to the blower bearings.
Oil splashing from these bearings serves to lubricate the gear teeth.
Oil draining from these gears collects at the bottom of the auxiliary drive casing and a ductallows the oil to drain back into the sump.

Oil from the jet enters the compressor shaft, and flows from the oilway, feeds the front and rear bearings via two series of radial drillings at the bearing locating positions.
The drillings for the rear roller bearing feed oil directly to the base of the roller track, whilst those for the front bearing feed the oil to an annular space behind the bearing.

Oil from the rear bearing drains into a recess in the bottom of the compressor shaft outer seal housing, and flows forward along two drain holes drilled in the flange of the flexible bearing outer race, the shaft inner seal flange, and ducts drilled in the bearing housing support plate, to reach the oil drain quill tube.
Oil flowing down the quill tube, passes through the 'T' piece and into the return tube, which projects upwards into the base of the compressor housing.

LUBRICATION SYSTEM (Cont'd)

This arrangement prevents undue splashing and frothing as the oil returns to the sump.

The oil sump, formed by the base of the compressor housing, contains the suction filter, oil pump, the 600 watt. 24 volt immersion heater, and the intake and overflow unions for the pressure re-oiling system.

A thermostat incorporated in the sump heater, maintains the oil temperature at 50° C. to assist starting at extreme temperatures.

RE-OILING PROCEDURE

The A.A.P.P. should be re-oiled after every 5 hours running. (Both ground and Flight running)

1. Remove blanking cap from engine oil filling connection, and connect the half coupling to the engine oil filling connection. It is possible that a small amount of oil will flow from the overflow drain connection pipe, on connecting the coupling half. This does not indicate that the engine oil level is full, and should be ignored.

2. Deliver oil to the engine until oil starts to flow from the overflow pipe.
   This indicates that the oil level is correct.

   Stop deleivery of oil and disconnect.

   Replace blanking cap on oil filling connection,
   Start and run A.A.P.P. for several minutes, and re-check oil level. (To allow for filling up oil cooler and pipes.)

FUEL SYSTEM

General Description.

The complete fuel system consists of a Rover MK.VIII multi-piston pump, incorporating automatic controls to prevent overspeeding and excessive Turbine temperature, together with a Simplex burner, electrically actuated high pressure shut-off cock and motorised air pump for starting.

The system is designed to supply the correct amount of fuel to the Turbine under each of the following conditions.

Starting.
Light-up and acceleration.
Overspeeding.
Excessive Turbine Temperature.
Turbine shut-down.

THE FUEL PUMP

This is secured to the auxiliaries driven gearbox cover by four set bolts and is driven through a coupling from a splined boss on the oil pump driving gear.
The main body of the pump is alum. alloy, and the drive shaft is housed in an aluminium bronze bearing body, which serves as a mounting end plate. The bearing body contains suction and delivery transfer ports and passages and also houses the shaft oil seals, one seal to prevent escape of fuel from the pump, and the other to prevent escape of lubricating oil from the gearbox.
The other end cover is of steel, on the inside of which is machined a circular angular cam face, the surface is hardened and ground to fine limits. Integral with the inner end of the drive shaft is a triangular shaped rotor, housing three spring loaded pistons disposed in bores around the axis of the rotor. A ball bearing attached to the closed end of each piston, seats in a cup shaped slipper pad, which held by the thrust of the piston spring rides on the angular cam face of the end cover. As the cam face is eccentric the pistons are pushed towards the end cover for one half of a revolution, and forced away from it for the other half. The reciprocating movement of the pistons constitutes the pumping action.
Fuel is drawn from the aircraft main tanks through a filter to the pump body which is completely filled. As the pump rotates, fuel is drawn from the body into the piston bores, via the inlet drilling in the bearing body and the semi annular suction transfer port in the nose of the bearing body.
On the second half of each revolution the fuel is discharged from the piston bores into the delivery transfer port on the opposite side of the bearing body, and is conducted through drillings in the body and pump outer casing to an outlet union.
Fuel at delivery pressure then passes through a feed pipe to enter the burner body through an inlet union. The burner body contains an electrically actuated shut-off valve.

OVERSPEEDING

The periphery of the pump rotor carries two fixing plates to which one end of two leaf springs are secured by three wire locked set screws. The free ends of the leaf springs carry a half ball spill valve, positioned to seal the mouth of a valve seat which is screwed into the rotor and communicates with the pump delivery passage. A balance weight is bolted to the rotor to counteract the off set weight of the leaf springs and fixing plates. During the initial revolutions of the turbine, spring pressure retains the half-ball valve on its seat and enables the full output of the pump to be delivered to the burner. As the turbine speed increases beyond the governed speed of 46,664 R.P.M. the free end of one leaf spring moves outwards under the effect of centrifugal force, and opens the valve to spill off fuel. This is the normal speed governor control. The second leaf spring carrying the spill valve, is set to open at 50,000 R.P.M. in event of normal speed control failure.

EXCESSIVE TURBINE TEMPERATURE

The turbine temperature is limited to a pre-determined maximum by a second half ball valve arranged to spill off fuel from the burner at critical temperatures. The valve is housed in a separate casing secured to the underside of the fuel pump body by three bolts, and consists of a mercury filled bulb located in the turbine exhaust stream and connected to a bourdon tube via a capillary tube. In the event of exhaust temperature rising above the safe maximum, the mercury vapourises, transmitting a pressure through the capillary tube to the bourdon tube. As a result of this pressure, the bourdon tube tends to straighten out, and in doing so lifts the control lever and opens the half ball valve to spill off fuel from the burner supply.
The control continues to operate until the exhaust temperature falls to a safe level. The half ball valve is attached to a pivotted lever and is retained on its seat in the temperature control casing by a coil spring. Movement of the control lever is dependent upon the expansion of mercury in the bourdon tube.
The pivot for the control lever is eccentrically mounted on a spring loaded cam, provision being made to alter the position of the cam, and thus adjust the half ball valve to the required setting.
A second adjustment, by means of a trimming screw on the control lever, determines the initial clearance between the control lever and the end of the bourdon tube.
Provision for inhibiting the fuel system is afforded by means of a $\frac{1}{8}$" BSF union at the side of the temperature control unit, and bleeding off the fuel pump can be carried out by attaching a long piece of rubber tube to the bleeder screw on the large hexagon plug on the top side of the pump body casing.

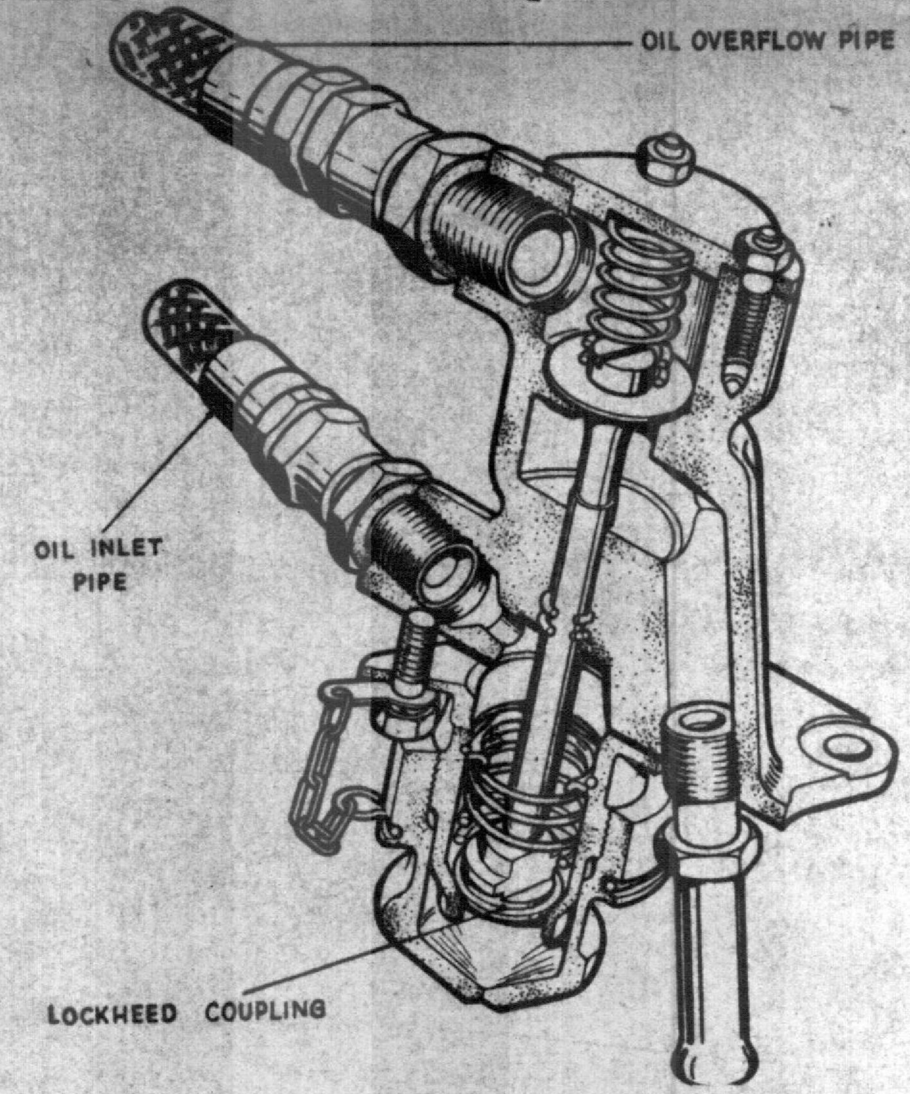


Fig. 3. Pressure re-oiling valve

Pressure re-oiling system

16. The pressure re-oiling valve (*fig.* 3) secured to the bottom panel of the unit casing, immediately to the rear of the sump, consists of a mushroom headed valve housed in an aluminium body. The valve head is seated in the upper portion of the body, which forms the overflow chamber and is held on its seat by a return spring seated on the face of the valve. The valve body also forms a guide for the valve stem and two 0-rings in the guide bore ensure that there is no loss of oil from the overflow to the intake side in the lower half of the body, which comprises a Lockheed coupling secured to the base of the assembly by four set bolts and spring washers. The spring loaded plunger within the Lockheed coupling serves as the intake valve and a clearance of 0·035 in. is maintained between the foot of the valve stem and the plunger.

17. The normal sequence of operations is as follows:—when ◀the oil delivery hose is attached▶ to the Lockheed coupling, the spring loaded plunger within the coupling is lifted from its seating and in so doing opens the overflow valve, the oil then flows from the intake side via an Avica pipe to the engine sump. When the correct level is reached within the sump, the oil overflows along a second Avica pipe to the head of the overflow valve which, being held open by the ◀oil delivery hose coupling▶, allows the surplus oil to escape. Immediately the ◀oil delivery hose is detached▶ the intake and overflow valves will close.

Oil cooler

18. The oil cooler (*fig.* 4) is located on the starboard side of the power plant, secured to the body of the alternator by a metal strap. A forced draught of air to the cooler is provided by a blower unit

ROVER A.A.P.P. MK.10201

AIRCRAFT ARGOSY C. MK1.

INSTALLATION OF ROVER A.A.P.P.

When the A.A.P.P. is installed in the aircraft boom.
To centralise the jet pipe (up & down) in the aircraft skin exhaust outlet, adjust on the 3rd. point mounting fork end.

Pipes to be connected.

1. Fuel feed (avery coupling)
2. Three hydraulic pipes. Inlet $\frac{5}{8}$" B.S.P. By-pass $\frac{1}{2}$" B.S.P. and pressure $\frac{3}{8}$" B.S.P. (All avery coupling)
3. Methyl Bromide $\frac{1}{2}$" B.S.P.
4. Drain pipes, from the re-oil tray to the aircraft outer skin $\frac{1}{4}$" B.S.P.

Electrics

1. Positive & negative leads for the starter generator
2. Hours & starts counter plug (4 pin)
3. E 23 plug 27 pin
4. C 12 " 4 pin
5. ~~C 13 " 12 pin~~ N/A

Fill the oil system via the re-oil valve.

Bleed hydraulic pump. by loosening the inlet pipe connections at the hydr. pump when air free fluid is present, retighten the pipe & wirelock.

To bleed the fuel system, and de-inhibit.

1. With the L.P. cock closed, ~~remove~~ loosen the fuel pump governor blanking plug, bleed screw.
2. Place container underneath the fuel pump, approx. 2 gall. capacity.
3. Select No.2. tank group booster pump "on" if tank contents are below half.
4. Open No.2. tank group crossfeed cock & check magnetic indicator shows 'in line'
5. Select 'open' on the L.P. cock & bleed off approx. 1 gall. of fuel
6. Shut L.P. cock.
7. ~~Replace~~ Tighten fuel pump, blanking plug bleed screw & wire lock.
8. Open L.P. cock.

~~For~~ the following ~~items~~ Sequence, a or b may be carried out.

a. Carry out wet cycle i.e. select ~~blow out~~ START, with wet cycle switch in the ~~'on'~~ WET position, and motor over for 30 secs. Allow approx. 4 mins. for the fuel to drain out of the engine, drain pipe situated to the rear of the intake scoop, on the outer skin of the boom.
Carry out a dry cycle i.e. select blow out with the wet cycle switch in the ~~'off'~~ NORMAL position and motor over for 30 secs.
(IN A.A.P.P. BAY IN PORT BOOM.)

INSTALLATION OF THE ROVER A.A.P.P. (Cont'd)

b. Disconnect the fuel feed pipe to the burner & pipe to a container with a slave rubber pipe.
Select start or blow out & motor over for 30 seconds.
Re-connect the feed pipe to the burner & wire lock.

Replenish the oil sump level. Ox 38.

On completion of these checks, the A.A.P.P. is ready for running.

Ground Starting.

Fuel, gravity feed from No.2. tank.

1. OPEN A.A.P.P. L.P. cock , magnetic indicator should show white.
   Permanently 'ON'
2. "GROUND, FLIGHT, CHARGE" switch selected to ground or flight.
3. A.A.P.P. generator switch to 'NORMAL' check generator dolls eye indicates fail 1/1
4. Select A.A.P.P. master switch to "start"
   a. Check oil pressure warning light 'on' (RED)
   b. Sump heater warning light 'on' (AMBER) if engine is cold, or if the sump heater had not been selected previously.
5. Press A.A.P.P. Start button, this must be held in for at least 2 seconds before it will hold in magnetically.

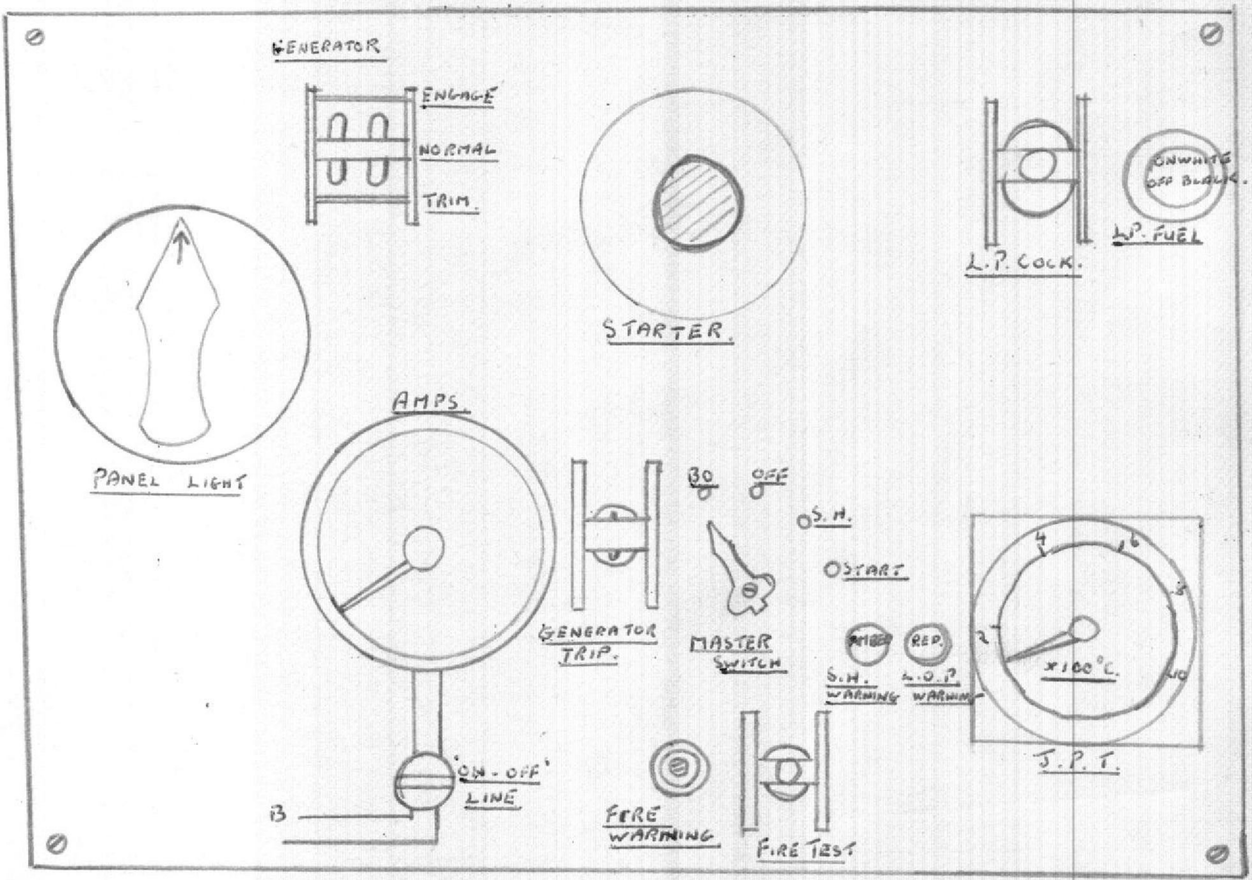
On normal start, the following should take place.

1. The starter button should throw out after approx. 10 seconds. (If the engine is late lighting, or if the battery is on low voltage, the starter button will hold in for a longer period, also if the engine fails to light, the starter button will throw out on completion of the 30 second time cycle.)
2. Oil pressure warning light extinguishes.
3. The J.P.T. does not exceed 665° C. for more than 10 seconds.
4. ~~After approx. 5 mins. running the sump heater warning light should extinguish.~~
   To bring generator on line, select engage on the generator control switch.
   Check magnetic indicator shows generator 'ON LINE'
   TO STOP select 'OFF' on the A.A.P.P. master switch.

Flight Starting.

As for ground starting, with the exception of item 2. when the 'GROUND FLIGHT CHARGE' switch will be in the flight position, and the addition of the following, select No.2. tank group fuel cross feed open.

A.A.P.P. CONTROL PANEL.



__NEVER__ off load generator on generator trip switch.

If the 'Ground, Flight, Charge' switch is set to charge while the A.A.P.P. is running, the A.A.P.P. cannot be stopped.

MODIFIED ELECTRICAL CIRCUIT

CIRCUIT FUNCTION

FIRE EXTINGUISHER BUTTON, FIRE DETECTOR OR CRASH SWITCH will at any time fire extinguisher bottle & shut down A.A.P.P. or sump heater, crash switch will also trip R.C.C.B. killing generator.

MASTER SWITCH & L.P. FUEL SWITCH 'OFF'

L.P. & H.P. Cocks & scoop closed, All other supplies broken

MASTER SWITCH AT SUMP HEATER

Sump heater 'ON' controlled by thermostat.

MASTER SWITCH AT START L.P. FUEL SWITCH 'ON'

L.P.Cock opens, indicator operator scoop opens, closing relay P.47R3 making supply to:-
- Start Button
- Timer Contact
- Hour Meter
- Oil Pressure Wng.

Relay P.47R4 opens, breaking supply to H.P. cock shut line.

START BUTTON DEPRESSED

Start relay energised making supply from battery, main generators or external supply to generator.
Supply made to start counter & wind up coil of time delay switch which closes, making supply to overspeed relay contacts closed due to starting current, and then to hold in coil to start button. Relay P.47R5 closes making supply to H.P. cock open line & via wet blow-out switch (wire locked shut) to air pump and igniter.
As starting current drops to 40-50 amps, overspeed relay opens breaking supply to start button hold in coil & opening start relay.

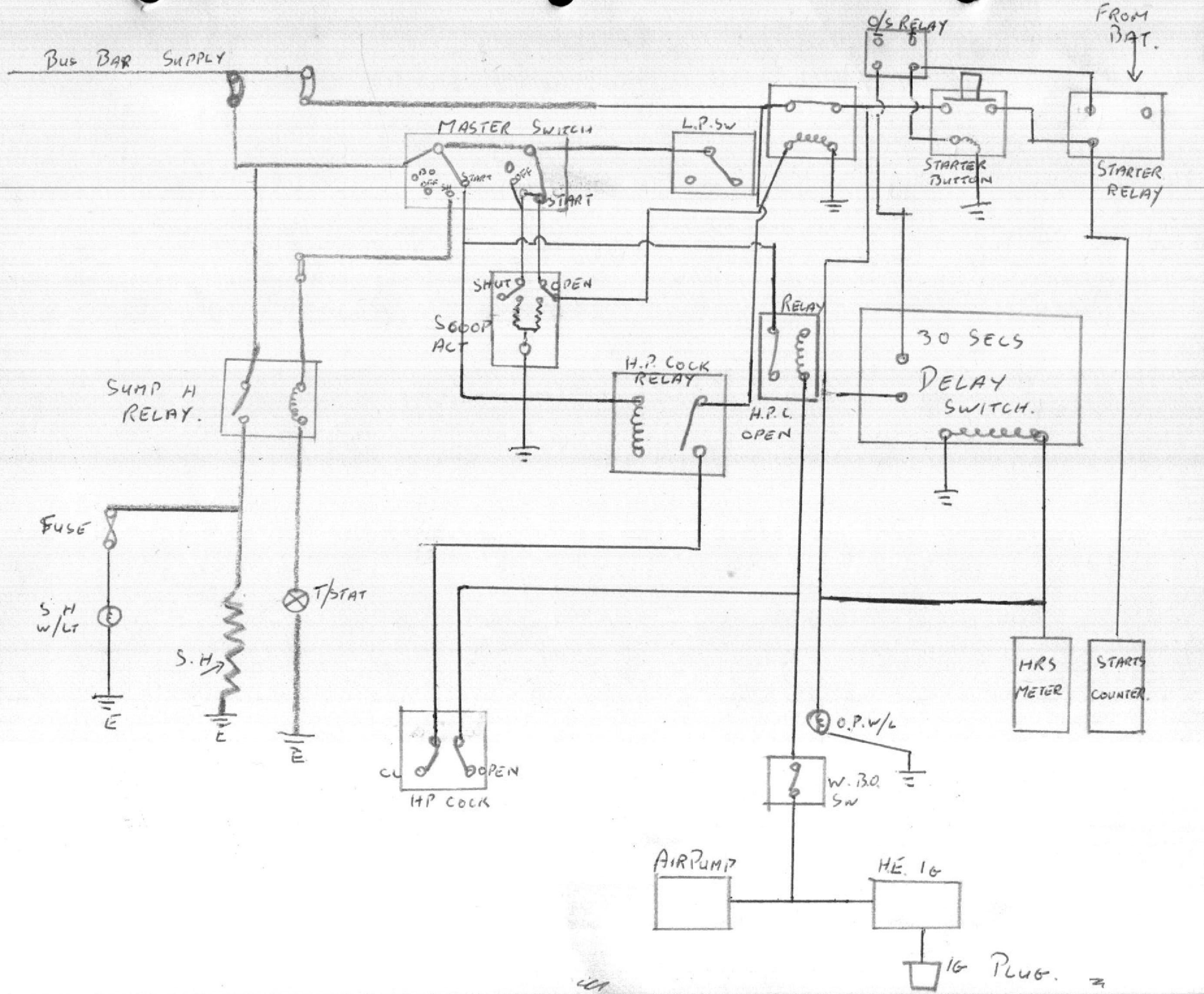
After 30 secs. time delay switch contacts open, causing relay P.47R5 to open breaking supply to H.P.cock open line, igniter & air pump.

MASTER SWITCH AT BLOW OUT

As for start but P.47R4 is not energised, maintaining supply to H.P.cock shut line and no supply is available through relay P.47R5 to H.P. cock open line, igniter or air pump.

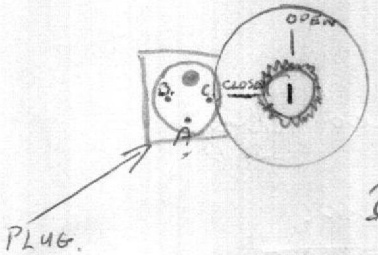
WET BLOW OUT

Master switch at start, L.P.Fuel switch 'ON' and wet blow-out switch opened as for start, but igniter and air pump are isolated.



Bus Bar Supply
MASTER SWITCH
OFF
START
L.P.SW
O/S RELAY
FROM BAT.
STARTER BUTTON
STARTER RELAY
SHUT
OPEN
SCOOP ACT
SUMP H RELAY.
H.P. COCK RELAY
RELAY
H.P.C. OPEN
30 SECS DELAY SWITCH.
FUSE
S H W/LT
S.H
T/STAT
E
HRS METER
STARTS COUNTER.
O.P.W/L
CL
OPEN
HP COCK
W.B.O. SW
AIRPUMP
H.E. IG
IG PLUG.

H.P. COCK ACTUATOR.



Functional check is to energise A. & B. and ensure scribed line on shaft aligns with closed position on cock body.

Energising A & C. opens cock.

Compressor Washing Solution.

3 parts AVTUR. 3 parts Distilled water, 1 part Turbeo.

at every 100 hours or, 20 hours A.A.P.P.

Cons replenishing. Remove drain valve on servicing tray. Disconnect air pipe at H.P. cock. Select blow out and press S/B. at same time operate flushing rig at 30 lbs/□". Allow to soak for 15 mins, this should loosen deposits on compressor. Repeat blow out cycle but spray in distilled water. Repeat blow out cycle, replace pipes, etc. Carry out normal start.

Inhibiting Seized engine

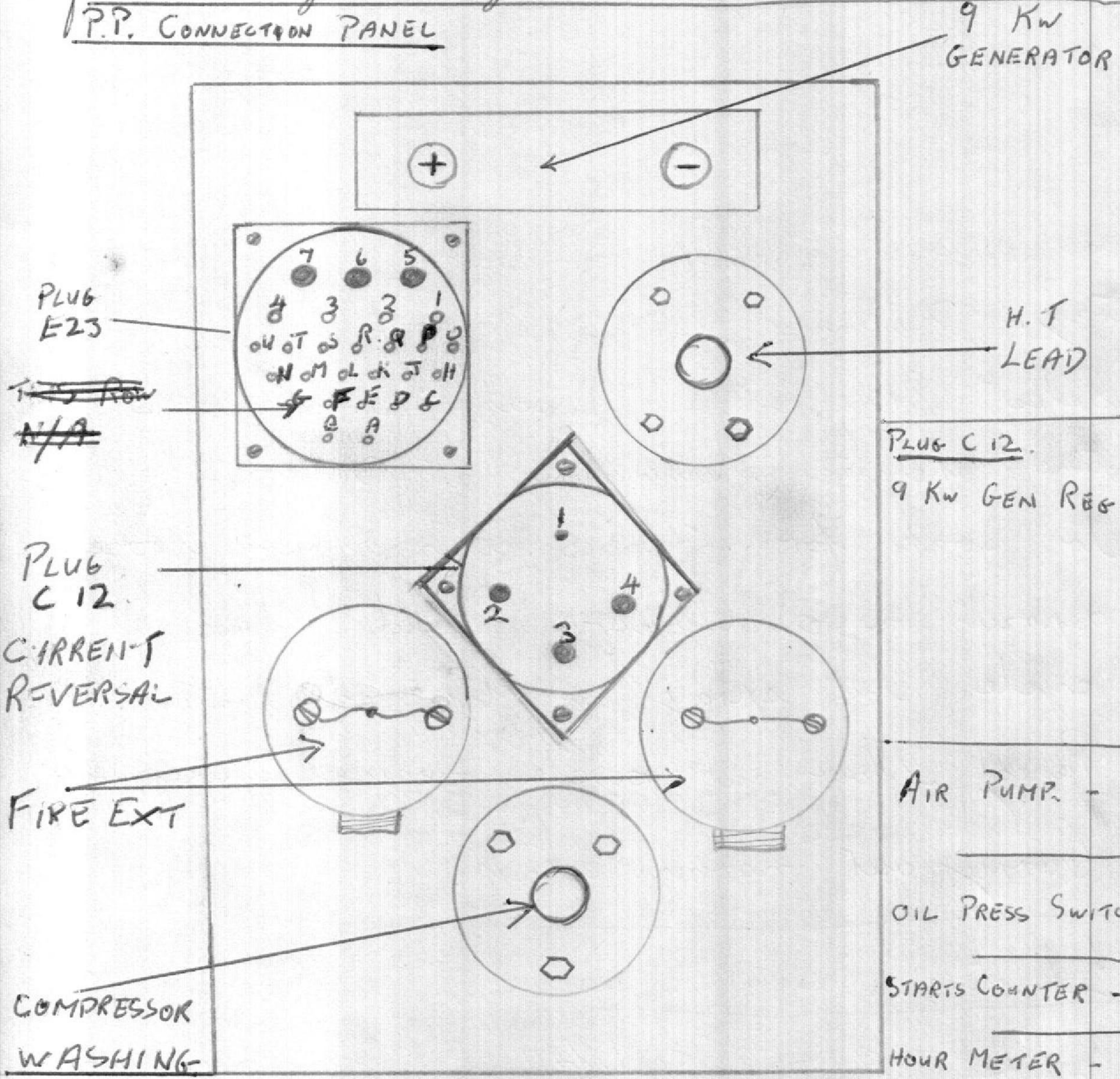
Inhibit at 350/450 lbs□" at connection on T.C.U. ZX.17.

Burner Sit-Back.

·065" ± 5 from burner shroud. Obtained by fitting shims on flange of burner/H.P. cock.

ENTERED IN ERROR ~~Shims are Klingerite seats~~ ^ ~~Individual engine Measurement obtained from engine log book~~.

P.P. CONNECTION PANEL



PLUG C 12.

9 KW GEN REG - 1 & 3.

AIR PUMP - H - POS
J - EARTH.

OIL PRESS SWITCH - M & N.

STARTS COUNTER - C & D.

HOUR METER - A & B.

PLUG E 23:- EX THERMO/C - N° 1 POS, N° 2 NEG. : OIL HEATER - 5 & 7 PINS.

BURNER ACT: E - NEG, F - POS } OPEN; E. NEG, G POS } CLOSED.

Fault Diagnosis

__Engine Fails to Rotate__: (1) A/c batteries discharged or low voltage. (2) Faulty or loose connections. (3) Circuit breaker open.
(4) Faulty generator or reverse current switching unit, or dirty or greasy breeze plug.
(5) Engine seized.

__Engine Rotates but Fails to Light__

__Fuel.__

1. Check ~~L.P. filter~~ Drain Valve for fuel.
2. Check L.P. filter.
3. Check full fuel supply through cock and L.P. filter.
4. Air in fuel system.
5. ~~Motor~~ Inhibiting fluid in fuel system.
6. Burner actuator not operating.
7. Faulty air pump if aircraft is at high altitude
8. Check air pump filter.
9. Check N/R. valves at air pump union and T peice union.
10. Check electrical supply to air pump.
11. Fuel pump delivery

__Ignition__

1. Igniter plug failure. Check gland nut and gland housing
2. High Tension harness. Check for continuity and insulation.
3. Check supply from batteries to A.A.P.P.
4. High Energy igniter unit faulty.
5. Wet Cycle switch in Wet Blow Out position.

Engine Lights but Fails to Accelerate to Governed Speed.

1/ Low A/C. batteries.
2 Insufficient fuel supply. L.P. cock, burner actuator. L.P. filter - (T.C.U.
3 Restriction of air intake.
4 Insufficient fuel in main A/C tanks with booster pumps off.
5 Incorrect grade of oil.
6 Partial seizure of engine.

Engine Surges During Acceration.

1. Starting engine on full load
2/ Operation of rear doors.
3 Faulty fuel supply
4 Blocked drain valve after attempted wet starts.
5 Faulty fuel pump.
6 Faulty T.C.U.

Engine Surges During Running.

1/ Restriction of air intake.
2 Faulty fuel supply. L.P. cock L.P. filter. Fuel pump.

Low Oil Pressure.

1/ Insufficient oil or incorrect grade of oil
2/ Blocked oil cooler indicated by high oil temperature
3 Faulty oil pressure transmitter. Check pins and wiring.
4 Oil leakage, Check pipes and unions.
5 Blocked sump filter.

J.P.T. Exceeds Limitations during No Load, steady Running Conditions.

1/ ~~Air~~ Restriction of air intake.

OVER.

2 Faulty J.P.T. gauge or thermocouple.
3 Loose nut on thermocouple.
4 Faulty T.C.U.

Continuous ~~fuel~~ drain ~~flow~~ from Secondary Drain Valve whilst engine is running-

1 Fuel leakage - Faulty H.P. cock spindle seals.
2 Hydraulic oil - Inner seal failure of Hydraulic Pump.
3 Engine oil - Outer " " " " "
NOTE Check avery coupling on top of mounting loop.

Engine stalls when Electrical or Hydraulic Loads applied.

1 Restriction of air intake
2 Dirty compressor. If compressor cleaning does not restore power
~~3~~ check for insufficient fuel supply.
3 Partiall seizure of engine or its components.

P.P. Fails to accept electrical load. J.P.T. stays within limits

1 Faulty generator 3 Faulty gauge.
2 Faulty wiring.

P.P. fails to accept Hyd load J.P.T normal.

1 Check Hyd fluid level.
2 Bleed Hyd lines.
3 If fault remains change Hyd pump.