TYNE ENGINE CONSTRUCTION

TYPE OF ENGINE

1. The Transall C160Z is powered by two Rolls Royce R TY20 MK 22, propellor turbine (twin shaft).

ENGINE GENERAL

1. a. Power (static sea-level at 15,250 LP rpm).

   b. Minimum rating 5,440 shp + 1,080 lb thrust.

   c. Average 5,665 shp + 1,125 lb thrust.

   d. Total engine weight (including accessories fitted) 2,487 lb

   e. Centre of Gravity 41 in. aft of propellor cone fitting line.

   f. Reduction Gear.

   g. Type Compound Epycyclic.

   h. Ratio 0,064-1 (Between prop shaft and LP turbine).

DIRECTION OF ROTATION

1. a. Engine Anti clockwise (viewed from the rear).

   b. Propellor Left hand tractor.

   c. Propellor (Hawker Siddeley Dynamics).

   NOTE: Four bladed hydromatic constant speed, capable of feathering and reversing.

   d. Compressor Axial flow
   Low presure 6 stages
   High pressure 9 stages

   e. Compression Ration 13,5-1

   f. Combustion Chámbers: Ten interconnected straight flow flame tubes in an annular casing.

   g. Turbines Axial flow
   High Pressure 1 stage
   Low pressure 3 stages

OPERATION

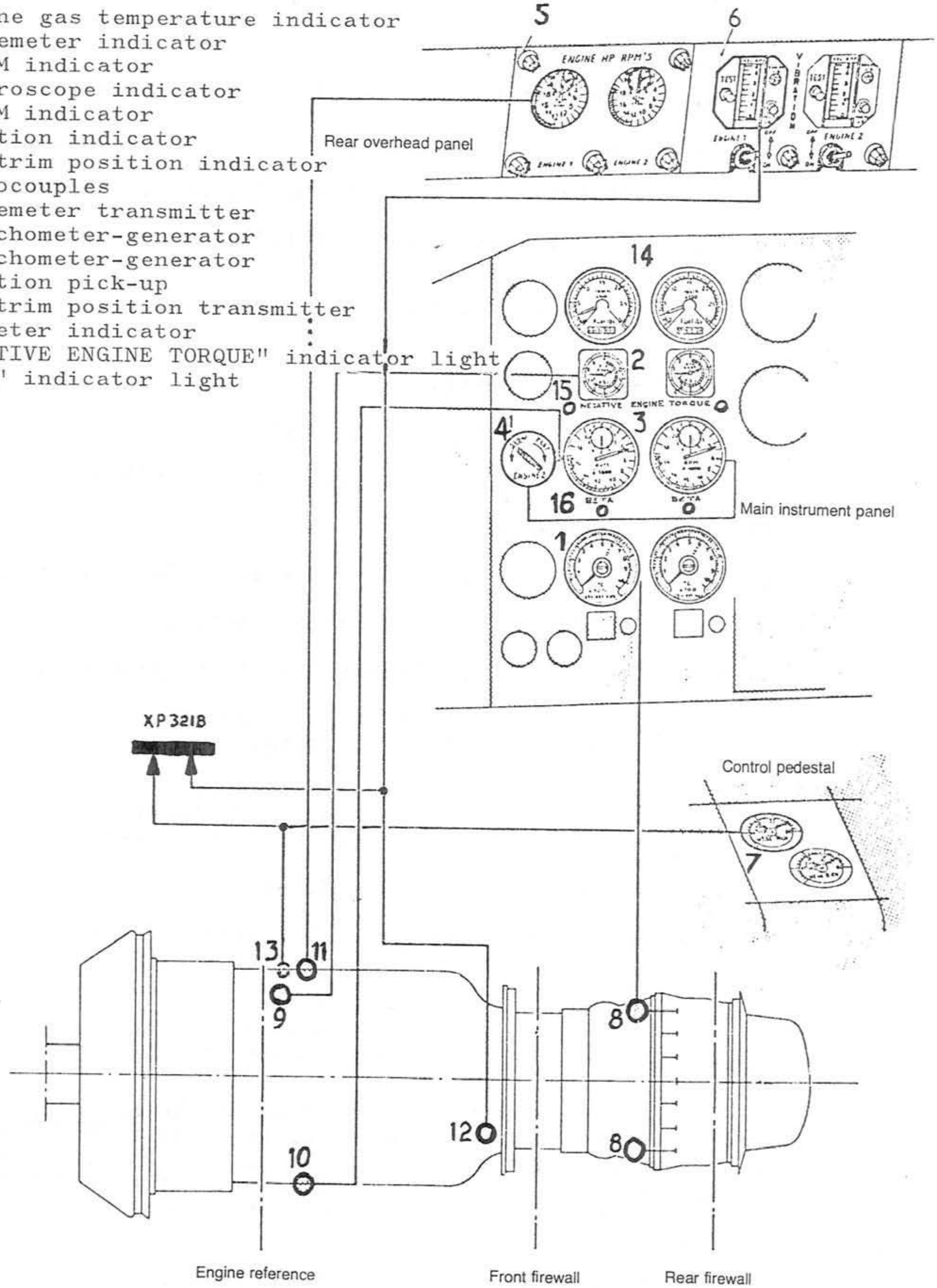
1. As no new principle is involved in the basic operation of the engine, we shall confine ourselves to considering that feature of the design which is so largely responsible for its high power and low specific fuel consumption, ie why it is a twin spool (twin shaft) compressor and why the two shafts run at their respective speeds.

2. To produce the design power and specific fuel consumption, the compressor must have a high pressure ratio (13.5:1); the power range also requires that it will operate with stability over a wide range of rpm.

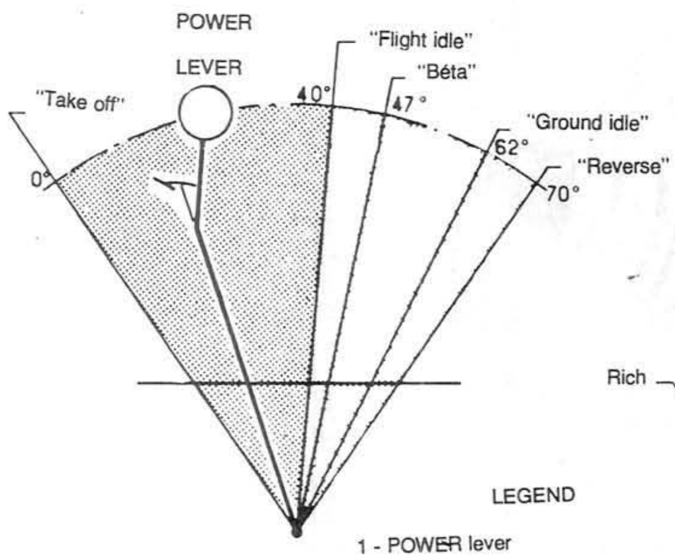
2/.....

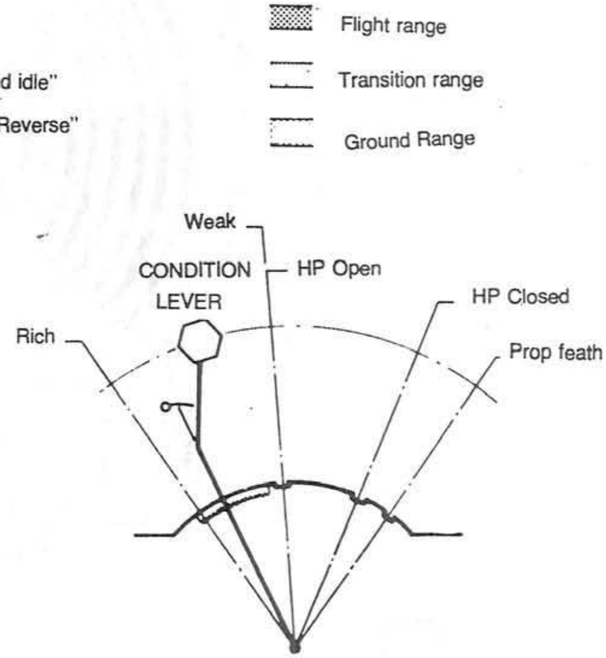
ENGINE INDICATING

1 - Turbine gas temperature indicator
2 - Torquemeter indicator
3 - LP RPM indicator
4 - Synchroscope indicator
5 - HP RPM indicator
6 - Vibration indicator
7 - Fuel trim position indicator
8 - Thermocouples
9 - Torquemeter transmitter
10 - LP tachometer-generator
11 - HP tachometer-generator
12 - Vibration pick-up
13 - Fuel trim position transmitter
14 - Flowmeter indicator
15 - "NEGATIVE ENGINE TORQUE" indicator light
16 - "BETA" indicator light



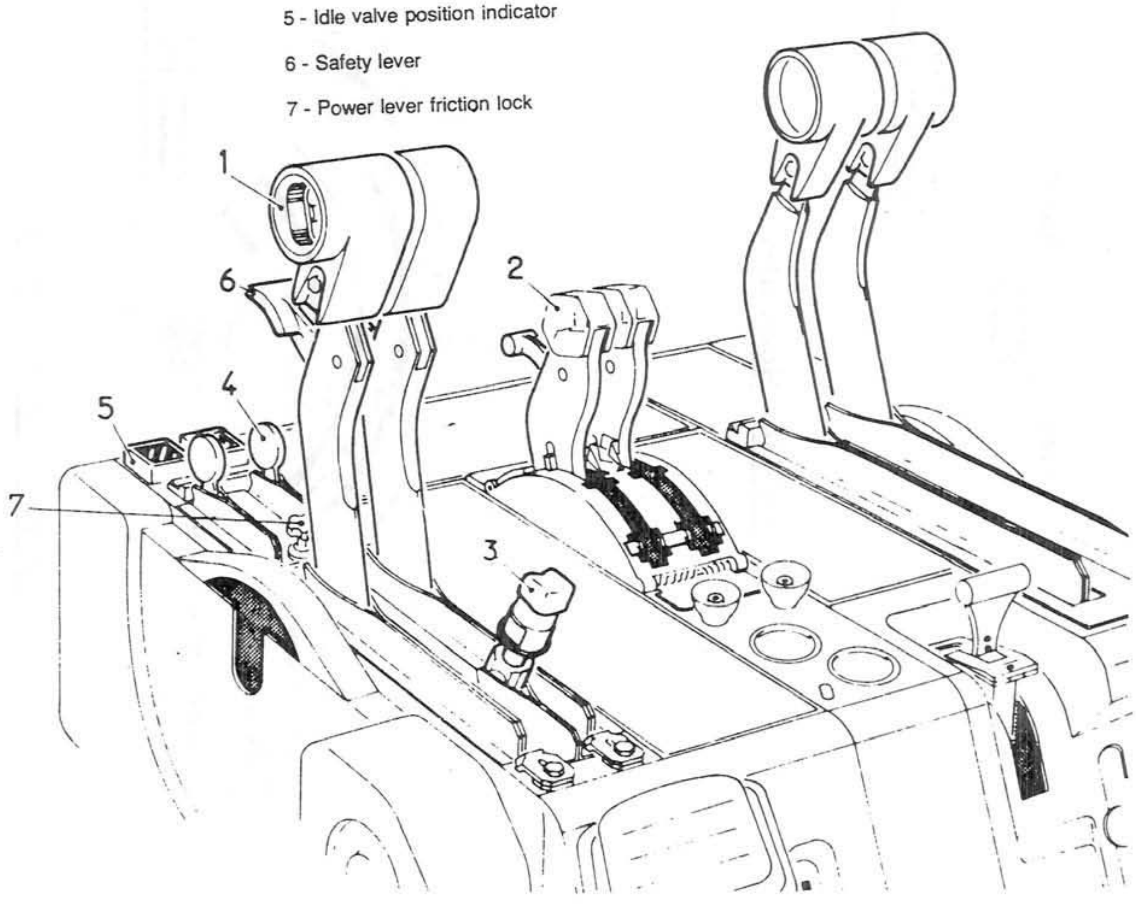
TURBO-PROP ENGINE CONTROLS

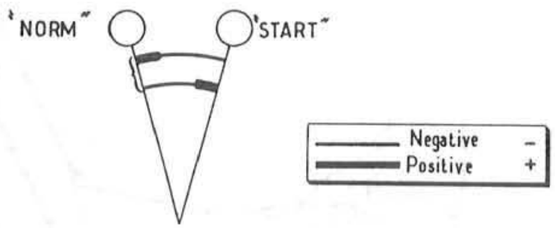




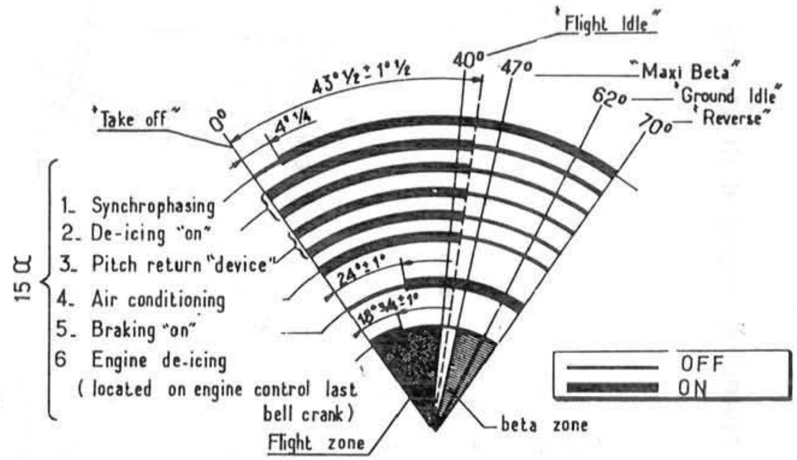
LEGEND

1 - POWER lever
2 - CONDITION lever
3 - AIR/GROUND lever
4 - IDLE lever
5 - Idle valve position indicator
6 - Safety lever
7 - Power lever friction lock

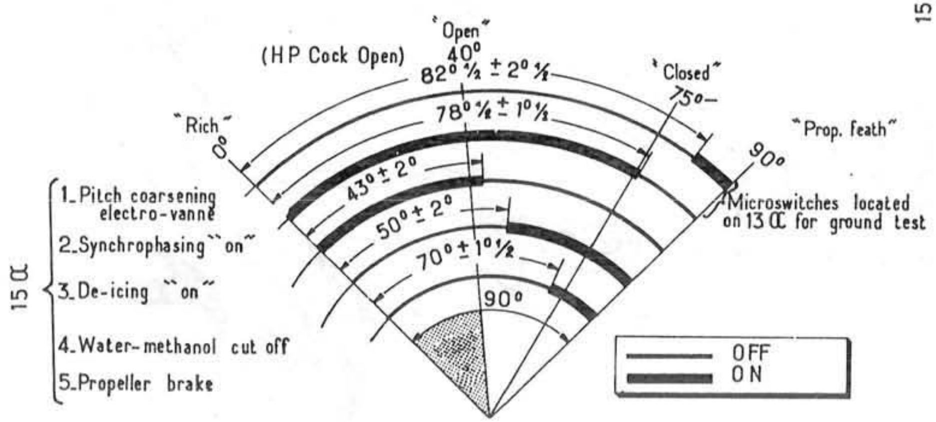




Idle Lever Microswitches

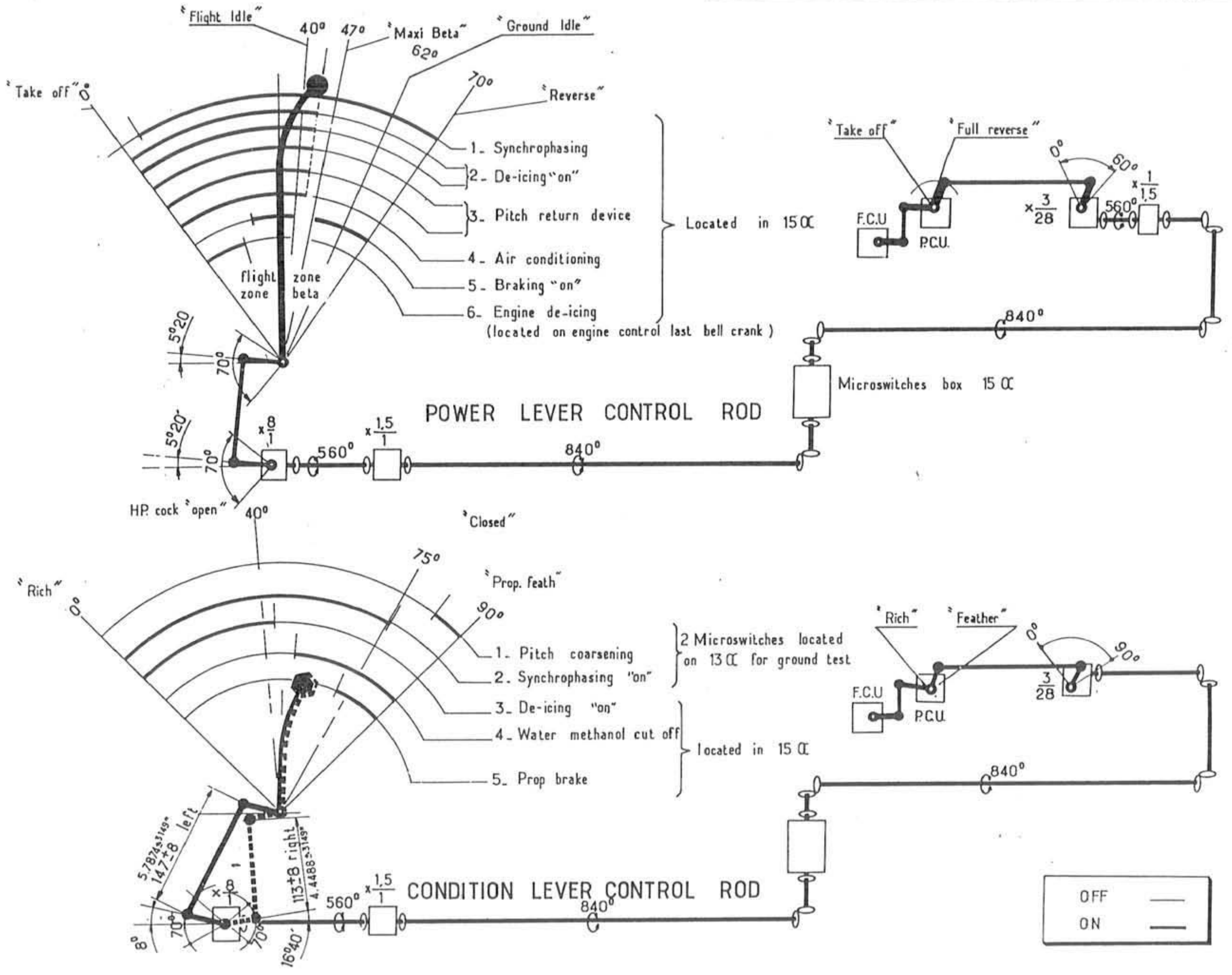


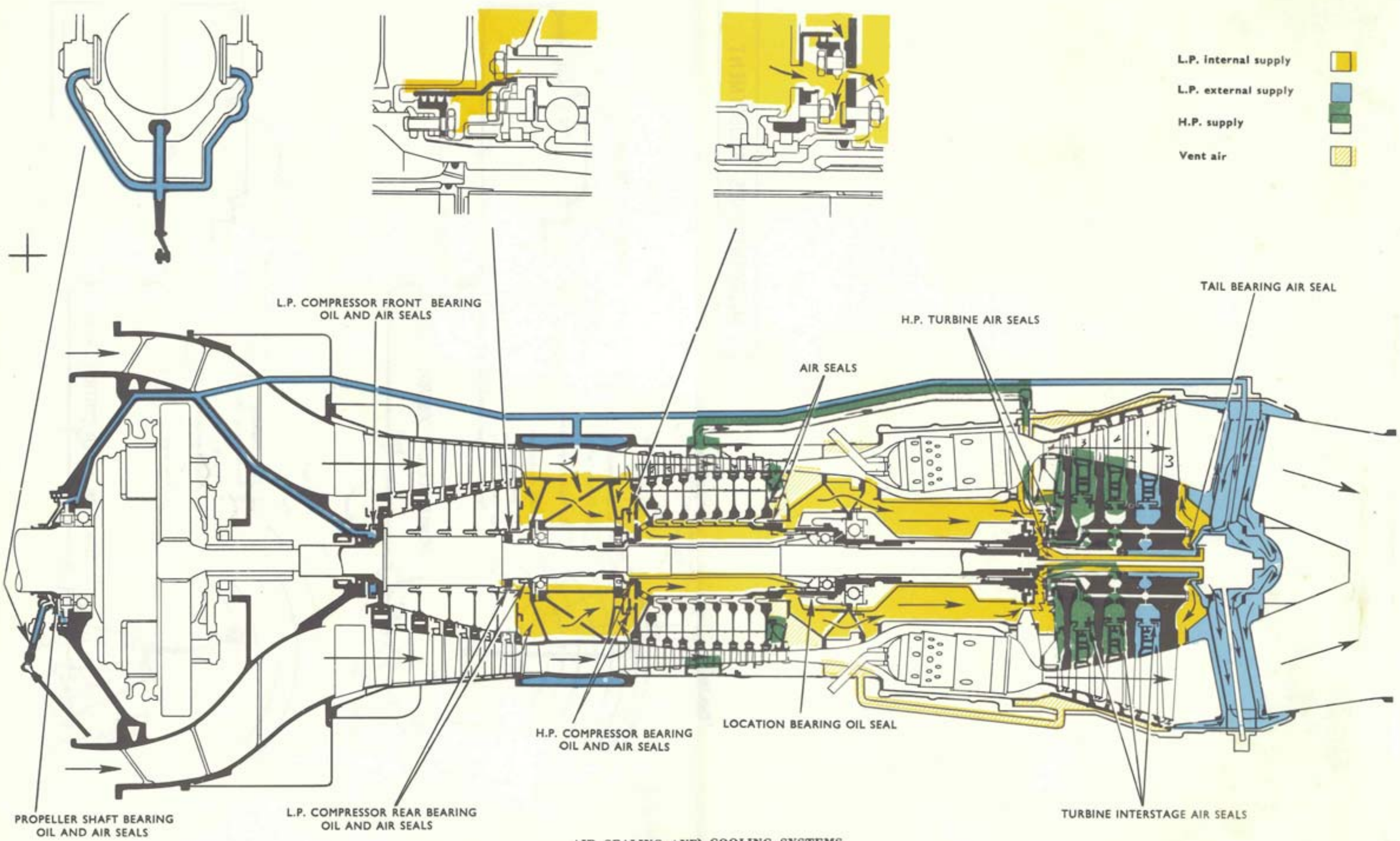
Power Lever Microswitches



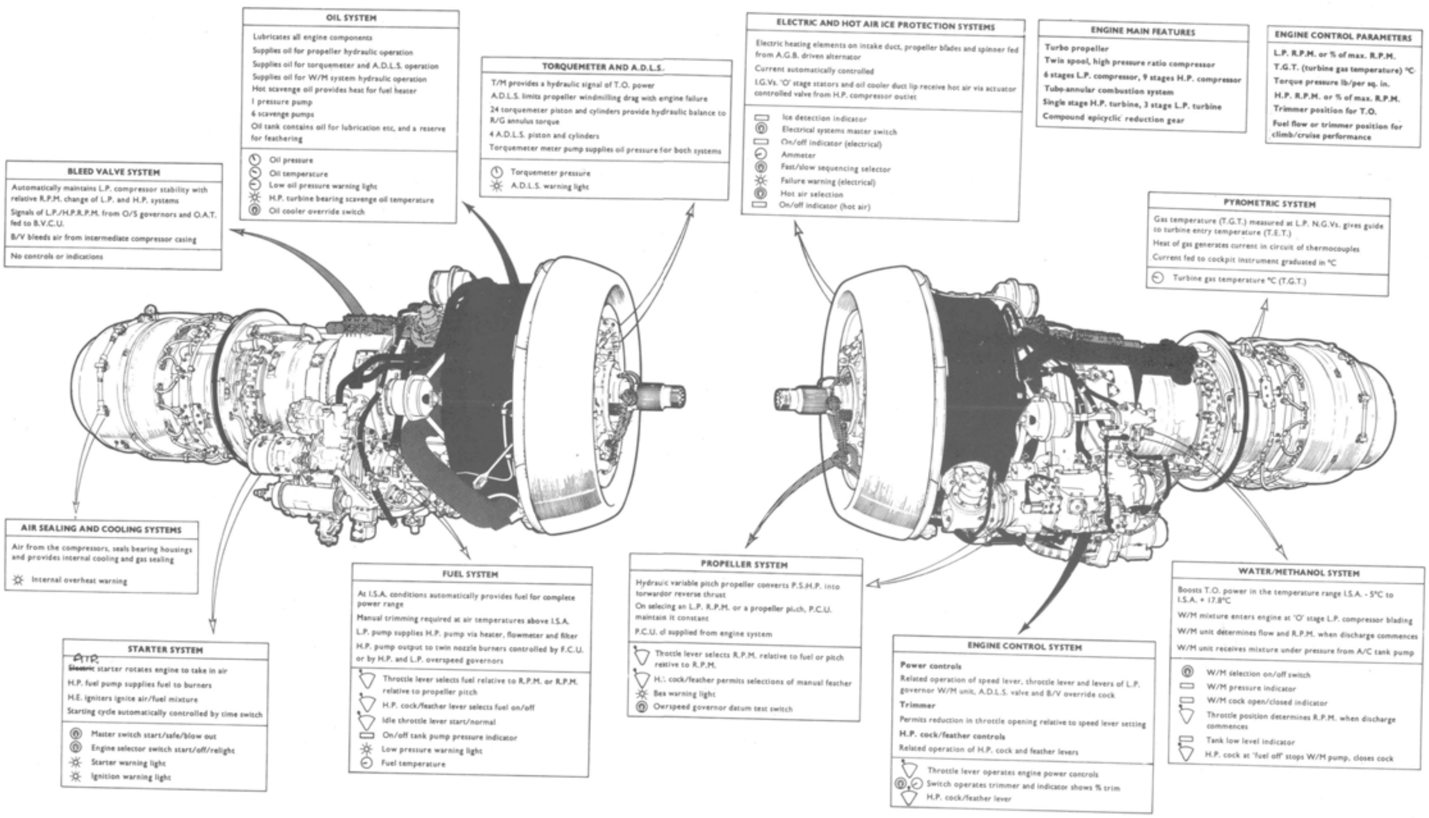
Condition Lever Microswitches

MICROSWITCHES ADJUSTMENT



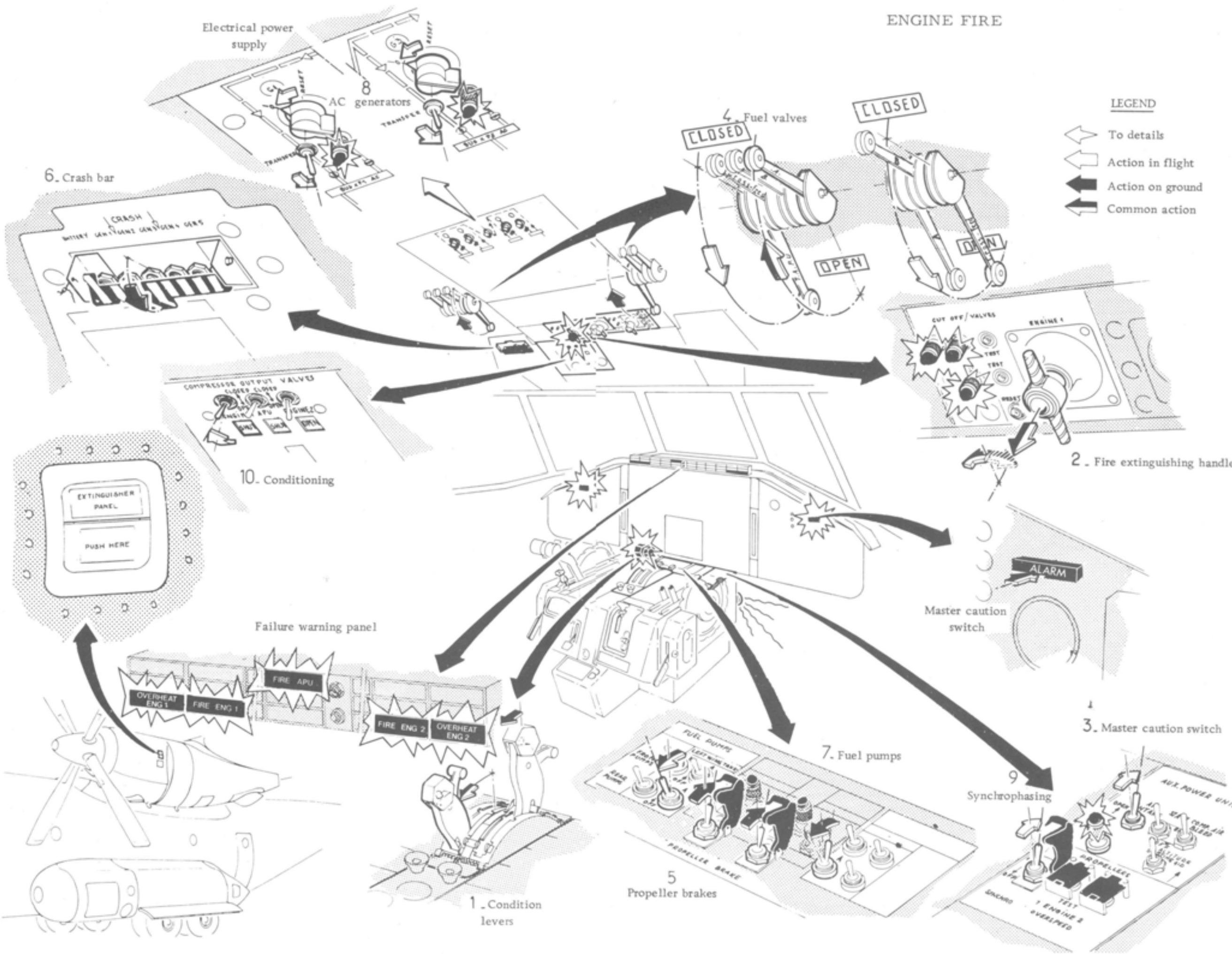


AIR SEALING AND COOLING SYSTEMS



TYNE ENGINE SYSTEMS, CONTROLS AND INDICATIONS

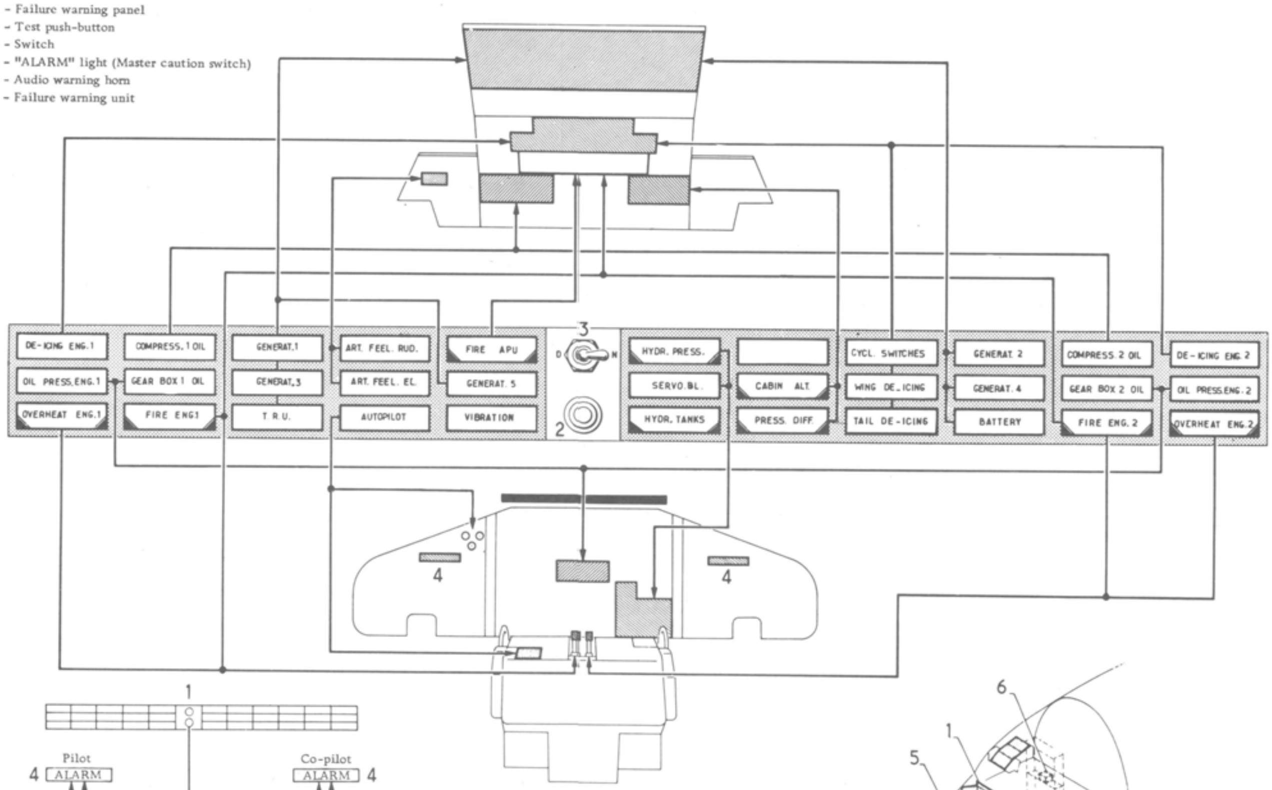
ENGINE FIRE

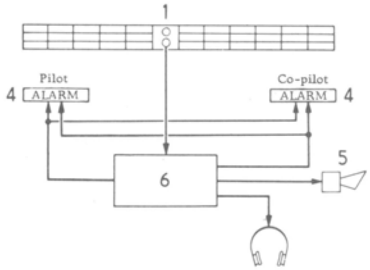

LEGEND
To details
Action in flight
Action on ground
Common action
Electrical power supply
8 AC generators
6. Crash bar
CRASH
4. Fuel valves
CLOSED
OPEN
CLOSED
OPEN
COMPRESSOR OUTPUT VALVES
10. Conditioning
EXTINGUISHER PANEL
PUSH HERE
2. Fire extinguishing handle
ALARM
Master caution switch
Failure warning panel
OVERHEAT ENG 1
FIRE ENG 1
FIRE APU
FIRE ENG 2
OVERHEAT ENG 2
FUEL PUMPS
7. Fuel pumps
3. Master caution switch
9 Synchrophasing
AUX. POWER UNIT
PROPELLER BRAKE
PROPELLERS
1. Condition levers
5 Propeller brakes

LEGEND

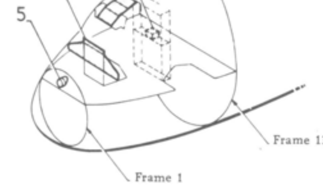
1 - Failure warning panel
2 - Test push-button
3 - Switch
4 - "ALARM" light (Master caution switch)
5 - Audio warning horn
6 - Failure warning unit

FAILURE WARNING PANEL





Flight crew interphone system



3. These combined conditions are met when the compressor is divided into two sections, each section being driven by an inde= pendent turbine, fig.2.

4. The object of this arrangement is to permit the sections to be driven at different rpm.

5. The first and second half of the compressor and their asso= ciated turbines are called respectively the LP and HP sections.

6. Let us now consider how the relative rpm are obtained, using as a datum the conditions at Take-Off power and then reducing power to Flight Idle.

a. HP rpm (T.O.)

7. The HP compressor passes the airflow of 46.5 lb/sec from the LP compressor and on a new engine, will run at 17850 (101.3%) rpm.

8. This mass flow and rpm determines the power required by the compressor.

9. The fuel burnt determines the total energy available in the combustion system and the HP turbine only extracts sufficient energy from the gas stream to provide the power for the HP com= pressor at the rpm mentioned.

a. LP rpm (T.O.).

10. The LP turbine converts most of the remaining gas energy into shaft horse power and this is substantially in excess of the com= pressors requirement at 15250 (99.8%) rpm.

11. Assuming no off take of power by the accessory gearbox, all the surplus power is transmitted via the reduction gear to the propellor.

12. Under the control of the PCU, the angle of the propellor blades is then adjusted, so that apart from converting the shaft power into thrust, the propellor maintains rpm constant by acting as a torque balance at 15250 (99.8%) rpm.

13. To summarise the previous comments, we see that at T.O. power the LP rpm is maintained constant by the propellor under the con= trol of its speed sensitive governor (PCU) and that the flow, which is related to the T.O. LP rpm.

14. This relationship is a simple mechanical tie-up between the throttle lever on the fuel control unit (FCU) and the speed lever of the PCU, it is called 'interconnection' and is controlled by a single cockpit lever.

15. RPM relationship at reduced power.

16. When the cockpit lever is moved towards Min Cruise, power falls as a result of lower interconnected values of both LP rpm and fuel flow.

17. The LP rpm will fall under the control of the propellor system and HP rpm in sympathy with the reduced fuel flow.

18. Now observe the change which occurs in the final power re=

duction from Min Cruise to Flight Idle.

19. In this range, the interconnection is affected by the man= datory performance conditions for an overshoot.

20. This requires the engine to produce not less than 95% of T.O. power when the lever is moved from FI to TO in 5 seconds; these conditions will be met if the LP rpm are not allowed to fall below 10,500 (68.7%).

21. My maintaining the selection of 10,500 (68.7%) rpm and redu= cing fuel flow as the power (throttle) lever is moved to FI, turbine torque falls and propellor pitch is reduced to maintain 10,500 (68,7%) rpm; this will reduce propellor thrust and also HP compressor speed.

22. These actions affect the aerodynamic working of the compres= sors, but this will be covered under "Compressor Bleed Valve."

ENG DRIVEN GEARBOX

1. The internal wheel case provides drives to the two external wheelcases ie the R/H, driven by the HP turbine, the L/H driven by the LP turbine.

EXTERNAL WHEELCASE

1. RH Wheelcase. This wheelcase contains drives for:

a. Percentage or direct reading tachometers.

b. Seven oil pumps and fuel system LP pump.

c. Starter motor.

d. Fuel pump and HP hydromechanical governor.

e. Breather.

2. The starter motor which is flexibly mounted on the rear face of the wheelcase, drives the HP system by engaging at the rear end of the first motion shaft.

3. LH Wheelcase. This wheelcase carries drives to:

a. Percentage or direct reading tachometers.

b. Fuel system variable datum hydro-mechanical governor.

c. The aircraft mounted accessory gearbox.

4. The accessory gearbox is mounted on the front fire wall and has a rear and front face, each providing dirves for the acces= sories.

5. Front Face:

a. 60 KVA alternator variable frequency.

b. 9 KVA alternator. Constand frequency.

c. Prop brake.

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6. Rear Face:

   a. Eng driven compressor.

   b. Green system hydraulic pump.

   c. Blue system hydraulic pump.

AIR SEALING AND COOLING SYSTEMS

1. Requirements of Systems:

   a. Supply air at adequate pressure for:

      i. Sealing bearing housings against loss of oil

      ii. Cooling internal components.

   b. Cooling air flows are required for two reasons:

      i. To insulate components against heat radiation from the combustion system.

      ii. To prevent leakage of hot gas from the main stream and to dissipate heat from the turbine assembly which is conducted from the gas stream.

ENGINE PARAMETERS AND WARNING INDICATIONS

1. TGT Turbine Gas Temp Indicating. The system consists of 20 thermocouples mounted on the leading edge of the LP turbine 1st stage guide vanes; and is connected in parallel which indicates TGT to a gauge graduated from 0^{o} to $1000^{o}C$.

2. Torque Meter. This system indicates the oil pressure in the torque meter system by means of a transmitter to a gauge with two coaxial pointers. The short pointer indicates hundreds and the long pointer tenths.

3. LP rpm indicator. A tachometer generator mounted on the LP gear box (L/H) is connected to a LP rpm gauge. The gauge con= sists of a single pointer and graduated from 0 - 20,000 rpm and a small circular gauge located at the upper part of the main dial which is graduated from 0-1000 rpm.

4. Synchro Scope. This indicator is connected to No's I and 2 eng LP rpm indicating systems. No 2 eng will indicate either "FAST" or "SLOW". In comparison with No 1 eng rpm indication.

5. HP rpm indicator. A tachometer generator mounted on the HP gearbox (R/H) transmits the HP rpm to a gauge graduated from 0-20,000 rpm and incorporates a small circular gauge graduated from 0-1000 rpm.

6. Eng virbration indicator. A vibration pick-up is mounted on the eng to indicate the amount of vibration through an amplifier to a rectangular gauge which is graduated from 0-5. A press button is fitted on the gauge to check the "LO" frequency vibra= tion on the prop. When the button is released it indicates a "HI" frequency virbration (ie TNE ENGINE). A test button is incorporated in the system for checking the "HI" and "LO" indi= cations, and should give a reading between 3 and 4 on the gauge.

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When the vibration increases to a value of 2.5 or above, a light will illuminate on the vibration indicator, and also indicates "ENG VIBRATION" on the master warning panel-as-well as an "ALARM" on the main instrument panel.

7. Fuel flow indicator. A gauge is provided to indicate the rate of fuel being used as well as the amount of fuel used for any fixed period. Graduation is from 0-3000 LBS/HR and the total fuel consumed is displayed in a window at the bottom of the in= strument. A pull button is provided to zero the fuel consumed indication.

8. Fuel pressure and temp gauge. A dual gauge is installed, indicating absolute booster pump pressure. On the top part of gauge, and the fuel temperature at the bottom part of the gauge. The pressure graduation varies from 3 to 30 PSI absolute, and the temp graduation is between-60°C to +90°C.

9. Oil pressure and temperature indicator. This is also a dual gauge with the oil press indicator on the top part and the temp at the bottom part. The press graduation is from 0 to 75 psi and the temp is from -30°C to +120°C. There is one gauge for each engine.

10. Rear turbine bearing temp indicator (HP). A single gauge indicating both eng turbine bearing temperatures, by means of two different pointers. The gauge is graudated from 0°C to 250°C.

11. Accessory gearbox temp indicator. A single gauge mounted on the front part of the overhead panel.

a. With a 4 position switch, marked 1 and 2 "GEARBOX", 1 and 2 "COMPRESSOR" from L to R. A single pointer indi= cates the temp on a dial graduated from 0 to 150°C, for each abovementioned selection.

12. Warning Lights:

a. HP fuel pump low inlet press warning which will illumi= nate when the press falls below 9 psi.

b. Eng low oil pressure warning, will illuminate if the pressure should drop below 30 psi.

c. Gearbox low oil press warning will illuminate if the pressure falls below 7 psi.

d. Gearbox overheat warning will illuminate when gearbox oil temp exceeds 120°C.

ENGINE CONTROLS

1. Controlling Flight and Ground Thrust. Whether the power unit is producing forward or reverse thrust it is controlled by a single cockpit lever, but because the method of control is diffe= rent and reverse thrust is only permitted after landing, it is ncessary to separate the control ranges as follows:

a. The full movement of the lever is divided into two main ranges, termed "Flight Range" and "Ground Range", a very short range spearates the main movements and this is called Transition Flight Range.

i. The controls on the engine interconnect a throttle valve within the fuel control unit (FCU) with the rpm selection lever of the propellor control unit (PCU).

ii. Therefore, for each position of the cockpit lever the fuel system will produce a specific fuel flow and the speed sensitive PCU the appropriate rpm, this arrangement produces the design power response at ISA conditions.

iii. However, certain operating conditions require an alteration to this combination, the condition which affects the control procedure for both engineers and pilots is the occasion when OAT exceeds the ISA value.

iv. An additional cockpit control (trimmer) will permit the necessary correction to the fuel flow normally obtained by the power lever.

b. Transition. Within this range occurs the changeover from the control method outlined above to that which follows.

c. Ground range. The controls on the engine interconnect the blade angle selection lever of the PCU with the rpm selection lever of the LP fuel governor.

i. Therefore, for each position of the cockpit lever the PCU produces a specific blade angle and the LP governor adjusts the fuel flow to obtain the se= lected rpm.

ii. As the lever is pulled back over its full range the blade angle will be reduced from a positive value through zero and then become increasingly negative.

iii. Consequently, while the aircraft is stationary, a maximum forward thrust is obtained at the maximum positive blade angle and the selected rpm.

iv. As the lever is pulled rearwards the thrust will diminish to zero at approximately the zero blade angle and then increase to the maximum reverse thrust at the maximum negative blade angle and the selected rpm.

v. Due to the changed airflow condition over the pro= pellor blades at the normal aircraft speeds on touch down, a negative thrust is obtained with the power lever fully reduce, ie at Max Reverse.

vi. When the lever is pulled rearward the thrust progressively increases and it should be noted that the maximum negative thrust will be obtained if the lever is pulled fully rearwards at the maximum speed on touch down.

CONTROL

1. Power Lever (throttle).

a. The lever moves in two main ranges, Take-off to Flight Idle and Max Beat to Full Reverse; a range of seven degrees divides them and is termed Transition.

i. To permit movement of the levers below Flight Idle on landing, a lever, known as the Air/Ground lever, must first be moved to Ground.

ii. Also, any one of the finger latches on the levers must be lifted: this similarly affects all levers. These interlocks ensure that once in the flight range, the ground range cannot be inadvertently selected.

iii. At the lever position in the Ground Range which corresponds to propellor minimum torque is a de= tent; this permits easy selection of Ground Idle without impeding thrust modulation on the landing run.

2. Micro switches operated by the power lever.

a. De-energize the prop synchrophase system at the full power position.

b. De-energize prop and engine electric de-icing in the Beta range.

c. Energize the secondary safety device in the flight range.

d. Energize the cabin compressor valve close in the Beta range.

e. Regulates the degree of opening for the engine hot air anti icing valve.

f. Energize the U/C "UP" warning system between 24° to 70° of power lever positions.

g. Arming the anti skik system between 24° to 70° of power lever position.

3. Mechanically controls the following.

a. Controls the opening of the engine bleed valve in the flight idle and Beta range.

b. Controls the oil pressure by emans of the ADLS relief valve for various power lever positions in flight range, and prevents ADLS operation in the Beta range.

c. Mechanically opens the oil valve permitting servo oil pressure for the water methanol operation during take-off.

d. Controls fuel flow in the FCU according to engine de= mands in the flight and Beta range.

e. Varies the datum setting in the LP fuel governor to regulate the HP fuel pump out-put according to engine requirements in the Beta range.

8/.....

4. Idle throttle lever.

a. Reduces the normal fuel flow to facilitate engine star= ting, by means of a electric motor which actuates the idle throttle valve in the FCU to a value of 3,500 to 4,000 LP rpm, when the lever is in the "START" position. In this position the ITL also energizes the starting system, by actuating a micro switch. A cam mechanism will also lock the power lever to prevent movement beyond the GI position.

b. By placing the idle throttle lever in the "NORMAL" position, the starting system is de-energized, and the ITV is retracted to produce a normal fuel flow in the FCU by accelerating the engine to ± 12,300 LP rpm. This is called normal ground idle, and the power lever movement is unrestricted beyond the GI position. A magnetic indicator will indicate either "START" or "NORMAL" depending on the position of the idle throttle valve.

5. Condition lever.

a. The segment of lever travel used for fuel trimming has 50 detents engaged by a spring loaded ratchet pawl on the lever; each detent represents 2% fuel trim.

b. A pointer on the lever traverses a scale, the forward end of which represents 100% of fuel trim available, 'RICH' and the rearward end 0% fuel trim available, 'WEAK'.

c. The scale has 5 main divisions each having 5 minor di= visions; each minor division therefore represents 4% fuel trim (2 ratchet clicks) and the smallest amount of correction that can be applied is 1 ratchet click ($\frac{1}{2}$ a minor diversion) ie 2%.

d. The only approved method of setting up take-off perfor= mances requires a precise positioning of the trimmer; the position is related to the prevailing OAT and pres= sure altitude and is obtained from a table.

e. A similar procedure must be used to determine the per= formance for climb and cruise.

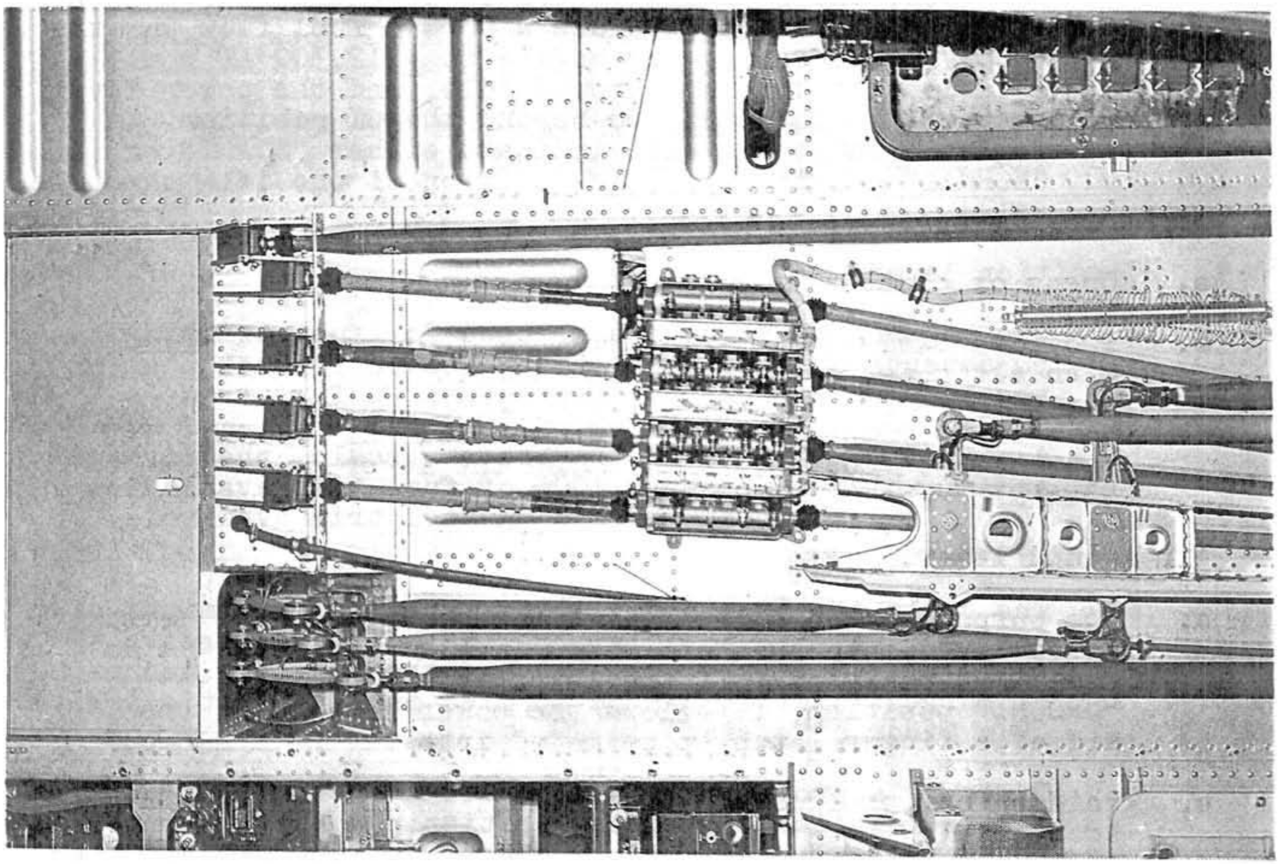
f. Movement of the lever rearwards is arrested when a detent is engaged, first at 0% trim (HP cock open) and then at HP cock closed (Unfeather).

g. The finger latch must be lifted to disengage the detent.

6. Trimmer (electrically operated indicator). A dial gauge with a full scale reading of 0% to 100% has 10 main divisions, each has 5 minor divisions indicating 2% trim per division.

a. The 0% and 100% are marked WEAK and RICH respectively.

NB: Power lever (throttle lever) - its position determines the torque pressure and therefore the power with varying rpm.



b. Fuel trimmer - permits a change in torque pressure and therefore power <u>at constant rpm</u>.

7. <u>Micro switches operated by the condition lever</u>.

a. De-energizes the propellor synchrophasing system in HP cock "CLOSE" or "FEATHER" position.

b. De-energize the W/M system in the HP cock "CLOSE" position.

c. De-energize propellor and engine electrical de-icing system in HP cock "CLOSE" position.

d. Energize the propellor brake system in HP cock "CLOSE" position.

e. Energize the coarse solenoid valve in the PCU when the HP cock is in the "FEATHER" position.

8. <u>Mechanically controls the following</u>:

a. Opens or closes the HP fuel cock in the FCU.

b. Provides fuel adjustment according to temp variations with altitude, above ISA conditions.

c. Mechanically actuates the main control valve in the FCU via the Beta control beam. When the lever is in the "FEATHER" position.

9. <u>Air ground lever</u>.

a. The purpose of this lever is to prevent the power lever bo be moved into the Beta range, while this lever is in the "AIR" position. If the lever is placed in the "GROUND" position, it allows the power lever with the aid of a finger latch to be moved into the Beta Range.

b. This safety precaution prevents the power levers to be accidentally retarded into the Beta range during flight or before landing, with the result of a uncontrollable swing of the a/c caused by the drag of the propellor's negative thrust.

<u>TYNE FUEL SYSTEM</u>

1. <u>Operation of system (Detailed)</u>. The system must fulfil the following requirements:

a. Provide efficient atomization over the complete flow range.

b. Vary the flow according to engine demand.

c. Produce a specific fuel flow for a given power lever position.

d. Vary the fuel flow to compensate for change in altitude and forward speed.

e. Power limitation.

10/......

f. Control rpm overspeed and miximum fuel pressure.

g. Control rpm in the Beta range.

h. Control starting fuel flow.

j. Have a means to shut off the fuel flow and stop the engine.

k. Provide high fuel pressure for compressor bleed valve operation.

l. Provide the means for altering the HP governor signal to the bleed valve.

2. Provide efficient atomization. This is obtained by the com= bined action of the Burners, Pressurizing Valve and Fuel Pump.

a. Duplex Burners:

i. The ten burners protrude into the flame tubes and receive high pressure fuel from the pump.

ii. Each burner has two co-axial orifices, the smaller primary orifice is employed independently at low fuel flows, whilst at higher flows a pressurizing valve permits fuel to pass to the larger main orifice.

iii. This twin flow arrangement ensures efficient atomization throughout the flow range.

3. Fuel anti-icing.

a. General:

i. Water in solution in the fuel will precipitate when the fuel temperature is low and pass to the engine in the form of ice crystals. These are arrested by the engine filter and will ultimately stop the fuel flow.

ii. In order to combat this condition an oil heated fuel heater is incorporated in the fuel system. This operates automatically and maintains the fuel temperature above +5°C at the fuel filter inlet under all conditions of flight.

b. Location: The fuel heater is rigidly attached to a bracket which is flexibly mounted on the HP wheelcase. It is interposed in the fuel system between the engine inlet and the backing pump. In the oil system it is situated in the scavenge oil return line from the pumps to the hollow air intake struts.

c. Operation:

i. Fuel enters the heater and passes through the tubes of the matrix, these have a series of restrictions in them to increase the heat transfer.

ii. Valve movement commences at 15°C fuel temperature simultaneously shutting off the flow the matrix and opening the by-pass. Oil flow through the matrix ceases at 22°C.

iii. In the event of the oil pressure drop across the heater exceeding 30 psi the pressure difference across the bypass valve will open it and prevent damage to the heater matrix.

4. Low pressure fuel pump.

a. Requirements. To maintain the fuel pressure at the HP fuel pump inlet at a value high enough to prevent cavitation under all normal operating conditions.

b. Operation:

i. Operating on the eccentric sliding vane principle, the pumping mechanism positively displaces fuel from inlet to outlet at a quantity always in ex= cess of the HP pump requirement.

ii. A relief valve maintains a pump differential pres= sure of approx 15 psi and disposes of the excess fuel by returning it to the inlet.

iii. In the event of pump failure a by-pass valve opens at a differential pressure of 1 psi.

c. HP fuel pump low inlet pressure warning. This is a lamp, controlled by a switch which operates when the pressure falls to 9 psi; on receipt of the warning, the altitude performance should be curtailed to prevent faulty engine operation and damage to the HP fuel pump by cavitation.

d. LP Filter. The LP Filter prevents the ingress of par= ticles of foreign matter into the engine fuel system. It is situated in the fuel line between the flowmeter and the HP fuel pump.

e. Back Pressure Valve: The back pressure valve limits the amount of fuel to the throttle valves until the pump delivery pressure is sufficient to ensure rapid operation of the bleed valve.

f. Throttle Valves: The three throttle valves provide variable restrictions in the fuel line to the burners. The forward and reverse valves are positioned by the power lever and the idle valve by an electric actuator controlled by a cockpit switch. (Idle throttle lever).

5. Provide a specific fuel flow for a given power lever position

a. Pressure Drop Control Piston and Spill Valve - (FCU):

i. Movement of the piston determines the position of the spill valve via a push rod acting on the lever supporting the valve.

ii. This unit maintains a constant pressure drop across the throttle valves at any fixed intake pressure, by controlling a bleed from the fuel pump servo.

b. Capsule Assembly:

i. The unit consists of two opposed capsules, one evacuated and the other open internally to an intake pressure.

ii. The function of the unit is to correct the fuel flow in proportion to the changes in mass air flow, due to reduced density with altitude under ISA conditions and the additive effect of forward speed.

c. HP Cock: The HP cock is operated by the condition lever in the cockpit. When closing the HP cock all fuel to the burners are cut off and fuel flow is directed back to the HP pump inlet. Any fuel in burners and manifold are vented to atmosphere via the overboard vent with the aid of combustion chamber press.

d. Pressurizing Valve:

i. This unit is located in the Fuel Control Unit (FCU). It consists of a spring loaded plunger operating in a sleeve and is positioned in the flow path from the throttle valve to the primary orifice in the burners.

ii. Primary burner pressure acting on the end of the plunger will open the valve against its spring loading at a predetermined pressure. This will permit fuel to flow to the main burners.

iii. As fuel flow increases, the increase in primary burner pressure progressively opens the valve to regulate main burner flow, thus proportioning the fuel flow to primary and main burner orifices to maintain efficient atomization at all fuel flows.

e. HP Pump Action:

i. The pumping unit consists of an engine driven rotor carrying seven plungers spring loaded against a circular camplate. The angle of the camplate relative to the rotor can be varied.

ii. With the camplate at its maximum angle from the rotor and the rotor revolving, each plunger will follow the cam profile, first moving outwards under the influence of the spring and inducing fuel into the cylinder, then moving inwards due to camplate thrust to deliver at high pressure to the burners.

f. HP Pump Servo Mechanism:

i. To obtain maximum fuel flow: With the spill valves closed and no fuel pressure difference across the piston the spring will hold the camplate at maximum angle ie maximum fuel flow.

13/.....

ii. To decrease fuel flow: With the spill valve open, fuel is bled away from the spring side of the piston. Flow through the restrictor orifice pro= duces a pressure difference across the piston and a force to overcome the spring and reduce the camplate angle.

iii. To stabilize the fuel flow: Spill valve opening can be stabilized to produce a pressure difference across the piston to balance spring load at any stroke position. The piston remains stationary and fuel flow constant.

6. LP Governor. The governor controls the fuel flow to the engine at all throttle lever positions in the Beta Range and functions as an LP shaft overspeed governor in the Flight Range.

7. Operation of system (Basic Presentation). All control of the fuel is by varying the HP fuel pump output. The pilot's power lever (throttle lever) determines which unit in the system is in control as follows:

a. Lever in 'Flight Idle' to 'Take-Off' Range:

i. Signals of the condition at the Forward Throttle valve and of pressure at the Air Intake are re= ceived by the Fuel Control Unit. The FCU computes them and directs a control signal to the Fuel Pump.

ii. The LP and HP governers sense any tendency of their respective shafts to overspeed.

NOTE: A congrol signal from the governor will limit pump output and consequently over= speed by overriding the FCU.

b. Lever in 'Max Beta' to 'Full Reverse' Range: The Reverse Throttle valve takes over from the Forward Throttle and the LP governor controls as follows:

i. At the fixed propellor pitch for any pilot's lever position an excess of fuel is scheduled by the Reverse Throttle.

ii. The LP governor senses the resulting tendency to overspeed and limits it by overriding the FCU.

COMPRESSOR BLEED VALVE AND CONTROL UNIT

1. Requirements of System. To maintain stability when running at HP/LP rpm relationships at which surge would occur.

INTRODUCTION

1. A better understanding of the working of the Bleed Valve (B/V) will be obtained by a brief consideration of the compres= sors to change in rpm differential and AIT.

a. RPM Differential.

2. In the rpm range TO to Min Cruise the HP/LP speed relation= ship is arranged to ensure freedom from surge.

3. When power is reduced at constant LP rpm from Min Cruise to Flight Idle, the LP compressor air flow cannot be accepted by the HP compressor because of its falling speed.

4. This causes the LP compressor mass flow to fall and its pres= sure ratio to rise to the point where surge occurs.

5. The B/V counteracts this by opening at a safe margin of rpm differential from surge, then, as the HP speed is reduced, the valve progressively opens and bleeds to atmosphere the air which the HP compressor cannot accept.

6. The B/V control unit must therefore respond to HP/LP rpm differential.

7. Air Temperature.

8. At air temperatures pther than ISA the compressors react as though their rpm had been changed, eg:

a. On a hot day the effect is as though the rpm had been reduced and the safety margin is in consequence also reduced.

b. A rise in temperature must therefore cause the B/V to open at a higher actual rpm differential and vice versa at lower temperatures.

BLEED VALVE OVERRIDE COCK

1. The duties of the B/V override cock are as follows:

a. Flight Range. To fully open the B/V when the power is reduced from a point just below Min Cruise; this safe= guards the LP compressor blading from the effects of surge, which results from the combined effect of drift in the characteristics both of the B/V control unit and of the LP compressor.

b. Ground Range:

i. To fully open the B/V over the whole 'ground range' with the exception of the last few degrees towards full reverse where automatic action is returned, ie B/V fully closed.

ii. The full open position of the valve prevents LP compressor surge which results from compressor blade deterioration with increasing life.

iii. The fully closed position is necessary to prevent 'choke' flutter of the blades which would occur at the compressors relative rpm and the B/V fully open.

FUEL DRAIN SYSTEM

1. General. The fuel drainage system, is provided to reduce fire risk by collecting and disposing of any unburnt fuel which may escape from the engine and through the seals of fuel-operated

units. Interconnected with the system are the oil drains from the centre and turbine bearings and the NTS valve in the torque= meter system.

OIL SYSTEM

1. Requirements of System. The oil system fulfils the follow= ing requirements:

a. Provides lubrication to the engine bearings and gears.

b. Supplies oil for the operation of the torquemeter system.

c. Supplies oil under pressure to act as a servo force for the operation of the W/M unit.

d. Supplies oil to the PCU for the hydraulic operation of the propellor.

e. Provides an oil reserve fro the operation of the pro= pellor feathering system.

i. Under all operating conditions to maintain a supply of hot oil for the efficient operation of the fuel heater.

f. Supplies hot oil to certain air intake struts for the prevention of ice formation.

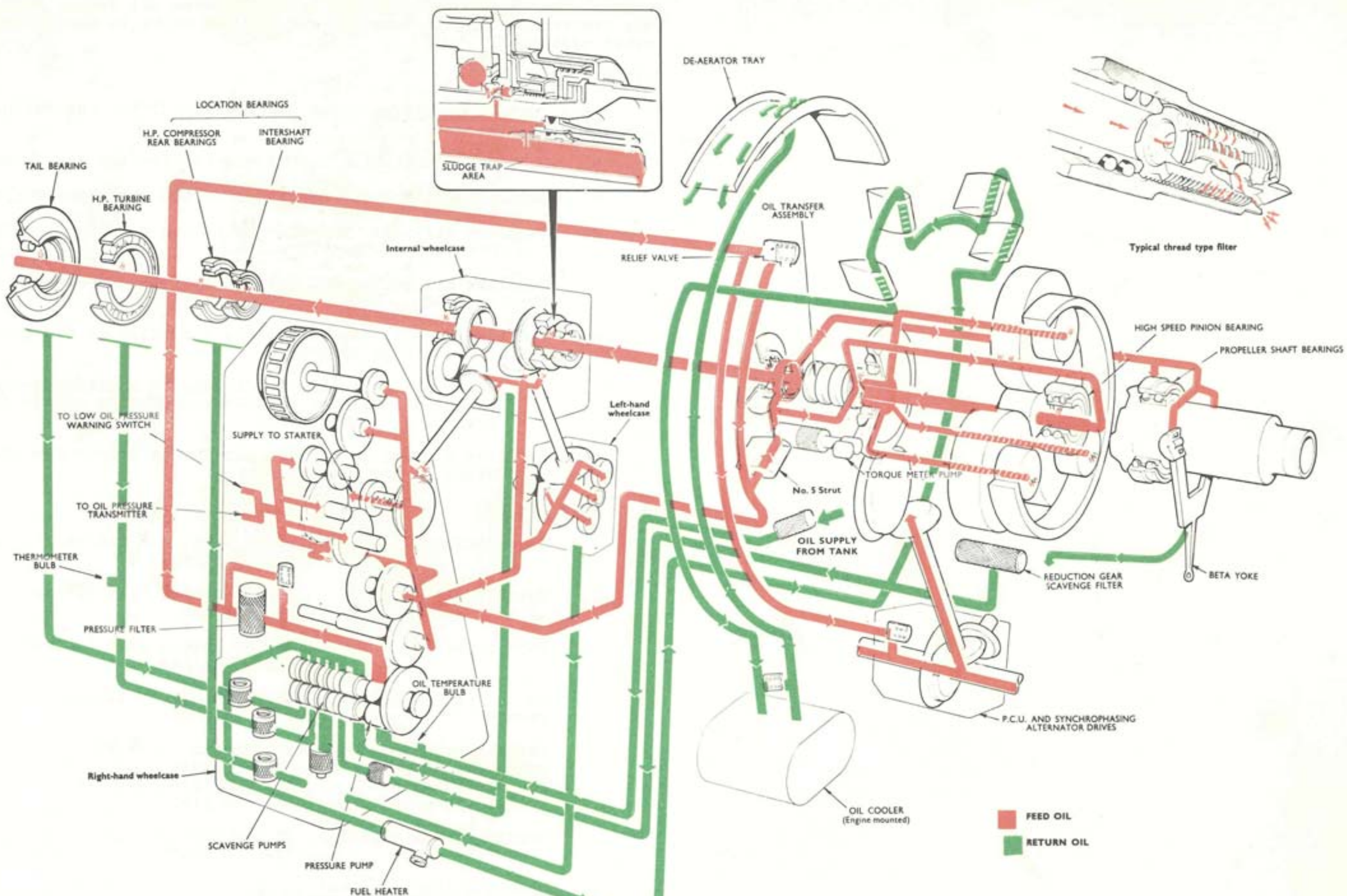
2. Data (MK 22)

a.	Consumption	1 Imp pint, 0.6 litres 1.2 US pints
b.	Useable oil	20 Imp pints, 11.4 litres 24 US pints
c.	Tank capacity	52 Imp pints, 29.5 litres 62.4 US pints
d.	Including feathering reserve	16 Imp pints, 9 litres 19.2 US pints
e.	Total system capacity excluding propellor & pcu including oil cooler capacity	95 Imp pints, 54 litres 114 US pints 15 Imp pints, 8.5 litres 17.7 US pints
f.	Engine system capacity	28 Imp pints, 15.9 litres, 33.6 US pints

g. Checking the oil level in the tank:

NOTE: To allow the level in the tank to stabilize, not less than 15 minutes must elapse before it is checked after shut down, subsequent to a flight or routine ground running. During this period the engine must not be run or motored over.

16/.......

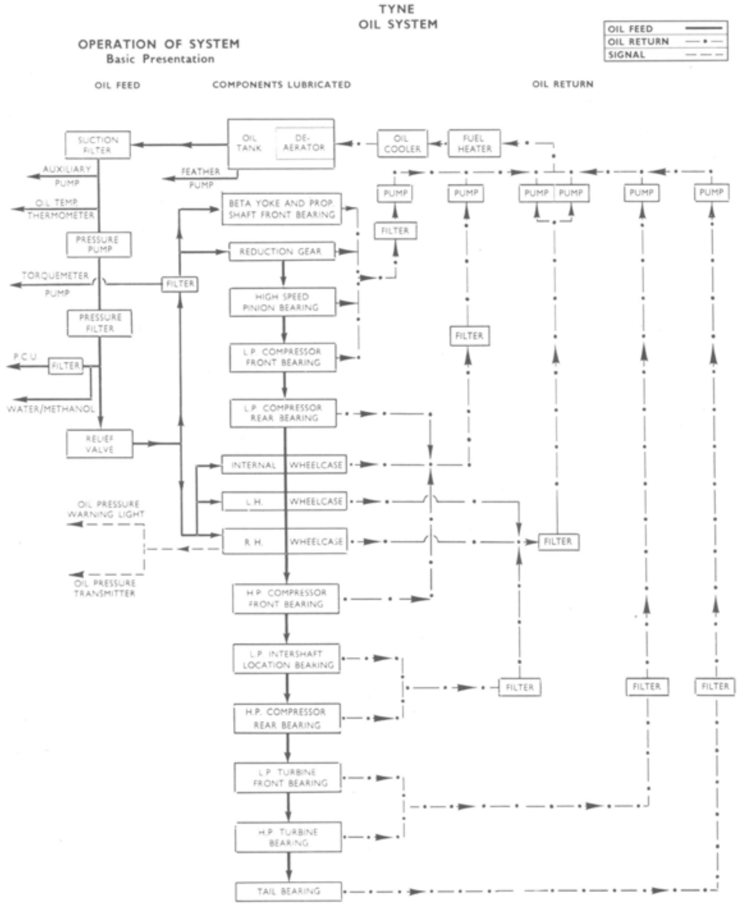


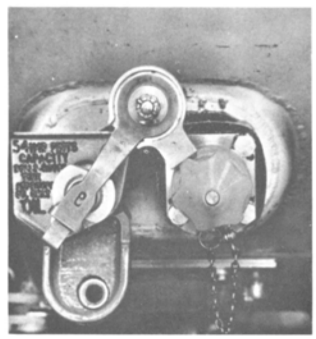
LOCATION BEARINGS
H.P. COMPRESSOR REAR BEARINGS
INTERSHAFT BEARING
TAIL BEARING
H.P. TURBINE BEARING
SLUDGE TRAP AREA
DE-AERATOR TRAY
OIL TRANSFER ASSEMBLY
RELIEF VALVE
Internal wheelcase
Typical thread type filter
HIGH SPEED PINION BEARING
PROPELLER SHAFT BEARINGS
TO LOW OIL PRESSURE WARNING SWITCH
SUPPLY TO STARTER
Left-hand wheelcase
TO OIL PRESSURE TRANSMITTER
No. 5 Strut
TORQUE METER PUMP
OIL SUPPLY FROM TANK
THERMOMETER BULB
REDUCTION GEAR SCAVENGE FILTER
BETA YOKE
PRESSURE FILTER
OIL TEMPERATURE BULB
P.C.U. AND SYNCHROPHASING ALTERNATOR DRIVES
Right-hand wheelcase
OIL COOLER (Engine mounted)
FEED OIL
RETURN OIL
SCAVENGE PUMPS
PRESSURE PUMP
FUEL HEATER

OIL SYSTEM

TYNE OIL SYSTEM

OPERATION OF SYSTEM
Basic Presentation





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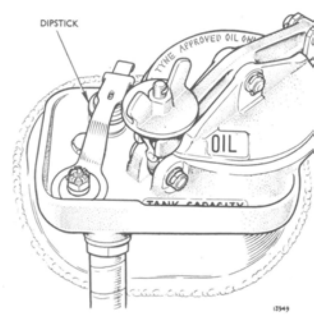
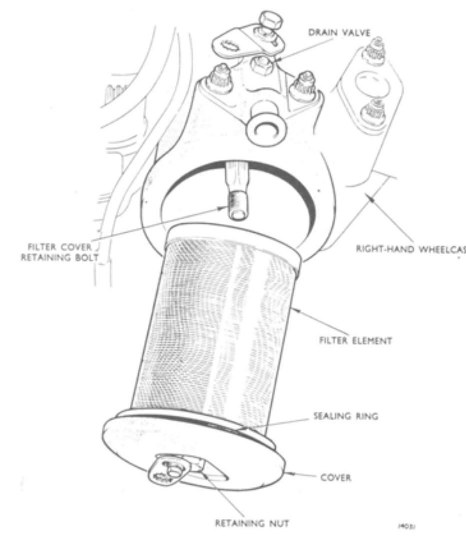


Gravity filler



Pressure filter