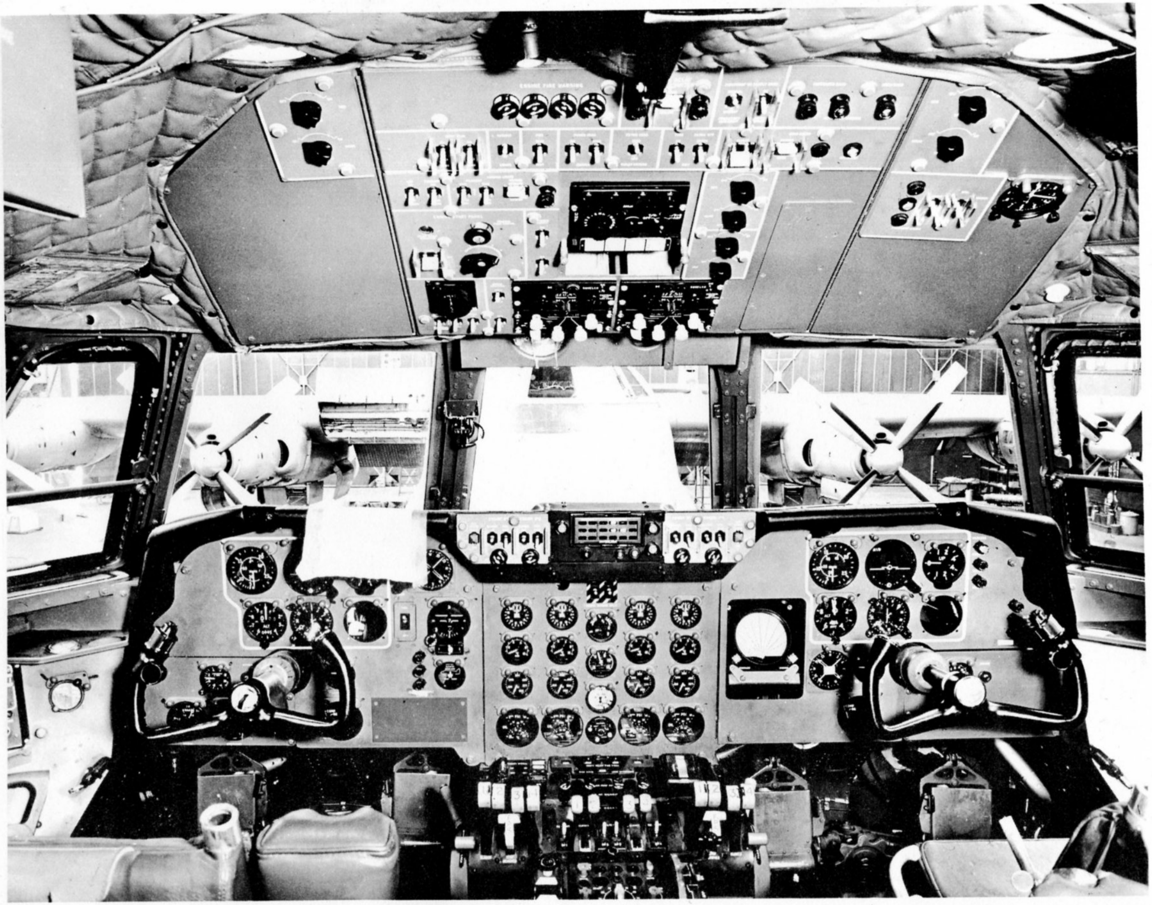
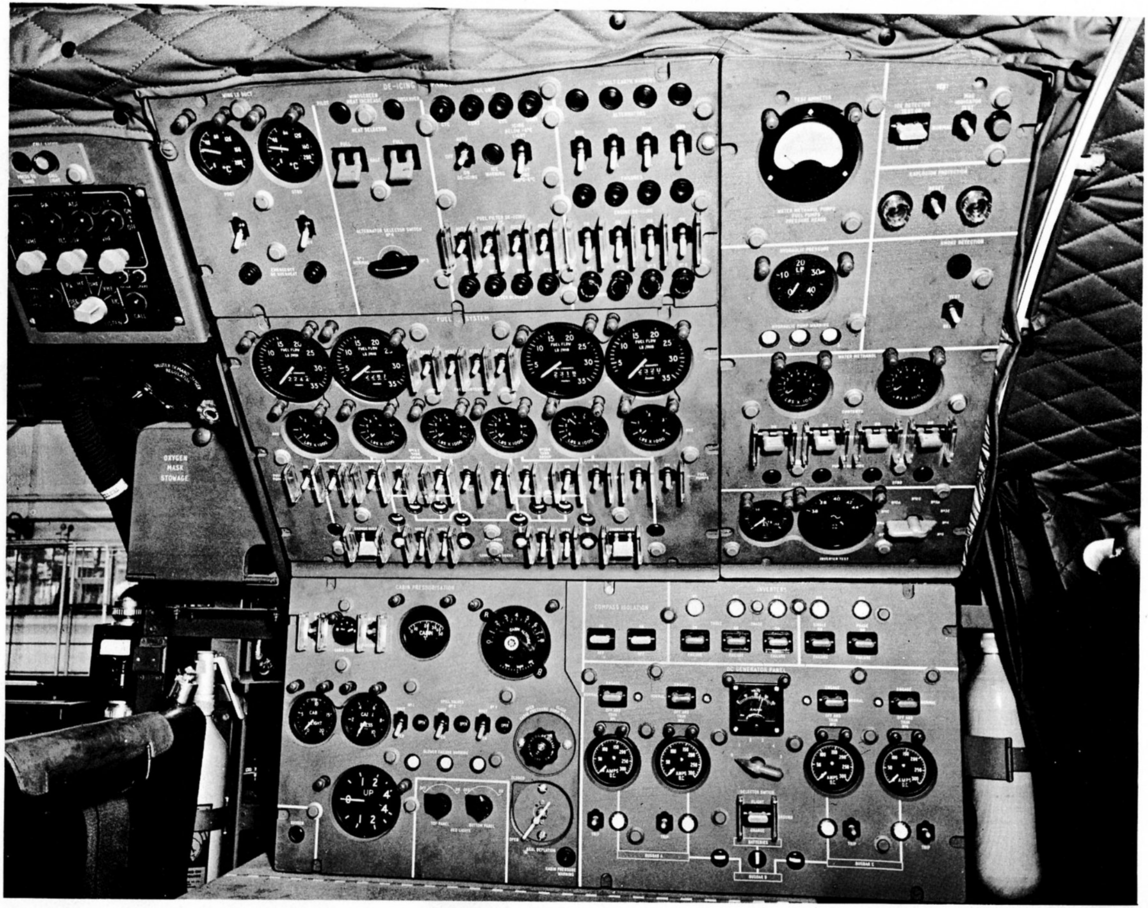
AIRCRAFT SERVICING SCHOOL

WHITWORTH GLOSTER AIRCRAFT LIMITED
COVENTRY, ENGLAND

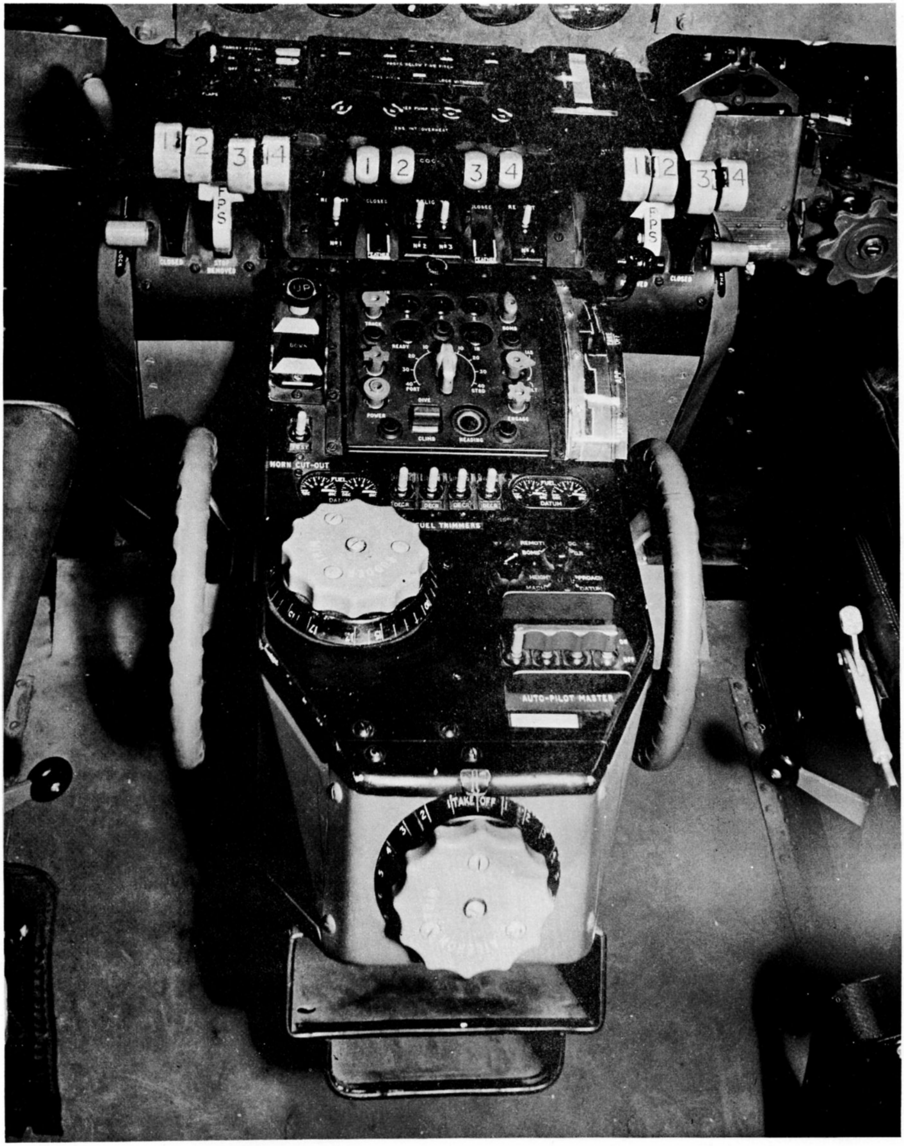
FUEL

Leading Particulars



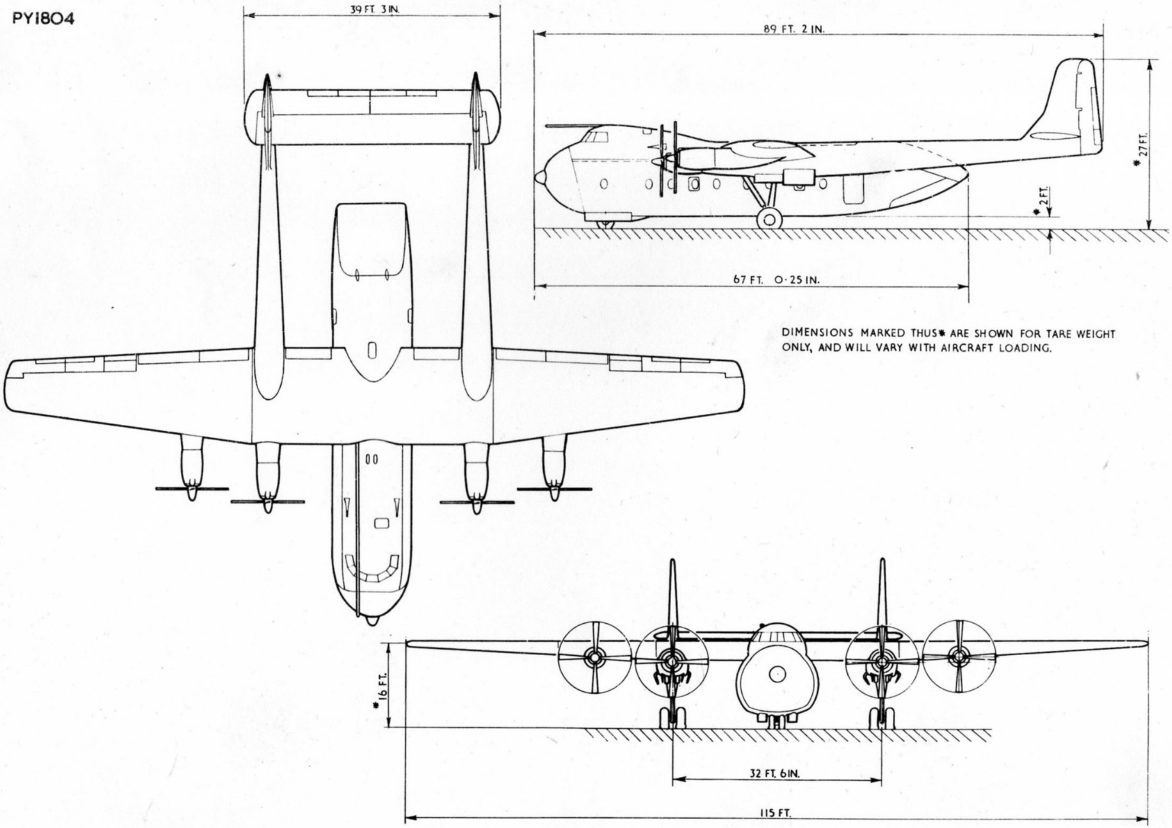


DE-ICING
FUEL SYSTEM
OXYGEN MASK STOWAGE
CABIN PRESSURISATION
INVERTERS
COMPASS ISOLATION
DC GENERATOR PANEL



HORN CUT-OUT
FUEL TRIMMERS
AUTO-PILOT MASTER
TAKE OFF
DATUM
CLOSED

PY1804

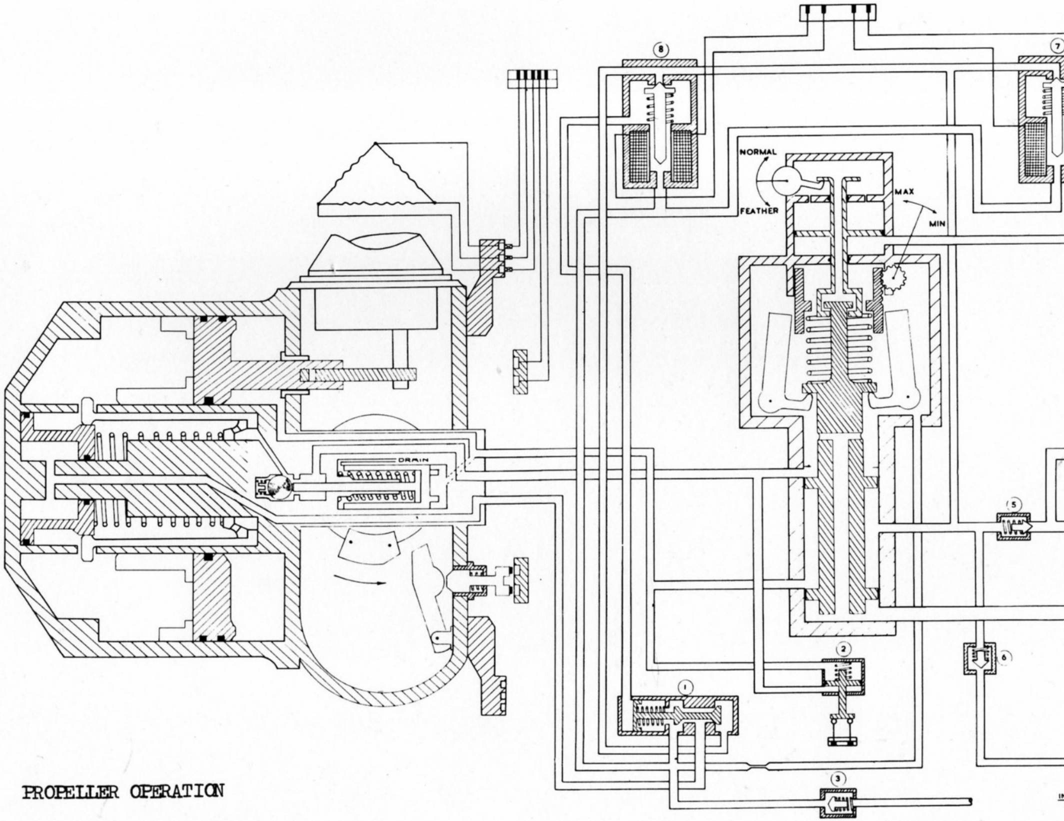


General arrangement

SECTION 16

PROPELLER

LIST OF CONTENTS



PROPELLER OPERATION

INST/GAW/25

6151

CHAPTER 1

PROPELLER CONTROL

1. General

The Rotol Variable Pitch Propeller is hydraulically controlled, and is capable of assuming any pitch angle between 0° (Ground Fine Pitch) and 84° 55' (Feathered). When the aircraft is airborne, a mechanical stop is introduced to prevent the propeller adopting a pitch angle finer than 19½°. This is known as the Flight Fine Pitch Stop. The Stop can be withdrawn on touch down enabling the propeller to move through towards the Ground Fine position, thus producing a considerable drag component which will appreciably shorten the landing run. The Flight Fine Pitch Stop is controlled by a lever on the Throttle Quadrant, the Lever positions being designated 'Stop Armed' (forward), and 'Stop Removed' (rearward).

2. Propeller Pitch Stops

A. Ground Fine Pitch Stop

Permanently fixed at 0° pitch, provides for:

(1) Minimum Engine load when starting.

(2) 'Discing' as an additional form of braking.

B. Flight Fine Pitch Stop

When 'Armed' prevents propeller from 'fining off' below 19½° pitch.

A warning lamp is illuminated whenever the lock is withdrawn.

C. Hub Switch

Set 2° below Flight Fine Pitch (17½° pitch), and when operated, will energise the Pitch Coarsening Solenoid. If the Flight Fine Pitch Stop should fail in flight, operation of the Hub Switch will cause the propeller to coarsen when an angle of 17½° pitch is reached.

Under these circumstances, the propeller will 'hunt' over a small angular range, but will not decrease pitch below 17½°. Hunting will be indicated by intermittent illumination of the 'Below Lock' Warning Lamp.

3. Electrical Operation

A. Lock Withdrawal

Operation of the F.F.P.L. Withdrawal Lever affects six toggle switches in the following manner :-

(1) Withdrawn Position

Switch H is opened, isolating the Pitch Coarsening Valve Solenoid. Switches J are closed, energising the Lock withdrawal Solenoids from Bus Bar 'B' via a 10 amp circuit breaker in the Main Distribution Panel, and completing a circuit for the duplicated warning lamps via a 2.4 amp fuse in the Main Distribution Panel, and a 10 ohm resistor.

(2) Armed Position

Switch H becomes closed, and the Pitch Coarsening Valve Solenoid is now dependent upon the Hub Switch for its supply.

Switches J become open, de-energising the Lock Withdrawal Solenoids and extinguishing the warning lamps.

It should be noted that if, due to mechanical failure the positive Lock Withdrawal switch fails to open when the F.F.P.L. Lever is in the armed position, a circuit exists which will permit current to flow through the Withdrawal Solenoids. However, the combined resistive values of the solenoids, the warning lamps, and the 10 ohm resistor all in series, restrict the current to a value insufficient to withdraw the lock. The lamp being illuminated, will indicate that the circuit is unsafe. Conversely, the lamp will be illuminated should the negative lock withdrawal switch remain made at "Stop Armed".

B. Auto Coarsen

Operation of the Hub Switch completes a circuit for the Pitch Coarsening Valve Solenoid which is in the Propeller Control Unit, mounted on the Engine. The operation of this valve causes hydraulic fluid to be directed to the underside of the piston, jacking it up. This in turn causes hydraulic fluid to be directed to the forward face of the propeller operating piston, moving it towards the 'Coarse' position.

Simultaneously, the 'Prop. Below Lock' warning lamps will be supplied via contacts of the Auto Coarsen Relay, located on the Propeller Control Panel.

C. Auto Feathering

Before automatic feathering can occur, the following conditions must be fulfilled.

(1) Throttle must be opened to a position coinciding with at least 12,900 R.P.M.

(2) Torque must be reduced to a value not exceeding 50 lbs.

(3) The H.P. Cock must be open.

Under these conditions, the coil of the Auto Coarsen Relay will be supplied from Bus Bar 'B' via a 10 amp circuit breaker in the

Main Distribution Panel, the Throttle switch, Low Torque Switch and H.P. Cock switch A/B. The Relay will be energised, and the Feathering Pump Relay will be supplied via contacts 1-1 and 3-3 of the Auto Coarsen Relay. Simultaneously, the Pitch Coarsening Valve Solenoid will be supplied via contacts 5-5 and 7-7 of the Auto Coarsen Relay. With the Feathering Pump Relay on the Propeller Control Panel energised, the Pump Motor is supplied from Bus Bar 'B' via a 200 amp fuse in the Main Distribution Panel. A 'Feathering Pump Energised' lamp, mounted on the Centre Pedestal, is supplied from the same source via a 2.4 amp fuse on the Propeller Control Panel.

D. Manual Feathering

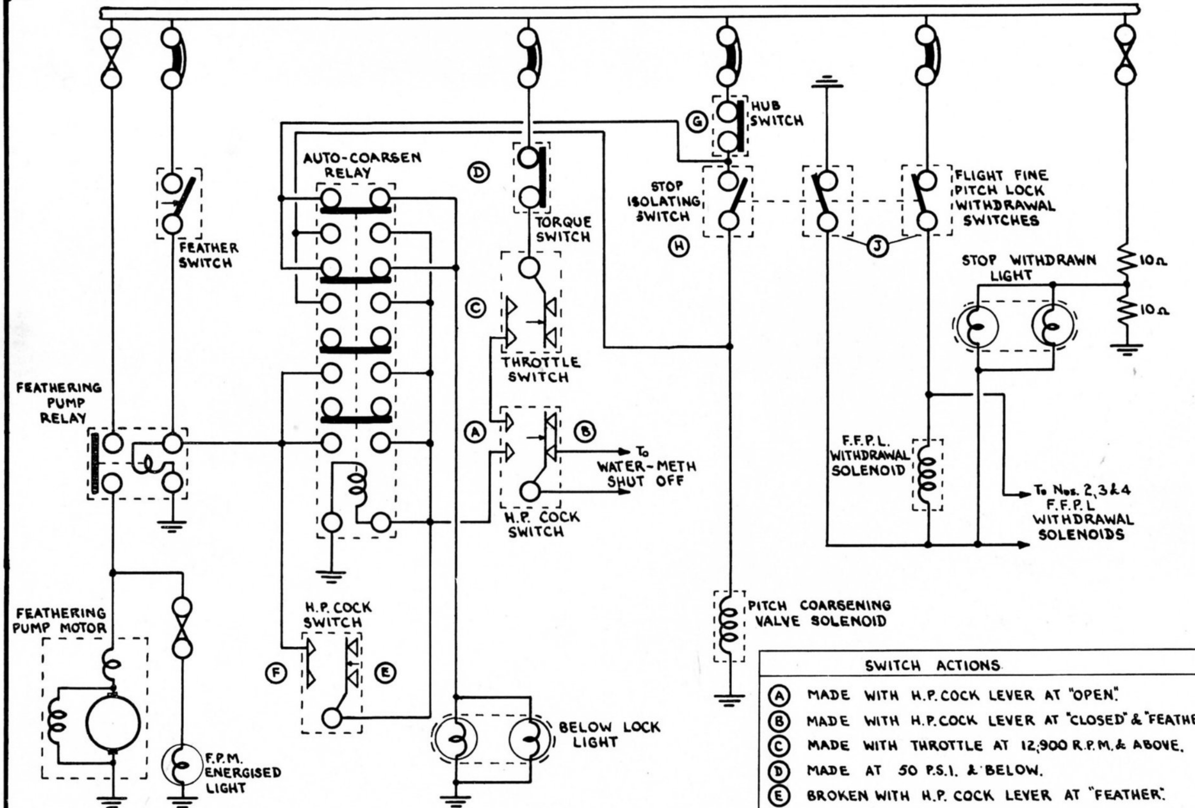
Operation of the spring loaded Feathering Switch (Centre Coaming Panel) will energise the Feathering Pump Relay, and the Pump Motor will be supplied.

Movement of the H.P. Cock to the 'FEATHER' position operates a switch E/F which causes the Auto Coarsening Relay to be energised, when the Feathering Switch is closed.

With the Auto Coarsen Relay energised, the supply, via the Feathering Switch, the H.P. Cock switch, and contacts 5-5 and 7-7 of the Auto Coarsen Relay is applied to the Pitch Coarsening Valve Solenoid. This is an additional safety factor, since the P.C.U. piston which is hydraulically raised on operation of the Pitch Coarsening Valve is also mechanically raised by movement of the H.P. Cock lever.

E. Unfeathering

With the H.P. Cock in the 'OFF' position, the H.P. Cock switch E/F has its contacts broken thus isolating the Pitch Coarsening Valve Solenoid. Operation of the Feathering Switch will cause the propeller to unfeather.



SWITCH ACTIONS	
(A)	MADE WITH H.P. COCK LEVER AT "OPEN".
(B)	MADE WITH H.P. COCK LEVER AT "CLOSED" & "FEATHER".
(C)	MADE WITH THROTTLE AT 12,900 R.P.M. & ABOVE.
(D)	MADE AT 50 P.S.I. & BELOW.
(E)	BROKEN WITH H.P. COCK LEVER AT "FEATHER".
(F)	MADE WITH H.P. COCK LEVER AT "FEATHER".
(G)	MADE AT 17½° PROPELLER PITCH & FINER.
(H)	MADE WITH F.P.S. LEVER AT "STOP ARMED."
(J)	MADE WITH F.P.S. LEVER AT "STOP REMOVED".

PROPELLER CONTROL.

(ONE ENGINE ONLY SHOWN, OTHERS SIMILAR.)

109199

CHAPTER 2

SERVICING

(from Civil Argosy Manual)

Propeller - System Checks with Engine Stationary

Action	Check	Acceptance Standard	Action if Incorrect
Ground Fine Pitch			
1. Ensure adequate oil supply, ground electrical supply connected, throttles CLOSED, H.P. Cocks, CLOSED, F.P.S. lever at STOP REMOVED.	1. A. Propeller on G.F.P. stop. B. F.F.P. lock. C. Below Lock Light	1. A. Marks on spinner and blades aligned. B. ON. C. ON.	1. A. Operate feathering switch, release when unfeathered. B. Check circuit. C. Rotate propeller; if defect persists, check circuit.
2. Operate feathering switch, retaining ON.	2. A. Feathering pump runs. B. Propeller remains at G.F.P. stop.	2. A. Feathering pump light ON. B. Propeller should not change pitch while H.P. Cock CLOSED, throttle CLOSED, and F.P.S. lever at STOP REMOVED.	2. A. Check circuit. B. Check control static settings, or F.P.S. lever circuit.
3. Release feathering switch.	3. Feathering pump stops.	3. Feathering pump light OFF.	3. Switch OFF supply. Check feathering pump circuits
Electro-Hydraulic Stop			
With propeller on G.F.P. Stop, H.P. Cock CLOSED, throttle CLOSED and F.P.S. lever at STOP REMOVED.			
1. Move F.P.S. lever to STOP ARMED.	1. F.F.P. lock withdrawn light	1. OUT.	1. Check circuit or F.P.S. lever linkage.

Action	Check	Acceptance Standard	Action if Incorrect
Electro-Hydraulic Stop (Cont/d...)			
2. Operate feathering switch retaining ON.	2. Propeller coarsens until F.F.P. angle and hunts about F.F.P.	2. Propeller will hunt (shown by Below Lock light flashing), unless F.F.P. lock engages (light out).	2. Check hub-switch circuit, F.P.S. lever linkage, or change P.C.U.
3. Return F.P.S. lever to STOP REMOVED, keeping feathering switch ON, until propeller reaches G.F.P.	3. F.F.P. lock withdrawn light ON. Propeller fines off to G.F.P. (Below lock light ON).	3. Propeller should fine off fully.	3. If Below Lock light does not come ON, rotate propeller before checking further.
Motor over or ground run as required to return oil to tank			
Auto-Feathering			
1. With propeller on G.F.P. Stop H.P. Cock CLOSED, F.P.S. Lever at STOP REMOVE, and throttle CLOSED, move H.P. Cock lever to OPEN.	1. Propeller does not auto-feather.	1. Throttle must be advanced into cruising range (12,900 RPM) as well as H.P. Cock OPEN to operate Auto-Feathering circuit.	1. Check throttle micro-switch circuit.
2. Move throttle lever to OPEN.	2. Below Lock light OUT, and propeller starts to auto-feather (feathering pump light ON) as soon as throttle reaches cruising range.	2. H.P. Cock and throttle micro-switches must make auto-feathering circuit in series with low torque switch. Below Lock light circuit must be broken.	2. Check auto-feathering circuit and/or low torque switch.
3. Immediately auto-feathering is apparent, move H.P. Cock lever to CLOSED.	3. Feathering pump light OFF, and auto-feathering stops.	3. H.P. Cock moved from OPEN must break auto-feathering circuit.	3. Close throttle to break auto-feathering circuit and check H.P. Cock micro-switch.

Action	Check	Acceptance Standard	Action if Incorrect
Manual Feathering (Functional)			
With throttle CLOSED, move H.P. Cock lever to FEATHER and operate feathering switch.	Propeller coarsens until fully feathered.	Feathering pump light ON. Propeller coarsens until feathering switch broken.	Carry out full installation manual feathering check.
Manual Feathering (On Installation)			
1. Disconnect electrical connections from P.C.U. With throttle CLOSED, F.P.S. lever at STOP REMOVED, move H.P. Cock lever to FEATHER. Operate feathering switch until propeller coarsening is confirmed, then release and move H.P. Cock lever to CLOSED.	1. Propeller starts to feather.	1. Propeller coarsens while feathering switch is ON. under mechanical feather selection only. (Electrical selection disconnected.)	1. Check control static settings or change P.C.U.
2. Reconnect and lock electrical connection to P.C.U. Disconnect control linkage from P.C.U. feathering selector lever, allowing this to assume the UF position. Move H.P. Cock lever to FEATHER, operate feathering switch until propeller is fully feathered, and release.	2. Propeller recommences to feather.	2. Propeller coarsens while feathering switch is ON under electrical feather selection only. (Mechanical selection disconnected).	2. Check H.P. Cock microswitch and/or Auto-Coarsen Relay circuit.
3. Reconnect control linkage to P.C.U. feathering selector lever. Verify control static checks and ensure security.			

Action	Check	Acceptance Standard	Action if Incorrect
Unfeathering and F.F.P. Lock Check			
1. With propeller feathered F.P.S. Lever at STOP ARMED and throttle CLOSED, move H.P. Cock lever to CLOSED and operate feathering switch.	1. Propeller unfeathers to F.F.P. Lock, with F.P.L. Withdrawn light OFF.	1. F.P.S. Lever at STOP ARMED ensures F.F.P. Lock withdrawal circuit is de-energised, propeller unfeathering limited to F.F.P. Lock	1. & 2. Check lock withdrawal circuit if all propellers are affected. Change P.C.U. and/or propeller if individual propellers are affected.
2. Keep feathering switch ON, move F.P.S. Lever to STOP REMOVED; when propeller reaches G.F.P. release feathering switch.	2. F.P.L. Withdrawn light ON, propeller fines off, Below Lock light ON.	2. With F.F.P. Lock withdrawn, propeller should fine off the G.F.P.	
3. Move control locks lever ON, and motor over or ground run as required.	3. Oil level in tank.	3. Oil level should be restored to original level (approx.)	3. Examine oil filters and lubrication system.

LOW TORQUE SWITCH

1. Inspection

If any external seepage of oil is noted from the low torque switch, replace the unit; examine electrical connection for oil contamination and rectify as necessary.

2. Removal

Disconnect electrical plug, unscrew 3 retaining setscrews and remove switch from Water Methanol Control Unit.

3. Operating Pressure Check

With switch removed from W/M Unit, check as follows:

A. Connect lamp and battery in series with contacts and apply an oil pressure to oil inlet.

B. Raise pressure slowly until light goes out. Lower pressure carefully and note that light illuminates at a pressure between 50 and 45 p.s.i. If check is unsatisfactory, switch must be changed.

4. Installation

A. Renew the sealing rings.

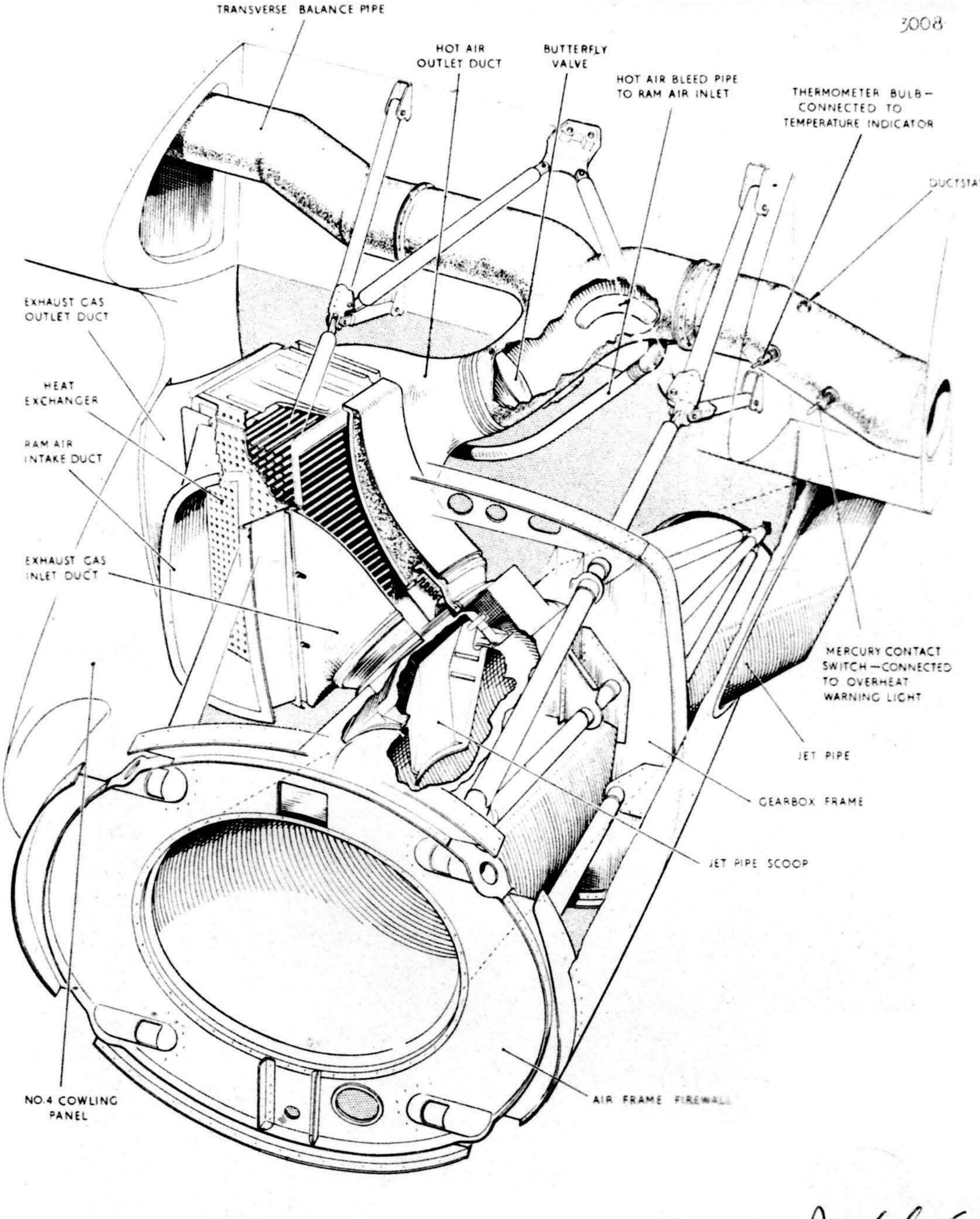
B. Secure unit with three retaining setscrews.

C. Connect electrical plug.

CHAPTER 3

COMPONENT LIST

ITEM	REF.NO.	NO.OFF	LOCATION
Feather /Unfeather Switch	5CW/6433	4	Centre Coaming Panel (P23)
Below Lock Light	CA.80093 (Phoenix)	4	Centre Pedestal
Filament, 28V	12005N (Philips)	8	Below Lock Lights
Lock Withdrawn Light	CA.80093 (Phoenix)	1	Centre Pedestal (P20)
Filament, 12V	12002 (Philips)	2	Lock Withdrawn Light
Lock Withdrawal Switch	5CW/6430	2	Centre Pedestal (P20)
E.H. Stop Isolation Switch	5CW/6430	4	Centre Pedestal (P20)
H.P. Cock Micro-Switch	5CW/6672	8	Centre Pedestal (P20)
Throttle Micro-Switch	5CW/6672	4	Centre Pedestal (P20)
Resistance Unit	V.G.H.K.3 (Berco)	1	Cockpit
Auto-Coarsen Relay	7CZ 105648/1 (Plessey)	4	Propeller Control Panel (P5)
Feathering Pump Relay	5CW/4621	4	Propeller Control Panel (P5)
F.P.M. Energised Lamp	A.915/E/6 (Page)	4	Centre Pedestal (P20)
Filament, 1W	995-9118 I/S Ref.	4	F.P.M. Energised Lamp



AK/ 6 50

Thermal anti-icing arrangement — Inboard nacelle

FUEL SYSTEM

FUEL SYSTEM

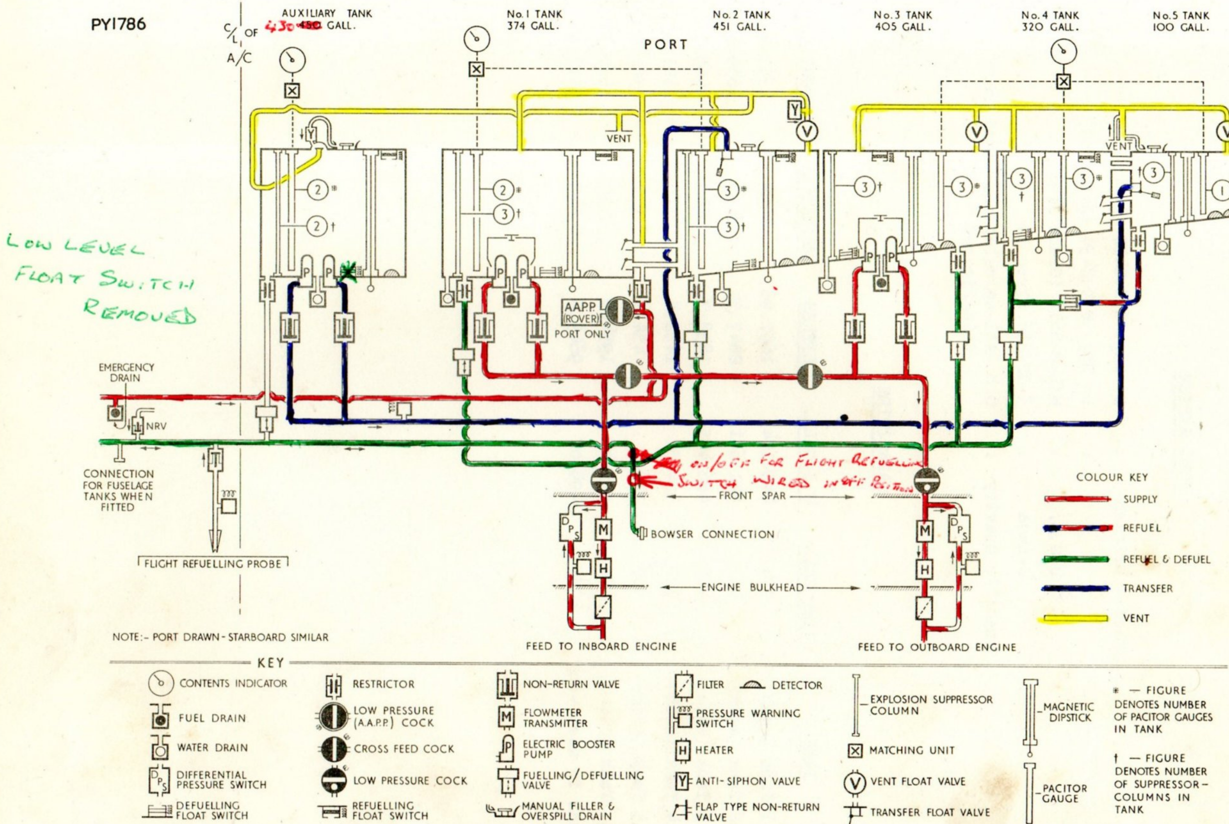
LIST OF CONTENTS

FUEL SYSTEM

Fuel - British	:	D. Eng. R.D.2482 (Avtur)
	:	D. Eng. R.D.2494 (Avtur 50)
U.S.A.	:	MIL-F-5616 (Grade JP-1)
Canada	:	3-GP-236 (Type 1)
Specific Gravity	:	0.8 (All calculations based on this figure)

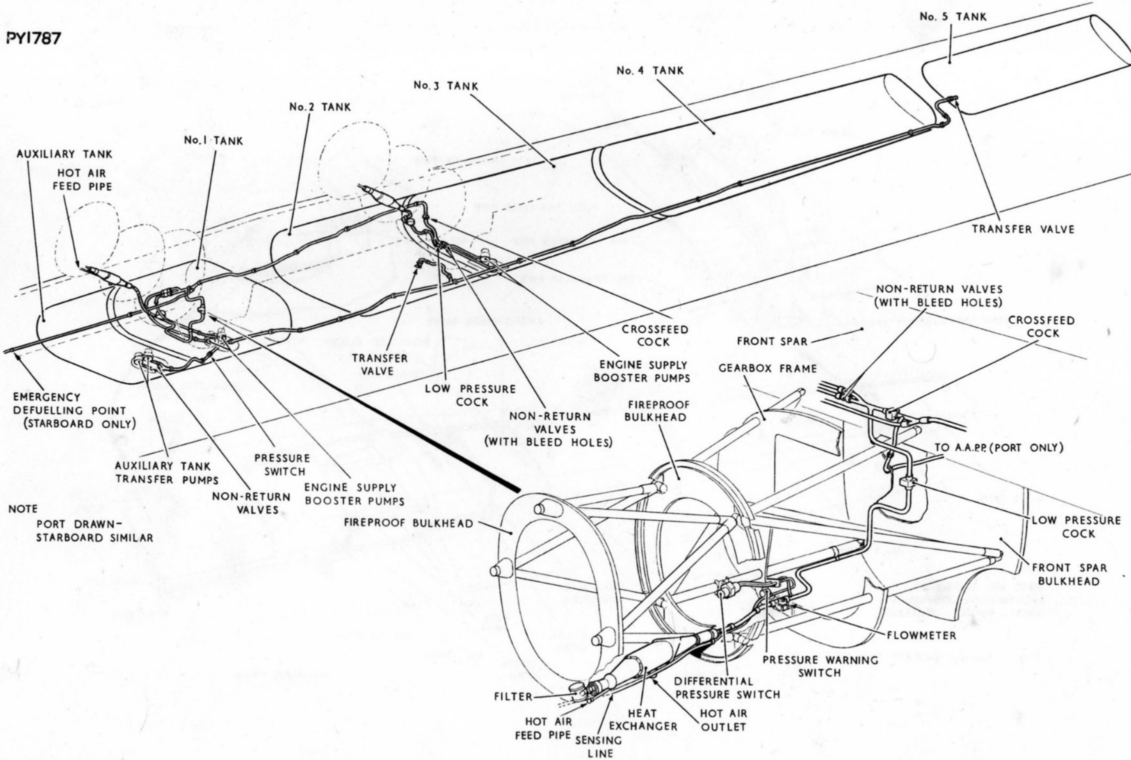
CAPACITIES

TANK	IMP.GALL.	U.S.GALL.	LITRES	WEIGHT(LB)	WEIGHT(KG)
No.1 Tank (each)	374	449.174	1697.96	2992	1357.2
No.2 Tank (each)	451	541.651	2047.54	3608	1636.6
No.3 Tank (each)	405	486.405	1838.7	3240	1469.7
No.4 Tank (each)	320	384.32	1452.8	2560	1161.2
No.5 Tank (each)	100	120.1	454	800	362.9
Aux. Tank (each)	430	516.42	1954.8	3440	1560.38
Total in each wing	2080	2498.07	9645.8	16,640	7547.98

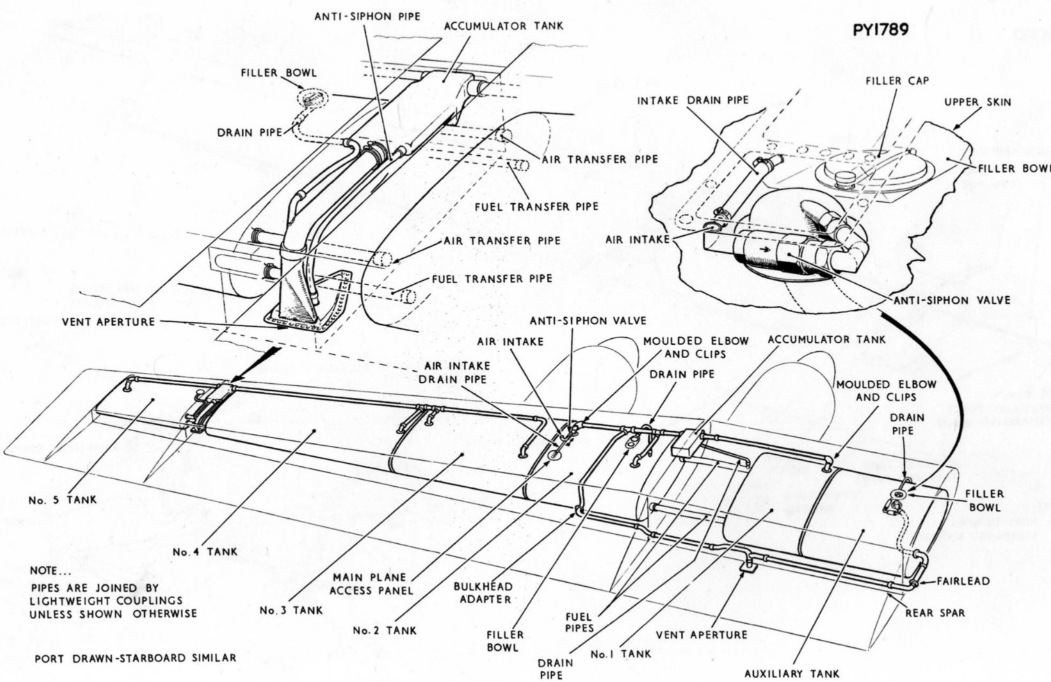


Fuel system diagram

PY1787



Fuel system



PY1789
ANTI-SIPHON PIPE
ACCUMULATOR TANK
FILLER BOWL
DRAIN PIPE
AIR TRANSFER PIPE
FUEL TRANSFER PIPE
AIR TRANSFER PIPE
FUEL TRANSFER PIPE
VENT APERTURE
FILLER CAP
INTAKE DRAIN PIPE
UPPER SKIN
FILLER BOWL
AIR INTAKE
ANTI-SIPHON VALVE
ANTI-SIPHON VALVE
AIR INTAKE
MOULDED ELBOW AND CLIPS
ACCUMULATOR TANK
AIR INTAKE DRAIN PIPE
DRAIN PIPE
MOULDED ELBOW AND CLIPS
DRAIN PIPE
FILLER BOWL
No. 5 TANK
No. 4 TANK
NOTE...
PIPES ARE JOINED BY LIGHTWEIGHT COUPLINGS UNLESS SHOWN OTHERWISE
PORT DRAWN-STARBOARD SIMILAR
No. 3 TANK
MAIN PLANE ACCESS PANEL
No. 2 TANK
BULKHEAD ADAPTER
FILLER BOWL
FUEL PIPES
DRAIN PIPE
No. 1 TANK
VENT APERTURE
AUXILIARY TANK
FAIRLEAD
REAR SPAR

Vent system

FUEL SYSTEM

1. General

A total supply of 4,160 Imperial gallons (33,280 lbs.) is carried in twelve flexible bag type tanks, housed within detachable light alloy skins in the wing, six tanks to each wing. The three outer tanks of each wing are interconnected, and feed the outboard engines, whilst the next two inner tanks are similarly interconnected to feed the inboard engine. The innermost tank in each wing is an auxiliary tank, and the fuel carried in it is used to replenish the fuel which has been used from the two groups in the corresponding wing.

A fuel balance system is incorporated, and by operation of fuel balance transfer cocks any engine may be fed from any of the main tank groups.

The system is non-pressurised, and vented to atmosphere, and pressure refuelling/defuelling is normally used, but provision is made for manual fuelling, and gravity draining.

Each tank has a drain point to enable water content checks to be carried out.

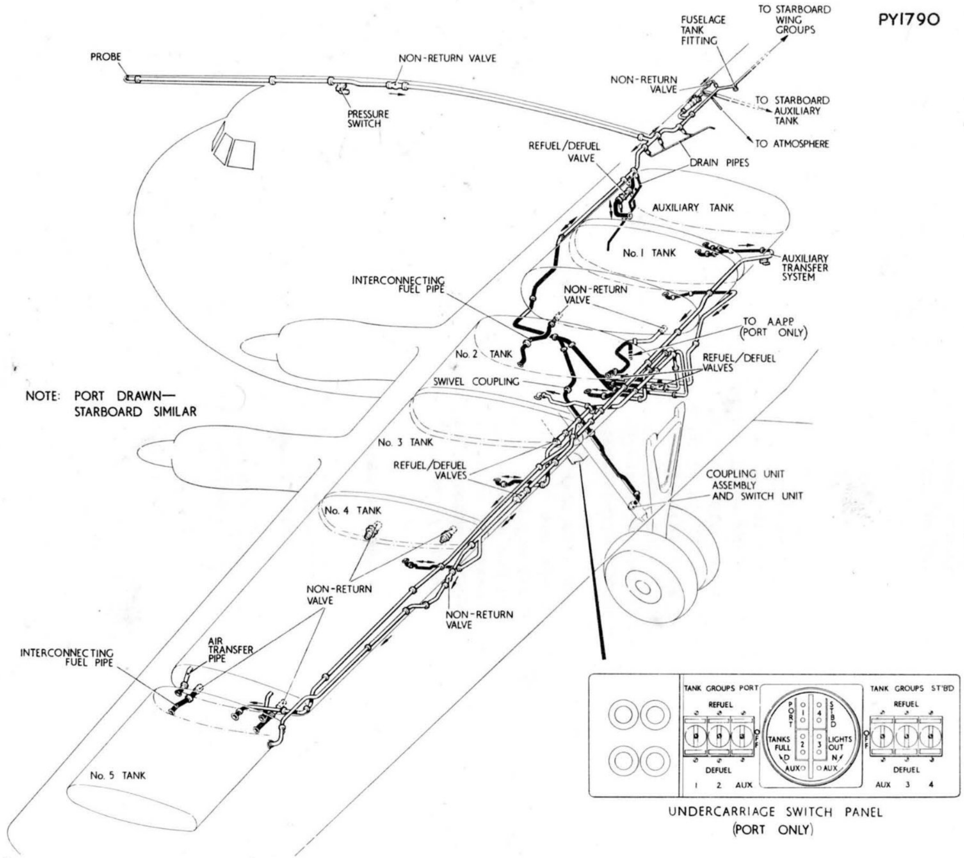
Fuel is supplied to the engines by electrically operated low pressure booster pumps, two for each main groups of tanks, situated in the inboard tank of each group. The sumps can be isolated from the remainder of the system so that pump maintenance can be carried out without completely defuelling the system. Two low pressure booster pumps are also fitted to each auxiliary tank, and the fuel from this tank is supplied to the outboard tanks of each main group in that wing.

Fuelling/defuelling is controlled by electrically operated valves. Any tank group, or auxiliary tank can be selected by operating the relevant switch situated on the inside face of the port main undercarriage front fairing door. Restrictors are fitted to the refuelling lines for each tank, to ensure that rated of refuelling is not in excess of rate of venting, and also to ensure an even filling rate to each of the main tanks. A refuelling float switch cuts off the supply to each tank by closing the appropriate refuelling valve, whilst a low level float switch operates this valve on defuelling. The selector switch on the fairing door must be reset manually.

A capacitor type fuel gauge system registers tank contents, whilst fuel flow to each engine and total fuel consumed is registered by means of fuel flow meters.

Fuel filter de-icing is effected by means of hot air from the engine compressor being bled off, and passed through a heater muff around the fuel pipe. A differential pressure switch gives warning of filter icing, and can be used to automatically operate the de-icing system.

An explosion suppression system is fitted to the fuel system in order that effects of enemy "strike" in fuel tanks may be minimised.


PY1790
PROBE
NON-RETURN VALVE
PRESSURE SWITCH
FUSELAGE TANK FITTING
TO STARBOARD WING GROUPS
NON-RETURN VALVE
TO STARBOARD AUXILIARY TANK
TO ATMOSPHERE
REFUEL/DEFUEL VALVE
DRAIN PIPES
AUXILIARY TANK
No. 1 TANK
AUXILIARY TRANSFER SYSTEM
INTERCONNECTING FUEL PIPE
NON-RETURN VALVE
TO A.A.P.P. (PORT ONLY)
No. 2 TANK
REFUEL/DEFUEL VALVES
SWIVEL COUPLING
NOTE: PORT DRAWN— STARBOARD SIMILAR
No. 3 TANK
REFUEL/DEFUEL VALVES
COUPLING UNIT ASSEMBLY AND SWITCH UNIT
No. 4 TANK
NON-RETURN VALVE
NON-RETURN VALVE
INTERCONNECTING FUEL PIPE
AIR TRANSFER PIPE
No. 5 TANK
TANK GROUPS PORT
REFUEL
DEFUEL
1 2 AUX
OFF
PORT
STBD
1
2
3
4
TANKS FULL
LIGHTS OUT
D
N
AUX
AUX
TANK GROUPS ST'BD
REFUEL
DEFUEL
AUX 3 4
OFF
UNDERCARRIAGE SWITCH PANEL (PORT ONLY)

TANKS

1. General

The tanks are identified from inboard to outboard on each wing, the innermost being the auxiliary, followed by numbers 1 to 5.

Fireproof Tanks Ltd. manufacture the tanks from Hycatrol (30 thou. thick) which consists of synethetic rubber sheeting reinforced on the outer surface with a special nylon fabric. This nylon reinforcement is designed to break under low shock loadings, allowing the rubber sheeting to stretch and conform to the distorted shape of the tank bay under heavy landing or crash conditions and yet remain fuel tight.

The tanks are attached to the detachable light alloy skins by colletted studs thus ensuring that static electrical charges are not built up.

2. Interconnection

Tank interconnection is facilitated by moulding connector pipes to the tanks into which metal pipes are inserted, and held in position by hose clips. Tanks 1 and 2 are interconnected by dual pipe lines, each line having a plate type N.R.V. in tank No.1, ensuring that fuel flows from 2 to 1. Tanks 3, 4 and 5 are similarly interconnected to allow fuel to flow from outboard to tank No.3. This ensures that the low pressure pumps fitted in tanks 1 and 3 do not suffer from fuel starvation.

3. Restrictors

The inlet connection to each tank has a calibrated restrictor. This restricts the flow of fuel to the tank to the rate of which air can be exhausted. Further consideration on the size of restriction gives an even filling rate to each of the main tanks. This does not apply to the auxiliary tank, which will, when refuelling takes place, require an unknown quantity of fuel, dependant on the amount of fuel from that tank transferred to the main groups during flight.

4. Sumps

Tanks No.1 and 3 have light alloy sumps of 6½ gallons capacity mounted in the base into which the booster pumps are fitted. Three inter-connected plate type valves are fitted into the sump. In normal operation these valves are in the OPEN position, but provision is made to close them by means of a T-shaped handle on the underside of the sump. This enables pump maintenance to be carried out by merely draining the contents of the sump and not the entire system.

NOTE : It is impossible to fit the sump access panel with the T-shaped handle in the 'LOCKED' position. Each sump has a drain plug, and a vent pipe to enable complete evacuation of the sump during draining.

5. Auxiliary tanks

Mounted in the base of each auxiliary tank are two low pressure pumps used to transfer fuel to the main groups contained in the same wing. A pipe line is led to the outboard tank of each group, and float operated cut off valves prevent over filling of the main groups by the auxiliary tank transfer system. A pressure switch in the transfer line will give indication to the pilot should pressure in the transfer line drop below 3 p.s.i.

6. Venting

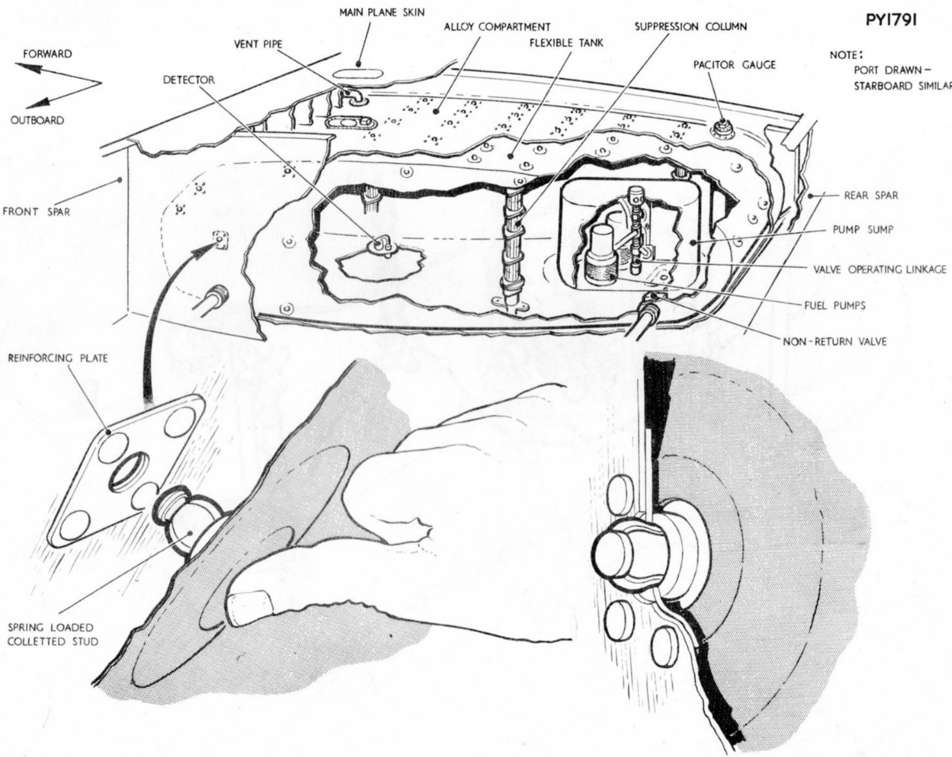
For venting purposes the tanks in each wing form two separate groups, tanks 3, 4 and 5 forming one group, and tanks 1 and 2 and the auxiliary tank forming the other. Float type vent valves are fitted to the outboard ends of tanks 2, 3, and 5 preventing fuel loss due to aircraft attitude, whilst plain vents are fitted to the inboard ends of the auxiliary tank and tanks 1, 2, 3, and 4. Tank 5 is connected by two high level pipes to tank 4.

The vents from tanks 3, 4, and 5 join a common pipe which leads to a fuel accumulator positioned between tanks 4 and 5. This accumulator incorporates an external vent and an anti-syphon pipe.

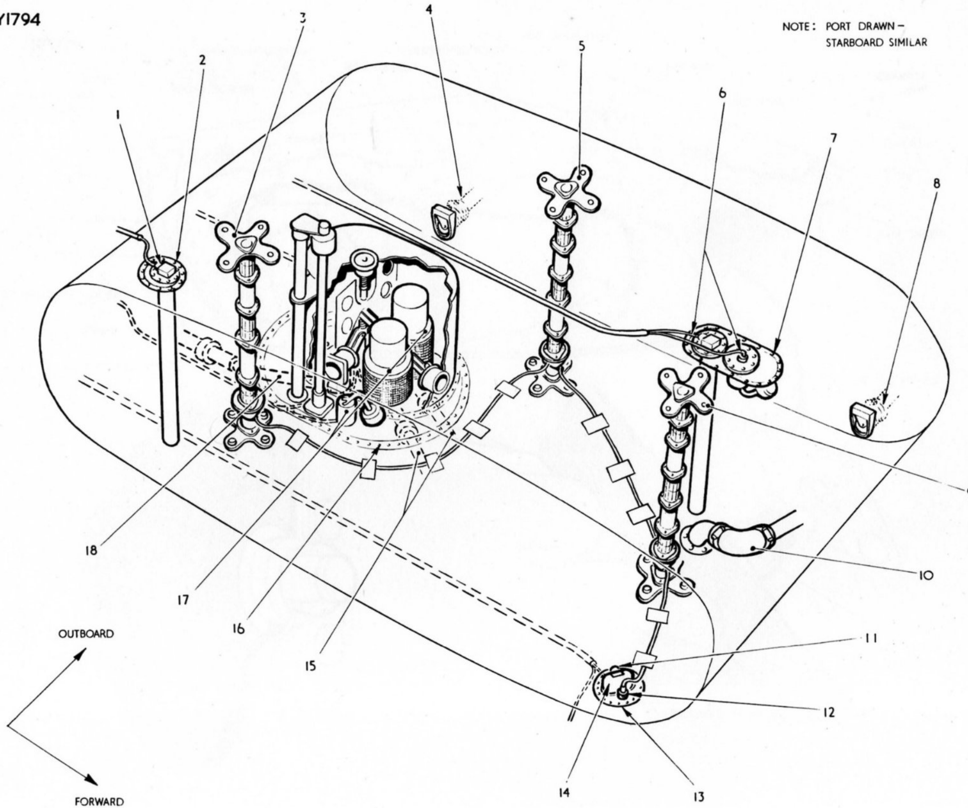
Vents from tanks 1 and 2 and the auxiliary tank are similarly joined to a common pipe which again joins an accumulator. An anti-syphon valve is fitted to the highest point of this common pipe, and the accumulator is also vented to atmosphere.

7. Tank capacities

Tank	Capacity	Position	Fuelling restrictor size
Auxiliary	430 Imp. galls.	Rib. 9 - 17) Centre	.813 inches
1.	374 Imp. galls.	Rib.17 - 24) Wing	.534 inches
2.	451 Imp. galls.	Rib. 1 - 5A)	.602 inches
3.	405 Imp. galls.	Rib.5A - 10A)	.602 inches
4.	320 Imp. galls.	Rib.10A - 17B)	.514 inches
5.	100 Imp. galls.	Rib.19 - 27 outerwing	.308 inches

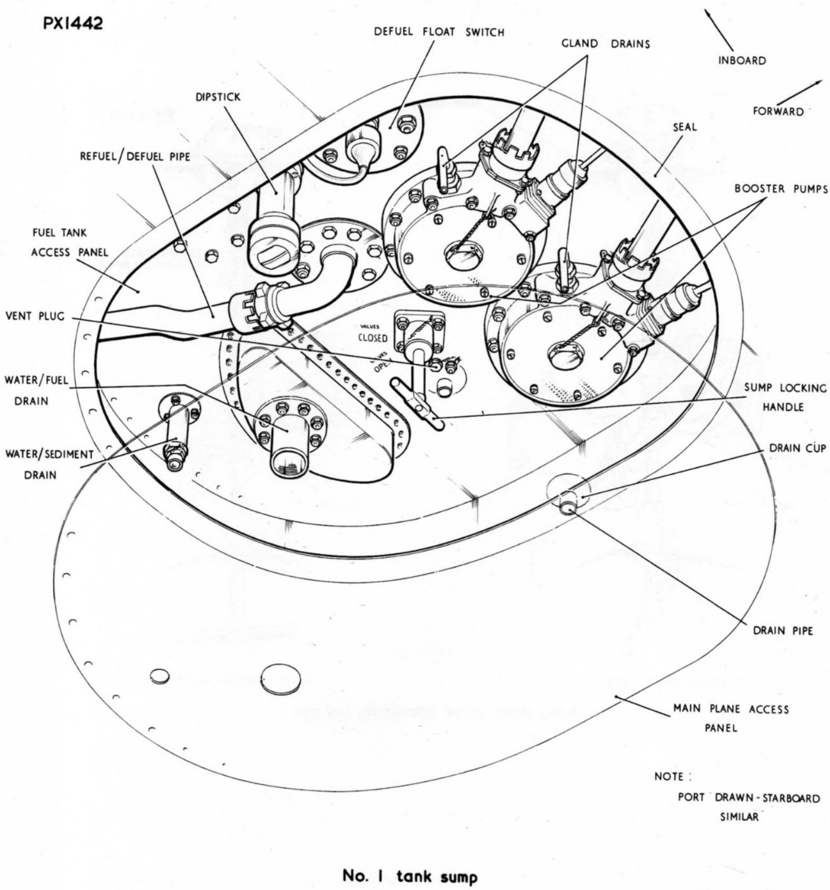


Fuel tank installation (No.1 tank)

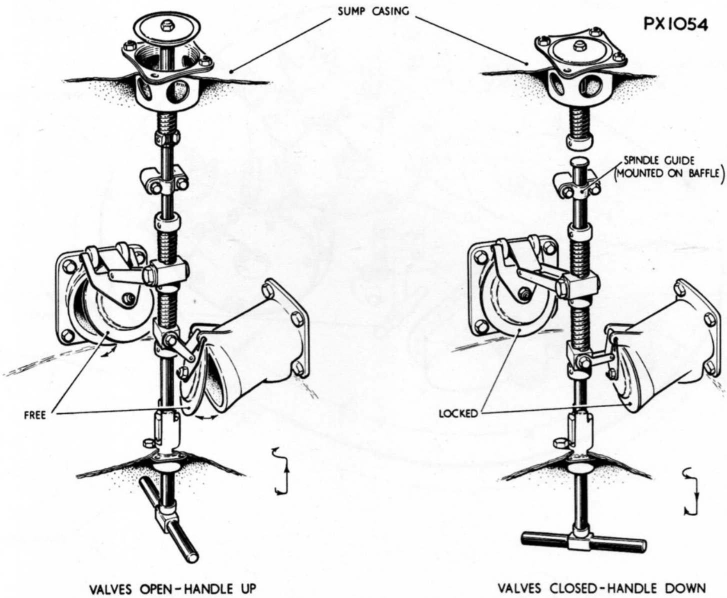


Removal and assembly of No.1 tank

PX1442



No. 1 tank sump



Pump sump valve operating linkage

FUELLING/DEFUELLING

1. General

Provision is made for pressure refuelling and suction defuelling through Avery/Hardoll bowser connections, fitted one to each main undercarriage leg. Tank group selection is obtained by the operation of any of six switches mounted in a panel on the rear face of the port main undercarriage front fairing door. Each switch has a three way selection DEFUEL, OFF and REFUEL.

Fuelling float switches are fitted to the highest point of each of tanks 1, 2, 3 and 4 and the auxiliary tanks, and close the appropriate refuelling valves when the respective tanks are full. Similarly defuelling float switches are fitted to the lowest points of the same tanks to close the appropriate valves when the tanks are empty.

Refuel/defuel valves are fitted in the fuelling lines to the auxiliary tank, and tanks 1, 2, 3, and 4. After the valve in the line to tank 4 the fuelling line divides, and a line is taken to tank 5. This line incorporates a non-return valve which ensures that on defuelling fuel is passed from tank 5 to tank 4, since the low level defuelling float switch is mounted in tank 4.

Tank unit capacitors are provided in each tank, and matching units transmit mean readings of each tank group to gauges situated in the cockpit. The capacitors are so positioned that errors due to aircraft attitude are kept to a minimum.

Refuelling is carried out at a rate of 150 G.P.M. and defuelling at a rate of 50 G.P.M.

For manual fuelling, hinged overwing filler caps are provided in the auxiliary tank, and tanks 2 and 5 overspill being drained to atmosphere.

Gravity defuelling can be carried out from a drain point in the starboard centre wing on the fuel transfer pipe.

2. Fuelling and defuelling float switches

Mark 4 fuelling/defuelling float switches are manufactured by Flight Refuelling Ltd. The complete switch extends into the tank, the mounting flange carrying a socket for electrical connection. The float is attached to a float arm which is pivoted about the face of the switch base plate. Internally, the switch consists of a rigidly mounted micro-switchette, the operating button of which is actuated by a striker attached to a rocker arm. A magnet mounted at one end of this arm is positioned opposite an armature plate attached to the float arm pivot, the switch base plate being positioned between the two items. As the armature is moved towards the magnet by the action of the float, the magnet is attracted to the armature and the rocker arm swings about its fulcrum point so that the striker depresses the micro switchette button.

3. Fuelling/defuelling coupling (FC.110 Mk.2)

The complete refuelling coupling consists of two parts, the Hose unit, normally attached to either bowser or hydrant dispenser, and the self-sealing aircraft unit.

The Aircraft units have a standard $2\frac{1}{2}$ inch three-point bayonet for connection to the Hose unit.

The aircraft units are sealed and protected by a light-weight sealing cap (FC.109).

The outlet connection to the aircraft of $1\frac{1}{2}$ inch inside diameter and has a B.S.P. screwed end.

Spillage when the hose unit is disengaged from the aircraft unit is below 2 c.c.

The unit consists of a self-sealing, spring loaded poppet-type valve, housed within a cast light alloy body to which is attached the bayonet flange. The valve has a fuel seal ring in an undercut groove, easily renewed by removal of the bayonet ring. The valve stem operates in a guide bush with a cone, which is carried in a spider integral with the body.

4. Flight Refuelling

Provision is made for flight refuelling through a probe extending from the upper starboard side of the fuselage. When contact is made between the probe, and the tanker drogue the refuelling valves are opened by the operation of a pressure switch in the flight refuelling line. This pressure switch is set to operate at 20 p.s.i. on rising pressure, an indicator lamp in the cockpit informing the crew when flow has commenced.

A non-return valve is fitted in the probe line to prevent feed back of fuel to the probe in normal fuelling operation.

When contact between probe and drogue is broken, any refuelling valve that has not already closed by action of the high level float switch will automatically close due to drop in pressure. at the pressure switch.

5. Refuelling Precautions

A. Before refuelling it is essential that bonding is carried out.

B. Dust covers on refuelling nozzles should not be removed until immediately prior to refuelling, and should be replaced on completion.

C. With overwing refuelling the orifice should be shrouded to prevent ingress of water or foreign matter.

FUELLING/DEFUELLING VALVES

1. General

The fuelling/defuelling valves are manufactured by Flight Refuelling Ltd. and are Mark 27 series 1, weighing 3 lbs. They are electrically operated and work in conjunction with tank float switches. A manual override is fitted to enable emergency defuelling to be carried out. In case of electrical failure the valve fails safe to the 'closed' position.

2. Principle of operation

The valve is so wired that it is not possible to energise both solenoids simultaneously.

A. Static - Both solenoids de-energised

The piston is held closed by the compression spring, and the seating in the cylinder and outer shell near the inlet end are also kept closed (fig.1).

B. Fuelling flow - fuelling solenoid energised

The Solenoid plunger is withdrawn and the exhaust port opened. Fuel enters through the inlet pipe and the holes in the cylinder. The piston is moved inwards by the fuel pressure, and fuel will flow through the passage between the outer shell and the cylinder, thence through the outlet pipe. At the same time, some fuel is by-passed through the hollow valve stem into the cylinder and thence through the exhaust port into the outlet pipe (fig.2).

C. Fuelling Shut-off - fuelling solenoid de-energised

When the circuit is broken by the action of the float switch, the spring loaded solenoid plunger is released, closing the exhaust port. The fuel pressure in the cylinder builds up and closes the piston (the area of the piston being greater than that of valve head), and valve (fig.3).

D. Defuelling flow - defuelling solenoid energised

When fuel enters the valve through the normal outlet it flows through the passage between the outer shell and the cylinder and so through the holes in the cylinder. The pressure build up at the back of the piston moves the piston inwards and opens the valve. Simultaneously pressure in the cylinder is relieved through the defuelling solenoid exhaust port. (fig.4).

E. Defuelling solenoid override - fuelling and defuelling solenoids de-energised

When the manually operated plunger valve is depressed the valve will open as described in para.D, but since the defuelling solenoid exhaust port is closed, the cylinder pressure is relieved by means of a by-pass duct opened by the plunger operation.

F. Defuelling Shut-off - defuelling solenoid de-energised

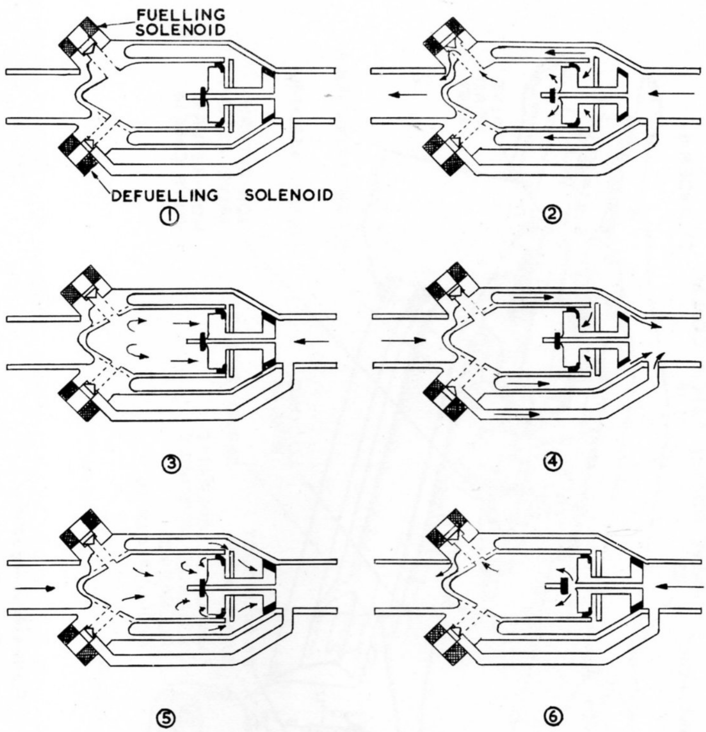
When the circuit is broken by the action of the float switch, the spring loaded solenoid plunger is released, closing the exhaust port. The fuel pressure in the cylinder builds up by leakage past the piston ring labyrinth and closes the piston and valve (fig.5).

G. Defuelling override shut-off - fuelling and defuelling solenoids de-energised

When the manually operated plunger valve is released to the closed position, the shut-off operation is the same as in para.F, except that the cylinder is sealed by closure of the by-pass duct.

H. Relief condition - fuelling and defuelling solenoids de-energised

Thermal expansion will cause a pressure to be applied to the valve head and force the piston non-return valve off its seat. Fuel will then flow through the hollow valve stem into the cylinder. At approximately 75 p.s.i. the fuelling solenoid exhaust port valve will be lifted thus relieving the pressure (fig.6).



PRINCIPLE OF OPERATION

① **STATIC**

Both Solenoids De-energised.
Piston Closed.
Exhaust Ports Closed.
By-Pass Valve Closed.

② **FUELLING FLOW**

Fuelling Solenoid Energised.
Exhaust Port Opened.
Piston Opened.
By-Pass Valve Opened.

③ **FUELLING SHUT-OFF**

Fuelling Solenoid De-energised.
Exhaust Port Closed.
Fuel Pressure Build-up Closes Piston.

④ **DEFUELLING FLOW**

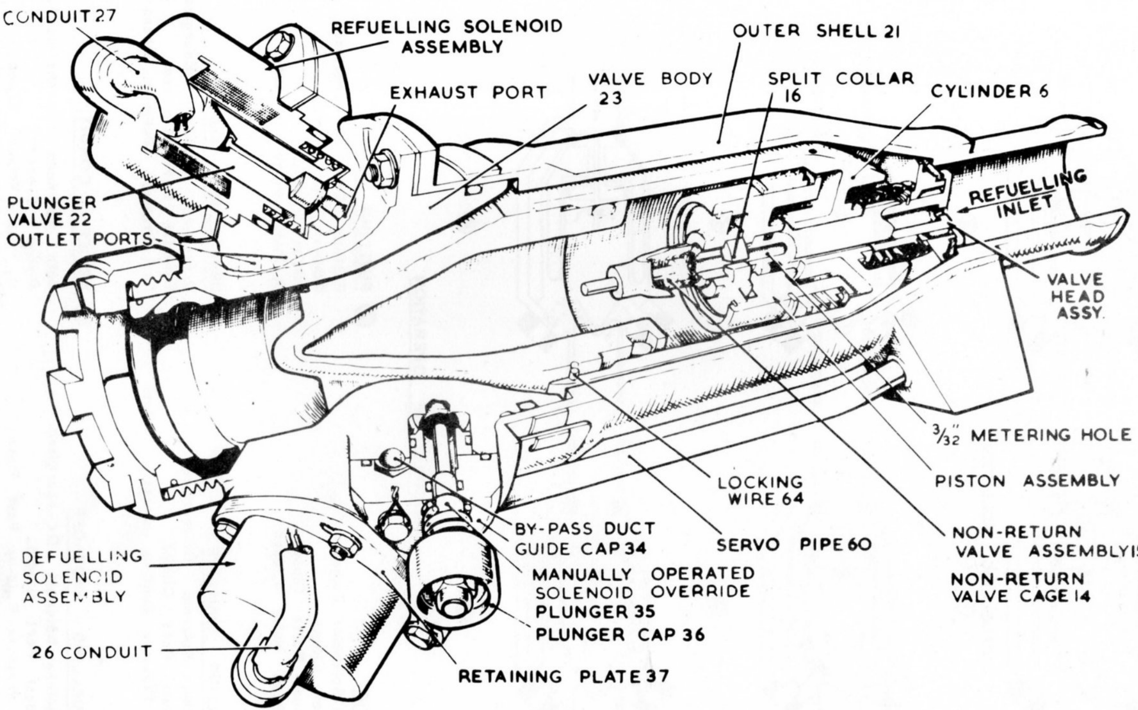
Defuelling Solenoid Energised.
Exhaust Port Opened.
Fuel Pressure Build-up Opens Piston.

⑤ **DEFUELLING SHUT-OFF**

Defuelling Solenoid De-energised.
Exhaust Port Closed.
Fuel Pressure Build-up Past Piston Ring Closes Piston.

⑥ **RELIEF CONDITION**

Both Solenoids De-energised.
Piston Closed.
By Pass Valve Open.
At 75 P.S.I., Fuelling Exhaust Port Opens.



Fuelling/defuelling valve
Figure 1

ENGINE SUPPLY

1. General

Fuel is supplied from either, or both low pressure booster pumps in each tank group, via N.R.V's, to respective engines, or to whichever engine is selected by operation of the fuel transfer balance cocks. Bleed holes incorporated in the N.R.V's, and relief valves incorporated in the low pressure fuel cocks, and transfer balance cocks, allow excessive pressure, caused by thermal expansion, to be relieved back to the tanks.

The low pressure cocks are opened by switching "ON" the appropriate fuel selector switches. Visual indication of operation of the cocks is provided by rotary indicators on the fuel instrument panel, white lines on the indicators lining up with white lines on the panel.

From the low pressure cocks, fuel is passed to a flow-meter and thence to a low pressure filter mounted forward of the engine firewall bulkhead. Having been filtered the fuel is supplied to the engine driven high pressure pump.

In the event of low pressure pump failure, a by-pass flap valve, normally kept closed by fuel pressure, allows fuel to be drawn from the tank by the engine driven pump. On booster pump failure, the aircraft should descend to its safe altitude to prevent any possibility of fuel aeration.

2. Low pressure fuel booster pumps

The pumps are manufactured by S.P.E. (Self Priming Pumps and Engineering Co. Ltd.) They are rated to deliver 200 G.P.H. of AVTUR at 9.5 lbs. per square inch minimum delivery pressure, at 24 volts D.C. input and weigh 7 lbs. 6 ozs. The gland of each pump has a drain connection which is led to atmosphere directly under the pump sump. A suction by pass valve allows fuel to be withdrawn from the tank by the engine driven pump with the booster pump idle.

The supply for each booster pump is individually controlled from switches on the fuel control panel, the switches being three position type ON, OFF and TEST. The TEST position connecting the pump supply to an ammeter and test master switch on the starboard console.

Operation

Fuel enters the pump through the wire mesh filters, passes into the helical impeller driven by the motor spindle, and is forced through the spiral volute in the base casting into the fuel line.

Under conditions in which the flow from the pump is low due to low engine requirements, the impeller continues to rotate at approximately normal speed without causing an excessive increase in fuel pressure.

3. Low pressure and transfer balance cocks

The low pressure cocks and fuel transfer balance cocks are manufactured by Saunders Valve Co., Ltd. The cocks are motorised and actuator controlled. A two position switch sets the cocks to OPEN or CLOSE. Limit switches, integral with the actuator, switch off the supply at each end of the actuator travel. The actuators are also fitted with series operated solenoid brakes. Magnetic indicators are located on the fuel control panel (which is in the form of a system diagram) indicating the cock positions. On the body of the motor a visual and feel indicator indicates the position of the valve.

Provision is made for pressure relief between 27 and 35 p.s.i. the normal system pressure being 20 p.s.i.

A. Sealing action under normal pressure conditions

With the valve shut, spring pressure on the up stream thrust ring ensures sealing contact between the plug and the seat, also between the seat outer flange, seat diaphragm inner circumference and thrust ring, the sealing remaining operative over the whole working pressure range.

B. Pressure relief function

Each seat has an annular recess concentric with the sealing surface and presented towards the plug.

On the upstream seat the space, between the annular recess and the plug surface, a fluid reaction occurs, increasing as the system pressure rises. At the pre-determined relief pressure the reaction is strong enough to lift the seat away from the plug, allowing fluid to escape into the body of the valve. This fluid can then be passed between the seat and seat diaphragm on the outlet side and so downstream.

4. Elliott Flowmeter (Type 3D.377)

Mechanical movement obtained from fuel flow is converted into an electrical signal which is utilised, in conjunction with an amplifier and indicator, to provide visual indications of fuel consumption and flow rate. The gauges, on the centre instrument panel, indicate fuel flow for each engine, and a 'Veeder' counter registers total fuel consumed, in pounds. Working pressure of up to 40 p.s.i. can be used with a maximum pressure drop of less than 1 p.s.i.

Construction

A light alloy casting forms the flow chamber, with inlet and outlet ports and mounting bosses cast integral with the chamber body.

The internal mechanism consists of a vane and spring assembly attached to a centrally mounted shaft, with a ring magnet at one end and a damping counterweight at the other.

Mounted on the flow chamber body is a sealed compartment which encloses a wire-wound potentiometer and two calibration resistors. A bar magnet is attached to the potentiometer shaft.

Operation

The transmitter is fitted in the engine fuel feed line between the L.P. cock and the fuel heater, being mounted on the forward face of the gearbox frame.

Fuel passing through the flow chamber impinges on the vane, the chamber being so shaped that the area of the orifice at the tip of the vane increases with movement of the vane under conditions of increased fuel flow, the chamber being so designed that vane displacement is proportional to flow rate.

The vane is restrained by a pretensioned spiral spring, so that with fuel flowing at a specific rate, an equalibrium position of the vane is attained when the torque (due to pressure across the vane) is balanced by reaction torque exerted by the spring.

By means of the ring magnet on the vane mounting shaft, and the bar magnet attached to the potentiometer shaft, a signal is transmitted to an amplifier proportional to the flow rate.

The counterweight on the vane mounting shaft dampens any erratic changes in fuel flow transmission.

Fitted into the chamber is a spring actuated relief valve which allows fuel to pass direct between inlet and outlet fuel ports should there be blockage in the flow chamber.

5. Fuel filter de-icing

The pipe between the airframe and engine firewall bulkheads, is surrounded by a heater to warm the fuel in the event of blockage of the low pressure filter by ice formation. Hot air is supplied from the second stage of the engine compressor, and after circulating through a heat exchanger, the hot air is exhausted to atmosphere from an outlet pipe in the lower engine cowling.

A pressure differential switch is operated by two fuel tappings, one from the fuel delivery line between the L.P. cock and flowmeter, and the other after the low pressure filter. When a differential pressure of 3 p.s.i. is sensed, a solenoid is energised, which causes a gate valve (mounted on the underside of the engine compressor casing) to open, and at the same time a FILTER BLOCKED warning light on the de-icing instrument panel is operated.

A pressure warning switch is fitted in the sensing line after the low pressure filter, and operates when the fuel pressure drops below 7 p.s.i.

The de-icing switches which are on the de-icing instrument panel are three position type, OFF, AUTO, and ON. When selected to AUTO the hot air supply is automatic by the differential pressure switches operating as soon as ice forms in the low pressure filter, restricting fuel flow. Warning lights are provided on the panel which glow when any filter is blocked. Positive override control, maintaining hot air delivery is provided by selecting ON.

As the pressure tappings to the differential pressure switch are taken upstream of the flowmeter and downstream of the filter, the formation of ice on the flowmeter filter would also cause the warning light to come on. Flowmeter icing can be recognised when, after switching on the fuel heater and waiting a reasonable time, the warning light remains on.

A. Hot air gate valve

The valve, manufactured by Teddington's is mounted on the underside of the engine compressor casing, and receives hot air from the second stage of the compressor. It consists of a sliding carbon pad which is moved across the outlet orifice by two different area pistons. The head of each cylinder is vented to atmosphere, but the vent from the head of the larger cylinder can be closed by a solenoid valve controlled by the heater operating switch.

In normal operating conditions, the Solenoid valve is spring loaded to the closed position, and due to a controlled leak past the head of the larger piston, both faces of the piston will be subjected to second stage air pressure, whilst the head of the smaller piston is open to atmosphere. This causes the sliding valve to be held towards the smaller piston, and no hot air is passed to the heater.

When filter icing takes place, the solenoid valve is opened and vents the head of the larger cylinder to atmosphere. The force of the pressure difference across the larger piston exceeds that across the smaller piston and the gate valve opens to pass hot air to the fuel heater.

B. Heat exchanger

The heater manufactured by Marston's is situated on the port side of the power plant, and connected into the fuel line from the flowmeter to the flow control unit. A pipe connects the heater to the gate valve and another pipe conveys the hot air overboard. An atmospheric drain prevents a possible internal leak causing fuel aeration.

C. Operating check

With the engine stationary operate the gate valve switch and listen for the 'click' of the solenoids. With the engine running at approach idling R.P.M. and the fuel filter heater switched on, ensure that the hot air discharges to atmosphere. The discharge should cease when the heater is switched off.

In the event of any leakage occuring from the drain pipe situated alongside the pipe conveying hot air overboard, the heater should be changed.

6. Fuel contents gauges

One for each tank group mounted on the fuel system instrument panel. Each indicator circuit is provided with an adjuster unit to permit adjustment of the whole system, first with empty tanks and then with full tanks. The 'full' adjuster is so connected that its operation does not affect the reading at empty.

For the purpose of gauging.

No.1 Fuel indicator indicates port tanks 3, 4 and 5.
No.2 Fuel indicator indicates port tanks 1 and 2.
No.3 Fuel indicator indicates starboard tanks 1 and 2.
No.4 Fuel indicator indicates starboard tanks 3, 4 and 5.

7. Fuel pressure warning lights

One for each engine system. Mounted on the fuel instrument panel, they glow red when the fuel pressure drops to 7 p.s.i. or below. A warning light test button is provided on the starboard console, to illuminate all warning lights for test purposes.

8. Fuel trimming

For any given R.P.M. a rise in ambient air temperature produces a reduction in mass airflow, due to density decrease. Were the fuel flow to remain constant the alteration in air/fuel ratio would result in high turbine working temperatures, cutting down engine life. To obviate this, a fuel trimmer is incorporated, which permits fine adjustment of throttle setting without affecting the R.P.M. selection. This enables the R.P.M. and fuel flow relationship to be adjusted so that turbine working temperatures can be maintained at optimum under varying ambient conditions, up to the maximum O.A.T. likely to be encountered.

The fuel trim switches, one for each engine, are mounted on the centre pedestal. With the trimmer set to full increase, fuel flow is normal but at full decrease, 25% of fuel flow can be trimmed off. The trimmer actuator positions are shown by means of Desyn transmitters on the centre pedestal.

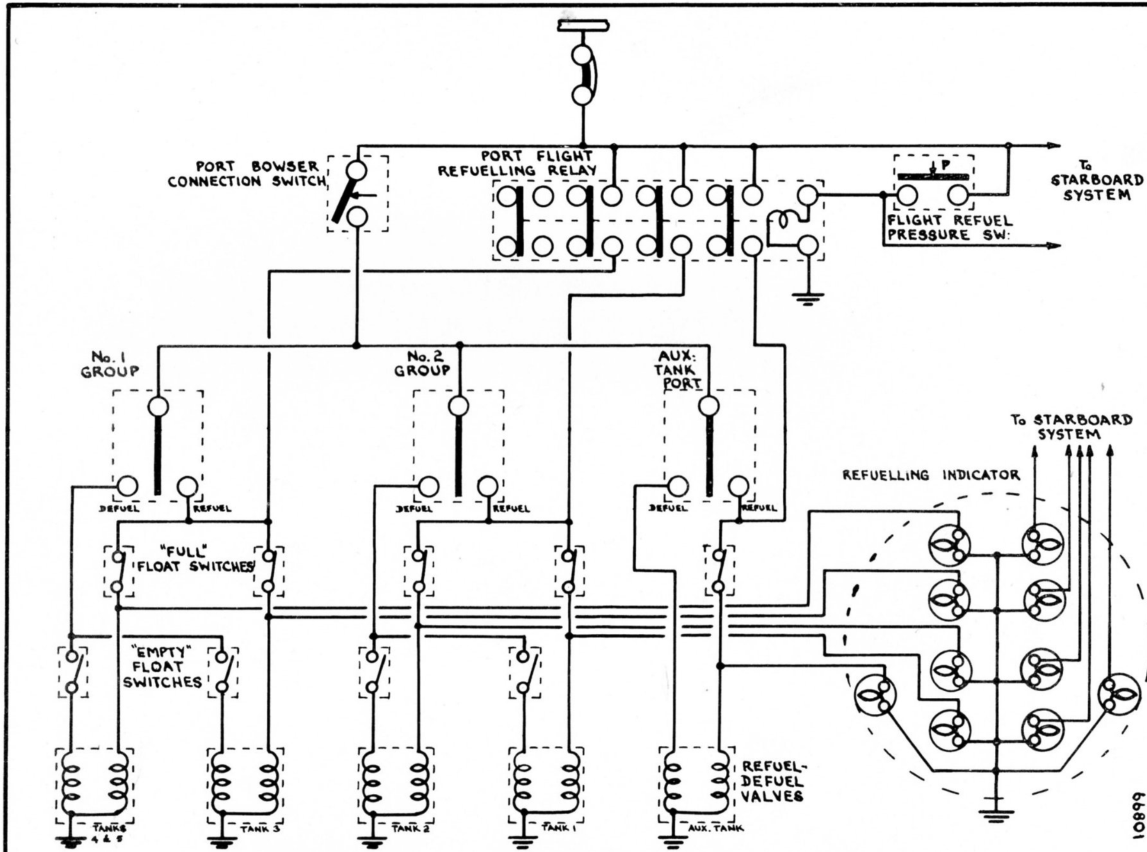
9. Pipe connectors

There are four types of pipe connections used on the fuel system, three being Flight Refuelling Ltd., manufactured connectors, the remaining type being rubber hose, clipped with standard hose clips.

The proprietary connections are Lightweight pipe connectors type FRS.175, Standard pipe connectors type FRS.110 and 132 and Bulkhead pipe connectors type FRS.122.

10. Water detection

A small quantity of fuel should be drained off from each tank into a clean container, and if a visual check for water content is not satisfactory the Shell detector kit can be used. This consists of a small yellow filter paper element, sensitised with chemicals and mounted in a plastic hood. In conjunction with a hypodermic syringe fuel is drawn through the filter, and if the water contamination is over .003% the filter element will discolour blue.



REFUEL-DEFUEL SYSTEM. (PORT SHOWN STBD. SIMILAR)

ENGINE INSTALLATION

DART Mk 101

	RPM	MAX TGT °C
MAX TGT DURING STARTING	—	930
GROUND IDLING	INCIDENTAL	550
APPROACH MIN	9,000	550
MAX CONT	14,200	730
OPERATIONAL NESSECITY	15,000	750
EMERGENCY	—"—	840

POWER PLANT - GENERAL

GENERAL DESCRIPTION

1. Introduction

The aircraft is powered by four Rolls Royce Dart turbo prop. engines, installed as four power plants at the two inboard and two outboard wing nacelles.

Each power plant assembly is made up of an engine with its associated fittings controls and auxiliary services driven from an auxiliaries gearbox.

The engine is installed forward of a bulkhead referred to as the airframe firewall, with the exhaust unit and jet pipe housed within the wing nacelles. A splined drive shaft is led aft from the engine to the auxiliaries gearbox located in a fireproof housing aft of the airframe firewall.

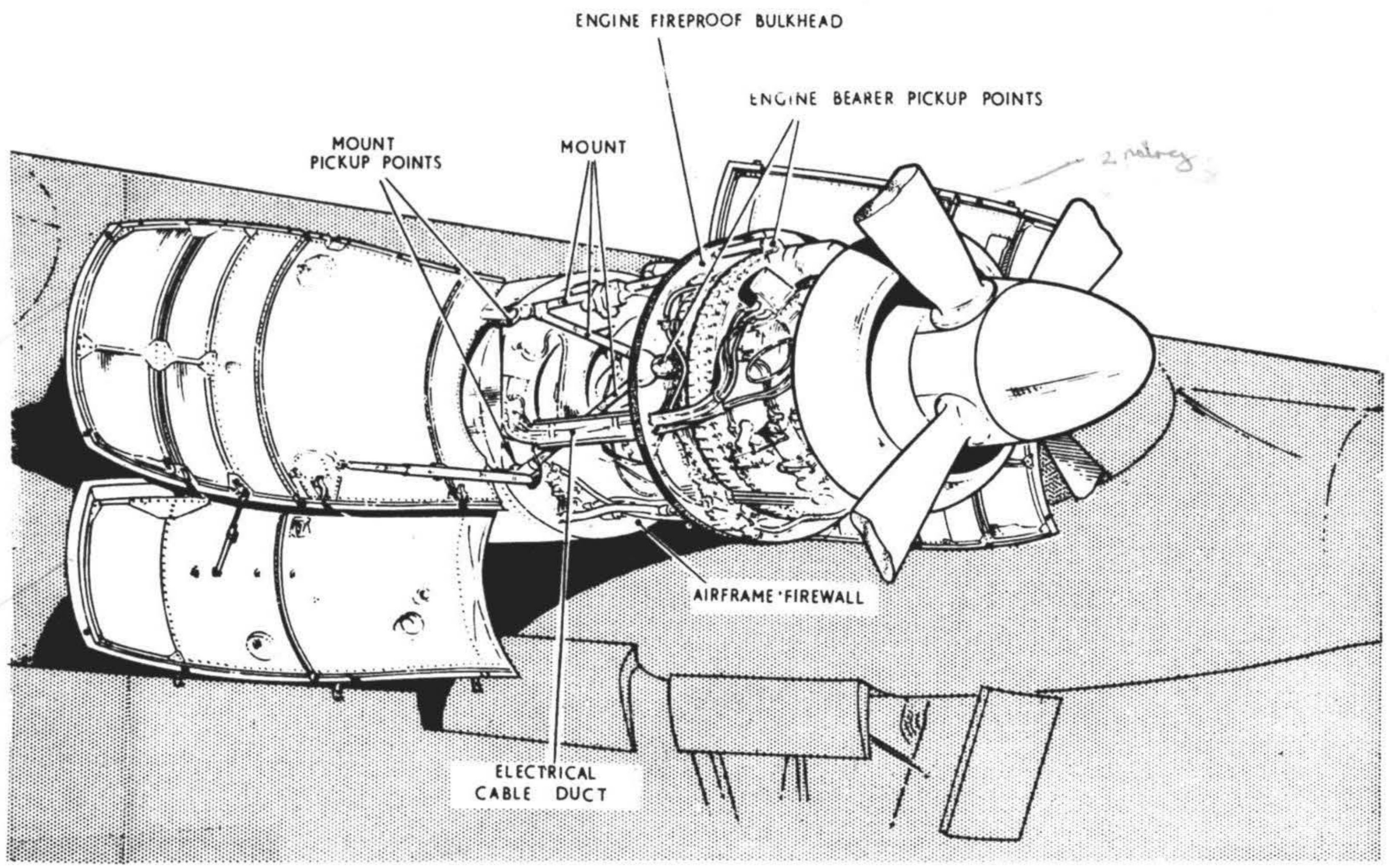
All connections are made at points located on or adjacent to the airframe firewall which also carries four mounting points to accommodate the attachment of the engine mounting frame.

Four cowling panels, mounted in pairs, complete the assembly. When spread and braced, they provide unrestricted access to the engine. Incorporated in the cowlings are servicing panels, exhaust vents, fire extinguisher panels and a pressure relief valve door. Though normally interconnected in pairs, either the top or bottom cowling panel can be opened independently if local access to the engine is required. Hook type hinges at the airframe firewall, facilitate removal or replacement of the cowling panels.

Attachment of the power plant to the airframe firewall is by four expanding type mounting pins at four housings; each pin connects an eye end fitting on the engine mounting frame, to a fork end fitting on each nacelle strut. When the engine is installed, the exhaust unit is arranged within a conical shroud, with its discharge gap centrally positioned in the jet pipe inlet. Jet efflux from each power unit is discharged through an exhaust system concisting of a jet pipe enclosed in a shroud and projecting through an opening in the nacelle rear fairing. Discharge from the outboard jet pipes is directed aft and slightly downwards, while the inboard jet pipes are off-set to clear the wheel bays and direct exhaust gases outwards, away from the fuselage.

The Rotol shaft mounted propeller is fitted to each engine complete with its associated equipment consisting of a spinner shell which encloses the propeller hub, an engine driven controller unit and an engine mounted feathering unit.

Synchronising equipment is fitted to bring the engine speeds into synchronisation and maintain them in that condition; one engine acting as a master engine, with the remaining slave engines synchronised to the speed of the master engine.


ENGINE FIREPROOF BULKHEAD
ENGINE BEARER PICKUP POINTS
MOUNT
PICKUP POINTS
MOUNT
AIRFRAME FIREWALL
ELECTRICAL
CABLE DUCT

Power plant

ENGINE INSTALLATION

PREPARATION FOR INSTALLATION

1. General

The installation preparation involves de-inhibiting the engine, and the assembly of the installation fittings and units which make up the complete power plant assembly.

By the utilisation of an engine stand, all assembly work can be carried out by prior to fitting namely :

A. Fitting of engine to engine mounting frame

B. Fitting engine firewall seal

C. Exhaust unit

D. All engine controls and services which extend forward of the airframe firewall.

2. Engine Mounting Frame

A. General Description

The frame consists of three Vee shaped tubular steel structures interconnected at each apex by machined steel forgings.

B. Attachment of Mounting Frame to Engine

Attachment of the mounting to the engine is carried out at the three apex end fittings. The end fittings locate in housings on the engine firewall at the rear end of the compressor casing. The housings are at the top central position and on each side of the engine, all three points being equidistant.

A heat shield surrounds each housing and is welded to the rear face of the engine firewall, becoming an integral part of the structure.

C. Attachment at Airframe Firewall

The frame is attached to the airframe firewall at four housings, with the two free ends of the mounting frame carrying sleeve type end fittings which attach to the two lower nacelle struts.

3. Engine Attachment

The end fittings of each triangular shaped structure of the mounting frame locate in three attachment housings at the engine firewall. Each end fitting is secured in its attachment housing through the medium of a sleeved bolt. The bolt is screwed into the larger of two concentric tappings in the end fitting. The inner tapping carries a left hand thread to take a locking bolt.

A special seating ring transmits thrust from the head of the sleeve bolt to the engine bearer foot, and a spherical seating ring takes the thrust between the engine bearer foot and the engine mounting frame.

A. Fitting

The sleeve bolt is tightened down to a pre-determined torque loading (~~600 lbs/ins.~~ 50 lbs/ft), and the complete assembly is locked by a left hand threaded bolt which locates through the sleeve bolt into the inner tapping, and is torque loaded to a value of ~~300/420 lbs/ins.~~ 30/35 lbs/ft. A tab washer locating in the head of the sleeve bolt, holds the locking bolt in position.

B. Engine Firewall Seal

The seal, around which is wrapped an asbestos based covering, is inserted into the seal channel which is situated on the periphery of the firewall, in such a manner as to bring both ends of the seal together at the uppermost point of the bulkhead. The joint is held together by hooks and eyes attached to the wrapping.

4. Exhaust Unit

A. General

The unit consists of two concentric cones both of which are fabricated from heat resisting steel sheet.

B. Fitting of Exhaust Unit to Engine

(1) Ensure that the unit is correct for the position of the engine in the aircraft, i.e. inboard or outboard, and that it is fitted in the correct angular position.

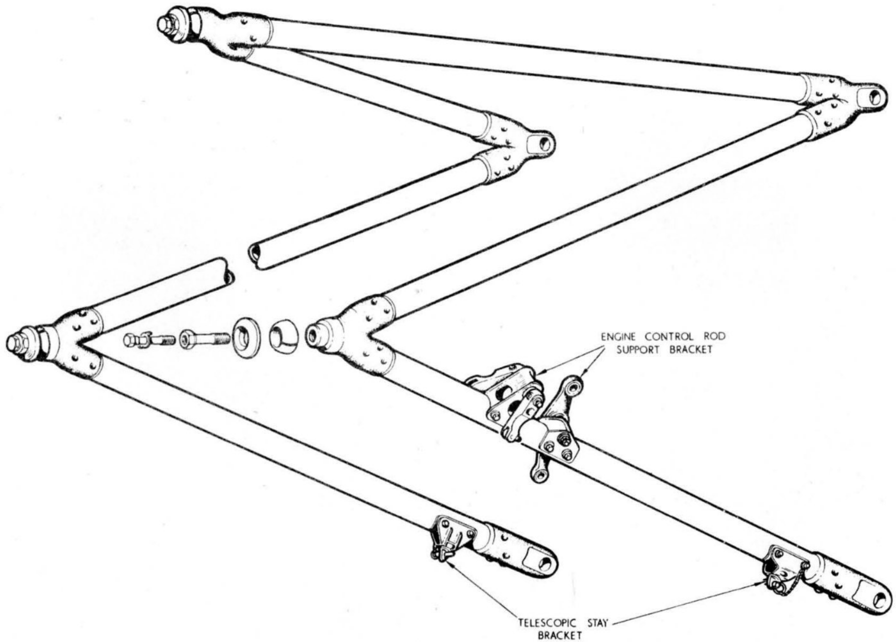
NOTE

In order to effect interchangeability of port and starboard inboard exhaust units, alternative drillings are provided in the mounting lugs. These drillings are marked appropriately for port or starboard installation.

The outboard exhaust units are completely interchangeable with each other.

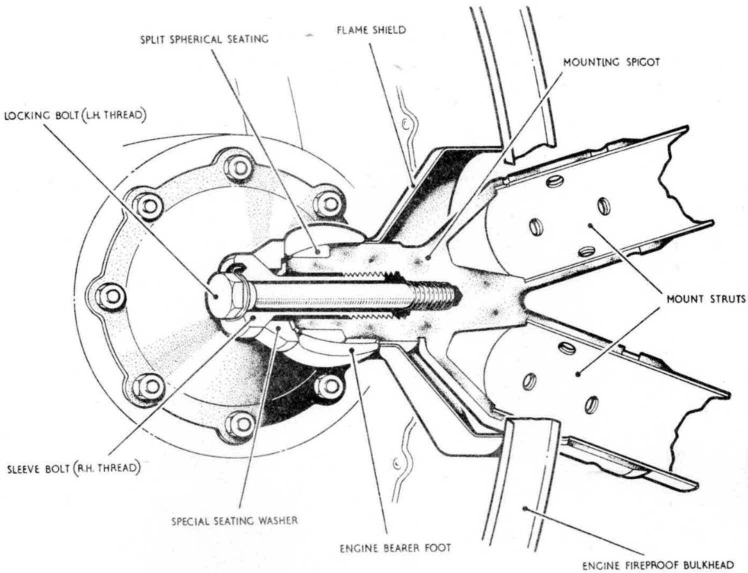
(2) Locate the exhaust unit to the engine shroud ring.

(3) Fit the attachment bolts and new tab washers; tighten nuts and lock.



Power plant mount

7105



Engine to mount attachment

L H BOLT 30 - 35 lbs/ft
R H BOLT 50 lbs/ft

ATTACHMENT OF MOUNTING FRAME AT AIRFRAME FIREWALL

1. General

The fork end fittings of the nacelle struts position on the sleeves of an inner and outer collar which are bolted to each attachment housing, with the eye end of each engine mounting strut locating between each pair of collar sleeves. The connection between the engine mounting frame and the nacelle struts at the airframe firewall position, is effected by a split sleeve mounting pin with an integrally tapered bore which houses a taper plug.

Axial movement of the taper plug, causes an increase or decrease in pin diameter due to the interaction of the tapers. The change in diameter of the pin is constant throughout its length.

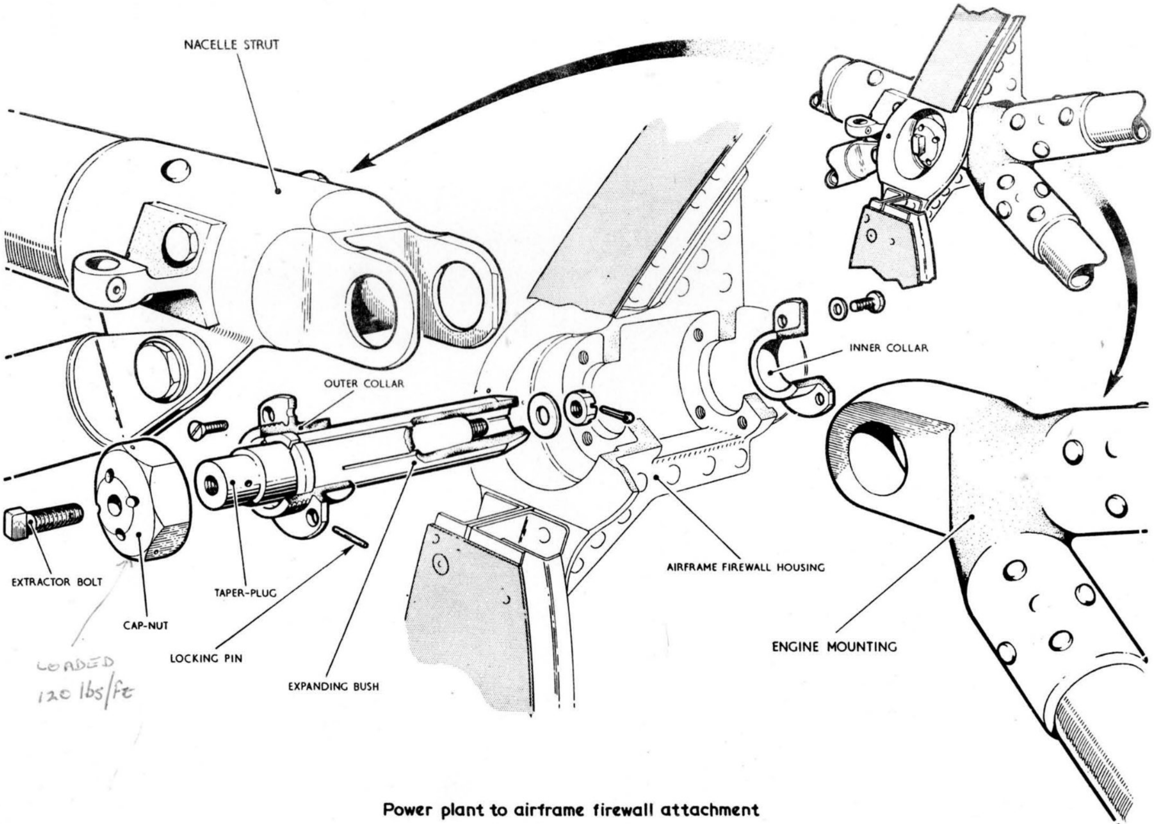
A cap nut and an extractor bolt are fitted to the outer end of the mounting pin, with the bolt passing through the cap nut and screwed into the outer end of the taper plug. A nut and washer on the inner end of the plug, prevents the sleeve pin and taper plug from becoming inadvertantly detached.

2. Fitting

The complete mounting pin assembly is pushed fully home and the cap nut tightened down to a pre-determined torque loading of 120 lbs/ft.

3. Removal

The action of unscrewing the cap nut causes the nut to bear against the head of the extractor bolt, and effects a decrease in pin diameter which facilitates removal.



Power plant to airframe firewall attachment

7101

CONNECTIONS AT AIRFRAME FIREWALL

1. The following connections are effected at or adjacent to, the airframe firewall, between the power plant assembly and the airframe.

   A. Accessories Gearbox Drive Shaft

   B. Engine Breather

   C. Water Methanol Supply

   D. Fire Extinguisher Supply

   E. H.P. Cock, Throttle and Fuel Trim Control Rods

   F. Main Fuel Supply

   G. Fuel Filter Ice Sensing Line

   H. Engine Main Drain and Turbine Heat Shield Drain

   I. Graviner Firewire

   J. Electrical Connections at Firewall

   K. T.G.T. Thermocouple Cables

2. Accessories Gearbox Drive Shaft

A drive shaft transmits the motive power from the engine rearwards to the accessories gearbox. The shaft is coupled to the engine drive at the compressor casing and a similar coupling is located at the forward face of the airframe firewall.

Both forward and rear couplings are made up of driver and driven plates secured by four special bolts and slotted nuts.

The forward coupling is housed within a cover which is secured to the compressor casing by five studs complete with nuts and spring washers.

3. Engine Breather

The forward hose connection branches from an elbow pipe on the engine casing at the rear of the engine firewall, and leads aft to a connection at the airframe bulkhead. The hose is attached at both ends by Jubilee clips.

4. Water Methanol Supply

The water methanol supply line connects up to an Avery Hardoll self sealing coupling at the forward face of the airframe firewall and is led forward through the engine firewall bulkhead, to the Water Methanol unit. A heat resisting steel duct encases the pipe throughout its entire length.

Support is provided at a point midway between engine and airframe firewalls by a dumb-bell type pipe clip attaching the pipe to the adjacent engine mounting strut, and at the engine firewall, by a Tufnol block with facing plates held in position by a circlip. A bracket on the engine casing provides support for the pipe forward of the engine firewall.

A. Attachment of Shroud Sleeve at Airframe Firewall

The shroud sleeve attaches to a pipe flange on the airframe firewall, and is secured by two half pipe clips. A peg integral with the top half pipe clip projects through the shroud and pipe sleeve and locates in a hole drilled into the body of the Avery Hardoll coupling.

5. Fire Extinguisher Pipe

The forward face of the airframe firewall carries an adaptor pipe to which is connected the metal braided fire extinguisher pipe which runs the length of the combustion bay, to locate on the engine firewall. Connection at the engine firewall is by means of a flanged coupling attachment secured by slotted nuts. The adaptor pipe at the airframe firewall is an integral part of the bulkhead.

Support is provided midway along the pipe by a pipe clip which secures the pipe to the adjacent engine mounting strut.

6. H.P. Cock, Throttle and Fuel Trim Control Rods

The connections for Throttle, H.P. Cock and Fuel Trim are also effected at the airframe firewall. Each control rod carries a ball and socket type end connector, with a means of quick release consisting of a cam pin which can be turned by a wire clip attached to the head of the pin. To disconnect the control, the clip is lifted and turned through 90° allowing the rod to be released from the ball end fitting.

7. Main Fuel Supply

The main fuel pipe between engine and airframe firewall is installed in two parts, separated by a heat exchanger through which the fuel passes. A Lockheed Avery coupling is used for connection at the airframe firewall. The complete assembly is encased within a heat resistant steel shroud extending through the combustion bay from airframe firewall to engine firewall.

Hot air is led from the compressor casing into the heat exchanger (nullifying the adverse effects of low temperatures on the fuel), and the air exhaust duct from the heat exchanger, together with a drain pipe is protected by an adjustable shroud pipe, one end of which projects below the bottom cowling panel.

The shroud is adjustable to suit inboard or outboard engines as required; the shape of the inboard and outboard cowlings differ slightly due to the smaller outboard wing nacelles.

The shrouded fuel pipe assembly is supported at three points throughout its length. At the forward face of the airframe firewall, a flanged pipe connects to a split shroud sub-assembly and at the engine firewall by a pipe sleeve fixed to the engine firewall, while midway along its length, support is provided by an anti-torsion stay, linking the heat exchanger to the adjacent engine mounting strut.

The split shroud sub-assembly at the airframe firewall is held in position with a peg on the upper half pipe clip which locates with a hole in the pipe flange.

8. L.P. Fuel Sensing Line

The sensing line connection at the airframe firewall, is made by an adaptor and pipe union nut. The pipeline which is metal braided, passes through the engine firewall to the attachment on the fuel pump. Protection of the coupling at the airframe firewall is afforded by a shroud which is bolted to the firewall.

A clip attached to the shroud of the heat exchanger and another on the main drain valve casing, provides support for the pipe in the combustion bay, while on the rear face of the engine firewall, the pipe is held by a split fairlead block locked in position by a circlip. The complete assembly is covered by a shroud which is bolted to the airframe firewall.

9. Main Fuel Drain and Turbine Heat Shield Drain

Both drain pipes are connected at the airframe firewall by normal pipe union nuts and adaptors and the outer coverings are of metal braided sheath construction.

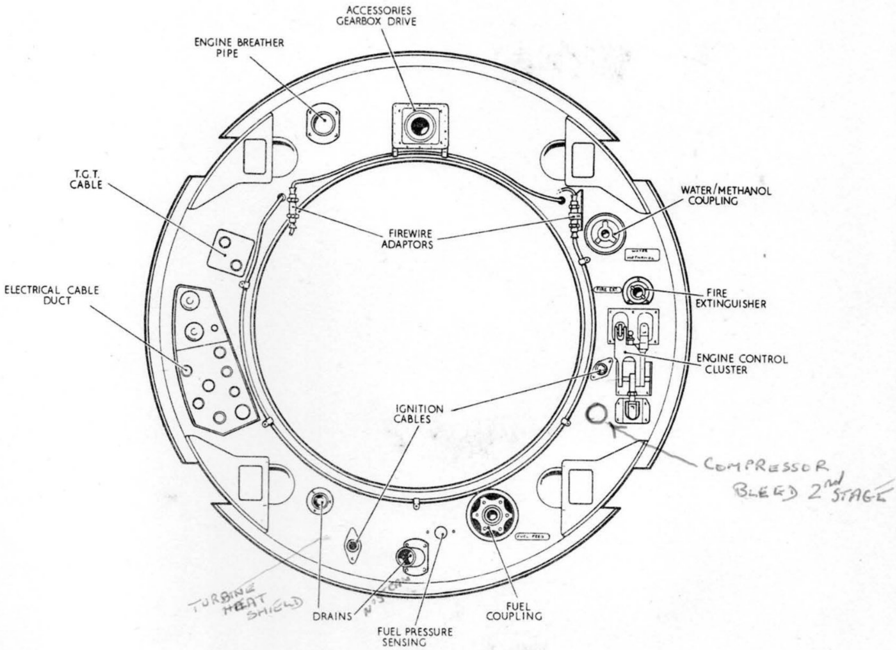
One pipeline is led from the engine main drain valve mounted on No.5 combustion chamber, the connection being made at the drain valve casing by a flanged coupling.

The other pipeline leads from the turbine heat shield drain directly into the collector box located at the exhaust unit, with both pipelines passing through the firewall.

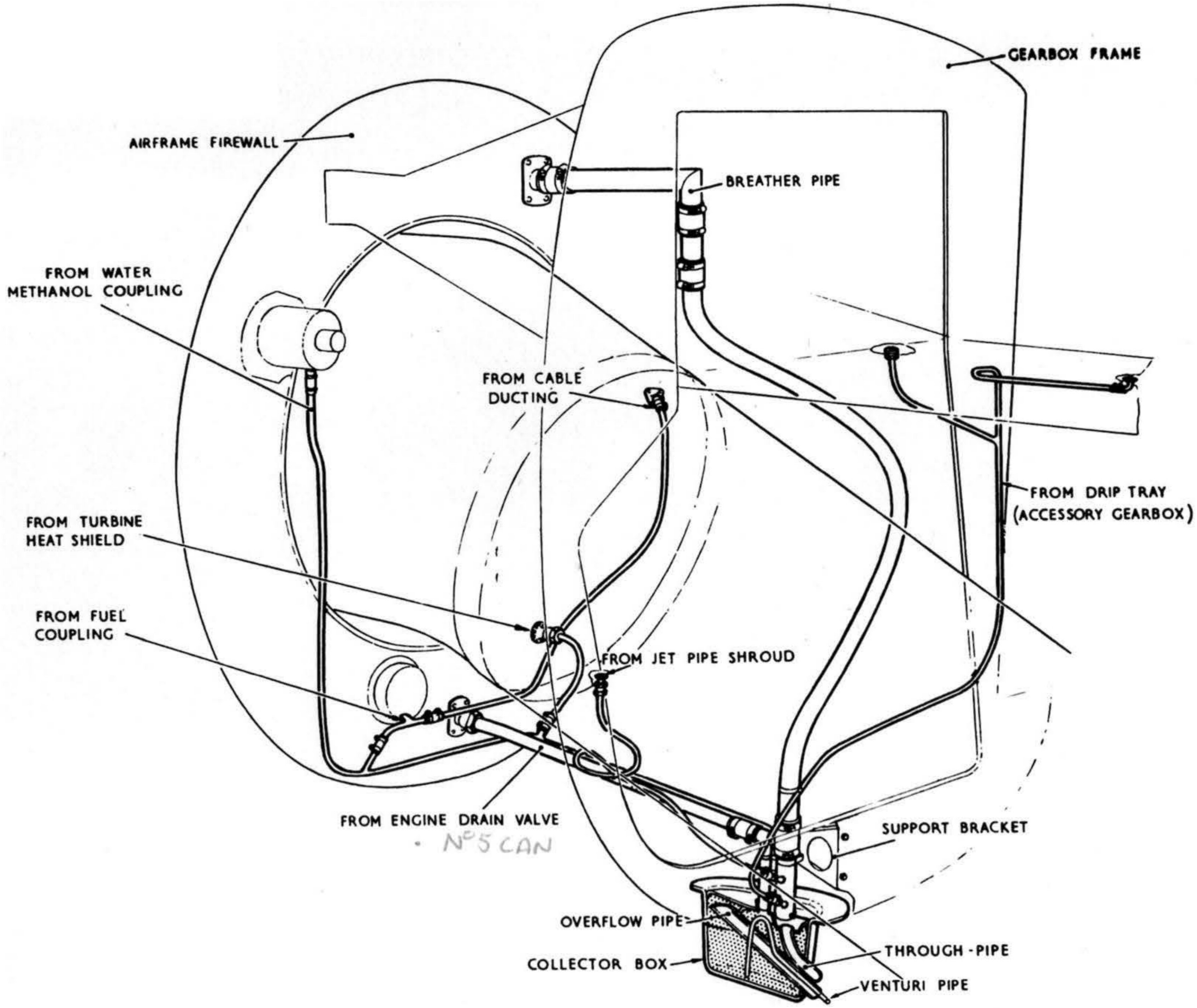
10. Graviner Firewire

The firewire installation is built up of six lengths of firewire, a Unit Detector and a secondary length. The layout commencing at the Airframe firewall is routed around the combustion bay with the Unit Detector fitted to the engine breather elbow, and is so designed as to cover all areas where an overheat condition is likely to occur before leading back to a further bulkhead connector on the airframe firewall.

All intermediate and bulkhead connectors are tightened down to a predetermined torque loading of 80 - 100 lbs/ins. A new sealing washer (Part No. D.2004) must be used at bulkhead or intermediate connectors when any connection has been dismantled.



Airframe firewall connections



No 5 CAN

Collector box drainage system

POWER PLANT REMOVAL & INSTALLATION PROCEDURE

A. Removal Sequence

CAUTION: Ensure that ground electrical supply is not connected to the aircraft, and that the Battery Isolation switch is selected to 'GROUND' before commencing removal.

(1) Disconnect the propeller de-ice and feather control breeze plugs at the propeller hub.

(2) Remove propeller and fit protective sleeve and cap nut to the engine propeller shaft.

(3) Open petal cowlings to 45°; lift and withdraw each panel assembly from hook hinges. Stow cowlings well clear of work area.

(4) Bind free end of main telescopic stays to lower engine mounting struts.

NOTE. Operations 5 to 16, which follow, refer to connections at the airframe firewall.

(5) Disconnect breeze plugs and heavy duty electrical cables housed in steel ducting. For access to cables, remove access panel (3 Dzus fasteners) and undo base plate.

(6) Disconnect both Firewire connections.

(7) Disconnect T.G.T. cable breeze plug.

WARNING: THE VAPOUR GIVEN OFF BY METHANOL IS TOXIC. HANDLING OR STORAGE SHOULD NOT BE CARRIED OUT UNDER CONDITIONS OF POOR VENTILATION. WATER/METHANOL MIXTURE IS CORROSIVE AND ANY SPILT LIQUID SHOULD BE IMMEDIATELY WIPED FROM THE AFFECTED AREAS.

(8) Remove shrouds and uncouple fuel and Water/Methanol connections.

(9) Disconnect fuel pressure sensing pipe.

(10) Disconnect fire extinguisher pipe at firewall adaptor.

(11) Disconnect the two fuel drain pipe unions.

(12) Slacken engine breather pipe hose clips and slide off hose forward.

(13) Pre-set engine controls and disconnect H.P. Cock fuel trim and throttle control rods from engine control cluster lever.

(14) Remove 4 bolts from aft accessories gearbox drive coupling.

WARNING: THE ELECTRICAL ENERGY WHICH MAY BE STORED IN THE CONDENSERS OF THE H.E. IGNITION UNIT IS POTENTIALLY LETHAL. IT IS ESSENTIAL THEREFORE, TO DISCONNECT THE L.T. SUPPLY AND WAIT FOR AT LEAST 1 MINUTE TO PERMIT THE STORED ENERGY TO DISSIPATE, BEFORE HANDLING THE UNIT OR ITS CASE.

(15) Remove the power plant mounting pins at airframe firewall as follows:

(a) Remove locking wire from cap nut.

(b) Unscrew cap nut from outer collar of both lower attachment points.

(c) Withdraw expanding bush and taper plug assembly from both lower attachments.

(d) Repeat items (1) to (3) above for both upper attachment points.

(16) Move the power plant forward to clear the exhaust unit from airframe firewall.

(17) Lift power plant clear of aircraft and lower into engine stand.

B. Installation of Power Plant

CAUTION: Before commencing installation, ensure that ground electrical supply is not connected and battery isolating switch is set to 'GROUND'.

(1) Fit engine sling adjusted for hoisting without propeller.

(2) Remove power plant from stand.

(3) Hoist power plant and centralize exhaust unit in nacelle jet pipe.

(4) Ease power plant rearwards, to engage mounting frame end fittings in attachment housings.

(5) Connect Water/Methanol coupling.

(6) Locate fuel coupling and fire extinguisher pipes and start threads.

(7) Insert bolts in gearbox driver coupling.

(8) Align mounting frame end fittings in attachment housings.

(9) Fit attachment pins as follows :-

(A) Apply anti-scuff paste (DTD. 5530) to expanding bushes.

NOTE: Apply paste thinly and rub well in. Remove surplus paste.

(B) Insert expanding bush and taper plug assembly in both upper housings. Ensure bushes are fully collapsed and are pushed right home.

NOTE: Bushes can be pushed home by inserting a thin rod through holes in cap nut and pressing on end of bush.

(C) Screw cap nut on to outer collars of housings.

(D) Repeat (B) and (C) above for both lower mounting pins.

(E) Tighten all cap nuts to torque loading of 120 lbs/ft.

(F) Wire lock all cap nuts.

(10) Remove engine sling.

(11) Connect and lock the following at airframe firewall

(1) Fire extinguishing pipe.

(2) Fuel sensing pipe.

(3) Turbine heat shield drain pipe.

(4) Engine drains valve drain pipe.

(5) Engine breather pipe hose.

(12) Complete accessories gearbox drive coupling.

(13) Secure bottom hinged access cover at rear of fireproof duct to aft firewall attachment (Dzus fasteners).

(14) Insert and tighten breeze plug connections at the airframe firewall.

(15) Connect starter and feather pump cables to terminal studs.

(16) Connect up T.G.T. thermocouple cables.

(17) Fit electrical connection access cover to duct at airframe firewall. (Dzus fasteners).

(18) Connect firewire to both unions and torque lead to 80/100 lbs/ins.

(19) Connect ignition cables to airframe firewall connections.

(20) Connect Throttle, H.P. Cock and Fuel Trim control rods at firewall.

(21) Fully connect fuel coupling, bleed system and check for leaks.

<u>WARNING:</u> THE VAPOUR GIVEN OFF BY METHANOL IS TOXIC. HANDLING OR STORAGE SHOULD NOT BE CARRIED OUT UNDER CONDITIONS OF POOR VENTILATION. WATER/METHANOL MIXTURE IS CORROSIVE AND ANY SPILT LIQUID SHOULD BE IMMEDIATELY WIPED FROM AFFECTED AREAS.

(22) Check for Water/Methanol leaks at coupling.

(23) Fit protective shield at Water/Methanol coupling.

<u>CAUTION:</u> If locking plug on shroud clamp does not align with hole in coupling, loosen 6 bolts in slots of shroud at rear of firewall, and turn coupling complete. Do not move coupling from fully locked position.

(24) Fit propeller.

(25) Connect propeller de-icing and feathering control breeze plugs at propeller hub.

(26) Attach petal cowling panel assemblies and connect main panel telescopic stays.

(27) Close petal cowlings and check position of fuel heater exhaust pipe at bottom cowling.

(28) Check engine oil level.

(29) Complete normal engine checks before ground running engines.

EXHAUST SYSTEM

1. General

The exhaust system consists of a jet pipe enclosed in a shroud and projecting through an opening in the nacelle rear fairing. A set of four thermal insulation blankets is interposed between each jet pipe and its associated shroud.

The forward jet pipe shroud receives the engine exhaust unit cone and is bolted to the rear face of the airframe firewall. There is no attachment between the engine exhaust unit cone and the shroud.

The main jet pipe shroud is secured to the forward jet pipe shroud by an upper and lower cover strap which clamps both units together.

Two attachment links with flexible type mountings, are fitted to the upper surface of the jet pipe shroud and support the jet pipe and shroud assembly. The upper ends of the shackles are attached to wing ribs No.6 and 7, immediately aft of the front spar, in the case of the outboard nacelles and to brackets on the front spar bulkhead in the inboard nacelles. The design of these shackles in such as to permit linear movement of the jet pipe, due to expansion and contraction, within the shroud.

An actuator operated port is incorporated in each inboard jet pipe assembly for the purpose of directing exhaust gases through a heat exchanger to provide warm air for thermal de-icing when required.

2. Jet Pipe

The jet pipe is manufactured of heat resisting stainless steel. A former is welded around the pipe in approximately the mid position and carries a support strop centralizer. The former ring locates the jet pipe support strop. Three dogs spaced around the flange at the belled out front end, engage with three keep plates attached to the front cone. This locates the forward end of the jet pipes when installed, and prevents it from rotating.

3. Thermal Insulation Blanket

The insulating blanket consists of a lightweight fibrous silica insulating material sandwiched between inner and outer skins of stainless steel foil, the edges of which are seam welded to prevent ingress of fuel, oil, etc. The foil covering is dimpled to provide additional strength, and breather holes are incorporated to compensate for pressure differentials.

Each blanket forms a close fit to the contour of the jet pipe. Welded to the foil skin are attachment strips which provide means of securing the blanket by wire lacing.

4. Jet Pipe Shrouds

The jet pipe shrouds are manufactured light alloy and are made up in sections, with the inboard assembly consisting of three parts and outboard in two parts.

A. Inboard Shroud Assembly

The front portion of the shroud is cone shaped to receive the engine exhaust cone. A flange is bolted to its forward end to provide a means of attachment to the rear face of the airframe firewall.

B. Outboard Shroud Assembly

The outboard shroud assembly consists of two sections similar to that of the inboard exhaust system, with a front cone and a rear portion which has cut-outs for the support shackles and strop, but no provision for a hot air scoop assembly.

5. Removal/Installation

A. Removal of Inboard Exhaust Unit

(1) Remove the upper cowl panel 2A, side panels Nos. 4 and 5 and also panel Nos. 6, 7 and 8.

(2) Disconnect the heat exchanger hot air scoop operating gear from its pivot shaft.

(3) Disconnect the heat exchanger coupling by removing the pipe clamps.

(4) Remove the drain pipeline from the bottom of the front cover.

(5) Remove the four $\frac{1}{4}$ inch B.S.F. stiffnuts securing the two halves of the front cover and remove the cover.

(6) Remove the three keep plates.

(7) Support the exhaust assembly and remove the pins from the upper end of the support shackles.

(8) Lower the exhaust assembly, remove the 46 bolts at the rear face of the airframe firewall and withdraw the exhaust cone shroud.

B. Fitting of Inboard Exhaust Unit

(1) Fit the exhaust cone shroud to rear face of the airframe firewall and secure with 46 bolts.

(2) Lift the exhaust assembly into position and engage the upper ends of both support shackles with the fork ends of the attachment brackets on the front spar bulkhead.

(3) Insert the pins through the shackles and secure with split pins.

(4) Fit the three keep plates.

(5) Assemble the upper and lower front cover straps and secure with four $\frac{1}{4}$ inch B.S.F. nuts.

(6) Connect the drain pipeline to the bottom cover strap.

(7) Assemble the pipe clamp to the heat exchanger coupling.

(8) Connect up the heat exchanger hot air scoop operating gear to the pivot shaft.

(9) Replace all cowling panels and fairing strips.

C. Removal of Outboard Exhaust Unit (see also diagram 71)

(1) Remove forward and aft side cowling panels.

(2) Remove inboard side panel and lower forward cowling panel.

(3) Remove jet pipe aperture fairing strip.

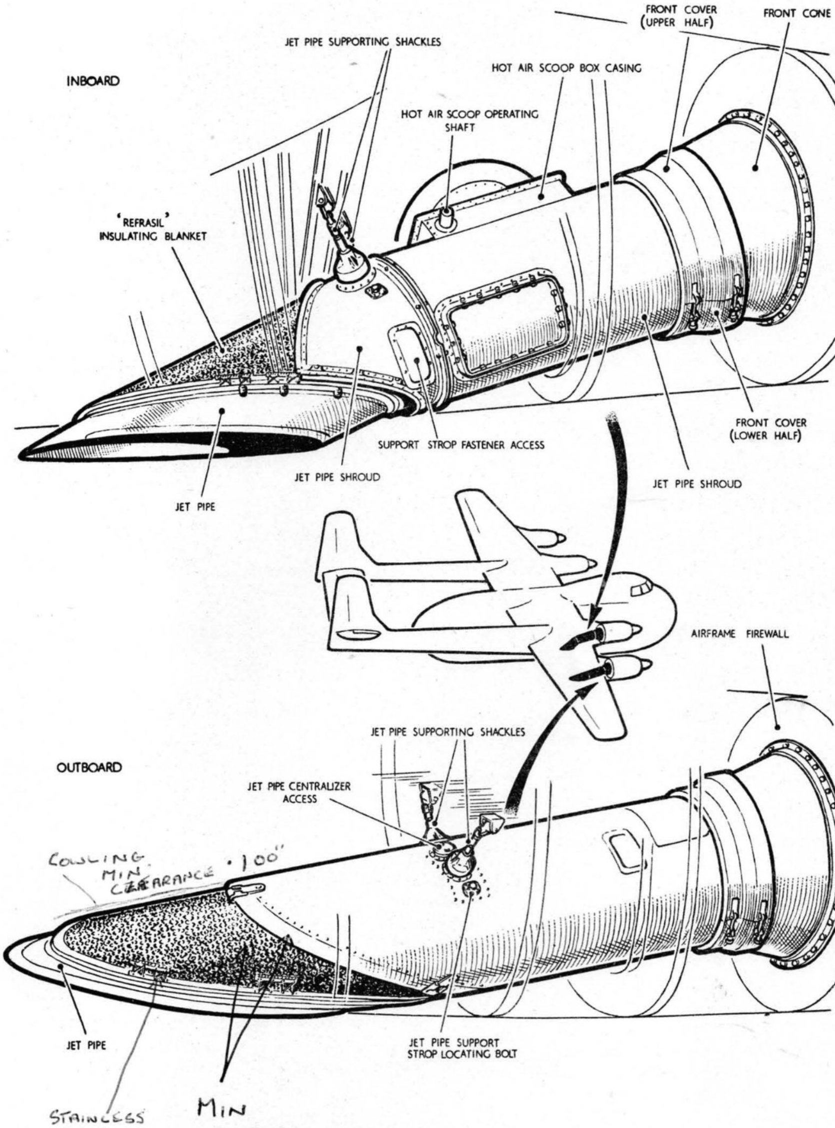
(4) Remove rear cowl panels and bottom rear panel.

(5) Remove front spar bulkhead lower member.

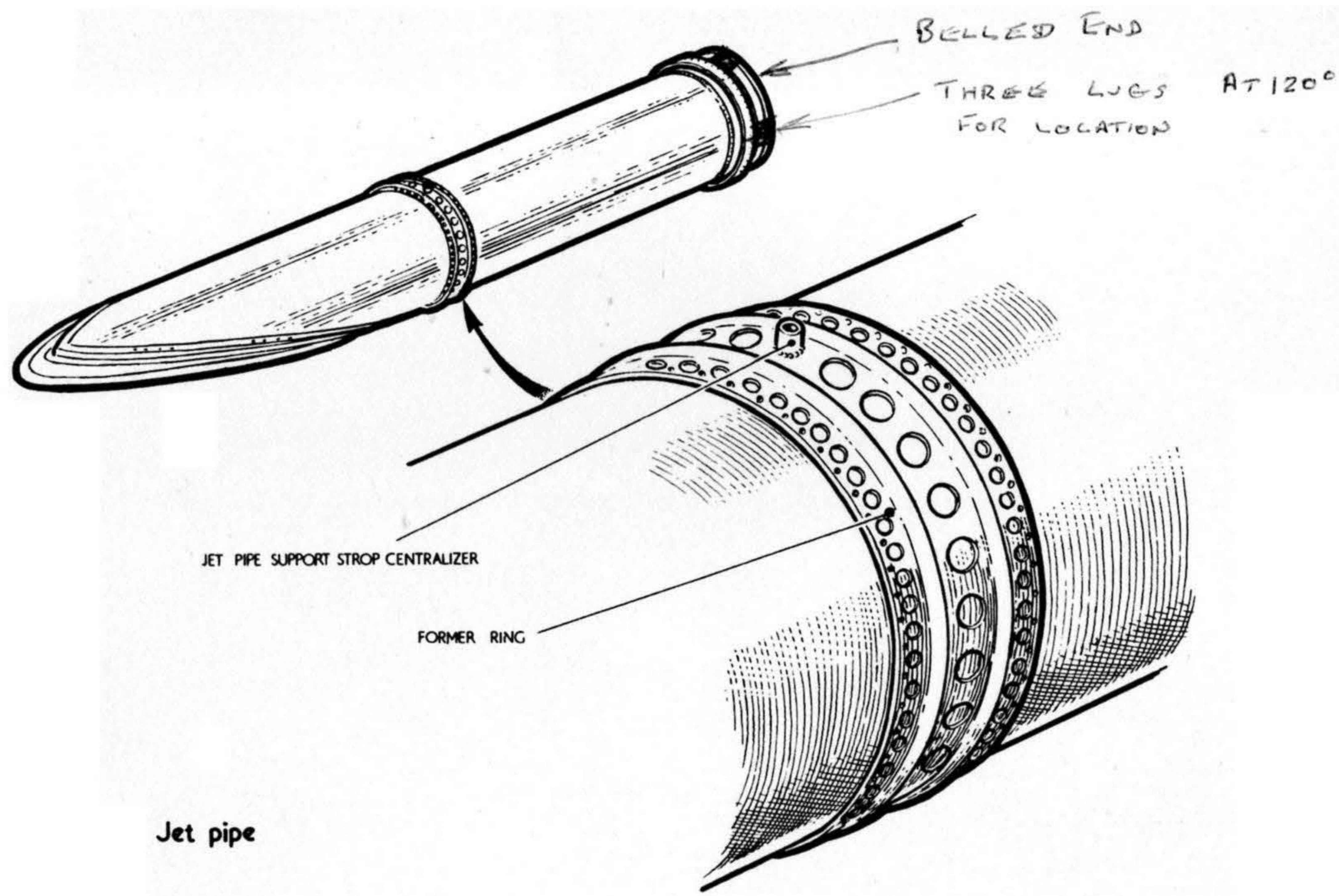
(6) Proceed as for inboard exhaust system removal commencing at item No.4 and deleting items (7) and (8).

D. Fitting of Outboard Exhaust Unit

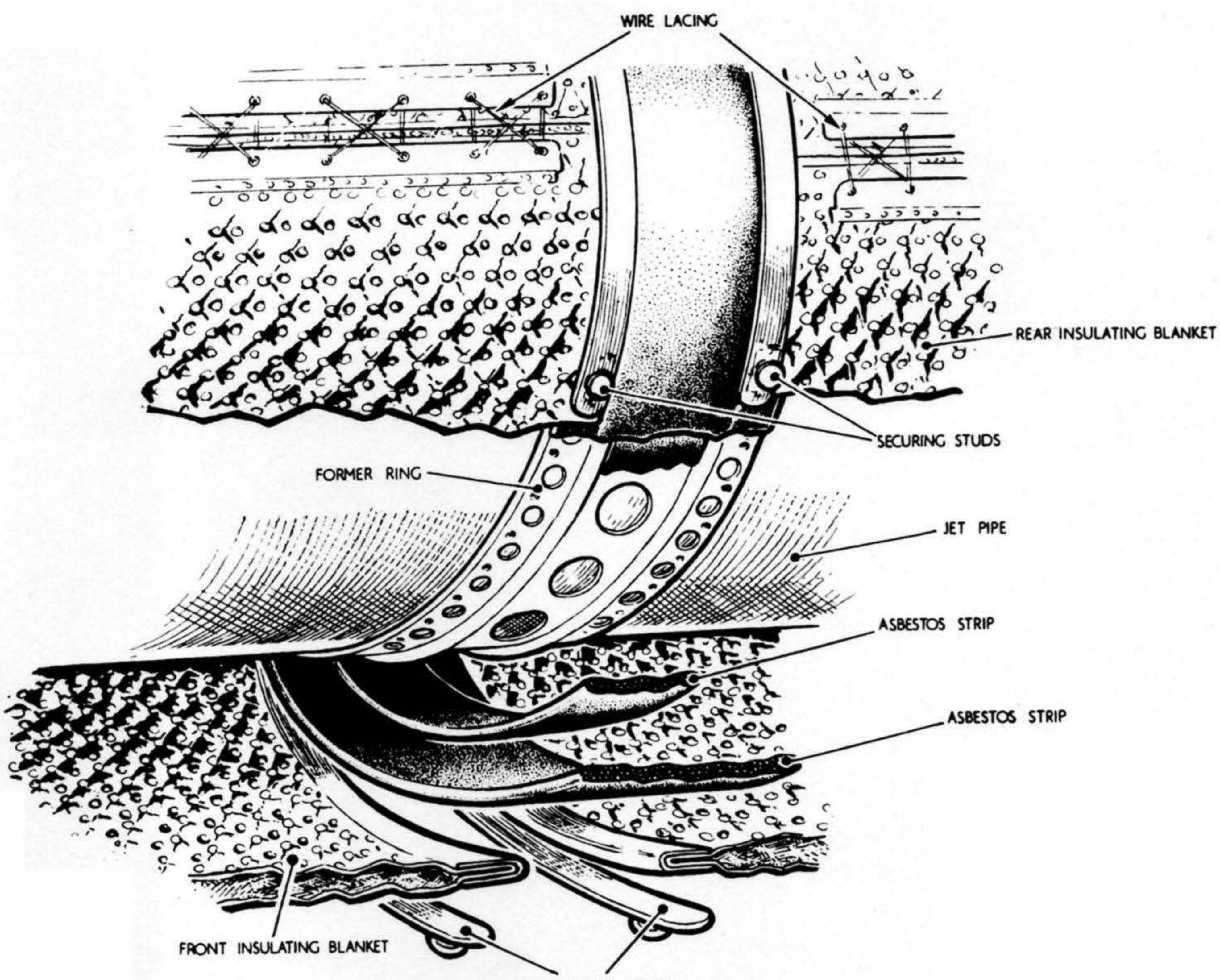
Proceed as for Fitting of Inboard Exhaust unit with the exception of items (7) and (8).



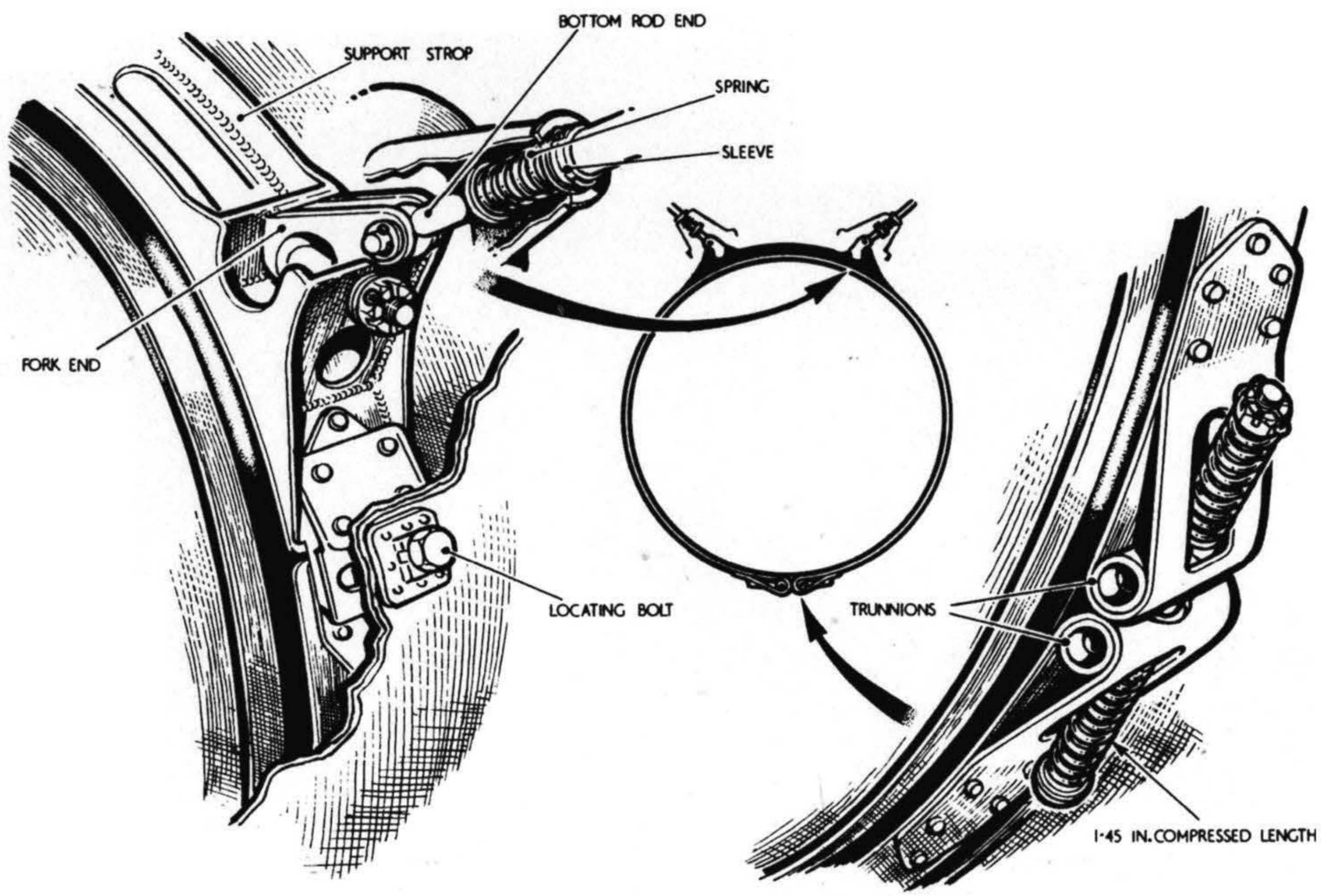
Exhaust system


BELLED END
THREE LUGS AT 120°
FOR LOCATION
JET PIPE SUPPORT STROP CENTRALIZER
FORMER RING

Jet pipe



Installation - insulating blanket to jet pipe



Jet pipe and shroud support

ACCESSORIES GEARBOX AND ACCESSORY DRIVE

TYPE :

1. Function

The accessories gearbox provides a mounting base for the various aircraft accessories, and transmits the engine power necessary to drive them, through the medium of a gearbox drive, quills and gearing.

2. General

✱ One gearbox with its associated drive is fitted to each engine and located in a compartment aft of the airframe firewall. The four gearboxes and basically similar with minor differences between the gearboxes fitted to the inboard installations and those fitted to the outboard installations. The suffix letter A or B added to the type number denotes whether for outboard or inboard installations respectively. The four gearbox drives are of identical type.

3. Accessories

The accessories driven by the gearboxes are namely :

A. Rotol synchroniser alternator

B. Lockheed hydraulic pump (No. 1, 2, & 3 gearboxes only).

C. Rotax 9 K.W. Generator

D. Godfrey Supercharger Type 15, Mk.9 (No. 1, 2 & 4 gearboxes only).

E. Tachometer Generator

F. Rotax $22\frac{1}{2}$ KVA alternator

4. Accessory Mounting Faces

The mounting faces on the gearbox are lettered for identification purposes together with the accessory for which each has been designed.

Gearbox Face	Accessory
A	Rotol Synchroniser Alternator
B	Lockheed Hydraulic Pump
C	Rotax Generator
D	Godfrey Blower
E	Tachometer Generator
F	Rotax Alternator

5. Gearbox

Each gearbox assembly consists of a light alloy main casing and cover, housing trains of spur gears and drives to operate the various accessories. The final drive to each accessory is provided by a quill incorporating a safety shear neck which protects the gearbox from damage in the event of seizure or failure of accessory. Lubrication is effected by a submerged gear type oil pump, to provide pressure oil for the gearbox mechanism and to supply the Godfrey Supercharger where this component is fitted.

Filling is carried out through a filler located near the top of the front cover, and provision is made for checking oil level by means of a graduated dip stick.

A centrifugal breather system allows satisfactory breathing of the gearbox under all conditions of flight.

6. Gearbox Drives

The gearbox drives are the double universal joint type. Universal joints are fitted to compensate for minor errors in alignment between engine and gearbox, while axial movement is allowed for by a serrated joint fork which is free to slide in a serrated shaft. The complete drive assembly is dynamically balanced to ensure vibration free running.

7. Mounting Attachments

The port and starboard sidewalls of the gearbox main casing each contain a pair of rectangular shaped machined faces which are provided with three blind holes. The two outer holes of each face are tapped to receive mounting bolts which secure the aircraft mounting brackets to the main casing.

8. Removal/Installation

A. Removal of Gearbox

(1) Disconnect and remove detachable portion of anti-icing air duct at rear of gearbox.

(2) Disconnect cabin seal system pipe at inside wall of gearbox tray and at blower outlet pipe; remove cabin seal pipe (Not No.3 Gearbox).

(3) Disconnect 4 Breeze plugs at tray outer wall.

(4) Disconnect all electrical cables at the following :-

(a) D.C. Generator

(b) Synchroniser Alternator

(c) Tachometer Generator

(d) Main Alternator

(5) Disconnect heavy electrical cables from terminals at tray walls - one each side of gearbox.

(6) Remove all clips and brackets attaching electrical cables to gearbox and tray walls.

(7) Disconnect air duct drains at bottom of tray.

(8) Disconnect all air ducts at D.C. generators and main alternator.

(9) Remove bolts attaching air duct junction pieces to inner and outer walls of tray.

(10) Remove air ducts and junction pieces.

(11) Removal all disconnected electrical cables.

(12) Disconnect two hydraulic pipes at the hydraulic pump (not No.4 gearbox).

(13) Remove main alternator and quill drive.

(14) Remove tachometer generator and quill drive.

(15) Remove bolts securing blower inlet to blower. (Not No.3 gearbox).

(16) Disconnect blower outlet trunk from blower outlet pipe by loosening jubilee clips and sliding the hose connection. (Not No.3 gearbox).

(17) Remove detachable top portion of frame fitted over gearbox drive shaft housing.

(18) Remove bolts securing the support and liner assembly to the airframe firewall.

(19) Disconnect the gearbox coupling flange at airframe firewall.

(20) Fit sling and take weight off gearbox.

(21) Remove nuts securing gearbox bearer caps to the airframe.

(22) Lift gearbox from the aircraft.

<u>NOTE</u> : When lifting the gearbox keep the drive end pressed down and raise rear end of gearbox slightly. Ease gearbox to the rear until the drive is clear for lifting.

(23) Refit alternator drive quill and alternator.

(24) Refit tachometer drive quill and tachometer generator.

(25) Protect gearbox against corrosion and damage.

B. <u>Installing Gearbox</u>

(1) Remove all protective blanks etc.

(2) Ensure mounting brackets are correctly secured to the side walls of the gearbox main casing and that bolts are wire-locked.

(3) Remove the tachometer generator and main alternator with their quill drives.

(4) Fit sling and lift gearbox into position for lowering into the nacelle.

(5) Lower gearbox with front end depressed and enter coupling flange into position at the airframe firewall.

(6) Ease the gearbox forward and lower the bearer into position in the aircraft.

(7) Secure the bearers with caps and split-pinned nuts.

(8) Remove sling.

(9) Connect gearbox drive forward of firewall.

(10) Bolt the support and liner assembly to the airframe firewall.

<u>NOTE</u> : Fit shins between assembly and firewall to ensure front edge coincides with the front face of the gearbox drive bearing housing at the front face of the firewall.

(11) Fit tab portion of frame over gearbox drive shaft housing.

(12) Bolt blower inlet to blower.

(13) Fit tachometer generator drive quill and tachometer generator.

(14) Fit alternator drive quill and alternator.

<u>NOTE</u> : To ensure correct seating, tighten and slacken the attachment ring nut three times; tightening to 100 lb/in. each time. Finally tighten to torque loading of 100 lb/in. and lock with serrated locking sleeve.

(15) Connect blower outlet trunk to blower outlet pipe. (Not No.3 Gearbox).

(16) Fit cabin sealing system pipe between blower outlet pipe and union on inside wall of gearbox tray. (Not No.3 gearbox).

(17) Fit two hydraulic pipes between pump and the union on tray wall. (Not No.4 gearbox).

(18) Lay the electrical cables in their approximate positions and connect them to the appropriate terminals at the D.C. generator, synchroniser alternator, tachometer generator and main alternator.

(19) Connect 4 Breeze plugs at the tray wall.

(20) Connect two heavy electrical cables to terminals on tray walls - one each side of gearbox.

(21) Position air ducts and junction pieces; connect ducts loosely to alternator and generator.

(22) Bolt junction pieces to tray walls.

(23) Connect air duct drains at bottom of tray.

(24) Fit securing clips and brackets to all pipes and electrical cables.

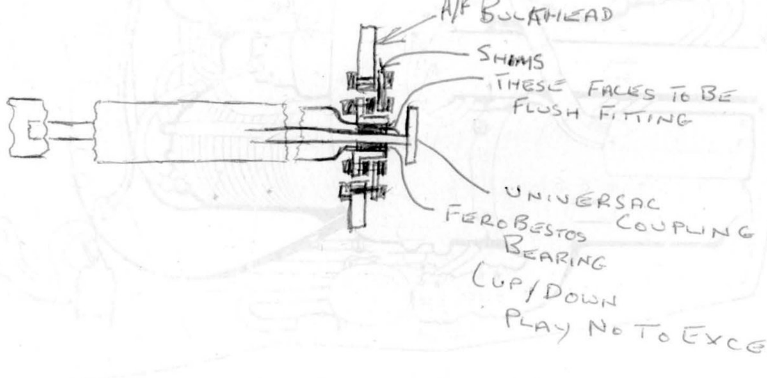
(25) Tighten all air duct connections.

(26) Check all electrical cables for correct routeing and security.

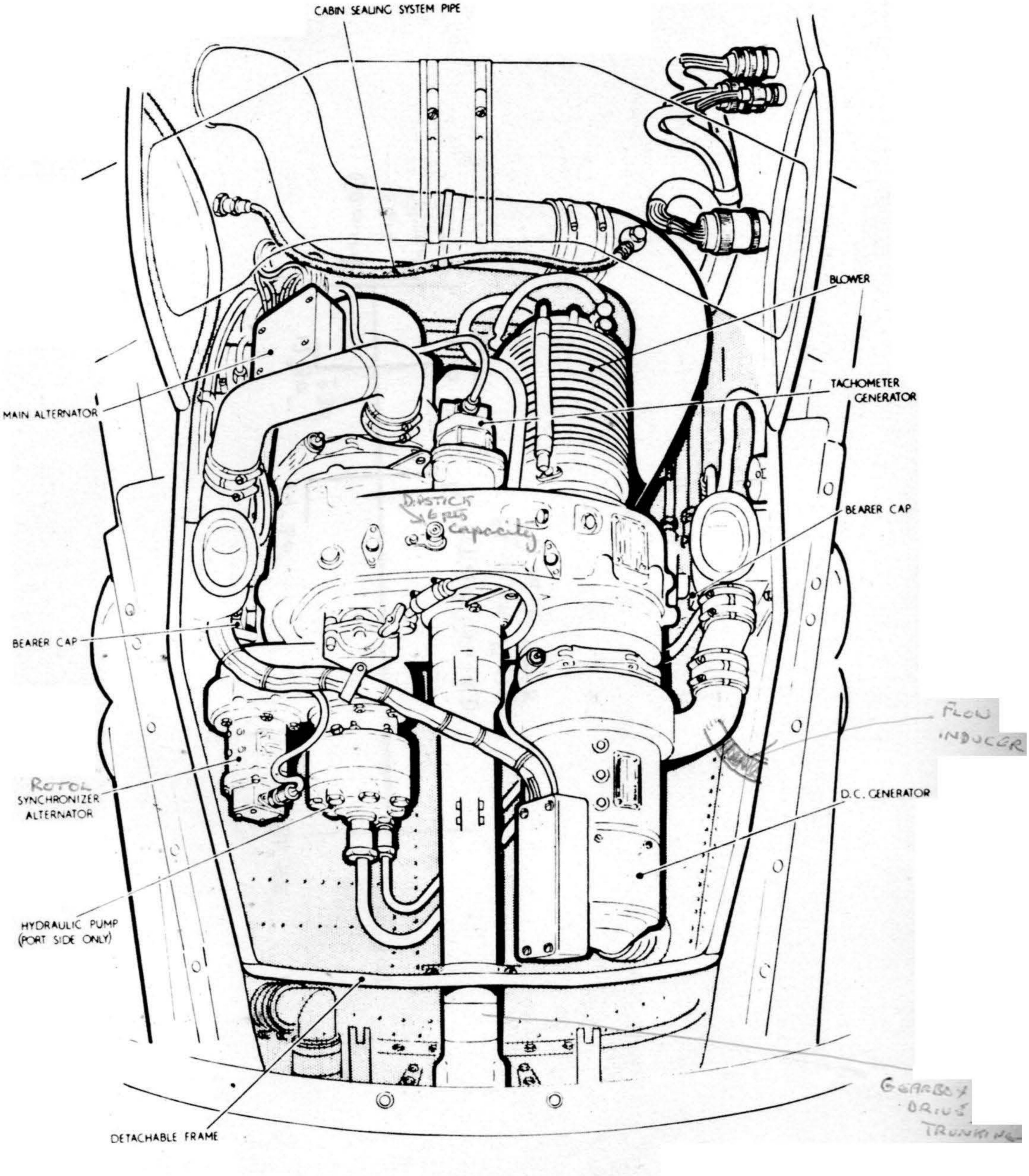
(27) Check all pipe lines for correct connection and security.

(28) Fit detachable portion of anti-icing air duct at rear of gearbox.

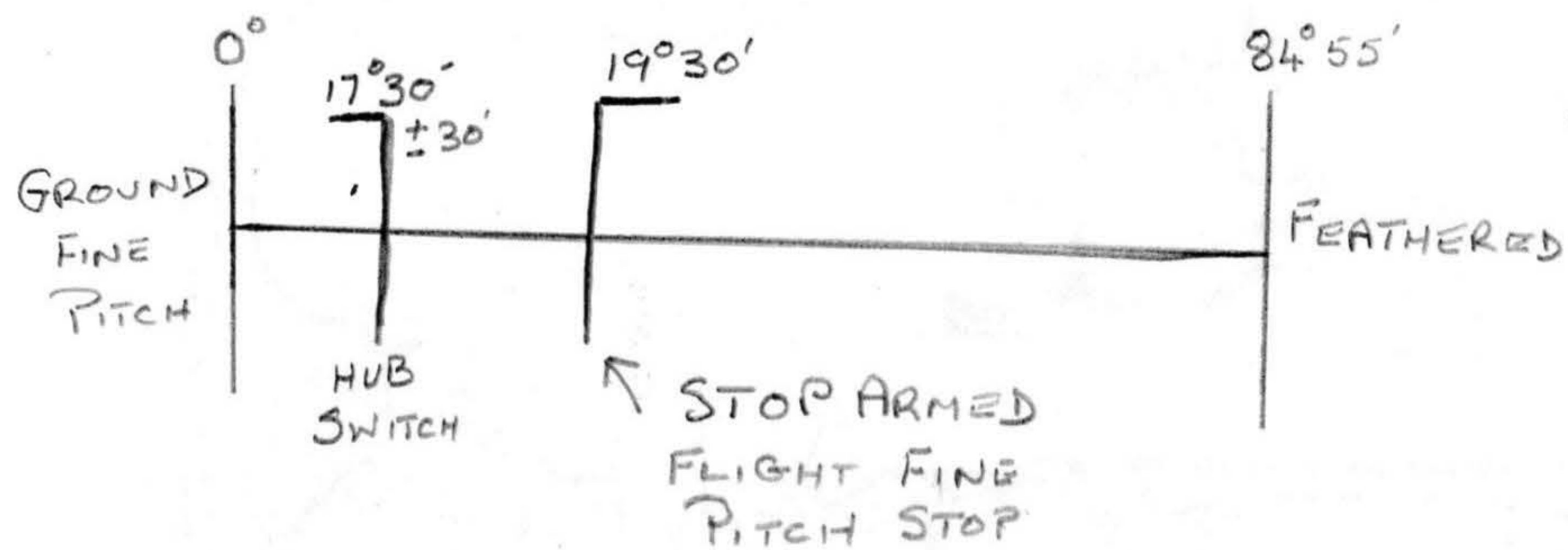
(29) Check level of oil in gearbox.



A/F BULKHEAD
SHIMS
THESE FACES TO BE FLUSH FITTING
UNIVERSAL COUPLING
FEROBESTOS BEARING
(UP/DOWN PLAY NO TO EXCEED .030")



Outboard accessories gearbox installation



0°
17°30'
±30'
19°30'
84°55'
GROUND
FINE
PITCH
FEATHERED
HUB
SWITCH
STOP ARMED
FLIGHT FINE
PITCH STOP

PROPELLER AND CONTROL UNIT

1. General

The propeller and its associated equipment consists of a four bladed, spinner enclosed propeller whose pitch changing mechanism is operated by a controller unit and a feathering pump unit, both of which are mounted on the engine.

2. Construction

A. Propeller

Type	R 207
R	Rotol manufacture
	Rotol aircraft identification
/4----/	No. of blades
/--30--/	Blade root size
/----4/	Engine shaft size 4/21
	Issue number of propeller type (Mod. standard)

B. Propeller Control Unit CU/96

Type	
CU	Controller Unit
	Issue number of unit type (Mod. standard)

This unit is mounted on, and driven by, the engine, and receives its oil supply from the engine lubrication system, at a pressure constant of 70 p.s.i. Its purpose is to control the propeller blade pitch to absorb the engine power output at a selected constant r.p.m.

3. Propeller Operating Range

When starting, the propeller pitch angle is 0°. As the power output increases, the propeller gradually coarsens pitch until a servo piston (Lock Servo Piston) is forced forward past a spring collet to a position on the barrel determined by the power output. (At Take-Off the piston will be past the spring collet i.e. Flight Fine Pitch - 19° 30').

On landing, the blades move to take up the Flight Fine Pitch position automatically, and the angle of 19° 30' is maintained until the aircraft has landed. Movement of the Fine Pitch lever rearwards to the "Stop Removed" position hydraulically withdraws the collet and allows the blade angle to reduce below the F.F.P. angle providing a discing action and facilitating braking.

Blade Angles

Ground Fine Pitch to Flight Fine Pitch 0° - 19° 30'	Take-Off Angle :- 22°
Flight Fine Pitch to Feather 19° 30' - 84° 55'	Cruise Angle :- 48°

PROPELLER INSTALLATION & REMOVAL

1. The propeller blades are to be at FEATHER for installation and removal operations.

A. Pre-Installation Checks

(1) Secure the de-icing brush housing to the engine nose section.

(2) Dress the slip rings with french chalk.

(3) Fit the rear cone to the engine shaft.

(4) Lightly smear the rear cone seating of the hub with marking blue.

(5) With the blades at FEATHER and the Rotol propeller sling attached, mount the propeller.

(6) Fit the front cone and hub retaining nut and tighten to the recommended torque figure (1,000 lbs/ft.)

(7) Using blade sticks on two opposite blades turn the blades to Ground Fine Pitch.

(8) Rotate the propeller one complete revolution.

(9) Return the blades to FEATHER and remove the propeller.

(10) Check the cone contact area and the slip rings for brush track.

(11) Clean the marking from the hub seating and cone face and remove the french chalk from the slip rings.

NOTE :

1. RENEW CONE IF UNSERVICEABLE (minimum cone contact area - 80% with marking evenly distributed).

2. RENEW SWITCH IF INCORRECT TRACK - (The hub switch must track evenly with the sling ring centres).

B. Installation (Final)

(1) As the de-icing brush housing is already installed, connect the de-icing and hub switch wiring (breeze connectors).

NOTE : If already fitted, the de-icing brush block assembly must be removed.

(2) Lubricate the whole of the exposed engine shaft with clean engine oil (DERD.2487).

(3) Lightly smear the contact area of the rear cone with grease DTD.825.

(4) Fit the rear cone to the shaft.

(5) Install the shaft oil seal assembly and fit the loading sleeve into the hub bore, with the chamfered edge towards the front of the propeller (lubricate seal with clean engine oil).

(6) Lubricate the threads of the oil tubes with clean engine oil and install the oil tubes.

(a) Fit the outer oil tube and tighten (R.H. thread) to a torque loading of 20 lbs/ft.

(b) Fit the inner oil tube and tighten (L.H. thread) to a torque figure of 20 lbs/ft.

(c) Fit the locking segment and circlip.

(7) Attach the lifting sling and with the blades at FEATHER mount the propeller on the shaft.

(8) Lightly smear the contact face of the front cone with DTD.825 and fit the front cone & hub retaining nut. Tighten (R.H. thread) to a torque valve of 1,000 lbs/ft.

* (9) Lubricate the lock seals of the lock unit and the cylinder barrel threads with clean engine oil. Install the lock unit and check for engagement with the hub retaining nut before spannering the lock unit retaining nut (L.H. thread).
Torque Figure for lock unit retaining nut - 210/230 lbs/ft.

(10) Fit lock unit locking plate and circlip.

(11) Fit the de-icing brush block assembly using the tool provided.

(12) Fit the inspection panel to the spinner back plate and secure.

(13) Before fitting the spinner shell put the blades to Ground Fine Pitch, start and run the engine and prime the propeller hydraulic system.

(14) Stop engine and check for signs of oil leakage.

C. To Put Blades to Ground Fine Pitch (Engines not running)

(1) F.P.S. lever to "Stop Removed".

(2) Check warning lamps showing "Stop Removed" ON.

(3) H.P. Fuel Cock lever OPEN.

(4) Throttle CLOSED.

(5) Close the feathering pump motor switch until the blades arrive at Ground Fine Pitch. The warning lamps showing blades below Flight Fine Pitch remain ON.

D. To Prime Propeller Hydraulic System

(1) With the engine running and the blades at Ground Fine Pitch, exercise the throttle to cause the propeller to increase and decrease pitch.

<u>NOTE</u> : The throttle must be open to select an R.P.M. within the governing range; at least up to 12,000 R.P.M.

E. Fitting the Spinner Shell

(1) The propeller blades are to be at COARSE pitch.

(2) Check that all locks are at 'UNLOCKED'.

(3) Apply grease DTD.825 to the lock pegs and drive pegs of the back plate.

(4) Dress the shell rubber loading ring with french chalk.

(5) Offer up the shell with the index arrows in alignment.

(6) To lock the shell, turn all locks to half lock, and then to 'LOCKED'.

NOTE : To move the blades from Ground Fine Pitch to Coarse Pitch :-

(a) Put H.P. Cock to FEATHER.

(b) Close feathering switch until the warning lamp "blades below Flight Fine Pitch" goes out.

2. Propeller Removal

A. With the blades at COARSE PITCH, unlock and remove the spinner shell.

To unlock the shell, first turn all locks to half-unlock and then to UNLOCKED.

NOTE : The locks can be damaged if the operator attempts to turn the locks direct to unlock.

B. Put the blades to FEATHER.

C. Remove the inspection panel from the spinner backplate and remove the de-icing brush block assembly.

D. Remove the bleed screw from the cylinder barrel.

E. Remove the circlip and lockplate from the lock unit, unscrew (L.H. thread) and withdraw the lock unit.

F. Slacken off the hub retaining nut.

G. Attach the lifting sling and remove the hub retaining nut and front cone, and withdraw the propeller from the engine shaft.

H. Remove the shaft oil seal assembly.

NOTE : The rear cone is an engine component.

I. Remove the circlip and lock segment from the oil tube assembly.

J. Using the lock segment and spanner, unscrew (L.H. thread) and remove INNER oil tube.

K. Using lock segment and spanner, unscrew (R.H. thread) and remove OUTER oil tube.

L. Disconnect the breeze plug contacts from the de-icing brush housing and remove the housing.

PROPELLER GROUND CHECKS AFTER FITTING

1. Auto Feathering Check (engine not running)

   A. Blades at Ground Fine Pitch

   B. Torque switch is CLOSED.

   C. H.P. Fuel Cock OPEN.

   D. F.P.S. lever at Stop Removed.

   E. Move throttle lever to select ~~12,900~~ 14,600 r.p.m. plus.

   The propeller blades will now move to FEATHER. When the blades arrive at FEATHER, move the throttle lever to CLOSE.

2. Check "STOP ARMED"

   Control setting

   A. Blades at FEATHER

   B. F.P.S. lever at Stop Armed.

   C. Torque switch is CLOSED.

   D. H.P. Fuel Cock lever OPEN.

   E. Throttle CLOSED.

   F. Close the feathering pump switch.

   The propeller blades will now reduce pitch to 19° 30' and the pitch change operating piston will be riding the lock collet.

   G. Move F.P.S. lever to Stop Removed in order to move the blades to a pitch angle below Flight Fine Pitch for the following checks.

3. Auto Coarsening Check (Hub switch operation)

   A. Move the F.P.S. lever Stop Removed (see preceding operation) and close the feathering pump motor switch until the warning lamp showing "blades below Flight Fine Pitch" is on.

   B. H.P. Cock fuel lever OPEN.

   C. Throttle CLOSED.

   D. Torque Switch is CLOSED.

   E. F.P.S. lever to Stop Armed.

F. Close the feathering pump switch.

NOTE : Due to the operation of the hub switch, the blades will now be moving about an angle of between $17^{\circ}\ 30' \pm 30'$, with the warning lamp showing intermittently ON/OFF.

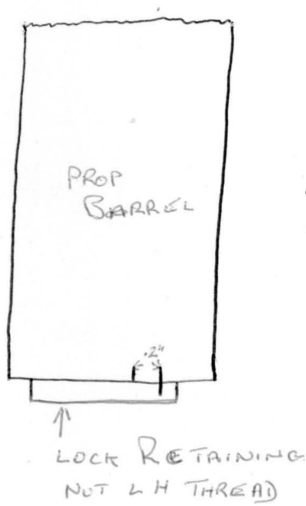
4. <u>Return Blades to Ground Fine Pitch</u>

A. Put the F.P.S. lever to STOP REMOVED.

B. Close the feathering pump switch.

C. Start and run the engine to return the sump oil to the tank.

*



Tightened by hand scribe a line on barrel and locknut and another .2" in direction of rotation and tighten with hammer

ENGINE COWLING PANEL ASSEMBLIES

1. General Description

The cowling assemblies encasing each engine, consist of left and right hand main side panels and top and bottom secondary panels.

When closed, the cowling panels are secured by heavy duty toggle fasteners and around the air intake casing by 'N' type fasteners.

To facilitate servicing, each cowling assembly opens petalwise; the main side panels pivot on hook type hinges on the nacelle structure, and the secondary panels are braced from their respective main panels by a telescopic strut, while each panel assembly is also braced by a telescopic strut extending from a main side panel to the lower strut on each side of the engine mounting frame.

2. Safety Factors

When closed and secured, the cowlings bear on the associated seals around the air intake cowling flange, the engine firewall and the airframe firewall thereby separating the engine into "zones", with the combustion bay between airframe and engine firewall, and the induction bay forward of the engine firewall. Isolation of combustion and induction bays in the event of fire is thus achieved.

All controls and services which are routed through the combustion bay are protected by shrouds or ducting.

A pressure relief door located in the port side cowling panel in the region of the compressor casing in the induction bay, is hinged at the forward end and secured by two shear rivets. Should there be a pressure build up in the induction bay as in the case of a compressor blow out, the rivets shear at a combustion bay pressure of $4\frac{1}{2}$ p.s.i., allowing the door to blow open and relieve the pressure.

3. Airflow and Access Doors

A. Oil Cooler

A scoop located at the top of the air intake cowling draws air through the engine oil cooler matrix, the air being ducted to atmosphere on the top cowling panel.

B. Air Circulation

Air intake ports situated in the cowling panels, allow air circulation of induction and combustion bays. Two intakes are utilised for the induction bay and six for the combustion bay. A gauze protected louvre located in the top cowling panel provides cooling air for the combustion bay.

C. Oil Filler Access Door

A quick release type door in the port side panel gives access to the oil filler cap.

D. Fuel Filter Access Door

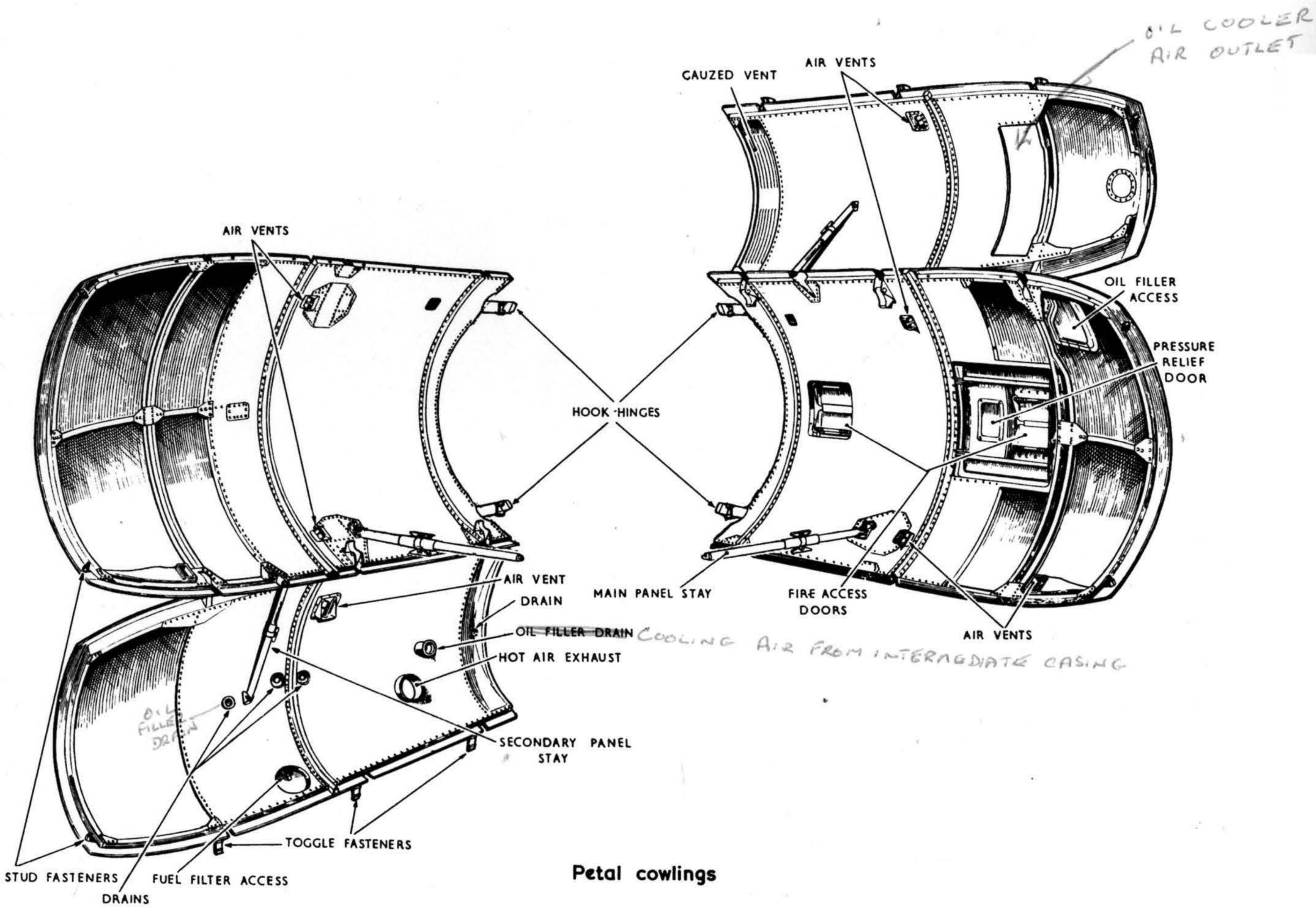
Access to the fuel filter is obtained via a quick release type door in the bottom cowling panel.

E. Cowling Drains

Drain holes located in the bottom cowling panel allow access for oil and fuel spillage into a drainage strake on the underside of the panel where it is allowed a free drain away.

F. Fire Access Doors

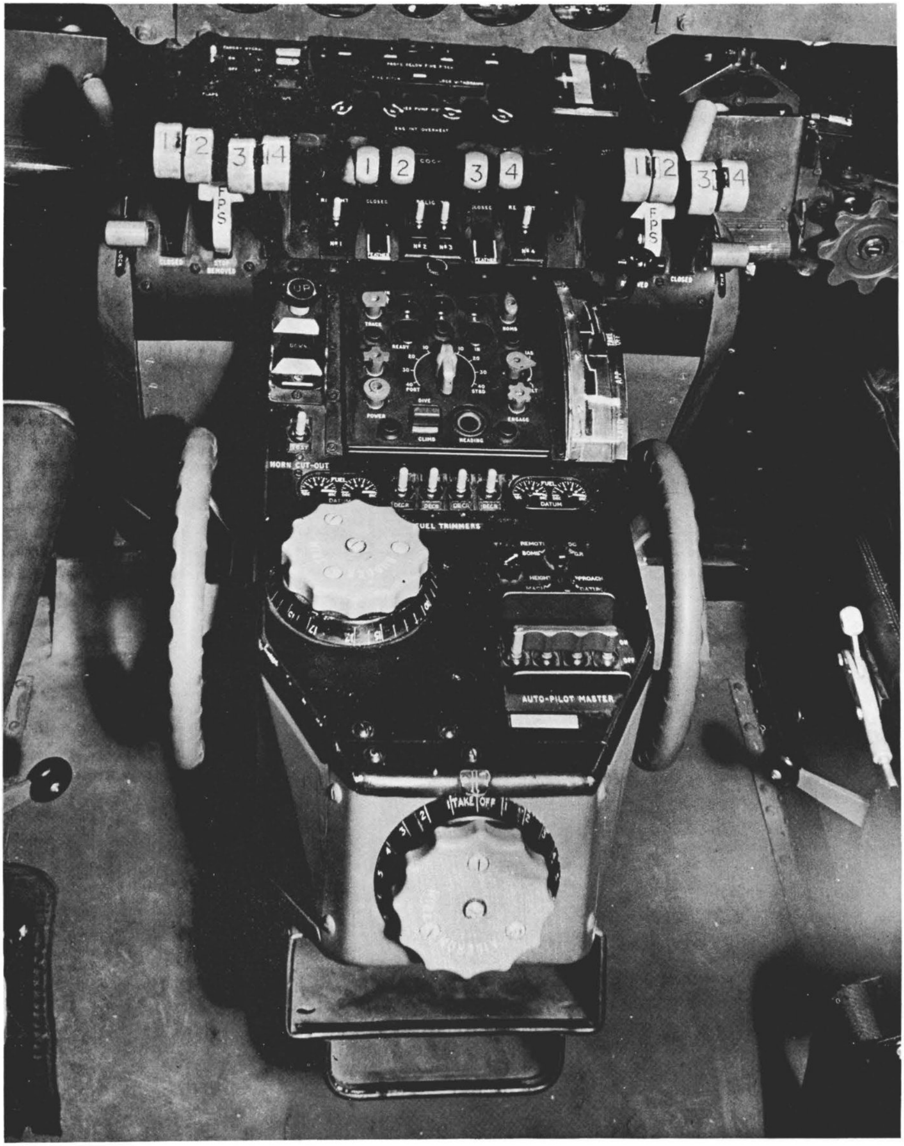
Also located in the port side cowling panel are spring loaded double flap doors giving access to both induction and combustion bays to allow the use of ground fire extinguisher should an engine fire occur.



Petal cowlings

ENGINE CONTROLS

ENGINE CONTROLS



FPS
CLOSED
FEATHER
UP
DOWN
TRACK
READY
BOMB
PORT
STBD
DIVE
POWER
CLIMB
HEADING
ENGAGE
HORN CUT-OUT
FUEL TRIMMERS
DATUM
DECR
REMOTE
HEIGHT
APPROACH
AUTO-PILOT MASTER
TAKE OFF

ENGINE CONTROLS - GENERAL

1. Description

The throttle, propeller fine pitch stop, H.P. fuel cock and throttle lock control levers are mounted on the centre pedestal and are duplicated and interconnected where necessary so that both first and second pilot can operate them.

The throttle and F.P.S. levers are mounted in two 'banks', one on the port side of the centre pedestal, the other on the starboard, and the throttles in each case are numbered 1 to 4 from port to starboard with the propeller fine pitch stop lever being marked F.P.S. and interposed between No.2 and 3 throttle levers. Each 'bank' is so arranged that it can be spanned with one hand for ease of operation. The high pressure fuel cocks are mounted in the centre of the pedestal between the two banks of throttles and are numbered 1 to 4 from port to starboard.

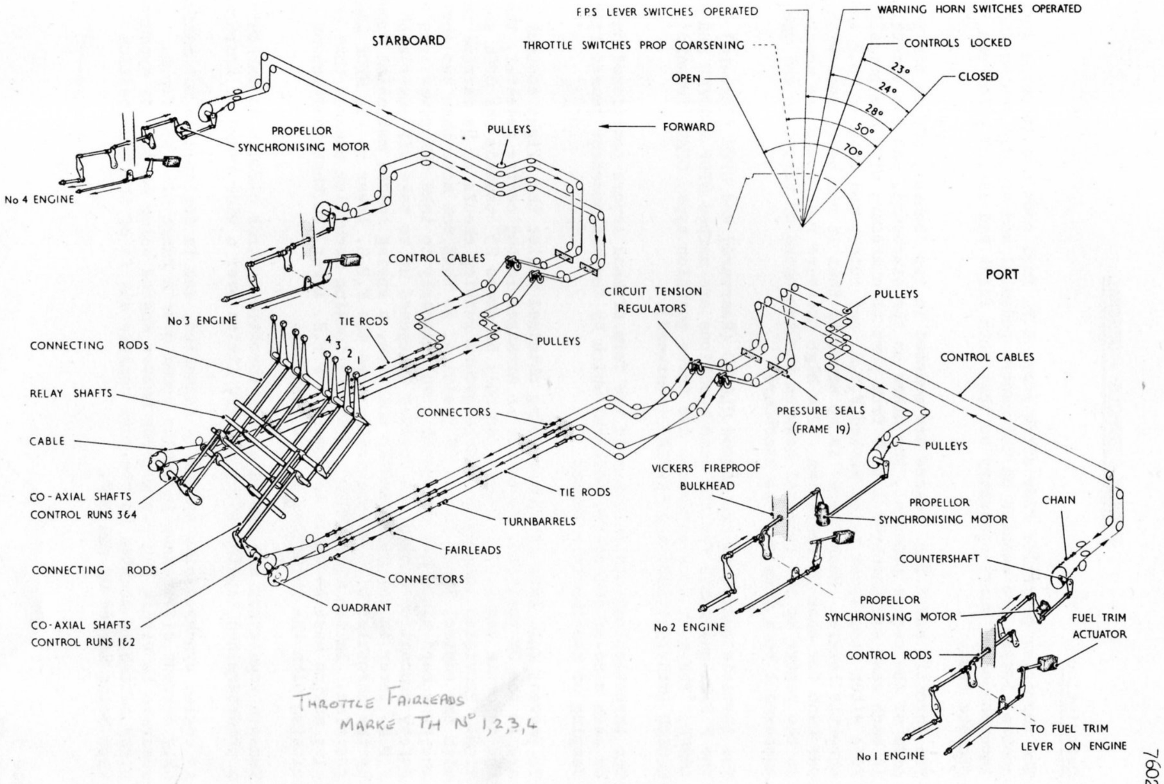
The throttle quadrants are marked CLOSED (Rearward) and OPEN (Forward) whilst the F.P.S. quadrants for the same positions are marked STOP REMOVED and STOP ARMED. The H.P. Cock quadrants are three position type, OPEN (forward) CLOSED (mid-position) and FEATHER (rearward).

The throttle lock controls are in the form of hand levers positioned one on each side of the centre pedestal which by forward movement causes friction damping of the throttle levers.

To prevent full take off power being obtained whilst the flight control locks are in the ON position, stops are so arranged in the centre pedestal, that the throttle and F.P.S. levers can only be moved 23° towards the OPEN position. Provision is made to enable ground running checks to be carried out with the control locks in the ON position, so that not more than two engines, one from each wing, may be opened simultaneously to take off power. As a safety precaution should all engines be opened up to take off power with the F.P.S. lever in the STOP REMOVED position, a spring loaded mechanism operated by the throttles will automatically move the F.P.S. lever to the STOP ARMED position. In the STOP ARMED position a locking mechanism ensures that positive action must be taken to move the F.P.S. lever, so that inadvertent closing with the throttles is not possible.

Tension regulators are fitted in the throttle control circuit to maintain a predetermined tension within narrow limits over a wide range of temperatures.

* An engine synchronising system is installed, and is designed to automatically correct differences in engine speed over a range of $\pm$ 450 r.p.m. accurate to within 3-5 r.p.m., the Master engine being No.3. The synchroniser switch is mounted on the Port console and is of the two position type being marked ON and OFF.



Throttle circuit diagram

THROTTLE CONTROLS

1. General

The first and second pilots throttle control levers are interconnected in the centre pedestal, so that operation of any one engine throttle lever also moves the equivalent lever of the opposite 'bank'.

The throttle damping levers are mounted on the throttle lever cross-shaft assembly on the centre pedestal and can be moved by the pilot or co-pilot to positively lock the port bank of controls.

Fore and aft movement of the throttle control handles in the cockpit is transmitted from the off-set levers of the throttle lever assemblies to link struts, which connect through cam assemblies, pivotted about the flight control lock lever shaft, to connecting rods attached to levers mounted on respective throttle shaft assemblies. From further levers on the throttle shaft assemblies, control rods pass through the flight decking under the centre pedestal forward of beam 2 and connect to levers mounted on hub assembly cross-shafts. Two cables are attached to a lug on each of four quadrants which are mounted two on each hub assembly cross-shaft. These cables pass around the quadrants, one over, one under, and are directed rearwards, the upper cable passing under a pulley mounted aft of beam 2. Turnbarrels forward of beam 3 connect to control rods which in turn, connect to 5 cwt. cables between frames 13 and 14, Aft of frame 14, pulleys direct the cables of 1 and 2 engines to port, and 3 and 4 engines to starboard, re-directing them aft on each side of the aircraft centre line until aft of frame 16 where they pass over tension regulators. Forward of the pressure bulkhead at frame 19, seal rods are fitted into the circuit, reverting to cable aft of frame 19. Pulleys on the forward face of frame 21 direct the cables upward and outboard to rib 10A of the centre wing, where they are directed forward to the rear face of the rear spar and outboard to their respective engines. On the rear face of the wing front spar behind each engine mounting, the cables are connected to a chain passing round a sprocket mounted on a countershaft; an off-set lever from the shaft being connected to a control rod of the main engine controls.

2. Throttle lever assembly

Consisting of a control handle with an off-set lever, the assemblies are manufactured from light alloy, and have control knobs attached with the engine numbers engraved on them. The throttle controls are so arranged that all levers of one bank may be spanned with one hand, and to achieve this arrangement the levers of 1 and 2 engines are toggled towards each other and operate in one quadrant quide, whilst levers of 3 and 4 engines, similarly toggled, are in a separate quadrant guide. All the throttle levers rotate about the same shaft which is mounted horizontally in the forward portion of the centre pedestal.

3. Throttle shaft assemblies

To the outer face of each end plate of the forward portions of the centre pedestal, below and forward of the throttle lock shaft assemblies, is mounted a bearing housing assembly. Four throttle shafts, numbered 1 to 4 from top to bottom, fit into bearings, and connecting rods from the throttle levers are attached to levers mounted on the shaft, the throttle levers from both banks being connected to their respective numbered shaft. From single levers on each throttle shaft, Nos. 1 and 2 on the port side, 3 and 4 on the starboard, control rods adjustable at the lower end, pass through the flight decking and connect to levers on the hub assembly cross-shafts.

4. Hub assembly cross-shafts

Mounted on brackets attached to the front face of beam 2 are light alloy port and starboard hub assembly shafts. Each assembly consists of an inner and outer hub rotating in ball races, and having a cable quadrant fitted to it. The port inner hub connects to No.1 throttle lever, the port outer to No.2, whilst the starboard outer connects to No.3 throttle lever and the starboard inner to No.4. An attachment lug on the quadrant is the pick-up point for two cables which are then directed aft through the fuselage.

Adjustable cams, mounted on the quadrants are set to operate the alternator "kill" and temperature control micro switches at 9,000 r.p.m.

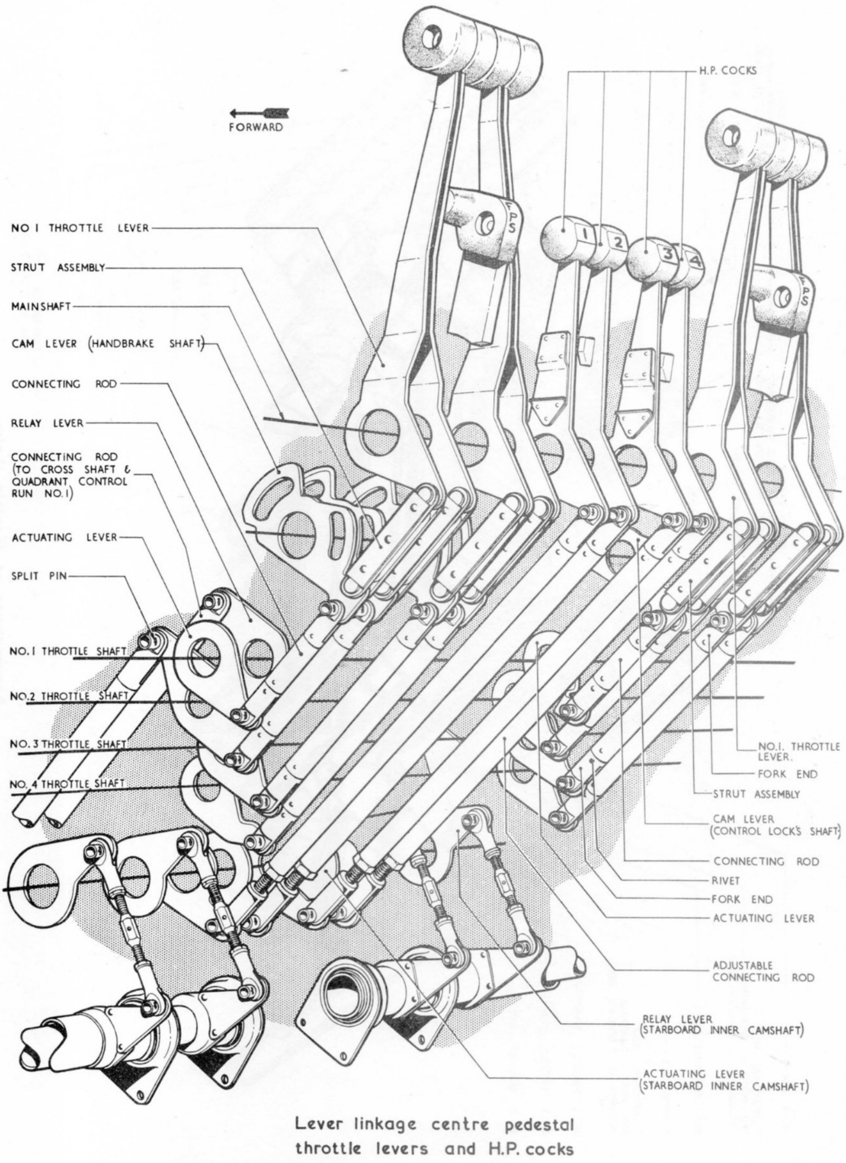
5. Tension regulators

Each tension regulator, one of which is fitted into each throttle control cable circuit, consists of a compensator unit with a cross-head assembly providing attachment for two pulleys. A compensation scale projects through one shoulder of the cross-head assembly. Total compensation is 3.6 inches.

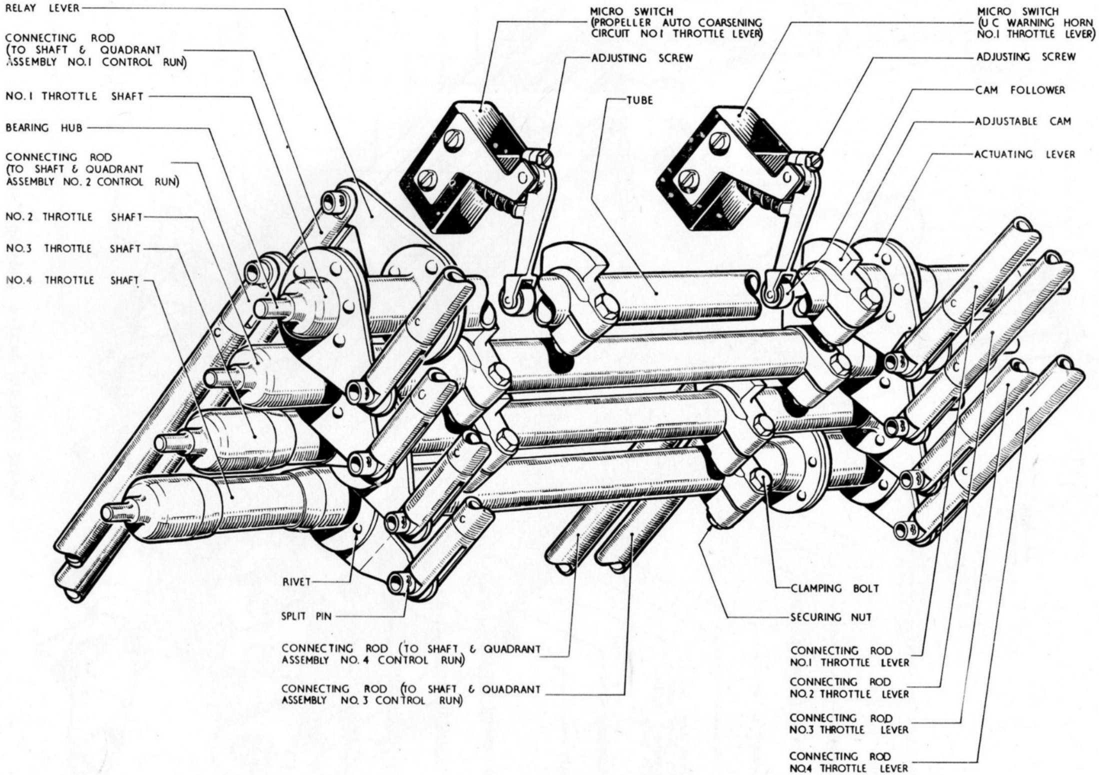
6. Throttle damping

The throttle damping levers are attached to a centre spindle passing through the throttle banks. Helical cams are attached to the throttle lock shaft where it passes through the port throttle bank, while further cams are integral with the support structure.

Movement of either lever forwards will rotate the cams and bring the helical cam faces into contact. The interaction of the cam faces becomes increasingly greater with increased forward movement of the levers, thus giving progressive throttle damping.

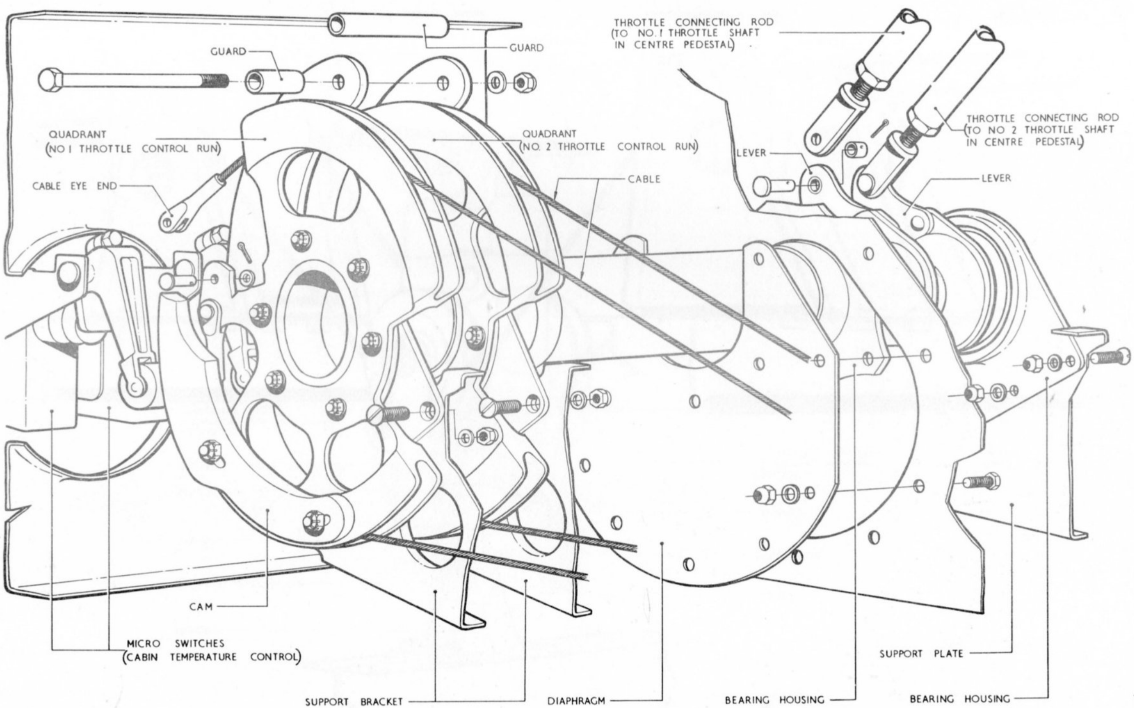


Lever linkage centre pedestal throttle levers and H.P. cocks



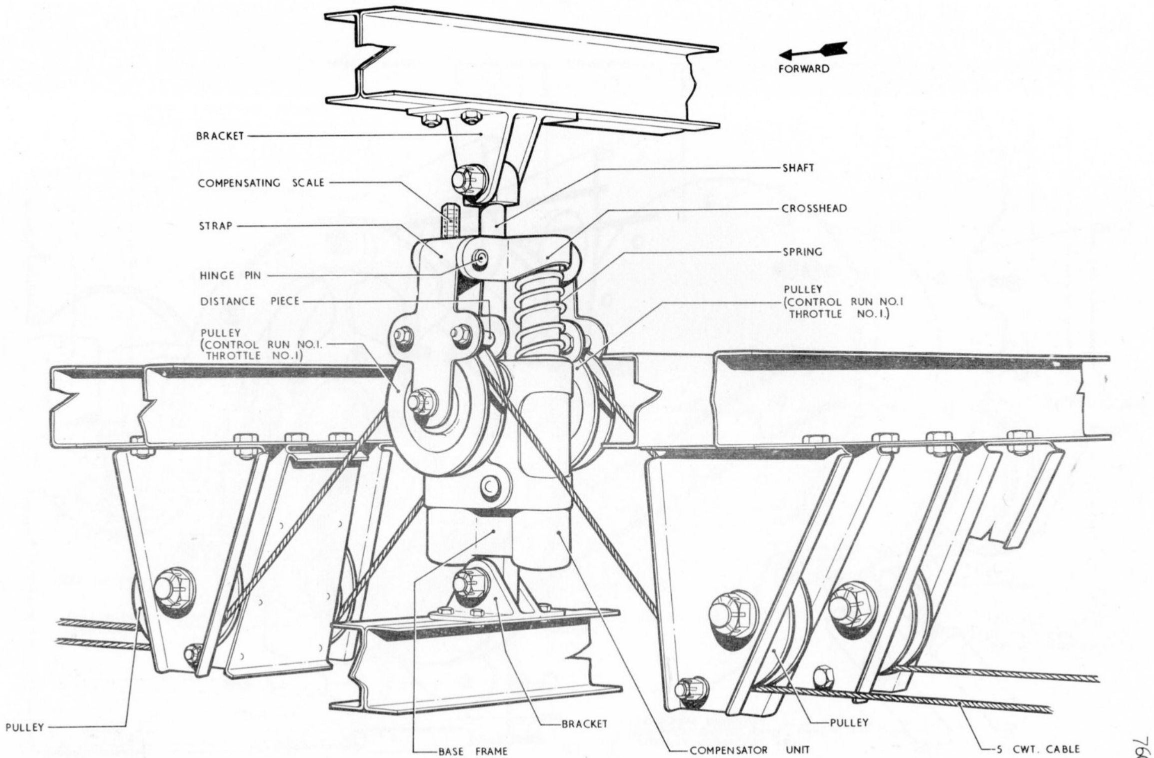
Arrangement of throttle shafts

7617

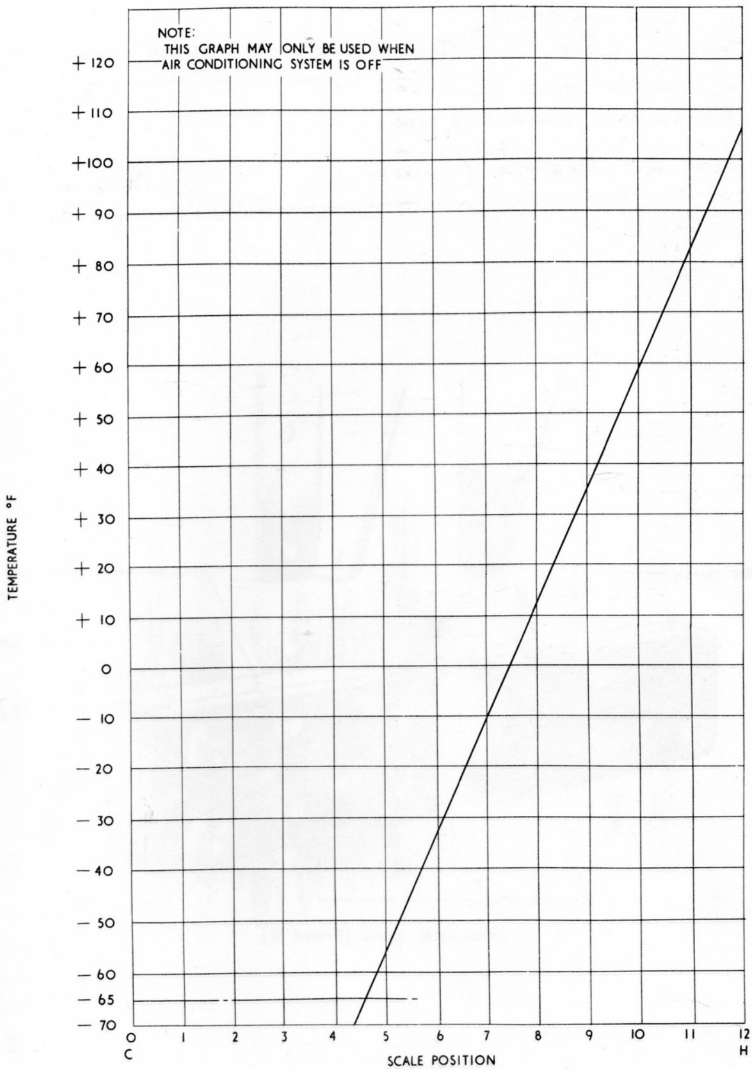


7616

Throttle circuit. Cross shaft and quadrant assembly



Cable tension regulator throttle circuit

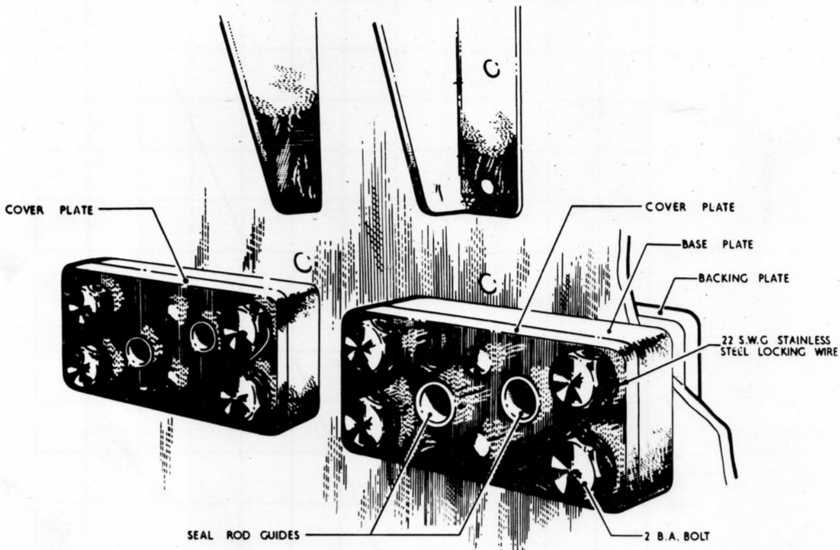


Throttle circuit rigging graph

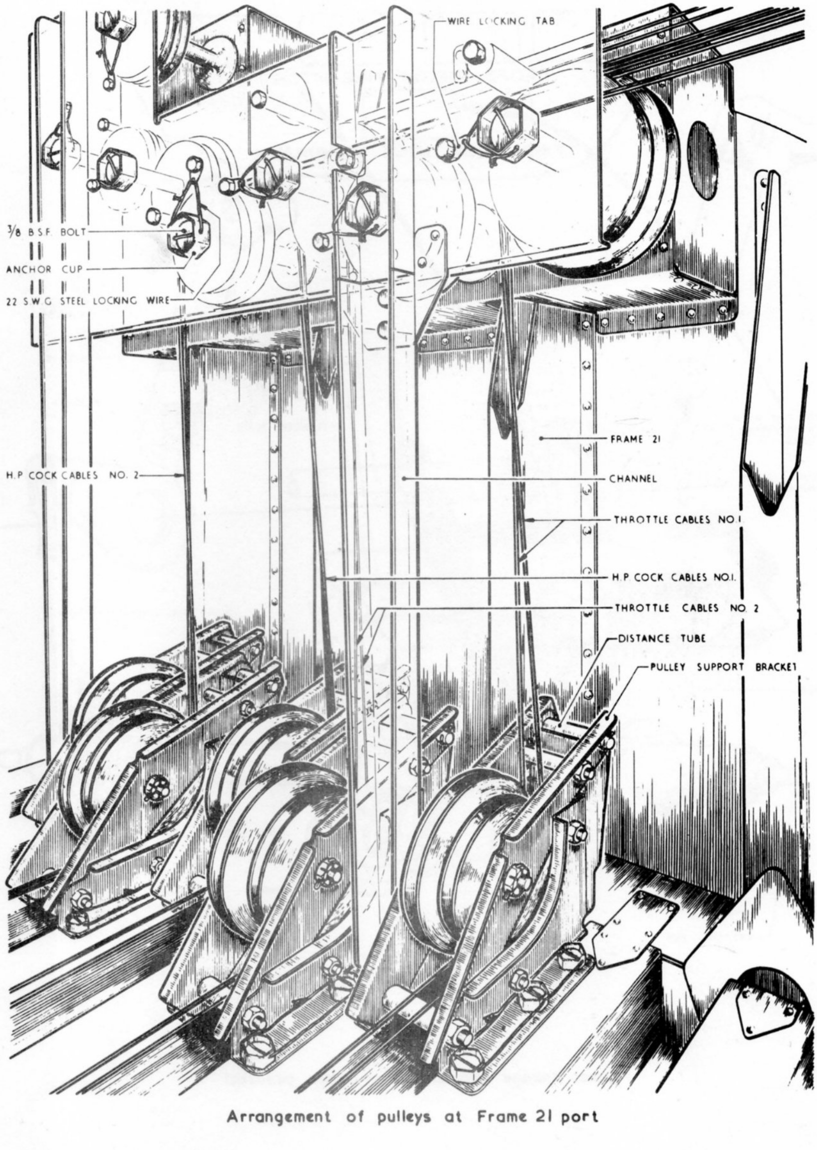
THROTTLE OPERATED SWITCHES

7612

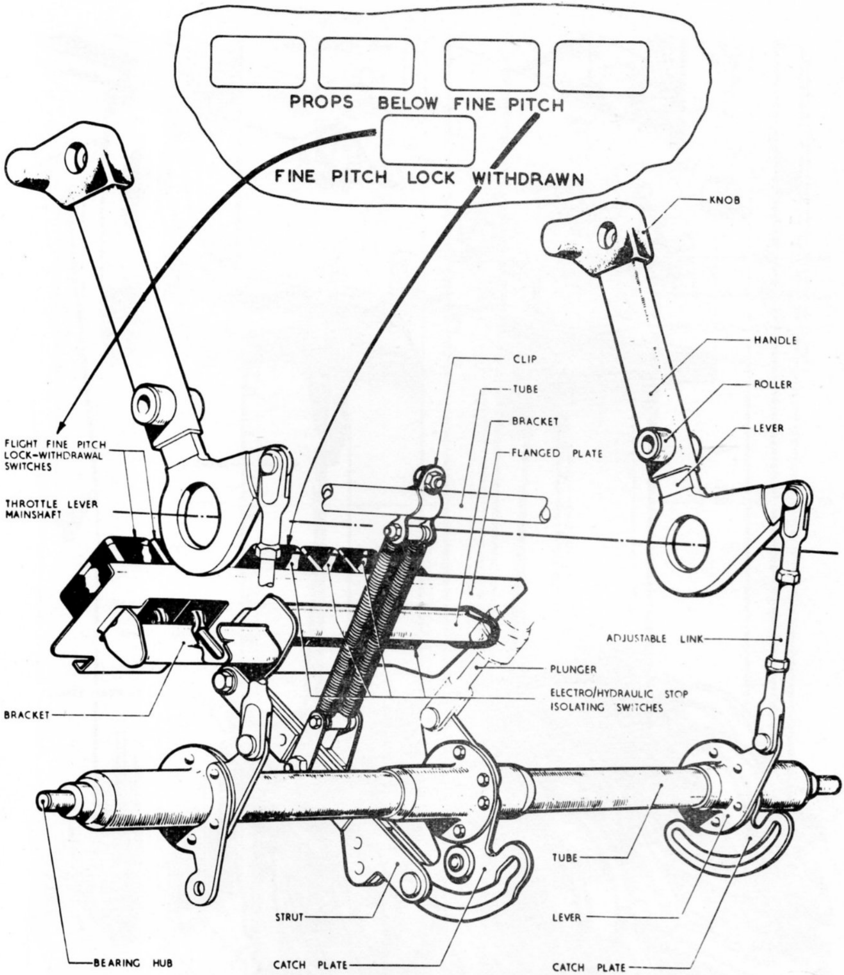
ANGLE	SWITCH	APP RPM
8½°	ALTERNATOR KILL (1 2 3 & 4 CABIN TEMP CONTROL (4 MICRO) (1 2 & 4 ONLY)	9,000
23°	THROTTLE RESTRICTED IF FLYING CONTROL LOCK IS "ON"	11,000/11,500
24°	U/C WARNING HORN (4 MICRO)	11600
28°	FPS SWITCHES OPERATE (6 TOGGLE)	—
66°	PROP AUTO FEATHER (4 MICRO)	14,600



Pressure seals (Frame 19)



Arrangement of pulleys at Frame 21 port



Lever linkage and switches - centre pedestal

FINE PITCH STOP LEVER CONTROL

1. General

Situated between 2 and 3 engine throttle levers and pivoted about the same shaft as the throttle levers, the first and second pilots fine pitch stop control levers are interconnected in the centre pedestal, so that operation of either lever will move the lever of the opposite 'bank'. There is also an interconnection with the throttle controls to ensure that the F.P.S. lever will spring to STOP ARMED on opening of all throttles to the take-off power position, and positively lock the lever in the forward position.

Fore and aft movement of the F.P.S. control handles in the cockpit, is transmitted downwards from off set levers and adjustable link assemblies to pick up with off set levers on the F.P.S. cross shaft. From a catch assembly mounted on the shaft, a spring tensioned strut is attached to a lever which operates the fine pitch stop toggle switches. In the fully forward (STOP ARMED) position a spring loaded catch assembly positively locks the control handle.

2. F.P.S. lever assembly

A mild steel lever with a 1.25 inch long parallel slot in the vertical arm has fitted over it a handle, also of mild steel, to the top of which is attached a knob of light alloy or plastic. Two mild steel rollers, one on each side of the handle are held in position by a bolt which is located in the lower slot of the lever. Location of the handle at the upper slot is by a peened bolt.

3. F.P.S. lever cross shaft assembly

Bearing housings attached to each end plate of the forward portion of the centre pedestal carry the F.P.S. lever cross shaft. A sleeve is taper pinned to each end of the shaft, each sleeve having an off-set lever riveted to it, which connects to the adjustable link from the operating levers. A further sleeve taper pinned on the centre line of the shaft has attached to it the catch assembly, consisting of a plate with a radial stepped slot machined in it, and between the slot and shaft pivot point two high tensile steel rollers mounted one on each side of the plate. The off-set lever on the starboard sleeve has attached to it a plate with a parallel radial slot machined in it. The slot is interconnected to the flight control lock lever mechanism.

4. Stop Armed Lock Mechanism

A lock assembly is incorporated at the forward end of the F.P.S. lever travel, to ensure that on closing the throttle during flight, the lever remains in the STOP ARMED position until positively released by manual selection to the STOP REMOVED position.

A. Catch Mechanism

The catch mechanism consists of a lever with a claw shaped head, and a spring loaded plunger mechanism which locates in a recess machined in the rear of the head. The lever is mounted on a cross shaft, and a lug which projects from the lever, engages with the claw of a catch plate positioned adjacent to the lever. The forward end of the spring loaded plunger mechanism is attached to a pin mounted on the catch plate. Also fitted to the cross shaft is a lever to which is connected the piston end of a spring unit, while the barrel of the unit is attached to a bracket on the rear face of the throttle box. Since the handle is located on the F.P.S. lever by bolts through slots on the lever, it is free to follow the change in direction of the slot, and is spring loaded to this position by operation of the catch mechanism.

(1) Stop Armed Selection

As the lever approaches the forward end of the quadrant guide, the forward face of the lever bears against a projecting pin on the spring loaded plunger. Compression of the spring loaded plunger mechanism disengages the catch lever from the catch plate which is rotated upwards and away from the lug on the catch lever. Once clear of the catch plate, the spring unit forces the catch lever rearwards and downwards causing the rollers on the handle to be moved to the base of the locking slot, and shortening the length of the F.P.S. handle.

(2) Release

To select STOP REMOVED, the control handle must be pulled out, which lifts the rollers and catch lever and allows the catch plate to engage the lug of the catch lever immediately the F.P.S. lever is moved rearwards towards the STOP REMOVED position.

5. <u>F.P.S. Lever - Automatic Operation</u>

When the throttle levers are advanced more than 28° to take off power, the F.P.S. lever is automatically taken to the STOP ARMED position.

As the throttle levers are moved forward, the link assembly, through an off-set lever, rotates a cam mounted on the control lock shaft. The forward face of the cam is brought into contact with the port throttle stop assembly. The throttle stop assembly is linked to the F.P.S. control shaft through the medium of a tie rod and off-set lever. A spring unit is connected between a similar lever on the shaft, and a bracket fitted to the rear face of the throttle box, which also provides a mounting point for the catch lever spring unit.

A. F.P.S. Lever Lock - Throttles above min. r.p.m.

As the throttle levers are advanced, the cam mounted on the control lock shaft is rotated. Rollers bearing on the cam face actuate a lever assembly to which is attached a locking pawl normally spring loaded to the OFF position. Rotation of the lever now positions the locking pawl to engage with a projection on the F.P.S. lever mounted on the throttle shaft when the lever moves forward.

Throttle movement is transmitted to the lever assemblies mounted co-axially on the handbrake shaft, and the F.P.S. lever is automatically taken forward due to the contact of the throttle cams with the port throttle stop unit which is in turn connected to the F.P.S. lever assembly. This movement results in rotation of the F.P.S. cross-shaft lever which pivots the spring unit, resulting in an initial compression of the spring. Further movement allows the spring to extend and assist movement of the F.P.S. lever to the STOP ARMED position.

FINE PITCH STOP AUTOMATIC OPERATING MECHANISM

KEY TO FIGURE 1

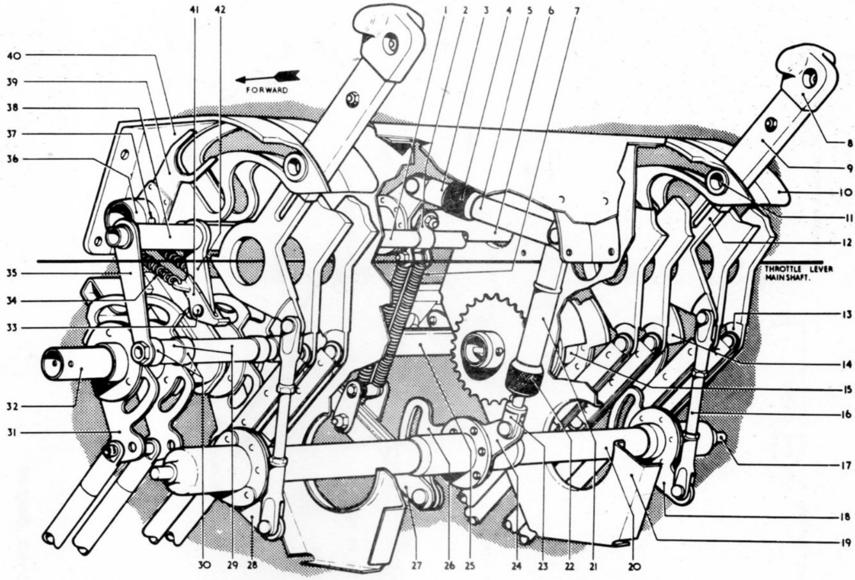
1. Tube
2. Clip
3. Plunger
4. Knurled nut
5. Cylinder
6. Shaft
7. Spring
8. Control knob
9. Handle
10. Cover plate
11. Roller
12. Lever
13. Lever hub
14. Cam lever
15. Control locks primary shaft
16. Adjustable link
17. Bearing hub
18. Relay lever
19. Throttle box inner plate
20. Fine pitch stop operating shaft
21. Cylinder
22. Knurled handnut
23. Plunger
24. Actuating lever
25. Switch bracket
26. Catch lever
27. Adjustable strut assembly
28. Relay lever
29. Distance piece
30. Cam roller
31. Cam lever (No.1 throttle lever)
32. Handbrake primary shaft
33. Pin
34. Spring
35. Cam bracket - side arm
36. Housing
37. Taper pin
38. Spindle
39. Fork
40. Guide bracket
41. Locking catch
42. Cam bracket - centre arm

KEY TO FIGURE 2

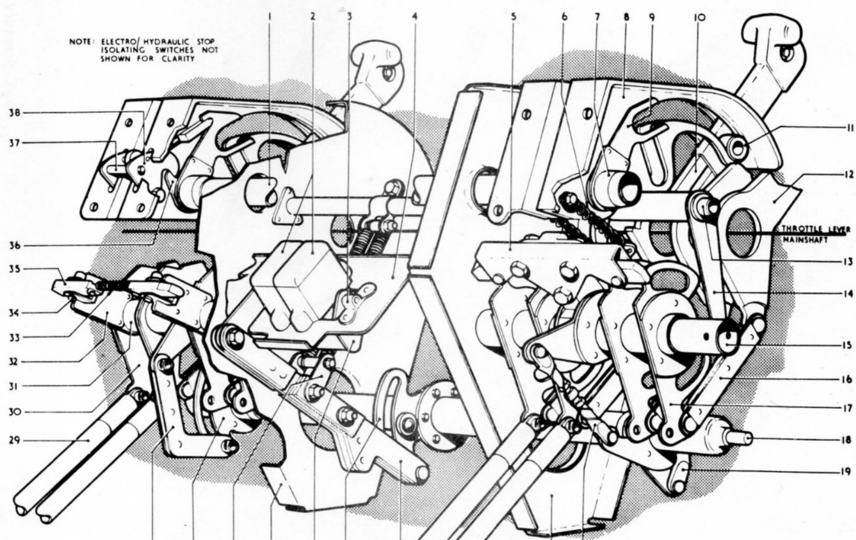
1. Shaft
2. Fine pitch lock-withdrawal switches

NOTE : Electro/hydraulic stop isolating switches (props. below fine pitch) not shown for clarity

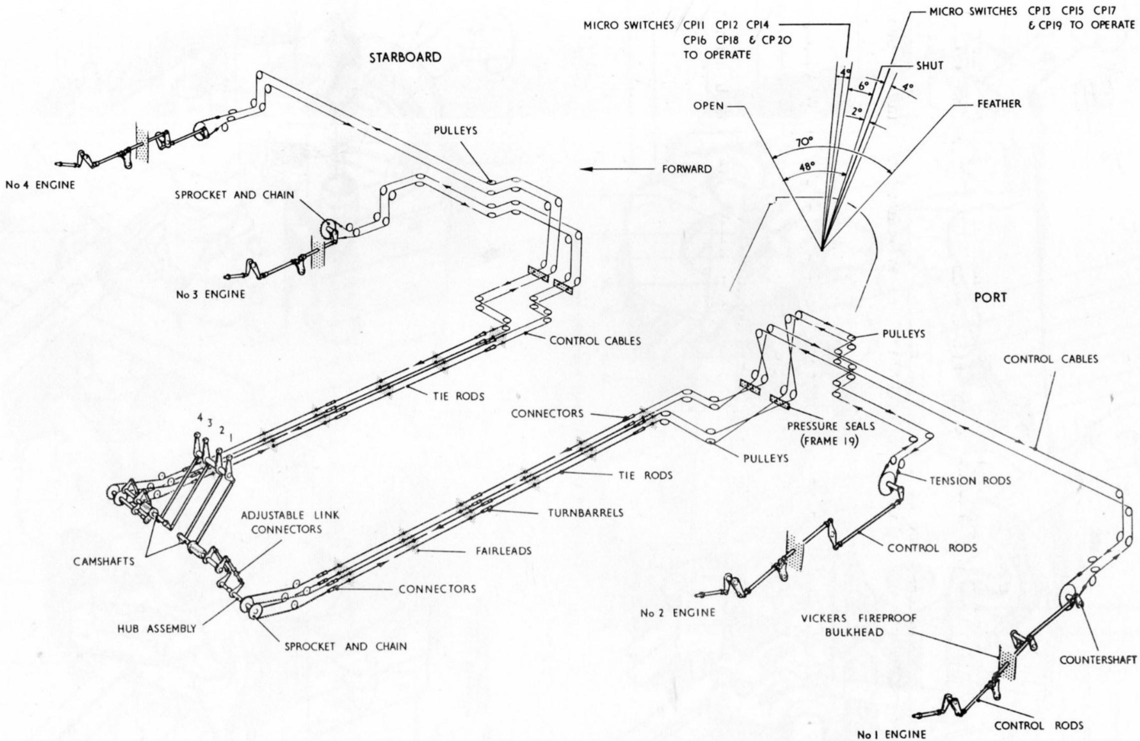
3. Housing
4. Flanged plate
5. Channel
6. Spring
7. Housing
8. Bracket
9. Fork
10. Lever
11. Roller
12. Throttle lever
13. Cam bracket spindle
14. Cam bracket - side arm
15. Handbrake primary shaft
16. Strut
17. Cam lever (No.1 throttle lever)
18. Fine pitch stop operating shaft
19. Adjustable link
20. Adjustable link
21. Throttle box - inner plate
22. Adjustable strut
23. Catch lever
24. Bracket
25. Throttle box - inner plate
26. Plate
27. Catch plate
28. Link strut
29. Connecting rod (No.4 throttle lever)
30. Cam lever (No.4 throttle lever)
31. Control locks primary shaft
32. Bracket
33. Spring
34. Pin
35. Throttle stop
36. Bracket
37. Distance piece
38. Catch



Fine pitch stop automatic operating mechanism
Figure 1



Fine pitch stop automatic operating mechanism
Figure 2



High pressure cock circuit diagram

7609

HIGH PRESSURE FUEL COCKS

1. General

A single bank of four levers, one for each engine, is positioned between the first and second pilots throttle bank.

They are mounted on the throttle lever cross shaft, and to ensure that there can be no possible interference with throttle and F.P.S. lever movement, a mild steel tube is fitted over a plain shoulder on the serrated collars of the inner plates, the H.P. cock levers being free to rotate on the tube. Leaf springs riveted to the control levers are attached to plungers protruding through the levers, and the plungers mating with recesses in the quadrant guides, locate the levers OPEN, CLOSED or FEATHER, as selected.

Adjustable connecting rods from the off set lever on the control handle connect to levers on the H.P. shaft assembly at the base of the centre pedestal, and from further levers on the shaft adjustable links connect to lever assemblies aft of beam 2. From sprockets on the lever assemblies, chains are connected by turnbarrels forward of beam 3 to control rods, which connect to cables between frames 13 and 14. Aft of frame 14 the cable circuits are directed outboard, 1 and 2 to port, 3 and 4 to starboard, and then rearward by pulley assemblies until at frame 19 seal rods fit into the circuit, reverting to cables aft of the pressure bulkhead. Pulleys on the front face of frame 21 direct the cables upward and outboard to rib 10A of the centre wing where they are directed forward to the rear face of the rear spar, and outboard to their respective engines. On the rear face of the wing front spar behind each engine mounting the cables connect to a chain passing round a sprocket mounted on a counter shaft, an off set lever from the shaft being connected to a control rod of the main engine controls.

2. H.P. cock lever assembly

Consists of a light alloy handle with an off set lever at the lower end, a plastic control knob being fitted to the upper end, engraved with the engine number. A hub, with a fitted bush is riveted to the handle, and the bush is the bearing on which the lever rotates on the cross shaft. A slot is cut in the handle, through which fits a locating plunger, the plunger being spring loaded by a leaf spring riveted to the handle.

3. H.P. Shaft assembly

The H.P. shaft assembly is the lowest of those mounted in the centre pedestal. The assembly consists of two shafts, port and starboard, mounted in the ball races, each shaft operating two H.P. cock controls. Each shaft has an inner mild steel tube, with an outer bearing housing mounted on it, toward the inboard end. The adjustable connecting rods from the operating levers are attached to the short levers on each inner tube and outer bearing housing, and from the long levers, adjustable links are connected to the lever assembly cross shafts below the flight deck. H.P. cocks 1 and 2 are operated through the port shaft, and 3 and 4 the starboard shaft.

4. Lever assembly

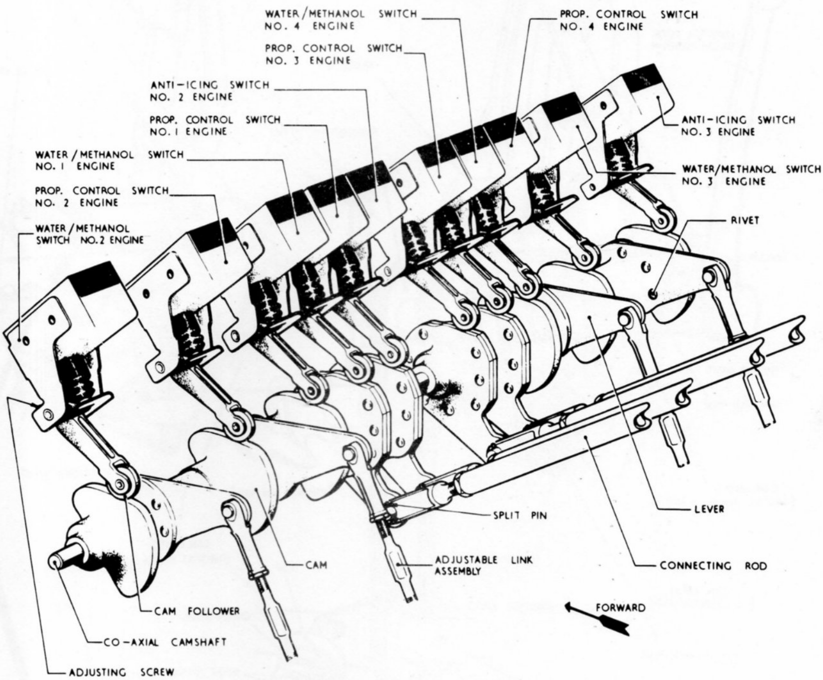
Mounted on brackets attached to the rear face of beam 2 are port and starboard lever assemblies. Each assembly consists of an inner and outer hub rotating in ball races, and having a chain sprocket fitted to it. The port outer hub connects to number 1 H.P. cock lever, the port inner to number 2, whilst the starboard inner connects to number 3 H.P. cock levers, and the starboard outer to number 4.

H P COCK OPERATED SWITCHES

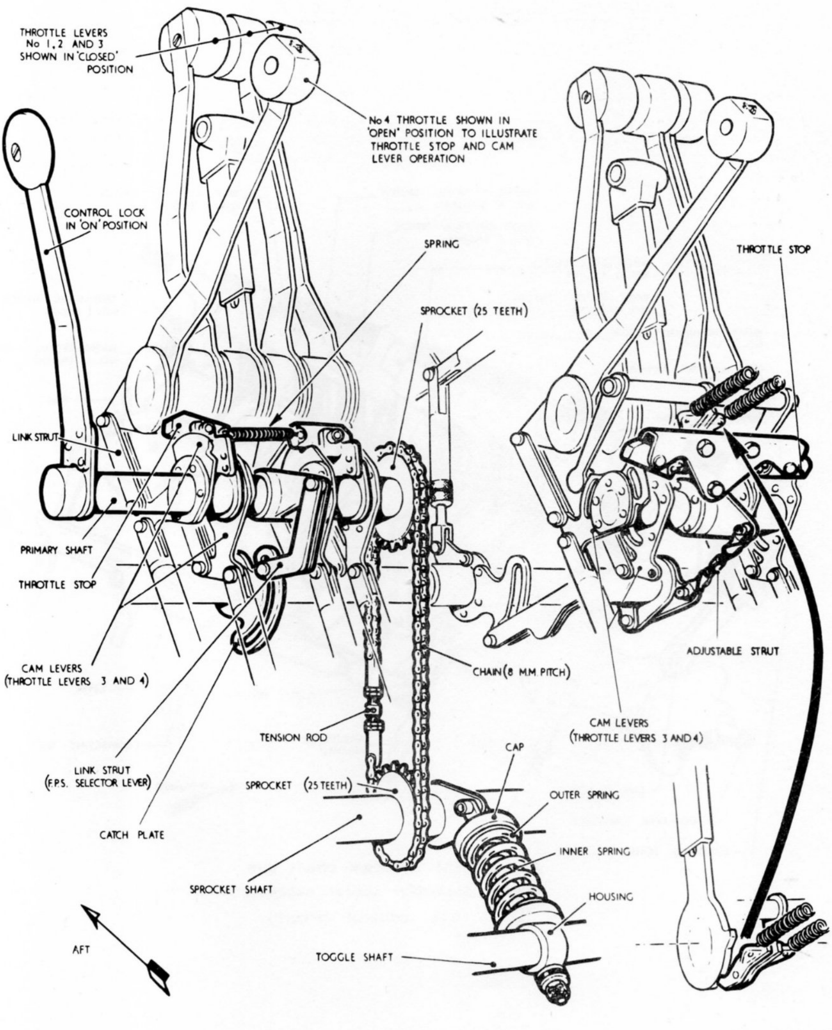
4 PROP AUTO FEATHER AND WATER/METH CUT OFF

2 ANTI - ICING SCOOPS N°2 & 3 ENGINES ONLY

4 MANUAL FEATHER



Arrangement of cam shaft and switch assembly—center pedestal (H.P. cock control circuit)



Control lock mechanism – centre pedestal

FLIGHT CONTROL LOCKS - THROTTLE AND F.P.S. CONTROL

1. General

When the flight control lock handle is in the OFF position, all throttles, and both F.P.S. levers can be moved through full quadrant range without interference. However, when the lock is in the ON position the throttles and F.P.S. levers can be moved only 23° towards the OPEN position, except that, to enable ground running checks to be carried out the locks are so arranged that two engines, one from each wing, may be opened to take off power simultaneously.

By means of rollers on a lever from the control lock shaft, moving in the radial slot of a cam plate mounted on the catch lever shaft, when the flight control lock lever is moved to the ON position, the F.P.S. control levers are restricted in the range of movement.

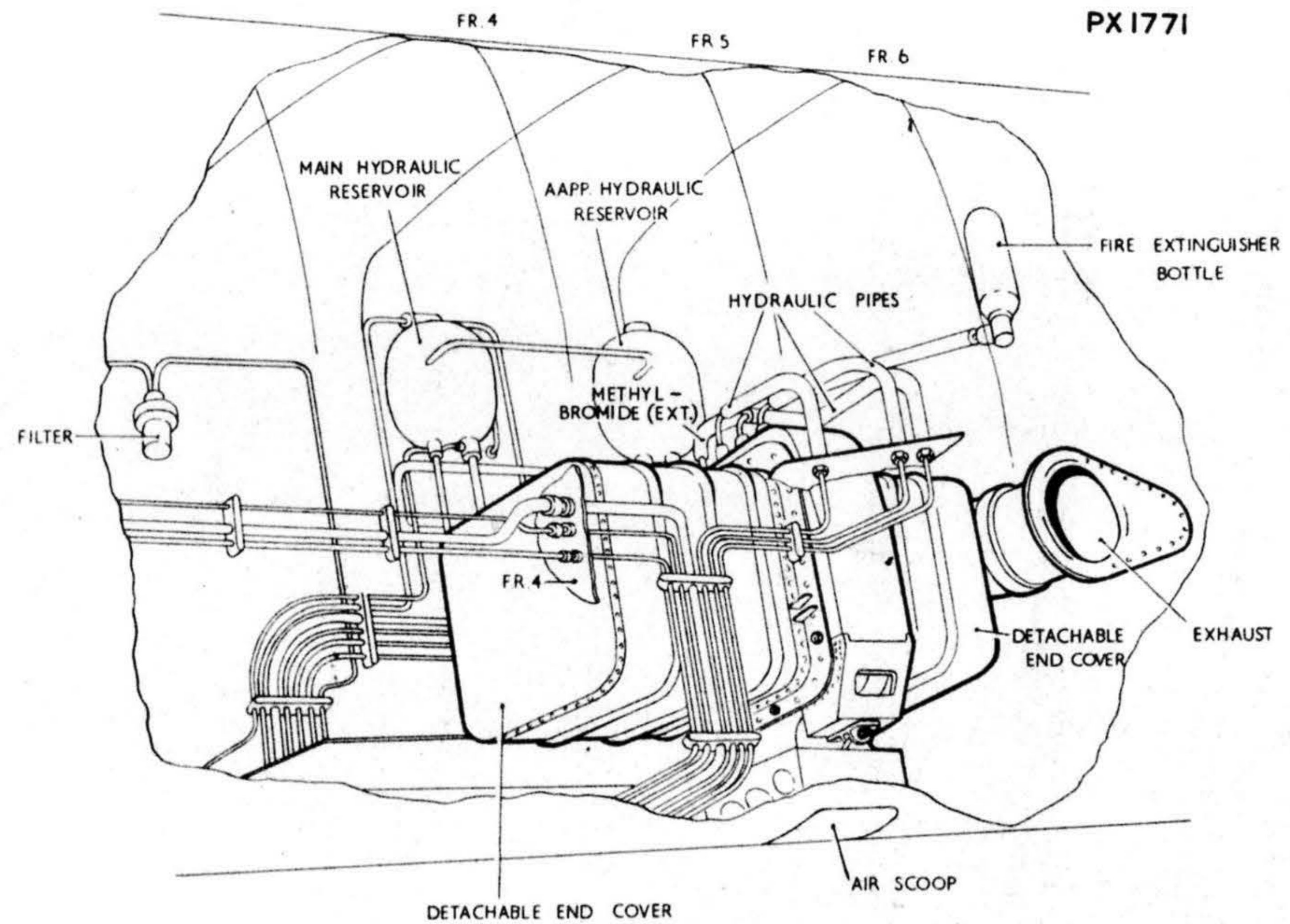
2. Operation

When the control lock lever is moved rearward into the on position, the control lock shaft is rotated rearward as is the lock assembly attached to it. In this position, as the throttles are moved forward cam plates strike on blocks of the bracket assembly. Individual cams ride on the chamfer on the blocks which are pivoted about the centre and interconnected by a spring, but should two throttles from one wing be advanced, two cams operating one on each side of the block pivot point would not be able to pass the chamfered portion of the block.

AAPP

A.A.P.P.

CONTENTS



A.A.P.P. Layout
Figure 1

WEIGHT OF APU 324 lbs
RPM — " — 4,000 RPM 60 BHP
FUEL — " — 400 lbs/hr
JPT — " — 630°C

A.A.P.P. - REMOVAL AND INSTALLATION

1. To Remove the A.A.P.P.

A. Render the A.A.P.P. electrically safe.

B. Remove the bulkhead panel from frame 4 in the port boom.

C. Disconnect electrical leads from the A.A.P.P. and fit them to the dummy sockets provided on the aft face of frame 4.

D. Disconnect the hydraulic and fire extinguisher pipes at the Avery couplings on top of the A.A.P.P. Fit blanking caps to the hydraulic pipelines and secure pipes to their stowages on the port side of the boom.

E. Remove the air scoop and duct assembly from the underside of the port boom.

F. Remove the jet pipe and shroud.

G. Disconnect the fuel, oil, and drain pipes from the underside of the A.A.P.P. and fit the appropriate blanks to the pipe ends.

H. Attach the hoist support trolley, with its adjustable steadying sling aftermost, to the slinging beam and ensure that the rubber stops are fitted to each end of the beam.

I. With the pip-pins provided, secure the slinging beam to its mounting points in the port boom; forward point being aft of frame 2 and the rear point at frame 6.

J. Position the hoist in the trolley sling and connect the forward hook.

K. Roll the trolley aft and position the hoist over the A.A.P.P. then lower the hoisting cable and with the 0.75 in. dia. ball end or a shackle (AGS.912/G) and pin (AGS.916/G) connect it to the hoisting lug on the A.A.P.P.

L. Tauten the cable to take the weight of the A.A.P.P., then remove the mounting bolts.

M. Raise the A.A.P.P. to clear the surrounding structure and roll the trolley forward to the main wheel bay.

N. Position the cradle beneath the wheel bay and lower the A.A.P.P.

O. Secure the A.A.P.P. to the cradle with the bolts provided and disconnect the hoisting cable from the A.A.P.P.

P. Remove the hoist, slinging beam and trolley from the aircraft and replace the access panels to frame 4.

2. <u>To Install the A.A.P.P.</u>

The procedure for installation of the A.A.P.P. is the reversal of the removal procedure except for the following items:-

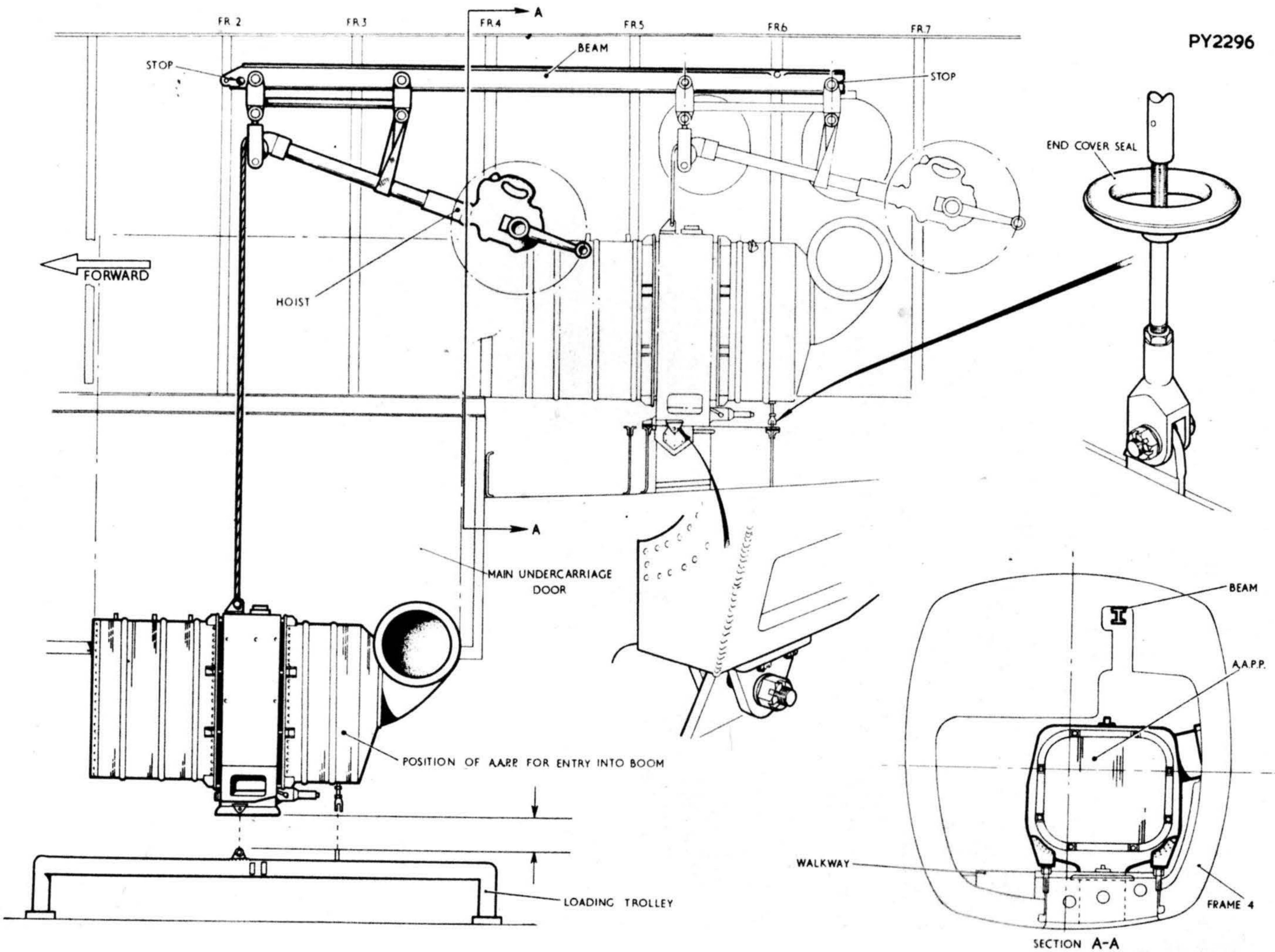
A. When fitting the mounting bolts, it is recommended that the outboard bolt is inserted first as this is the least accessible point.

B. Bleed the fuel supply pipe.

C. Bleed the hydraulic suction pipe and the engine driven pump by slackening the first stage blanking plug on the pump. Turn the turbine by hand and when air-free fluid emerges tighten and lock the blanking plug.

N.B. Access to the turbine is obtained when the exhaust pipe is removed from the unit.

D. When the jet exhaust pipe and shroud are fitted, adjust as necessary on the fork end of the aftermost mounting point to vertically centralize the exhaust pipe within the outboard end of the shroud, then tighten and lock the mounting bolts.



PY2296
FR.2
FR.3
FR.4
FR.5
FR.6
FR.7
A
BEAM
STOP
STOP
FORWARD
HOIST
END COVER SEAL
MAIN UNDERCARRIAGE
DOOR
A
POSITION OF A.A.P.P. FOR ENTRY INTO BOOM
LOADING TROLLEY
BEAM
A.A.P.P.
WALKWAY
FRAME 4
SECTION A-A

A.A.P.P. - BLEEDING AND DE-INHIBITING PROCEDURES

1. To Bleed Fuel System and De-Inhibit

   A. With L.P. cock CLOSED remove fuel pump governor blanking plug.

   B. Place container beneath fuel pump (approx 2 gallons).

   C. Select No.2 tank group booster pump ON.

   D. Open No.2 tank cross-feed cock and check that magnetic indicator shows in line.

   E. Select OPEN on L.P. cock and bleed off approx. 1 gallon of fuel.

   F. Close L.P. cock.

2. De-Inhibiting

   The following alternative methods (A) or (B) may be carried out :

   A. Carry out WET CYCLE (See APU-4 Page 1)

   OR

   B. Disconnect fuel feed pipe to burner and pipe to a container with a slave rubber pipe. Select START or BLOW OUT and motor engine for 30 seconds. Reconnect feed pipe to burner.

   NOTE : Replenish oil sump to correct level in both cases.

A.A.P.P. - STARTING PROCEDURES

1. **Ground**

Fuel gravity feed from No.2 tank. (IF TANK ABOVE ½ FULL AND BELOW 5000') *

A. Open A.A.P.P. L.P. cock (Indicator show WHITE).

B. Ground/Flight charge switch at GROUND. (IF EXTERNAL SUPPLY SWITCH TO CHARGE)

C. A.A.P.P. Generator switch at NORMAL. Check generator dolls-eye indicator (FAIL).

D. Select the A.A.P.P. master switch to START.

(1) Check oil pressure warning light on (RED)

E. On normal start the following should take place :

(1) Starter button should throw out after 10 seconds.

(2) If start up is late or battery low in voltage the starter button will hold in for a longer period.

(3) If engine fails to light the starter button will throw out on the completion of the 30 seconds time cycle.

(4) Oil pressure warning light OUT.

(5) J.P.T. does not exceed 665° for more than 10 seconds.

(6) Bring generator on line by selecting engage on the generator control switch and check that magnetic indicator shows generator is on LINE.

F. To stop A.A.P.P., select master switch to OFF.

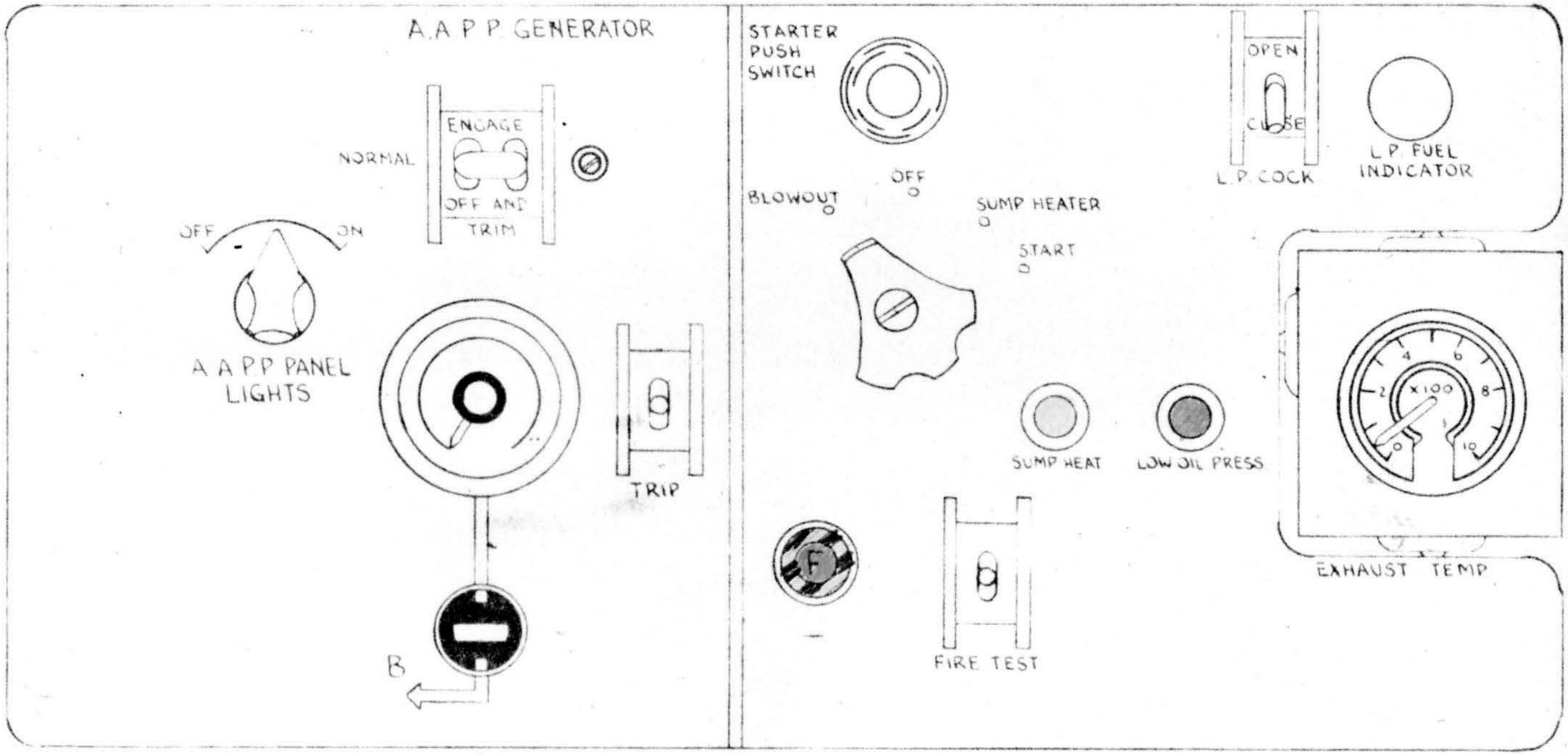
2. **Flight Starting**

A. As for ground starting but with Ground/Flight switch at FLIGHT.

B. No.2 fuel tank cross feed OPEN, and No.2 tank group booster pumps ON.

C. At extreme temperatures sump heater ON.

* IF THESE CONDITIONS DO NOT PREVAIL USE BOOSTER PUMPS



A.A.P.P. GENERATOR
ENGAGE
NORMAL
OFF AND TRIM
OFF
ON
A.A.P.P PANEL LIGHTS
TRIP
B
STARTER PUSH SWITCH
OPEN
CLOSE
L.P. COCK
L.P. FUEL INDICATOR
OFF
BLOWOUT
SUMP HEATER
START
2
4
6
8
10
0
x100
SUMP HEAT
LOW OIL PRESS
EXHAUST TEMP
F
FIRE TEST

A.A.P.P. PANEL.

A.A.P.P. - WET CYCLE AND RE-OILING PROCEDURES

1. Wet Cycle Run

To carry out wet cycle proceed as follows :-

A. Select the WET CYCLE switch to WET BLOW-OUT.

B. Select the starter switch to START, press the STARTER PUSH SWITCH and allow turbine to motor for 30 seconds when the time switch will operate and stop the turbine.

C. Allow approx. 4 minutes for the fuel to drain out of the turbine unit; the drain outlet is situated aft of the air scoop, on the outer skin of the boom.

D. Select the WET CYCLE switch to OFF, then select the starter selector switch to BLOW OUT and depress the STARTER PUSH SWITCH to dry out the turbine unit.

E. When the lubricating oil sump has been replenished, the A.A.P.P. is ready for normal running.

2. Re-oiling Procedure

Re-oil using the following procedure :-

A. Remove blanking cap from engine oil filling connection and connect the half coupling to the engine oil filling connection.

NOTE : It is possible that a small amount of oil will flow from the drain pipe on connecting the half coupling. This does NOT indicate that the engine oil level is full and should be egnored.

B. Deliver oil to the engine until oil starts to flow from the engine oil overflow pipe. This then indicates that the engine oil level is correct. Stop delivery of oil and disconnect the half coupling.

Replace blanking cap to the oil filling connection.

SUMP CAPACITY 4 ½ pints Total 5 pints

A.A.P.P.

FAULT FINDING

1. Turbine Fails to Rotate

   A. Check the electrical circuits.

   B. Remove the blower and oil cooler assembly and turn the turbine by hand. If turbine is seized, remove A.A.P.P. for repair.

2. Turbine Rotates but Fails to 'Light-Up'

   A. Check that the starter selector switch is set to START and that the WET CYCLE switch is OFF.

   B. Check the electrics relevant to the igniter plug and aircraft supply.

   C. If the aircraft is stationed at 4,000 ft. or more above sea level, check for air pressure at the air pump schrader valve connection.

   If no air pressure :-

   (1) Check electrics relevant to the air pump motor and the A.A.P.P. harness.

   (2) Remove the air pump inlet and check for presence of dirt.

   (3) Disconnect the air pump delivery pipe at the pump outlet and check for air pressure. If no air pressure is present, renew air pump.

   (4) Remove the P^2 non-return valve and check its operation.

   D. Check the drain manifold for presence of fuel and if inhibiting fluid is present, de-inhibit the unit fuel system.

   If no fuel is present :-

   (1) Check electrics to burner actuator and the A.A.P.P. harness.

   (2) Remove and test the burner actuator.

   If fuel is present :-

   (1) Check the L.P. cock for correct functioning.

   (2) If no faults are found, check the A.A.P.P. fuel pump.

3. Turbine Lights Up but Fails to Accelerate to Governed Speed

   A. Check that the L.P. cock has been selected.

B. Check the fuel tank contents and/or that the appropriate booster pump has been selected, and that the air intake and exhaust are free from obstruction.

C. Disconnect the L.P. fuel supply at the fuel pump and check the flow into a calibrated container (Time with stop watch).

D. Ensure oil sump contains the correct grade of oil.

E. Remove the blower and oil cooler assembly from the A.A.P.P. and turn the turbine by hand. If turbine seized, remove A.A.P.P. for repair.

F. Check electrical circuits.

G. If no faults found, check the A.A.P.P. fuel pump.

4. <u>Turbine Surges During Acceleration</u>

A. After previous attempted starts or wet cycles, check the fuel drain valve. A steady drain of fuel will indicate that insufficient time has been allowed for the turbine to drain. Wait approx. 10 minutes for excessive fuel to drain from the turbine unit and carry out a 'blow out' sequence.

B. Check that there is no load applied to the turbine during the acceleration period.

C. If no faults are found during the check sequence, check the A.A.P.P. fuel pump.

5. <u>Turbine Surges During Steady Running</u>

A. Check the air intake and exhaust for obstruction.

B. If no other fault is apparent, check A.A.P.P. fuel pump

6. <u>Low Oil Pressure Indicated</u>

A. Check oil sump for correct oil level and correct grade of oil

B. Check all pipes, unions for leaks, security, etc.

C. Check oil pressure transmitter and its associated electrical circuit.

D. If no faults are found, the internal oil system is suspect and the A.A.P.P. must be removed for servicing and repair.

6. <u>J.P.T. exceeds operating limitations during steady running (no load) condition</u>

A. Check air intake and exhaust for obstruction.

B. Calibrate the J.P.T. gauge and exhaust thermo-couple.

C. Remove the blower and oil cooler assembly and turn turbine by hand. If the turbine or its auxiliaries are partially seized, the A.A.P.P. must be removed for servicing and repair.

7. Continuous Drain from Manifold whilst Engine is Pulling

A. If fuel is draining, disconnect the burner drain pipe at the burner drain union- fit slave drain pipe in lieu and run unit. Presence of fuel indicates failure of the burner H.P. cock spindle seals, but absence of fuel indicates failure of the fuel pump drive shaft inner seal.

B. If engine oil is draining, disconnect the hydraulic pump drain pipe; fit slave drain pipe in lieu and run unit. Presence of engine oil indicates failure of the hydraulic pump drive shaft outer seal.

C. If hydraulic fluid is draining, examine the hydraulic couplings in the A.A.P.P. central beam top tray; satisfactory couplings indicate a failure of the hydraulic pump device shaft inner seal.

8. Turbine Stalls when Electrical and/or Hydraulic loads are applied

A. Check the air intake and exhaust for obstruction.

B. Disconnect the L.P. fuel supply pipe at the fuel pump and check the fuel flow into a calibrated container (time with stop watch).

C. Check electrics to the burner actuator.

D. Remove blower and oil cooler assembly and turn turbine by hand. If turbine seized, the A.A.P.P. must be removed for repair.

E. If no faults found, suspect that the compressor and diffuser are excessively dirty or that the fuel pump and/or the temperature control are at fault.

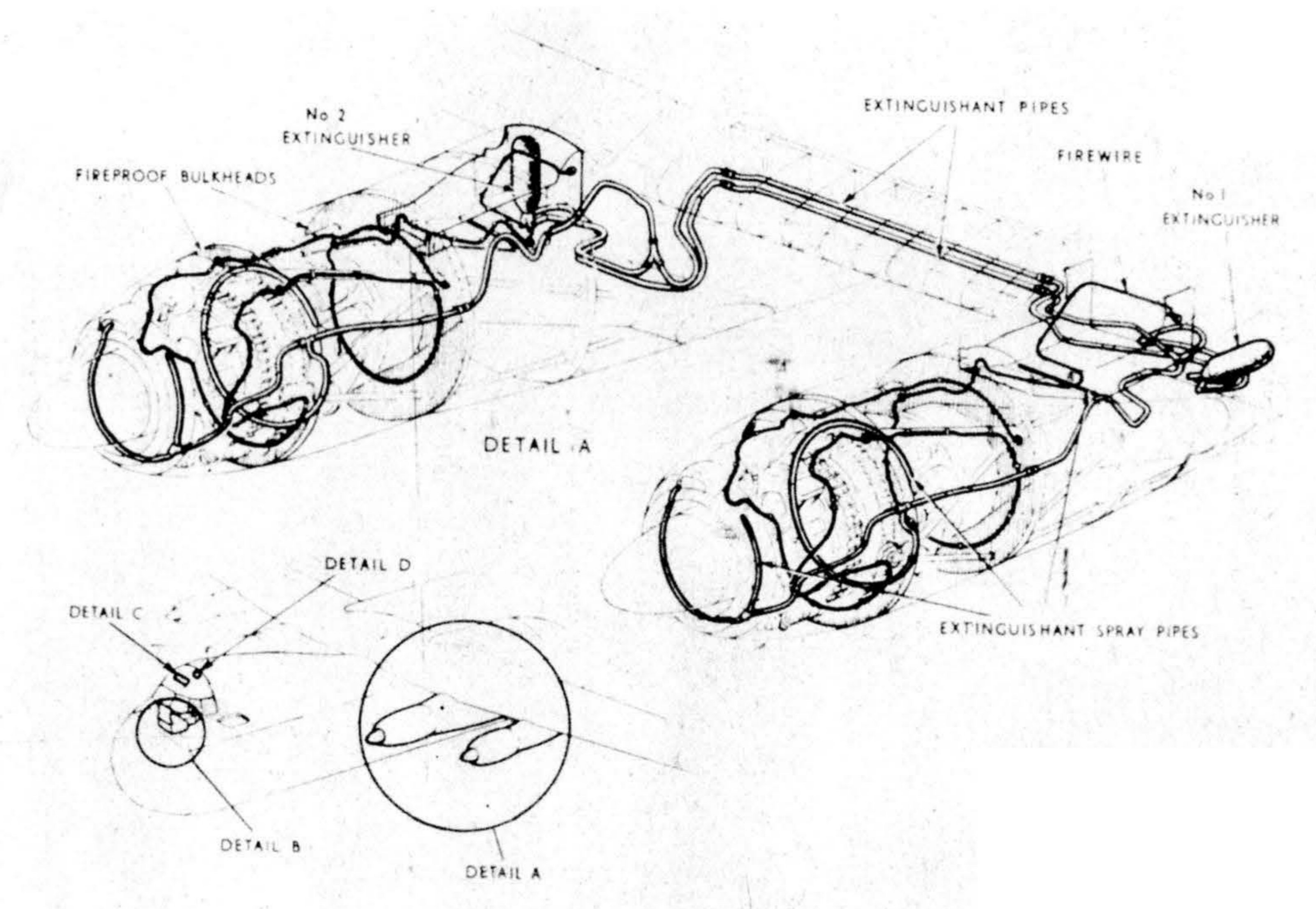
9. If the turbine fails to accept electrical load and the J.P.T. remains within operating limits, check all relevant electrical circuits. If turbine fails to accept a hydraulic load and the hydraulic system is correctly filled, suspect the hydraulic pump. Should a replacement pump fail to rectify the fault, check the aircraft hydraulic system.

FIRE
PROTECTION

SECTION 6

FIRE PROTECTION

LIST OF CONTENTS



Engine fire protection system

CHAPTER 1

ENGINE FIRE PROTECTION

1. Warning System

A. General

A severe engine overheat condition or an outbreak of fire is indicated by two warning lamps per engine, one of which is located on the centre coaming panel, and the other on the centre roof panel. A further warning lamp for each engine is located on the Centre Pedestal. It is operated by a Fire Detector in the Engine Breather Pipe, or by the overheat thermocouple in the jetpipe shroud.

* B. Components, Firewire System

Graviner flexible "Firewire" sensing elements are situated in the Engine Nacelles, and the circuit is controlled by Relay Boxes.

(1) Sensing Element

Th
t
The Sensing Element consists of a stainless steel capilliary tube, through which passes a nichrome conductor. Between the capilliary tube which forms the outer electrode, and the inner nichrome electrode is a graded glass-like thermistor insulating material. This material possesses a negative temperature coefficient of Resistance.

(2) Relay Boxes

The Relay Boxes are hermetically sealed units, and are mounted in the Undercarriage Nacelles. Each Unit contains the following components.

(a) Transformer - nominal output 26 V

(b) Full Wave Rectifier

(c) Relay - controlling supply to the warning lamps

(d) Test Relay - remotely operated by Test Switch mounted on Centre Roof Panel.

Relay Boxes are supplied from a 115V 400 cycle sources, via 2.4 amp fuses
N°s 1 & 4 engines supplied by N°4 inverter N°2 & 3 supplied by N°5 inverter

C. Operation

The transformer output is applied across the full wave rectifier, and the rectified output is used to operate the relays. Under normal temperature conditions, the system is open circuited by the insulating material in the sensing element. With increased temperature, the resistive property of the material deteriorates, and a value is reached which will permit the flow of sufficient current to energise the operating relay. Through the closed contacts of this relay, a supply is fed to the Fire Warning Lamps. Any subsequent reduction of temerature will be reflected in a recovery of Sensing Element resistance, and the Warning Lamps will be extinguished. The warning lamp supply also operates the Centralised Warning System.

2. Fire Extinguisher System

A. Fire Extinguishers

One Graviner dual headed extinguisher bottle is provided for each engine. The bottles contain methyl bromide, and are mounted behind the nacelle fire proof bulkhead.

Two spray rings are fitted to each engine. One around the intake cowling spraying rearwards to blanket the fuel system, and one around the end of the hot zone spraying inwards to blanket combustion chambers and the nozzle box. A further spray pipe serves the accessories gearbox.

The four bottles are so interconnected that the contents of two bottles may be delivered at any one engine if the situation should warrant emergency action.

In the event of fire, the Fire Warning Lamp on the Centre Coaming Panel for that engine will be pushed, and the bottle discharged. Should the amount of extinguishant prove inadequate, the contents of the second bottle can be dishcarged into the faulty engine by pushing the Emergency Fire Warning Lamp on the Centre Roof Panel.

B. Indicator Fuzes

Mounted on the aft face of the main U/C doors, these fuzes provide indication of the fact that a bottle has been discharged.

The fuze consists of a plastic cylindrical tube, which houses a pyrotechnic match head and quantity of bright red inert powder.

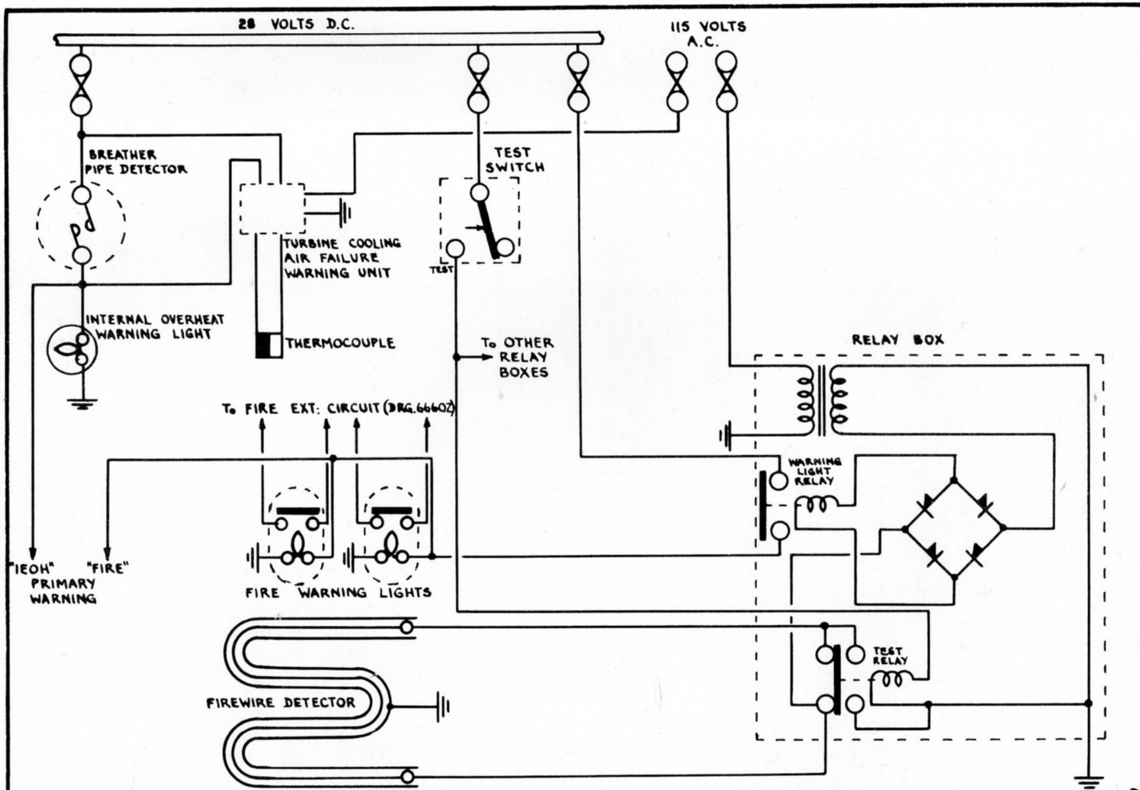
The match head is connected in parallel with the extinguisher head, and the assembly is surmounted by a transparent perspex dome.

When the match burns, a pressure sufficient to rupture a sealing disc is generated, and the red powder is sprayed over the perspex dome. Rupturing of the sealing disc also breaks the electrical circuit to the fuze, thus ensuring that electrical continuity does not exist after firing.

* Firewire operating range 180°C to 300°C

Breather detectors operate 180°C to 300°C

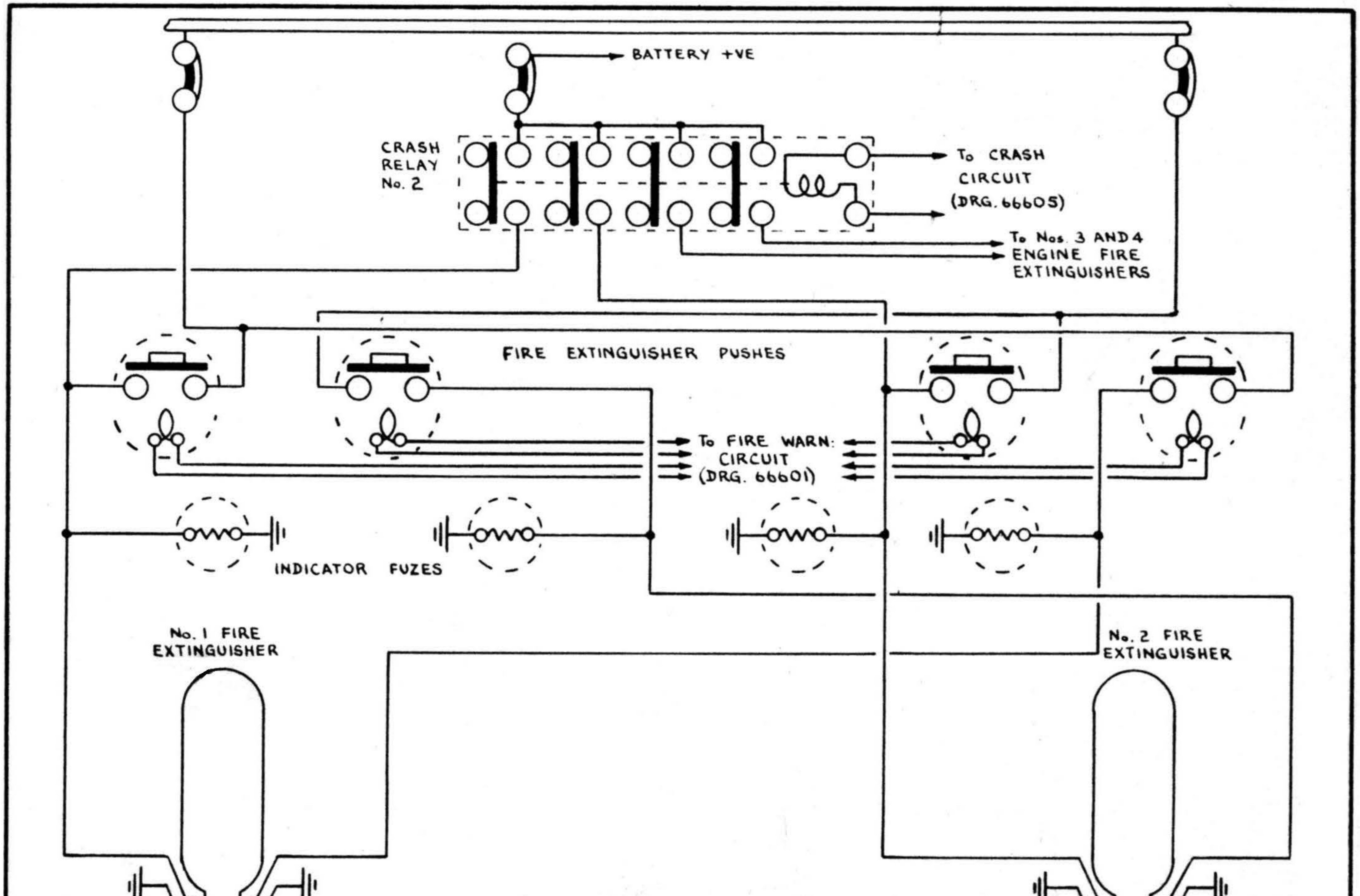
Turbine cooling failure at 350°C



ENGINE FIRE WARNING.

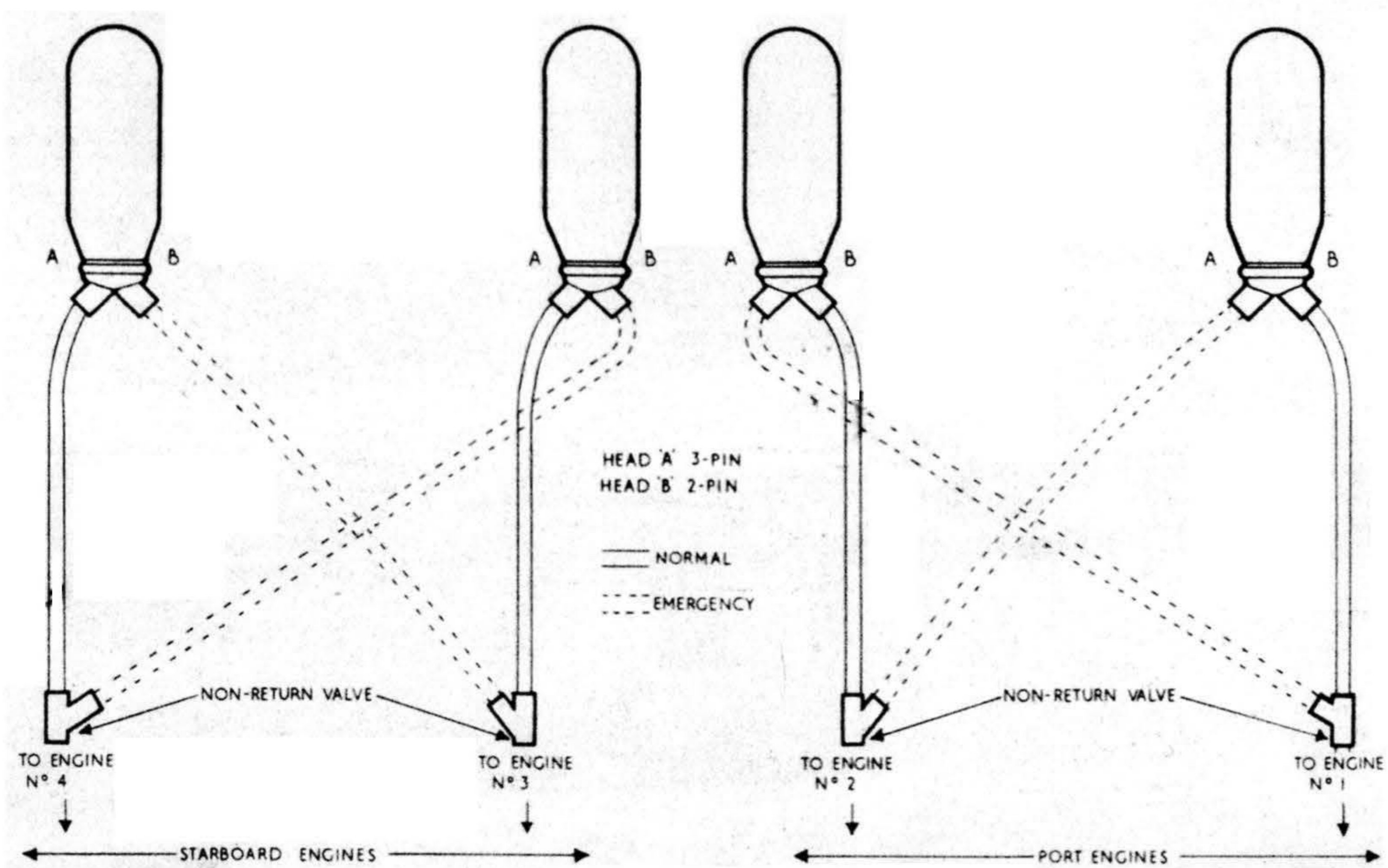
(ONE ENGINE ONLY, OTHERS SIMILAR)

10999



ENGINE FIRE EXTINGUISHERS.

2604



Piping system diagram

Turbine Cooling Air Failure
Warning Amplifier
23 FWU/1/350

The purpose of this amplifier is to detect any rise of temperature in the region of the High Pressure Turbine Disc due to the failure of the cooling air blast over this region of the Dart engine. The detector, consisting of a Chromel/Alumel thermo couple, is situated up-stream of the High Pressure Turbine Disc.

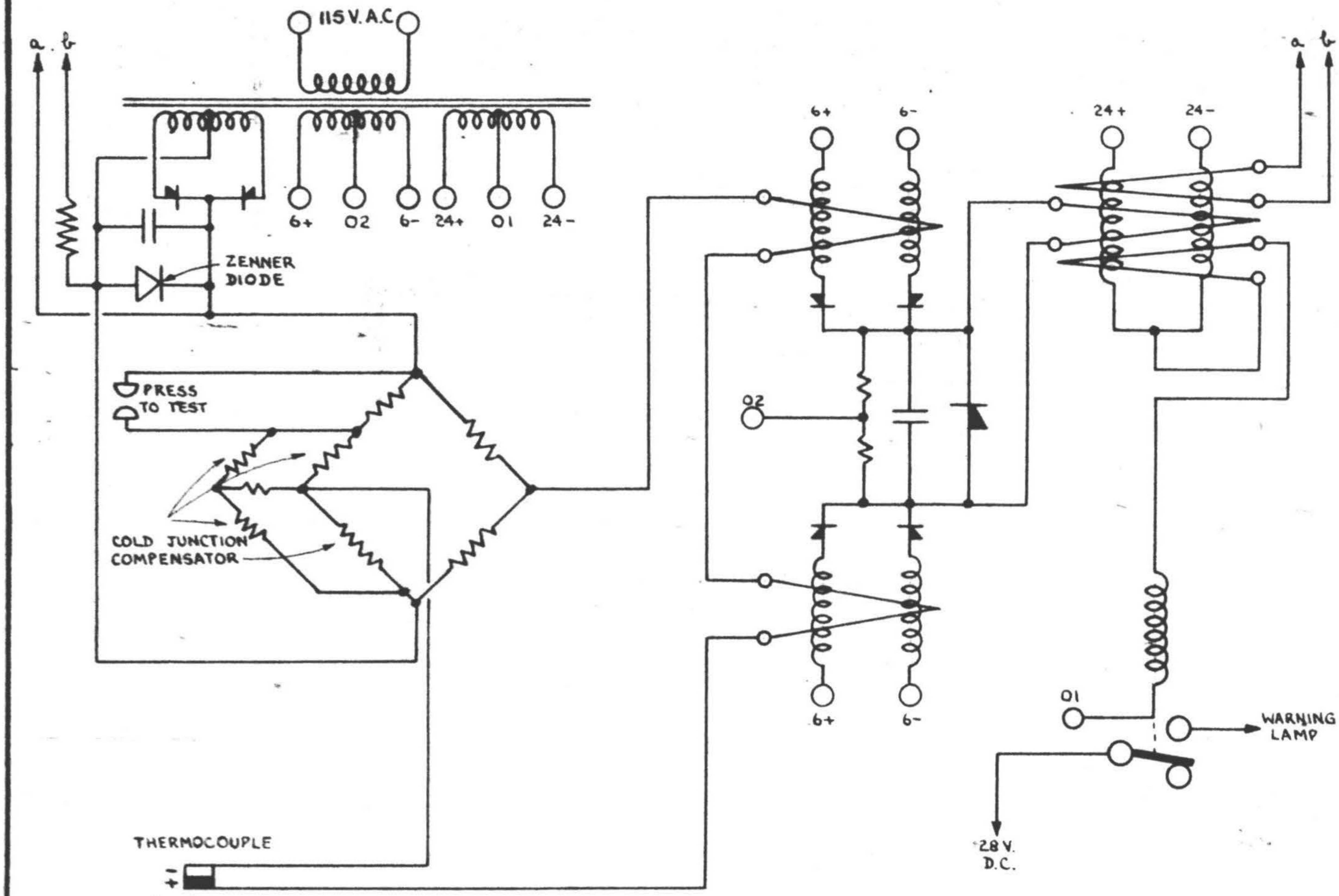
When the air temperature in this region reaches the specified temperature (this temperature being indicated by the final suffix of the code, i.e. /350) a relay within the unit operates a warning light, or feeds a signal to any central warning system installed.

The E.M.F. produced by the Thermo Couple is compared with a Cold Junction Compensator, and is thus made to represent temperature above 0°C. It is then compared with a stable reference voltage, produced from within the unit. The difference between these two voltages, either positive or negative, is amplified by a single stage magnetic power amplifier, and then fed to a single ended magnetic output stage. This output stage is biased so that it will only operate from a positive input, and to prevent a large negative signal from driving the output stage down too far a diode limiting device is used to limit the negative signal. A positive signal will trigger the output stage when the Thermo Couple E.M.F. rises above the reference E.M.F. and thus becomes positive. The output stage operates a micro relay which then switches on the warning lamp.

"press to test" lamps are provided on the centre pedestal which, using the continuity of the Thermo Couples, suggests an increase of temperature to the amplifier to about 450°C. This will of course cause the amplifier to operate.

Tolerances

Operating Tolerance:	± 5°C i.e. the amplifier will switch the warning lamp on and off within 5° either side of its stated operating temperature.
Amplifier Hystersis:	About 1½°C.
Power Supply Tolerances:	115V A.C. ± 10% 400 c/s ± 10%
Ambient Temperature:	+60°C to -30°C
Recommended warming up time:	5 minutes.

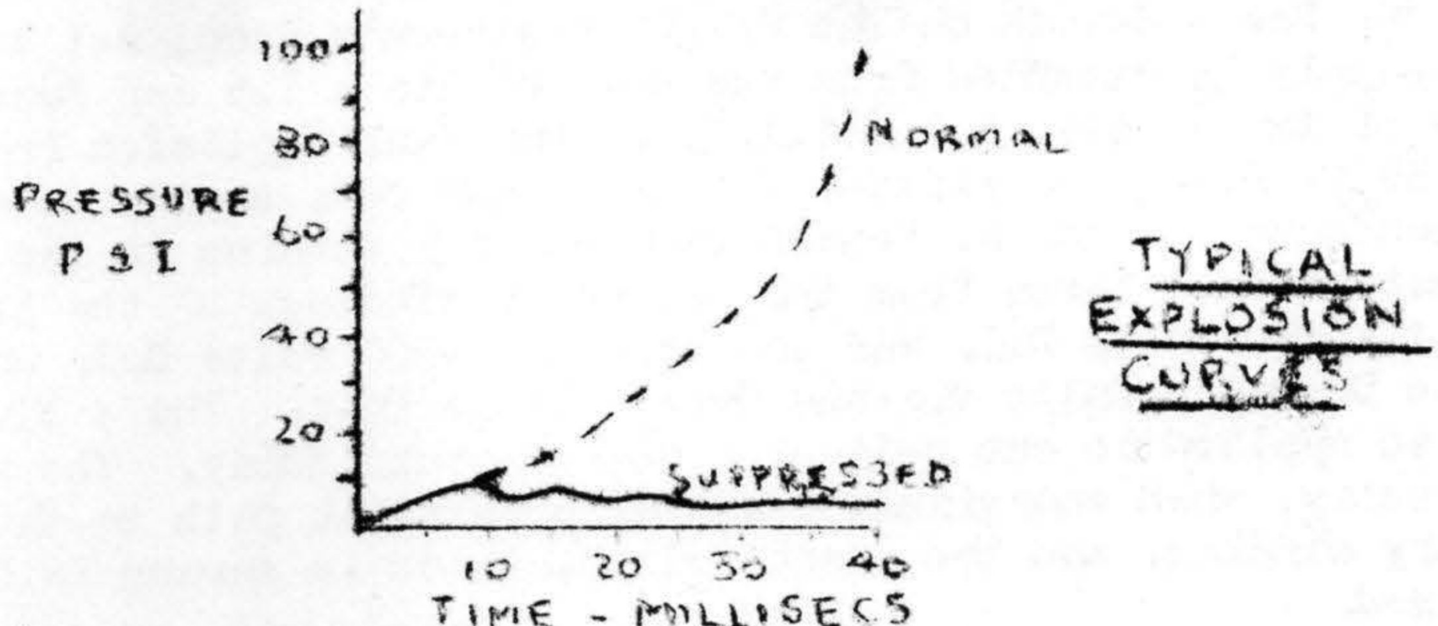


TURBINE COOLING AIR
FAILURE WARNING UNIT

FUEL TANK EXPLOSION PROTECTION

1. General

An explosion in a fuel tank is not an instantaneous development of pressure; in the first few milli-seconds, the rate of pressure-rise is very low. Thus, if the early development of the flame can be detected, the explosion may be stopped before the more rapid pressure-rise begins.



The system comprises three basic elements designed to take advantage of this short time before the destructive pressure is built up.

A. A photocell detector for visual detection of the flame.

B. A tubular metal suppressor unit containing a quantity of suppressing agent and an electric detonator for rapid dispersal of the suppressant.

C. A power pack fed from the aircraft supply to energise the detectors and detonators.

2. Components

A. Detector Unit - Consists essentially of a highly-sensitive photo-electric cell combined with a firing circuit.

B. Indicator Fuze. - Consists of a matchhead fuze, surrounded by a red-oxide powder which is deposited over the fuze window to indicate operation.

C. Suppressor - Virtually a cylindrical metal can with a detonator in the centre, and containing suppressant. The can walls are scored, so that when the suppressor is fired, the walls fold back like petals.

D. Detonator Pack - A thin plastic tube, with the detonator centrally disposed, bridged between a plug pin at one end and a socket at the other.

E. Power Pack - Contains transformer, rectification and stabilising circuita, converting the aircraft 115V, 400 c.p.s. supply to outputs of + 150V and - 500V, D.C.

D. Testing

Test lamps are fitted in each tank, and a test socket is mounted adjacent to each tank. To test the system, the dummy plug in the test socket should be removed and a Graviner Test Kit connected in its place. This breaks the detector output to the detonator, and connects it to the test kit. A switch on the test kit, when set to ON, causes the test lamp in the tank to be illuminated, which will cause the Detector to be triggered, and Neon indicators on the test kit will be illuminated.

SMOKE DETECTION

1. General

A Smoke Detector is fitted in the Equipment Bay, and operates a lamp on the Flight Engineer's Panel. A sprung-to-centre 'OFF' RESET/TEST switch is also mounted on the Engineer's Panel. The Smoke Detector also operates the F.F.W. light on the primary warning system.

2. Description

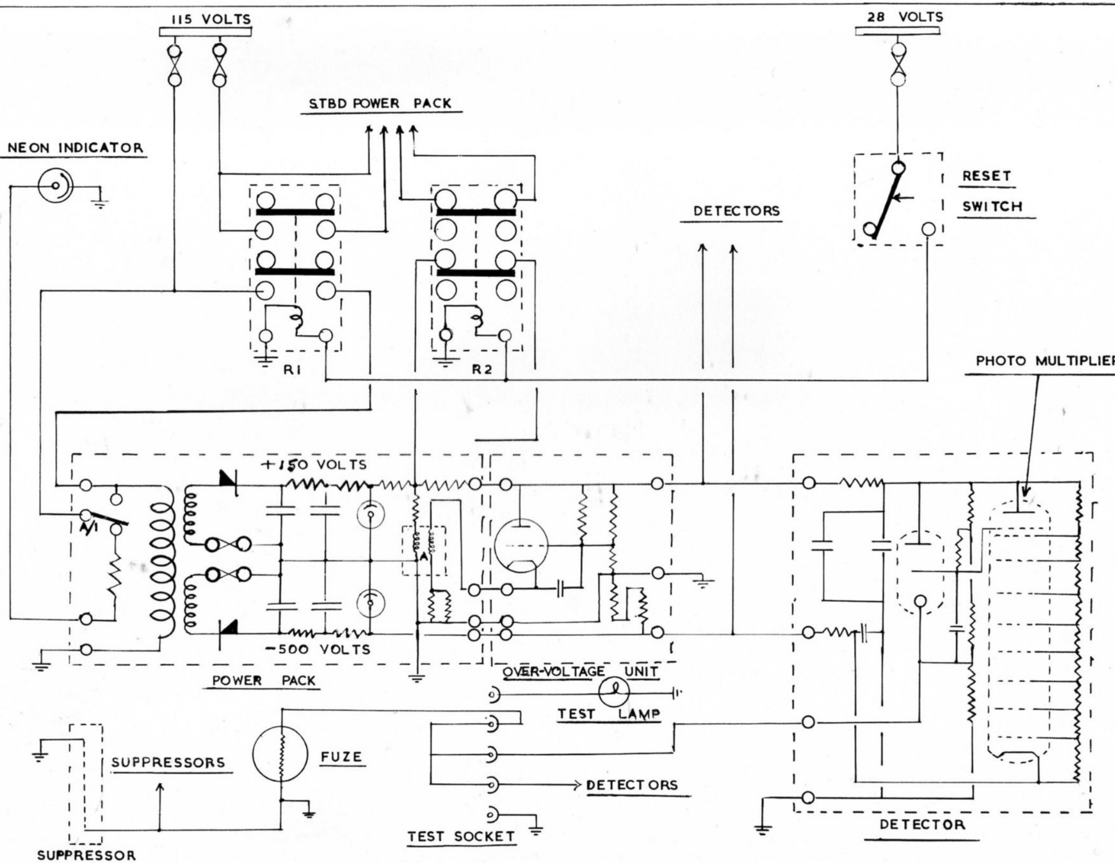
The unit is divided into three compartments comprising the Detection Chamber in the centre, a Lamphouse at one end and a Sensitive Relay Chamber at the other.

The Projector Lamp is supplied from Bus Bar 'B' via a 2.4 amp fuse and a resistance in the Detector. The beam of light produced is directed into the Detection Chamber by a lens, and falls on a light-absorbing screen at the far end which absorbs most of the light from the beam, thereby reducing stray light to a minimum.

The Detection Chamber houses two P.E. cells, the Detecting Cell having its sensitive surface exposed parallel to the light-beam axis, and the Balancer Cell being mounted upside down in such a position that it receives light directly from the Projector Lamp through a hole below the lens. The cells are connected in series and the coil of the Sensitive Relay forms a bridge network with the two cells.

If all extraneous light is excluded from the Detection Chamber, the quantity of light falling on the Balancing Cell will cause its output to match that of the Detector Cell, and the Sensitive Relay is de-energised. When smoke enters the Detection Chamber, it increases the stray light by reflection. This will increase the output of the Detector Cell but will not affect the Balancing Cell. The current in the Sensitive Relay will now cause it to close; it will be held closed by a small permanent magnet. The closed contacts feed a supply from pin B to the coil of the Power Relay which, when energised, passes the same supply to the Smoke Warning Lamp.

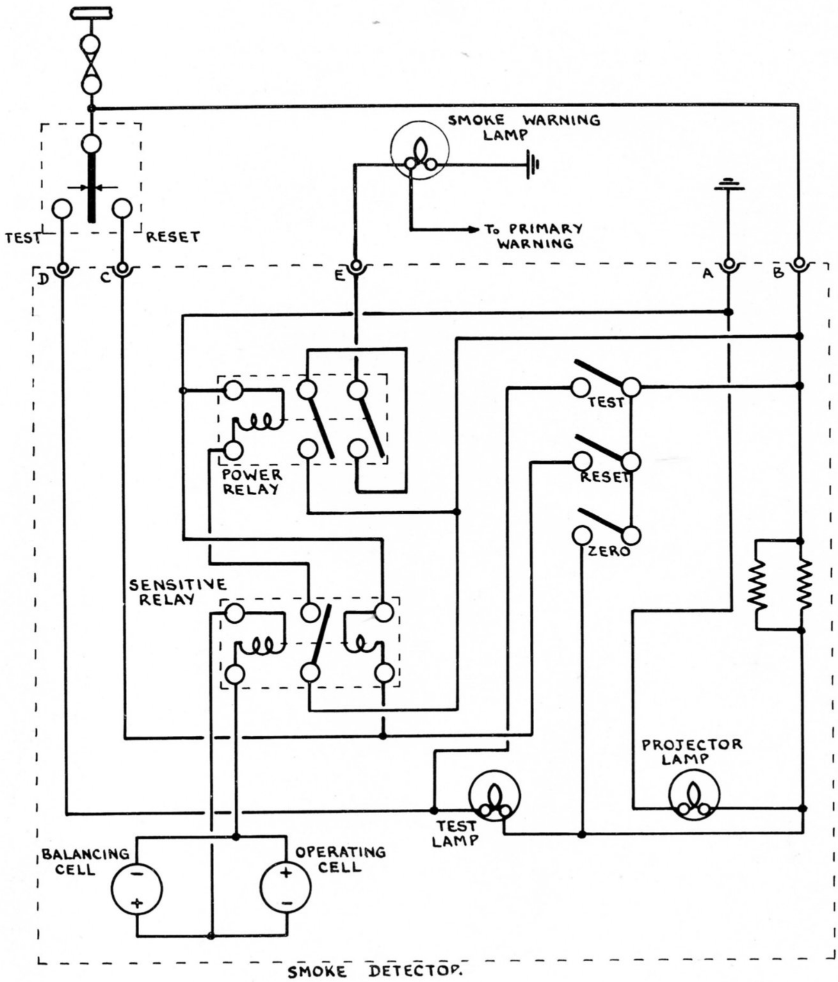
Selecting TEST on the RESET/TEST switch illuminates the Test Lamp across the resistance in the Projector Lamp circuit. This increases the stray light in the Detection Chamber, and causes the Sensitive Relay to close, making the Warning Lamp circuit. Selecting RESET on the switch energises the reset coil of the Sensitive Relay, and breaks the magnetic lock.



FUEL TANK EXPLOSION PROTECTION

E0666

66604



SMOKE DETECTION.

CRASH CIRCUIT

A. Pre Mods. 85 and 90

1. Introduction

Six Inertia Switches are fitted in the following locations:-

Two in each outboard nacelle.
Two below freight floor in the vicinity of the inverter rack.

These switches operate at a deceleration of 3G.

2. Operation

In the event of any pair of inertia switches (any one positive, and any one negative) operating, three crash relays in the battery junction box become energised, and are "locked-on" by a supply through contacts of Crash Relay No.1, and the ISOLATE/NORMAL switch located at the Centre Roof Panel. Blue lamps on the Centre Roof Panel indicate the operation of positive or negative Inertia Switches.

A. Crash Relay No.1.

Contacts 2-2 on breaking, de-energise the battery isolate relay.
Contacts 5-5 on making, supply Crew Emergency Lighting direct from battery.
Contacts 7-7 on making, supply Cabin Emergency Lighting direct from battery.
Contacts 8-8 on breaking, interrupt the supply to Normal Cabin Lighting.

B. Crash Relay No.2.

Odd numbered contacts on making, supply the engine extinguisher heads direct from the battery.

C. Crash Relay No.3.

Contacts 1-1 on making, supply the A.A.P.P. fire extinguisher head direct from the battery.

3. Reversion of all Inertia Switches to the "un-made" condition, and operation of the NORMAL/ISOLATE switch to "ISOLATE" will de-energise the Crash Relays.

B. Pre-Mod. 85, Post -Mod. 90

The six inertia switches are located as in A.1. above, but modicication 90 introduces a facility for tripping all generators off-line in the event of a crash. Four additional relays mounted in the battery junction box are energised at the same time as Crash Relays 1, 2 and 3. Each of these relays, on being energised, extends a supply from the battery positive to the trip coil of the respective generator reverse-current circuit-breaker. The R.C.C.B's are tripped, disconnecting the generators from the bus-bars, and also breaking their field supply. The A.A.P.P. generator R.C.C.B. is tripped in a similar manner by contacts 3-3 of crash relay No.3.

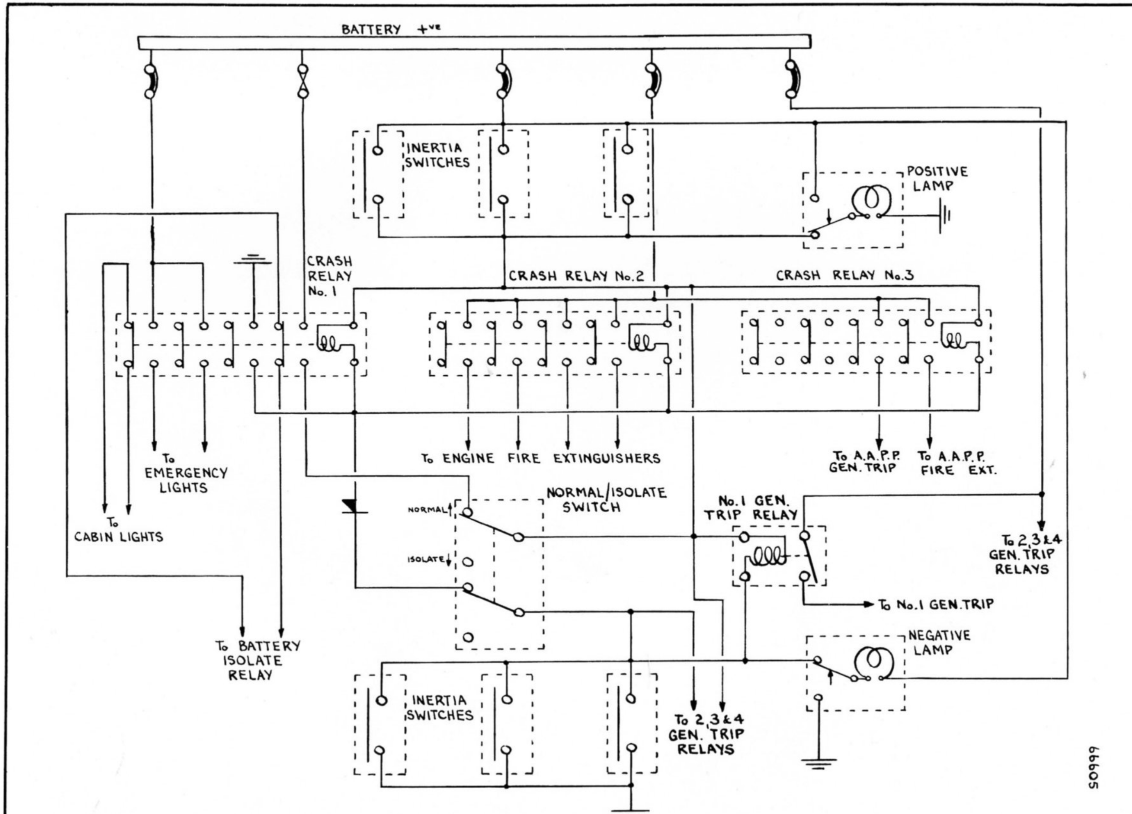
C. Post-Mods. 85 and 90

1. Introduction

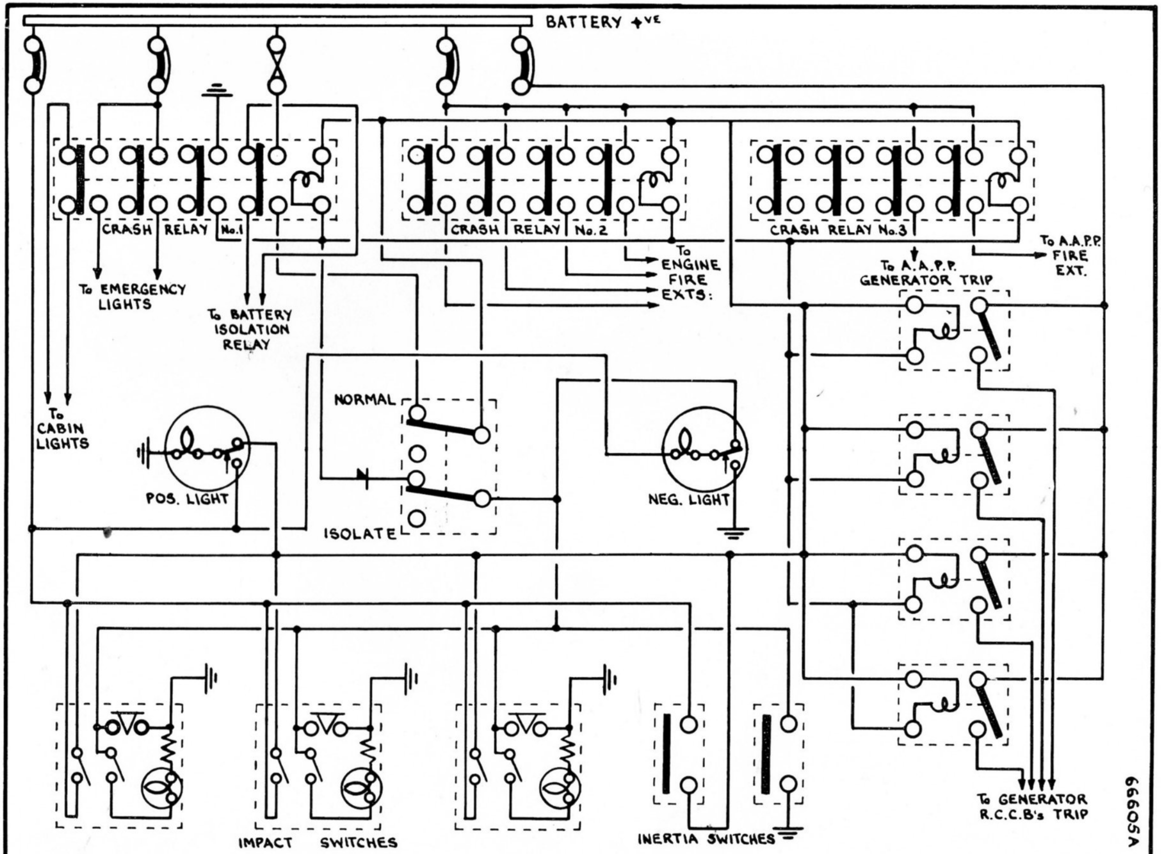
Modification 85 removes the inertia switches from the outboard engine nacelles, and introduces three "Pyrene" impact crash switches mounted below the fuselage. These are connected in parallel with the two remaining inertia switches, and any one impact switch will operate the crash circuit.

2. Impact Crash Switch

The crash switch consists of a cathodeon frangible switch, which will be made when its glass envelope is broken, and two micro-switches. Protruding from the lower part of the crash switch is a red lever, which through a toggle link mechanism is connected to a red flap. If the flap is free to move, operation of the lever will cause the flap to extend, and will also make the two micro-switches. This action completes the circuit from battery positive via the crash-relay coils and a test-lamp and resistance in the crash switch to earth. The test-lamp, being illuminated, indicates that the crash circuit is complete, but due to the resistance the relays will not be operated. Under crash conditions, the flap movement is restricted, and when the lever is operated, the toggle link mechanism will hinge and cause the breaking ring to fracture the frangible switch, short-circuiting the test-lamp and resistance, thus energising the crash relays.



CRASH CIRCUIT. (POST-MOD 90, PRE-MOD 85)



CRASH CIRCUIT.

(POST-MODS 85 AND 90)

CHAPTER 2

SERVICING

FIREWIRE

1. Removal

During engine changes, it is recommended that the two Firewire connections are uncoupled at the airframe firewall, and the Firewire lengths removed, when the engine is placed on its stand.

To enable the 10 ft. length of Firewire to be removed from the Accessories Gearbox casing, it will first be necessary to remove the Accessories Gearbox.

A. Ensure electrical supply is OFF.

B. Remove Accessories Gearbox.

C. Disconnect Firewire at bulkhead fitting on aft face of gearbox casing, and Firewire joint at airframe firewall.

D. Remove clips and lift 10 ft. length of Firewire from gearbox casing.

E. Remove Firewire lengths in sequence working from connection at airframe firewall around power plant to the bulkhead fitting on the airframe firewall.

F. After removal of fire detector from breather elbow, seal aperture with masking tape.

G. If a joint is to remain disconnected for a long time, replace both transport caps and 'O' rings until re-connected.

N.B. THE CLIPS ARE TO SUPPORT FIREWIRE ONLY. IT WILL BE NECESSARY TO PROVIDE ADDITIONAL SUPPORT WHEN UNSCREWING., TIGHTENING OR LOCKING FIREWIRE CONNECTIONS.

2. Preparation for Installation

A. Ensure that storage conditions and acceptance checks have been fulfilled.

B. Remove and discard copper asbestos washer, D.592, from each connection, and fit copper 'S' washer in its place. In addition, insert split bronze washer between connector and gland nut.

N.B. WHEN REMOVING TRANSPORT CAP, ENSURE THAT SILASTIC 'O' RING IS ALSO REMOVED. THIS IS FOR TRANSPORT AND STORAGE ONLY, AND UNDER NO CIRCUMSTANCES MUST THE SILASTIC RING BE RETAINED WHEN FIREWIRE IS INSTALLED.

C. When connecting elements, make a very light application of Silicone grease, Type MS.4, to end fittings, and ensure presence of sealing washer, D.2004, and anti-friction washer, D.2003. At each joint breakdown, a new sealing washer must be fitted.

3. Installation

A. Connect Firewire at bulkhead fitting on airframe firewall. Tighten and wire lock. Torque load to effect seal is 80 to 100 lb/ins.

B. Fit Firewire lengths and fire detector, taking care to clip at 9 inch intervals, and that slot in rubber bush is opposite clip mounting face.

C. Connect 10 ft. Firewire length to airframe firewall connection and bulkhead fitting. Clip at 9 inch intervals.

D. Install accessories Gearbox.

4. Functional Test

A. Connect electrical ground supply.

B. Operate Nos. 4 and 5 Inverter switches to ON. Check FAIL lights are extinguished.

C. Set Fire Test switch to TEST. All eight fire warning lights, and the primary warning system should be operated.

D. Release Fire Test switch, and switch off inverters.

5. Inspection/Check

A. On pre-flight inspection, check system as detailed on para. 4.

B. At periodic inspections, check Firewire elements for chafing, corrosion or other physical damage. Inspect support bushes D.2087, for signs of deterioration.

C. Carry out the following checks at specified intervals :-

(1) Disconnect power supplies at bulkhead fittings.

(2) Remove wire-locking and disconnect all Firewire elements.

(3) Using a 250V megger, check resistance between centre conductor and outer tube. This must exceed 1 megohm, at normal ground temperature. DO NOT MEGGER AT OTHER THAN NORMAL GROUND TEMPERATURE.

(4) Check continuity and resistance of centre conductor.

(5) Using a 250V or 500V megger, check insulation resistance of each bulkhead fitting. This must exceed 20 megohms at normal ground temperature.

(6) Visually inspect ceramic insulating bush in bulkhead fitting; ensure it is not cracked, and that the surface of the bush is clean.

(7) Check condition of terminal and end fitting attachment threads and inspect end fitting attachment bore for cleanliness.

N.B. ANY LENGTH OF ELEMENT WHICH HAS BEEN SUBJECTED TO FIRE ON AIRCRAFT MUST BE RETURNED TO "GRAVINER" FOR INSPECTION AND REPAIR.

SERVICING

RELAY BOX AND BASE UNIT

1. Removal

   A. Ensure electrical supply is OFF.

   B. Unscrew knurled nut, and lift relay box from base unit.

   C. Remove T.B. covers and disconnect wiring.

   D. Remove three 2BA bolts, to free base unit.

2. Installation

   A. Carry out acceptance checks.

   B. Mount base unit, secure with three 2BA bolts.

   C. Connect wiring to correct terminals, and fit T.B. covers.

   D. Position relay box on base unit, and tighten knurled nut.

3. Functional Test

   Carry out test as detailed in Firewire functional test.

4. Inspection/Check

A. Carry out acceptance check as follows :-

(1) Connect variable resistance, adjustable between 200 and 5,000 ohms to terminals A and B. Cornect a switched 24V positive to terminal 1; 24V positive to terminal 4: 24V negative to terminal C; 115V, 400 cps. across terminals 2 and 3; 24Vwarning lamp between terminal 5 and 24V negative.

(2) Set resistor at 1250 ohms, and make switch. Warning lamp must not light.

(3) Set resistor at 500 ohms, and make switch. Warning lamp must light.

(4) Without opening any circuit, or breaking switch, increase the resistance until the warning lamp is extinguished. At this condition, the resistance must be 1300-5350 ohms.

B. Examine relay box and base unit for damage.

C. Carry out insulation test between base unit terminals to frame, and relay box contacts to frame. Minimum reading - 20 megohms.

D. Ensure base unit contact pins move freely, and spring-loading on all pins is approximately the same.

E. Remove circlips retaining plastic cover over base unit bottom, and examine internal wiring for cleanliness and deterioration.

SERVICING

ENGINE FIRE EXTINGUISHER

1. General

Servicing of discharged extinguishers or of those below specified weight is by replacement only. Before installation, check weight, shelf life and that acceptance checks have been carried out.

N.B. IF AN EXTINGUISHER HAS BEEN DISCHARGED, DO NOT INHALE THE GAS. THIS IS NON-IRRITANT, BUT HIGHLY POISONOUS WITH A DELAYED EFFECT WHICH MIGHT BE FATAL. IF A DISCHARGED EXTINGUISHER IS SUSPECTED OF HAVING BEEN FIRED WITHOUT OPERATION OF THE APPROPRIATE CREW COMPARTMENT SWITCH, DO NOT RECONNECT CARTRIDGE ELECTRICAL PLUGS TO REPLACEMENT EXTINGUISHER BEFORE MAKING CONCLUSIVE ELECTRICAL TESTS.

Before the extinguishers can be removed, an access panel at each inboard nacelle, and a cowling panel at each outboard nacelle will have to be removed.

2. Removal

A. Check indicator windows to obtain first indication of extinguisher discharge.

B. Remove panel to expose extinguisher.

N.B. ENSURE ALL FOUR SWITCHES ARE OFF IN CREW COMPARTMENT.

C. As second check on discharge, observe that indicator pin protrudes about $\frac{1}{8}$ in. from one extinguisher head.

D. Disconnect plugs from both extinguisher cartridges.

N.B. DO NOT PROCEED UNTIL THIS HAS BEEN DONE.

E. Remove wire-locking, and disconnect both extinguisher pipes (A and B heads) Blank off pipes.

F. Remove safety locking pin from each restraining strap, release over-centre links, and remove extinguisher from cradle.

N.B. IF THE EXTINGUISHER IS TO REMAIN OUT OF THE AIRCRAFT FOR ANY LENGTH OF TIME, IT IS RECOMMENDED THAT CARTRIDGE UNIT BE REMOVED, AND PLASTIC CAP FITTED.

3. Preparation of Replacement Extinguisher

N.B. EXTINGUISHER CARTRIDGES CONTAIN GUNPOWDER. DO NOT REMOVE CARTRIDGES FROM THEIR POLYTHENE BAGS, NOR RED PLASTIC CAPS AND PETROLITE WASHERS FROM CARTRIDGE APERTURES IN EXTINGUISHER HEADS UNTIL IMMEDIATELY BEFORE FITMENT OF CARTRIDGE TO EXTINGUISHER.

A. Remove disposable red plastic cap and petrolite washer from each cartridge.

B. Insert cartridge unit, ensuring that silastic 'O' ring is in position.

C. Fit new tab washers, tighten nuts and lock.

4. Installation

A. Remove blanking caps or masking tape from extinguisher and pipe connections.

B. Check security of extinguisher cradle, and lift extinguisher into position.

N.B. PIPE CONNECTIONS TO A AND B HEADS SHOULD BE MADE FINGER-TIGHT BEFORE EXTINGUISHER IS FINALLY CLAMPED IN POSITION.

C. Adjust screw until straps are tight.

D. Test the over-centre links and re-fasten.

E. Tighten knurled lock-nut, and refit locking pin.

F. Tighten and wire-lock pipe connections to A and B heads.

N.B. ENSURE ELECTRICAL SUPPLY IS OFF, AND SWITCHES IN CREW COMPARTMENT ARE OFF.

G. Connect up two electrical plugs to cartridge sockets.

H. Restore electrical supplies as necessary.

5. Inspection/Check

A. Fire Extinguisher Bottles

A regular check must be made to ensure extinguishers have not discharged. This can be done by visual check that :-

(1) The indicator pin on a junction box is not protruding.

(2) The indicator fuze cover is clear.

At least annually, extinguishers should be removed, and examined for chafing or other external damage. They should be weighed, and weight must agree, to within ± 1 oz., with that stamped on the operating head. The stamped weight refers to extinguisher without cartridge units, but including transport caps. If desired, cartridge units may be installed, and allowance made for their weight. Discharged extinguishers must be returned to manufacturer or approved organisation for overhaul.

Extinguishers must be returned to manufacturer or approved organisation for overhaul after 5 years.

B. Cartridge Firing Units

To test a cartridge, remove it from extinguisher, and mount it on a suitable fixture with the charge end shielded, but unrestricted, in case of accidental firing.

(1) Using a 250V megger, check the insulation resistance between each pole and earth. This must be not less than 20 megohms.

(2) Check fuze resistance by connecting a safety ohmeter across poles. The reading should be 5 - 6 ohms.

A cartridge unit must be returned to an approved organisation for renewal of powder charge 2 years after removal from its sealed packing, or 5 years after date of manufacture, whichever is the sooner.

SERVICING

INDICATOR FUZES

1. Removal

   A. Ensure electrical supplies are OFF.

   B. Remove panel covers.

   C. Unscrew fuze cover, and remove fuze.

2. Installation

   A. Ensure that acceptance checks and storage conditions have been fulfilled, and that shelf life has not been exceeded.

   B. Ensure that fuzes are continuous. See para.3.

   C. Position fuze in holder, and screw on fuze cover.

   D. Replace panel covers.

3. Inspection/Check

   A frequent visual inspection is necessary to ascertain whether a fuze has operated, thus indicating extinguisher discharge.

   Fuse continuity should be checked at regular intervals as follows :-

   A. Remove wires to fuzeholder, leaving fuze in position.

   B. Measure resistance of fuze with a safety ohmeter. This should be 10-16 ohms. IT IS ESSENTIAL THAT THE TEST CURRENT DOES NOT EXCEED 13mA.

   Fuzes must be replaced every 2 years.

SERVICING

SMOKE DETECTOR

1. 50 Hour Inspection

   A. Check balance of Cell and Relay Bridge by raising zero switch, and noting any movement of Sensitive Relay contact from zero position. Any out-of-balance indicated must be neutralised by turning the Balancer Screw in the same direction as that in which the contact needle is required to move the return to zero.

   B. Inspect Projector Lamp envelope shroud, to ensure no condensation between shroud and lamp envelope. If found, lamp must be replaced. Ensure lamp shroud is undamaged.

2. 200 Hour Inspection

A. Remove long inspection cover and brush light screen to remove dust. Clean windows of Cells and projection lens; ensure no dust is left inside Detection Chamber. Clean projector lamp shroud, and inspect for damage.

B. Check as in 1 (A).

C. Operate Test/Reset Switch, and check operation with all covers in position.

N.B. EVEN WITH ELECTRICAL SUPPLY OFF, DETECTOR WILL "FIRE" ON REMOVAL OF SIDE COVER, AND CANNOT BE RESET UNLESS SUPPLY IS RECONNECTED.

3. 500 Hour Inspection

A. Ensure that no blackening of lamp envelope has occurred in the Projector Lamp.

B. Ensure that no condensation has formed between Projector Lamp envelope and its integral shroud which must be in an undamaged condition.

C. Repeat 200 Hour Inspection.

4. After 2,000 hours, the Detector should be removed from the aircraft, and given complete workshop test.

CHAPTER 3

COMPONENT LIST

ITEM	REF.NO.	NO.OFF	LOCATION
Fire Warning Test Switch	5CW/6433	1	Centre Roof Panel (P24)
Firewire Relay Box	5CZ/5917	4	U/C Nacelles
Firewire Relay Box Base	5CZ/5918	4	U/C Nacelles
Firewire Detector	D.2370/30	4	Engine Nacelles
	5CZ/5835	8	Engine Nacelles
	5CZ/5836	16	Engine Nacelles
	5CZ/5837	4	Engine Nacelles
Fire Warning/Extinguisher Push	C.1102/3/A (Page)	8	Centre Coaming (4) (P23) Centre Roof Panel (4) (P24)
Filament	995-9118 I/S Ref.	8	As above
Shroud	A 223 (Page)	8	As above
Engine Internal Overheat Warning Lamp	C 1101/A/8 (Page)	4	Centre Pedestal (P20)
Filament, 28V, IW.	995-9118 I/S Ref.	4	As above
Fire Detector	27N/90	4	Engine Nacelles
Turbine Cooling Air Failure Warning Unit	1 x 23 FWU/1/350 (Smiths)		Equipment Bay
Compensating Lead Adjustment Spool	F.871 (Sangamo Weston)	4	Engine Firw Warning Panel (P59)
Indicator Fuze	27N/171	8	Leg Fairing Flap Panels (P41 48)
Indicator Fuzeholder	27N/241	8	Leg Fairing Flap Panels (P41, 48)
Extinguisher Bottle	62A (Graviner)	4	Engine Nacelles
Explosion Protection Reset Switch	5CW/6433	1	Flight Engineer's Panel (P.33)
Neon Indicator	D.681 MBC (Bulgin)	2	Flight Engineer's Panel (P.33)
Turbine Disc Thermocouple	F.1196 (KLG)	4	Engine Nacelles

ITEM	REF.NO.	NO.OFF.	LOCATION
Reset Relay	7CZ 105648 (Plessey)	2	Tank Explosion Prot. Panel (P6)
Power Pack	27N/164	2	Tank Explosion Prot. Panel (P6)
Overvoltage Unit	E.841, Mk.3 (Graviner)	2	Tank Explosion Prot. Panel (P6)
Detector	27N/271	20	Fuel Tanks
Test Lamp	27N/230	20	Fuel Tanks
Fuzeholder C/W Fuze	27N/170	12	Fuel Tanks
Smoke Detector	27N/132	1	Equipment Bay (1)
Smoke Warning Lamp	A915/A/6 (Page)	1	Flight Engineer's Panel (P.33)
Filament, 28V, IW	995-9118 I/S Ref.	1	Flight Engineer's Panel (P.33)
Smoke Detector Test Switch	5CW/6428	1	Flight Engineer's Panel (P.33)
Inertia Switch	27N/93	6	Under Freight Floor (2) Pt. and Stbd. Wings (4)
Normal/Isolate Switch	5CW/6436	1	Centre Roof Panel (P24)
Rectifier	5CZ/5403	1	Battery J.B. (J7)
Crash Relay	7CZ 105648 (Plessey)	3	Battery J.B. (J7)
Crash Lamp	C.500/E/7 (Page)	2	Centre Roof Panel (P24)
Filament, 28V, IW	995-9118	2	Centre Roof Panel (P24)
Impact Crash Switch	PSC1 (Pyrene)	3	Fuselage Lower Surface
Generator Crash Relay	5CW/6625	4	Battery J.B. (J7)

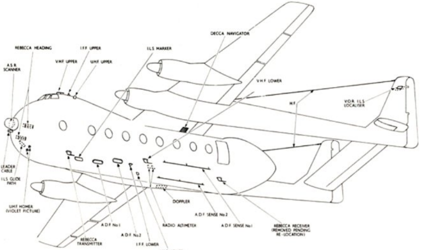


Fig. B Aerials

◀ *C Mk.* 1 *Aircraft* ▶

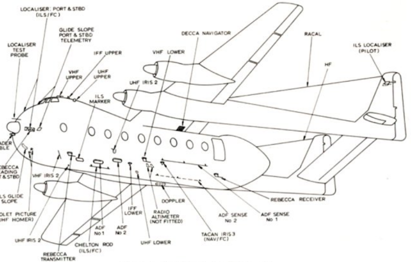


Fig. C Aerials (Flight Checking Role Aircraft)