Part I

DESCRIPTIVE

Part I

Descriptive

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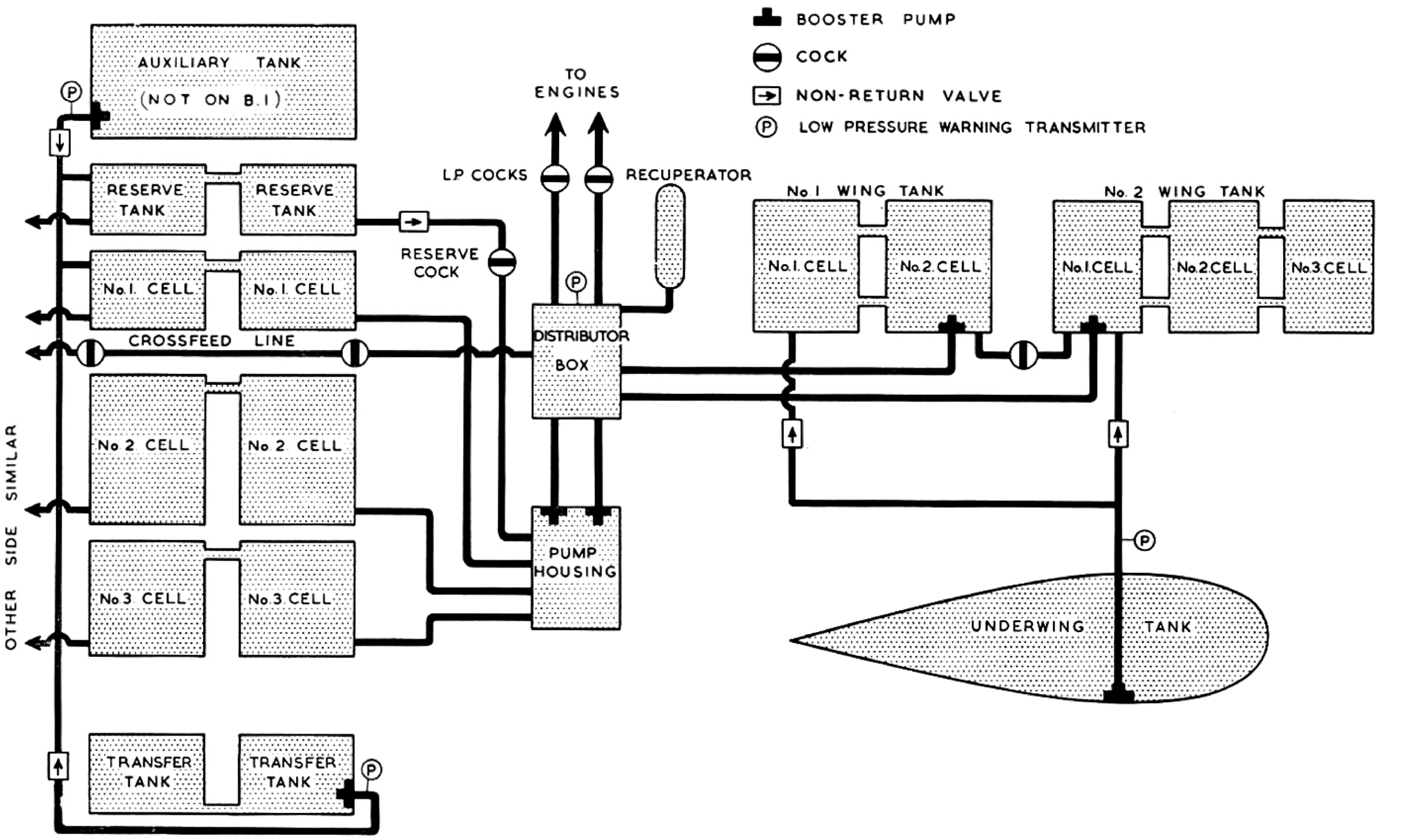


Fig. 1 Fuel system (simplified)

PART I

Descriptive

Fuel System

1 General

Fuel is carried in a number of flexible-bag type tanks in the fuselage and wings. Each tank comprises one or more cells. Extra fuel may be carried in fixed under-wing tanks, one mounted on a pylon under each wing.

2 Fuselage tanks

(*a*) The forward pair of cells, one on each side of the aircraft centre-line, comprise the reserve tank, each pair of engines being fed from one cell. It is not, strictly, a reserve tank, but, if the transfer tank fails to transfer, fuel is retained in the reserve tank.

(*b*) The six cells in the centre of the fuselage above the bomb bay comprise the main fuselage tanks, each pair of engines being fed from the three cells on the relevant side. There is no inter-connection between any of the three cells on one side.

(*c*) The rear pair of cells comprise the transfer tank, fuel from this being fed into the port cell of the reserve tank and into the port front fuselage cell.

(*d*) Each pair of cells is connected across the fuselage at the top of the cells, thus ensuring that when they are full the level in each pair of cells is the same. The transfer tank cells are also inter-connected at the bottom.

3 Wing tanks

The five cells in each wing are grouped to form two wing tanks. The two inboard cells are inter-connected to form the No. 1 wing tank; the three outboard cells are inter-connected to form the No. 2 wing tank.

4 Underwing tanks

Provision is made for carrying tanks on streamlined pylons under the wings. These tanks are completely self-contained, incorporating their own independent nitrogen systems and electric pumps, as well as a compressed air system for jettisoning fuel. Fuel from each tank is fed by an electric pump into the wing tanks. The tanks are not jettisonable. The nitrogen system may also be used to transfer fuel to the wing tanks if the electric pump fails. (See Part III, para 9.)

5 Auxiliary tank—BK1, B(PR)1 and BK(PR)1 only

Provision is made for fitting an auxiliary tank in the forward end of the bomb bay (camera bay) on BK1, B(PR)1 and BK(PR)1 aircraft. This tank incorporates its own electric pump which transfers the fuel into the port cell of the reserve tank and into the port No. 1 fuselage cell.

6 Tank capacities

(*a*) The following table shows the approximate effective fuel capacities of the tanks in gallons and pounds at 0·76 SG. The actual capacities may vary to a certain extent depending on the operation of the refuelling float valves and also on the attitude of the aircraft, but the figures given here are an average of the capacities actually obtained on a number of aircraft.

(*b*) There is a certain amount of unusable fuel in the tanks amounting to a total of between 240 and 400 lb. This is not included in the capacity, nor is it shown on the gauges.

	Gallons	Lb at 0·76 SG	CG ft, Aft of datum
Fuselage:—			
Cell 1	735	5,586	36·85
Cell 2	1,370	10,412	42·32
Cell 3	1,286	9,773	49·23
Reserve	590	4,484	33·54
Transfer	710	5,396	64·25
Auxiliary (Not B.1)	575	4,370	37·95
Wing:—			
Tank 1	1,106	8,406	52·59
Tank 2	946	7,190	56·53
Total external fuel (B1)	6,763	51,247	48·261
Total internal fuel (others)	7,318	55,617	47·450
Underwing tank (2 x 1,615 gall)	3,230	24,548	47·32
Total fuel, all tanks (B1)	9,993	75,795	47·958
Total fuel all tanks (others)	10,548	80,165	47·411

NOTE 1: 15 gallons of fuel are unusable in each underwing tank.
NOTE 2: All tanks and cells are subject to a tolerance of ± 10 gallons.

7 Normal operation

(*a*) Two pumps in each wing, one in each wing tank, deliver fuel to the respective distribution box in the fuselage. The fuselage tanks on each side feed by gravity through non-return valves, one to each cell, into the respective fuselage pump housing whence fuel is delivered by two electric pumps to the distributor box. Fuel is fed from each distributor box to the two engines on the respective side, each line incorporating an engine master cock, a fuel filter de-icing heater and a flowmeter transmitter.

(*b*) Fuel from the reserve tanks feeds by gravity, through a pair of cocks and non-return valves, into the pump housings. Fuel from the transfer tanks is delivered to the port cell of the reserve tank and the port front fuselage cell by a single electric pump. Mod 2443 will introduce an additional pump. Float valves in the reserve and fuselage tanks prevent flooding. Fuel from the underwing tanks is delivered to the wing tanks by an electric pump in each underwing tank. Float valves in the wing tanks prevent flooding.

NOTE: Until Mod 1012 (WP208) is fitted, there are no non-return valves in the lines from the reserve tank. The reserve cocks should therefore be closed whenever the aircraft is in a nose-down attitude, otherwise fuel will flow from the main fuselage tanks into the reserve tank.

(*c*) Fuel from the auxiliary tank (when fitted) is fed into the port cell of the reserve tank and the port front fuselage cell by a single electric pump.

(*d*) *Recuperators*

A recuperator is fitted on each side in parallel with the distributor box. One side of the recuperator is supplied with air from the engines at a constant pressure, and the other side is supplied with fuel from the distributor box at the fuel pump pressure which is higher than the air pressure. Under conditions of negative G when the fuel pumps might be uncovered and there is no pressure in the fuel lines, the recuperators will discharge their fuel into the distributor boxes and maintain the supply to the engines. When normal conditions are resumed the fuel pumps will again supply the engines and recharge the recuperators. (See Part III, para 10.)

8 Fuel pumps and indicators

(*a*) Eight electric fuel pumps, two each side of the fuselage and two in each wing, are controlled by eight ON/OFF switches (A/5, 6, 11, 12, 24, 25, 30 and 31) on the fuel panel. Two low pressure warning lights (B/32) on the right of the instrument top panel come on when the pressure in the distributor boxes falls appreciably below normal, which may be due to lack of fuel or failure of the pump(s) in use.

(*b*) Pre-Mod 2443 a single electric pump in the transfer tank is controlled by an ON/off switch (A/41) on the fuel panel. Post-Mod 2443 two pumps are fitted and the switch is changed to a three-position MAIN/OFF/AUX switch. The MAIN position controls one pump, and the AUX position controls the other. A warning lamp (A/42) below the switch comes on when pressure drops due to the failure of the pump or due to the tank being empty, but will go out when the pump is switched off.

NOTE: Until Mod. 1501 (WZ361) is embodied the warning lamp remains on when the pump is switched off.

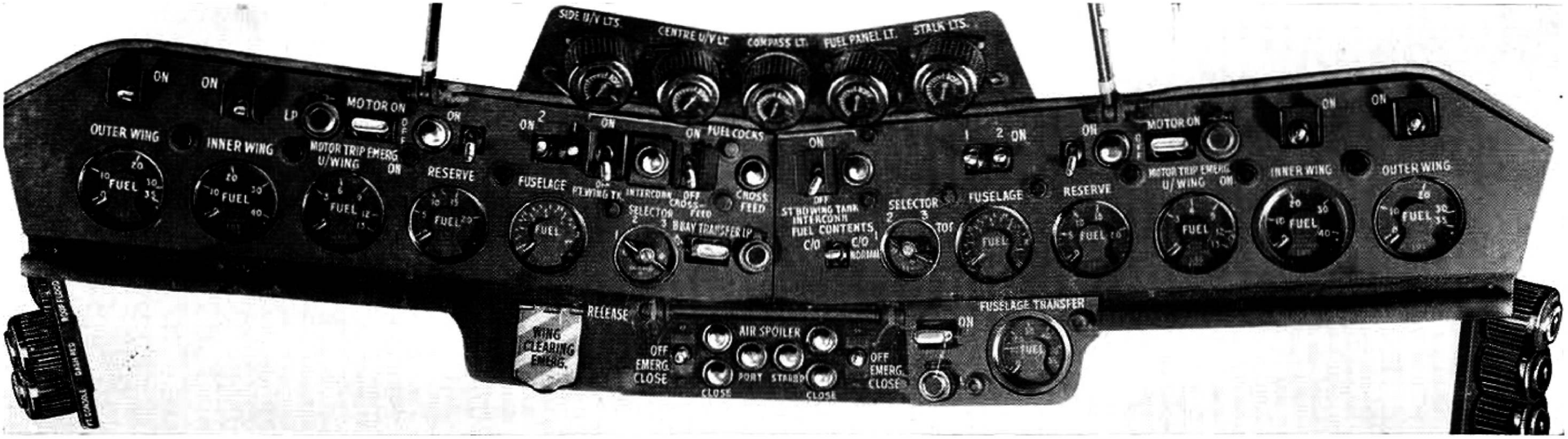


Fig. 2 Fuel Panel (Post-Mod. 2330 or 2331)

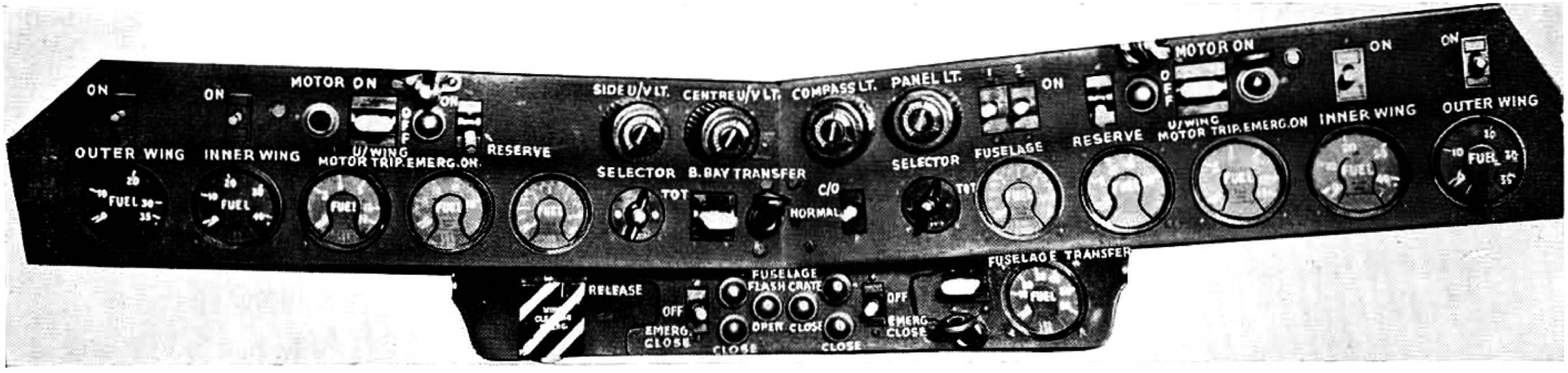


Fig. 2 Fuel Panel (Pre-Mod. 2330 or 2331)

(*c*) (i) The pump in each underwing tank is controlled by a switch for each tank (A8 and 28) on the fuel panel. When these pumps are switched on, the underwing fuel is pumped into the respective wing tanks through a refuelling valve which is controlled by a float switch in the wing tank. A low pressure warning light (A7 and 29) beside each switch comes on when the underwing tank is empty or if the pump fails. Pre-Mod. 2732 (B1 and B(PR)1), the LP warning light stays on all the time except when the pump is delivering fuel. Post-Mod. 2732, and on all BK1 and BK(PR)1 aircraft, the light is only energised when the pump is switched ON

or EMERG. Each switch has three positions, MOTOR ON, OFF, and MOTOR TRIP. EMERG. ON. When the latter position is selected the pump is stopped and the nitrogen in the nitrogen bottles is released into the tank to transfer fuel to the respective wing tank.

(ii) Post-Mod. 2784 or Command Mod. 45 two indicators (A45 and 48) on the fuel panel are operated by the underwing tank pump contactors. Each indicator shows black when the contactor is tripped and the pump is not running; it shows white when the contactor is energised. In the latter condition it does *not* indicate that the pump is running (i.e. the pump may have failed) but only that the pump circuit has been made.

(*d*) Although there is no harm in letting a booster pump run dry for a short time, the relevant booster pumps should be switched off when the " tank empty " warning appears.

(*e*) Pre-Mods. 2444 and 2473, a single pump in the auxiliary tank is controlled by an on/off switch (A49) on the fuel panel. Post-Mods. 2444 and 2473, two pumps are fitted and the switch is changed to a three-position MAIN/OFF/AUX switch. The MAIN position controls one pump, and the AUX position controls the other. When operating in the tanker role, the AUX position *must not* be used. A light (A47) beside the switch comes on when the tank is empty or if the pump fails. Until Mod. 1747 (WZ376) is embodied, the light stays on when the pump is switched off.

9 Fuel cocks and indicators

(*a*) The four HP cocks are controlled by the throttle levers (C12). When the levers are brought back beyond the ground idle gate, the HP cocks are closed. When opening the HP cocks, to ensure that they are fully open the throttles should be opened beyond the gate and then brought back to the gate. There are no HP cock indicators.

(*b*) The four engine LP master cocks are controlled by four ON/OFF switches (B15, 16, 26 and 27) on the instrument top panel. Indicators above the switches show black when the cocks are open and white when OFF is selected. *The black indication shows that the cock is actually open, but the white indication only shows that OFF is selected and does not necessarily mean that the cock is closed; e.g. if the actuator has failed and the cock does not close, the indicator will still show white when the switch is at OFF.*

(*c*) The two reserve tank cocks are controlled by two switches (A10 and 26) on the fuel panel. When these cocks are open fuel drains by gravity from the reserve tank into the pump housing. Indicators (A9 and 27) beside the switches operate in the same way as those for the engine LP master cocks, except that they show white when the cocks are open and black when off is selected.

(*d*) The wing tank interconnection cocks, one between the two wing tanks on each side, are controlled by two switches (C20 and 22) on the central pedestal pre-Mod. 2330 or 2331, or (A13 and 20) on the fuel panel post-Mod. 2330 or 2331. When the cocks are open the No. 1 and No. 2 wing tanks are inter-connected. Indicators above the switches operate in the same way as those for the engine master cocks, except that they show white when the cocks are open and black when off is selected. There are two crossfeed cocks, one each side, in the crossfeed line connecting the two fuel distributor boxes. They are both controlled by a single switch (C21) on the central pedestal pre-Mod. 2330 or 2331, or (A16) on the fuel panel post-Mod. 2330 or 2331. An indicator near the switch shows white when both cocks are open and black when closed is selected, in a similar manner to those for the engine LP master cocks.

10 Fuel contents gauges and flowmeters

(*a*) The fuel contents gauges are of the pacitor type, reading in pounds. All gauges are on the fuel panel; two for the fuselage tanks (A39 and 52) and two for each pair of wing tanks (A4, 32, 36 and 55), one gauge for each of the two underwing tanks (A37 and 54), two gauges for the reserve tank (A38 and 53) and one for the transfer tank (A40). Post-Mod. 2296 (not on B1 aircraft) the transfer tank gauge can also be used to show the contents of the bomb bay auxiliary tank by selecting the switch (at A51) on the fuel panel.

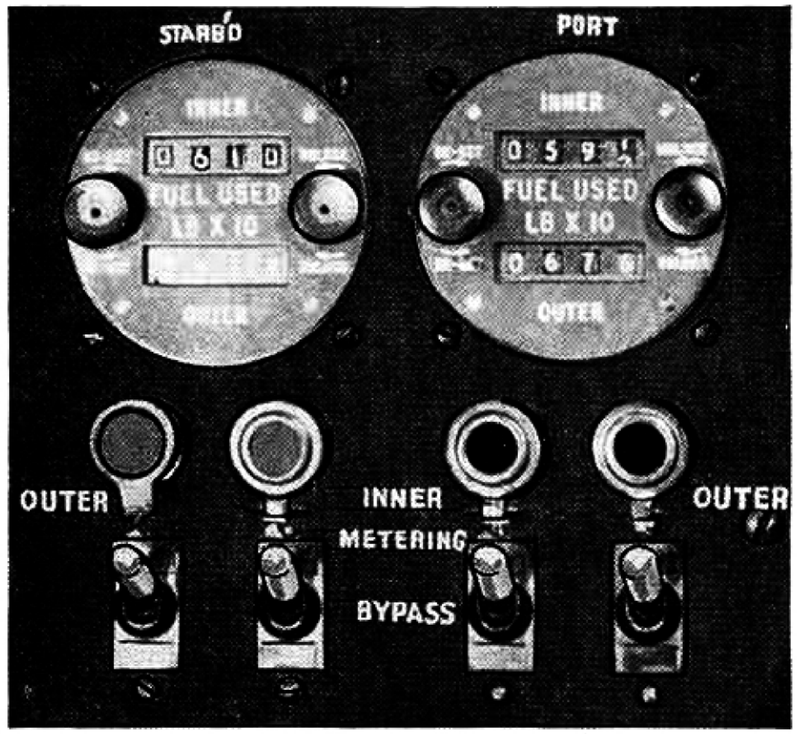


Fig. 3 Fuel flowmeters

(*b*) All gauges normally show the total contents of their respective tanks, excluding any unusable fuel. A selector switch (A43 and 50) beside each fuselage tank gauge enables the contents of each individual cell of the fuselage tanks to be checked, by moving the selector switch to No. 1 CELL, No. 2 CELL or No. 3 CELL. The switches should normally be left at TOTAL.

(*c*) If either the port or starboard wing tanks contents gauge power unit fails, the other may be used to operate the gauges by operating the changeover switch (A44) on the fuel panel. The port power unit then provides the power for the starboard gauges and vice-versa.

(*d*) Two dual flowmeter indicators (J8 and 9) on the starboard quarter panel indicate the "pounds gone" to each engine. Four METER/BY-PASS switches (J10, 11, 12 and 13) and four blue lights are below the indicators ; the lights come on when the flowmeters are switched to METER.

(*e*) Mod. 1039 introduces flowmeters, reading in pounds, at the navigator's station.

11 Tank venting and pressurising

(*a*) All internal tanks are pressurised with air from the engines, or nitrogen. Nitrogen will not normally be used except under operational conditions. The nitrogen and air systems are complementary to each other, using the same reducing valve. When nitrogen is used it will feed the tanks until the supply is exhausted, at which point the air supply automatically takes over. Air will automatically be used the whole time when nitrogen is not used. There are no controls or indicators in the cockpit.

(*b*) Seven, eight or nine nitrogen bottles may be fitted according to the role, and these are fitted in the nose behind the radome, in the "attic," and in the starboard servicing bay.

The servicing bay contains pressure gauges, shut-off cocks, a charging valve and test points. When the system is to be used the shut-off cocks must be opened before flight. There are no other controls. Damage to any one bottle will not affect the supply from the others.

(*c*) The underwing tanks each have two nitrogen bottles mounted inside the tank. A pressure gauge, charging valve and shut-off cock are in the nose fairing of each tank. The shut-off cock must be opened before take-off, after which the system is automatic.

(*d*) The air supply is tapped from all four engines, and starts as soon as the engines are running. The air (or nitrogen, if used) passes through reducing valves to supply all tanks except the underwing tanks which, if not using nitrogen, are atmospherically vented through inward relief valves. All fuselage tanks are inter-vented, the vents discharging to the underside of the rear fuselage. The wing tanks are inter-vented on each side, discharging to the wing tips. Reducing valves control the air or nitrogen pressure in the tanks at 0·9 to 1·2 PSI differential pressure, and vent valves maintain a pressure of 2 PSI when climbing. Inward relief valves are incorporated to prevent the tanks collapsing during a descent in the event of failure of the pressure reducing valves. Mod. 2107 (XD

857) introduces a thermostatically controlled heater muff round the reducing valves. The heaters are on whenever electrical power is available, and there are no controls or indicators in the cockpit.

12 Fuel filter de-icing

The fuel pipe to each engine passes through a heat exchanger which is used to heat the fuel if ice should form in the fuel filters. If ice forms in a fuel filter the filter will tend to clog, thus increasing the pressure differential across it. When this happens a pressure switch closes and lights a blue warning light (B25) (Command Mod. 64) on the instrument top panel. The spring-loaded switch (B24) beside the light should then be held up to feed hot air from the airframe de-icing system through the fuel heat exchangers, the air being exhausted through two vents in each side of the fuselage. The system should be checked for functioning before each flight. The switch has a TEST position which enables the functioning of the warning light to be checked. (See Part III, para. 13.)

13 Fuel jettisoning

The underwing tanks each contain a bottle of compressed air which enables the fuel in these tanks to be jettisoned in emergency. Two switches (E5 and 6) on the port coaming panel, when set to ON, open an electro-magnetic valve in the tank stub pylon, which releases high-pressure air to open the jettison valves in the bottom of the tanks. For fuel jettisoning drill see Part III, para. 9(*j*).

Refuelling Systems

14 Ground refuelling and defuelling

(*a*) On B1 and B(PR)1 aircraft, four pressure refuelling connections are fitted, one on each side of the fuselage under the centre of the wing root for the fuselage tanks, and one beneath each wing, aft and outboard of the main wheel bay, for the wing tanks. On BK1 and B(PR)K1 aircraft the wing refuelling connections are not fitted and all tanks are refuelled from the two fuselage connections. Switches at each refuelling point control the circuits to the float switches and shut-off valves in the tanks, and these control the supply of fuel to the tanks and automatically shut off the fuel when the tanks are full.

Filler caps are not provided for any tanks.

(*b*) Defuelling of all tanks may be carried out by the refuelling connections, and hand-operated cocks are fitted which enable any individual tank or cell to be defuelled.

15 Flight refuelling—Tanker See Appendix A.

16 Flight refuelling—Receiver See Appendix A.

Oil System

17 Each engine has its own independent integral oil system; the sump of each holds 9·6 pints and the system holds 2·4 pints. This gives a total capacity of 12 pints, of which only 7 pints are consumable. Four oil pressure gauges (B50 and 59) are on the instrument centre panel.

Electrical System

NOTE: The DC electrical systems were originally 112 and 28 volts, and these figures are quoted in these Notes. The voltage controllers have been reset to give 110 and 27·5 volts respectively. However, throughout these Notes, and on labels in the aircraft, the systems are referred to as 112-volt and 28-volt systems.

18 Introduction

(*a*) All auxiliary power used in the aircraft is taken from the electrical system. Undercarriage, flaps, bomb-doors, etc., are directly operated by electric motors, and electro-hydraulic systems are installed for the brakes, for the nosewheel steering and for the power controls.

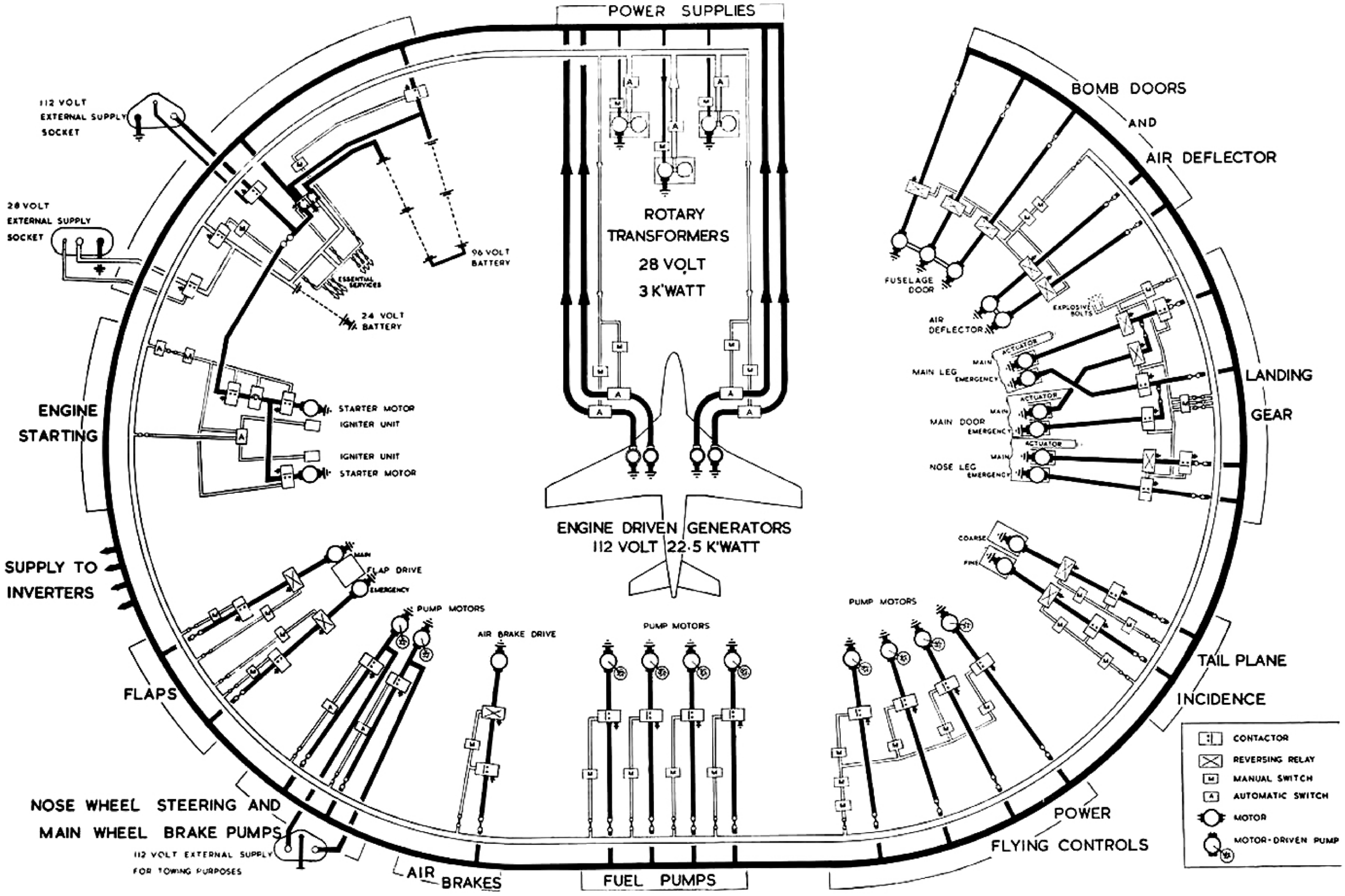


Fig. 4 Electrical system (simplified)

(*b*) Two DC systems are used in the aircraft, a 112-volt system for the heavy duty services, and a 28-volt system for the instruments and other services, as well as for the control lines of all services. The 28-volt system is fed by three rotary transformers driven from the 112-volt system.

(*c*) All services are remotely controlled through relays or contactors ; i.e. when a service is switched on, a 28-volt supply is connected to a relay or contactor which closes and makes the circuit between the system and the service selected.

(*d*) AC for operating the flight instruments and radar equipment is supplied by inverters. One of these, the instrument inverter, is driven from the 28-volt system, the others from the 112-volt system.

(*e*) Two main power distribution panels are in the "attic" aft of the pressure cabin, which also houses most of the electrical equipment. One power panel carries the 112-volt busbar which is fed with the combined output of the four generators, and the other panel carries the 28-volt busbar which is similarly fed by the three rotary transformers. The various services obtain their supply from the busbars through local fuses and, for the heavy duty services, through high-rupturing-capacity (HRC) fuses.

(*f*) An "essential services" busbar, which is permanently connected to the 24-volt battery, is on the 24-volt battery control panel at the forward end of the bomb bay. It supplies the following circuits:

Battery master control
Crash switch
Fire-extinguishers through crash switch
Internal start control (not used)
Intercomm when nosewheel towing plug is in
Canopy jettison
Fatigue meter

19 112-volt system

(*a*) There are four 22½kW generators, one driven by each engine. Full voltage is obtained at all engine speeds from idling to take-off RPM. These generators charge a 96-volt battery and supply power for the following services:

Fuel pumps
Undercarriage main and emergency motors
Flap main and emergency motors
Air brake motor
Tail plane incidence coarse and fine motors
Power controls hydraulic pump motors
Brakes and nosewheel steering hydraulic pump motors
Bomb door and deflector motors
28-volt rotary transformers
Radar inverters
H2S scanner
Hose drum unit (on Tanker aircraft only)

Fig. 5 (Deleted)

(*b*) Each generator has an ON—RESET—TRIM OR OFF switch, a failure warning light and an ENGAGE pushbutton. After a generator has been switched ON and has reached its correct output (see Part III, para. 19) it is brought on to line by pressing the ENGAGE pushbutton.

(*c*) On the right of the four switches is a rotary four-position selector switch and a voltmeter. Setting the switch to the appropriate generator number and selecting TRIM OR OFF on the generator control enables its voltage to be read when the generator is off line.

20 28-volt system

(*a*) Three 3kW rotary transformers are driven by the 112-volt supply ; they charge the 24-volt battery and provide power for

operating all services not powered by the high-voltage system. The 28-volt system is also used to operate the control relays in all electrical circuits.

(*b*) All rotary transformers start up together as soon as the 112-volt busbar is energised, provided that the control switches on the generator panel are ON.

(*c*) Each rotary transformer has a failure warning light and an ON—OFF OR RESET—TRIM control switch (Q5, 6 and 7) on the generator panel on the radio crate. If a warning light comes on it indicates failure of the rotary transformer. The TRIM position is only used when adjusting rotary transformer output.

(*d*) On the left of the switches is a three-position rotary switch and a voltmeter. Setting the switch to the appropriate rotary transformer number and selecting TRIM or OFF enables its voltage to be read when the transformer is off line.

21 Batteries

(*a*) The batteries are nominal 96 volts and 24 volts respectively, but are charged from the 112-volt and 28-volt systems when the generators and rotary transformers are charging. The batteries are in the battery compartment at the forward end of the bomb bay. The batteries are also charged from the ground trolley when it is connected.

(*b*) *96-volt battery control*

The 96-volt battery is controlled by an ON/OFF switch (F5) on the port console panel. When the switch is set to ON the battery is connected to the 112-volt busbar and a magnetic indicator (F7) above the switch shows black. The battery is disconnected from the busbar by setting the switch OFF and will also be automatically disconnected by operation of the crash switch (see para. 24). When the battery is disconnected the indicator will show white.

(*c*) *24-volt battery control*

The 24-volt battery is controlled by an ON/OFF switch (F4) on the port console panel. When the switch is set to ON the battery is connected to the 28-volt busbar and a magnetic indicator (F6) above the switch shows black. The battery is disconnected from the busbar by setting the switch OFF and will also be automatically disconnected by operation of the crash switch (see para. 24). When the battery is disconnected the indicator will show white.

NOTE: The 24-volt battery is always connected to the "essential services" busbar.

(*d*) *Emergency batteries*

(i) A 24-volt emergency battery, above the radio crate, supplies the canopy jettison circuit. This battery is completely independent of the aircraft systems and is not chargeable. There is no separate switch for it other than the hood jettison levers.

(ii) A separate battery at the rear of the port console panel, independent of the aircraft supplies, may be used to operate the main instrument panel emergency lamps. These are operated by a switch (E15 and G24) on each coaming panel.

(iii) Post-Mods. 2828 and 2876 two 12-volt batteries, in series, are fitted below the pilots' platform, port side, for the operation of the abandon aircraft warning signs and crew escape emergency lamps.

22 External supply sockets

(*a*) There are two external supply sockets on the port side of the aircraft forward of the bomb bay, one for the 112-volt system and one for the 28-volt system. An additional supply socket for use when towing, is in the nosewheel bay (see Part I, para. 36).

(*b*) When the 112-volt external supply is plugged in, all 112-volt services may be operated provided the 24-volt battery switch is ON. The rotary transformers can then be started. Pre-Mod. 2260 (XD816) the 96-volt aircraft battery will be charged from the

external supply irrespective of the position of the 96-volt battery switch. Post-Mod. 2260 the battery will only be charged if its switch is ON. If the rotary transformers are running the 24-volt battery will also be charged.

(*c*) When the 28-volt external supply is plugged in, the 24-volt battery will be charged, and if the 24-volt battery switch is ON all 28-volt services may be operated from the external supply. If the No. 3 rotary transformer is ON, it will not run as long as a 28-volt external supply is plugged in.

23 Voltmeters and ammeters

(*a*) The voltage trimmer panel, on the cabin port wall forward of the radio crate, carries two voltmeters (L7 and 13) which continually indicate the voltage of the busbars. Voltmeter (L6 and 15) and ammeter (L8 and 11) test sockets are also fitted on the panel, together with selector switches (L5 and 14), which enable the output voltage and current of each generator and each rotary transformer to be checked on the ground.

(*b*) Post-Mod. 2454 ammeters in the generator and rotary transformer circuits are fitted on the radio crate. These indicate continuously the current supplied by each generator and each rotary transformer.

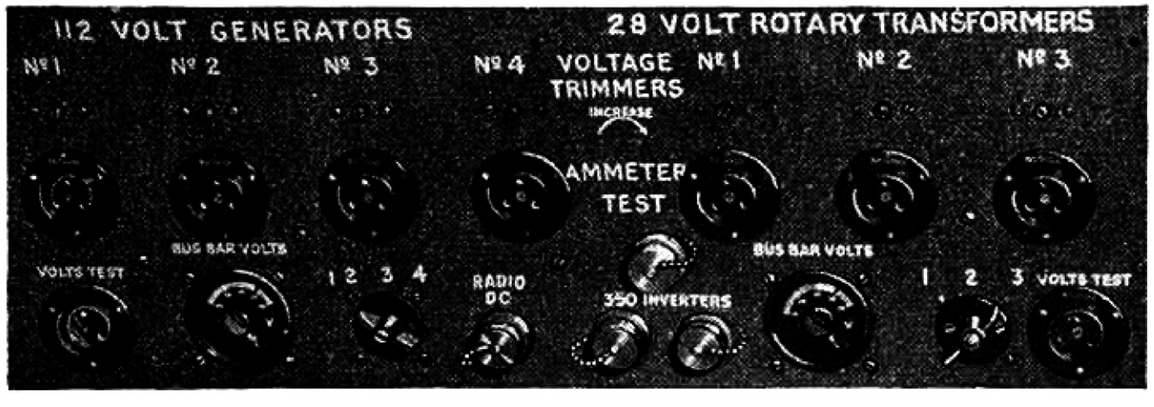


Fig. 6 Voltage trimmer panel

(*c*) Post-Mod. 2650 two charge/discharge ammeters are fitted on the extreme right of the radio crate, one for the 24-volt and one for the 96-volt battery. These show at all times the battery charge or discharge current and consequently, in the event of generator or rotary transformer failure, can be used to check the load which may have to be shed to protect the batteries. They will also give an immediate indication of a battery short to earth. (See Part V, para. 13 to 17.)

(*d*) Post-Mod. 2982 an accurate 0-160v AC voltmeter and a 0-40v DC voltmeter are fitted to the AC Manual changeover switch-box (see para. 61(*a*)(iii)) at the AEO's station. The meters are connected in parallel with the voltmeter test sockets and can thus be switched to read accurately the off-line voltage of any generator and the rotary transformer voltages.

24 Inertia switches

(*a*) In the event of a crash, inertia switches isolate the batteries from all aircraft services except the "essential services" busbar, and automatically discharge all the fire-extinguisher bottles in the engine and fuel tank fire-extinguisher systems. The generators are also isolated from the system by the inertia switches.

(*b*) Post-Mod. 2259 and 2680 additional inertia switches and associated latched contactors are fitted, one in each generator field circuit. When these switches trip in the event of a crash, the generator field circuits are broken, thus reducing the voltage generated if the engines are still rotating.

25 AC supplies

AC for the instruments, radar, radio and special equipment is provided by inverters. The instrument inverter is operated from the 28-volt system, the others from the 112-volt system.

	Inverter	*Supply*	*Stand-by*
	Instrument inverter Type 100A	Artificial horizon (1st pilot's only Post-Mod. 2218) Tanker controls (K only) PR Recce sight (PR only) Oil pressure gauges (Pre-Mod. 1350) Mk. 4B compass (Pre-Mod. 2040)	No. 2 and 3 radar inverters
Radio and radar inverters	No. 1 Type 350	H2S NBC	No. 3 radar inverter
	No. 2 Type 350	Mk. 4B compass (Post-Mod. 2040) Oil pressure gauges (Post-Mod. 1350) Auto-pilot Auto-stabiliser (Post-Mod. 2252) Tail warning Radio altimeter Gee H, Mk. II IFF T4 Bombsight (Post-Mod. 1648) Alternative store control Stand-by for instrument inverter Zero reader 2nd pilot's artificial horizon (Post-Mod. 2218)	No. 3 radar inverter
	No. 3 Type 350	ARI 5910 (PR only) Stand-by for instrument and No. 1 and 2 radar inverters	No stand-by
	Type 153	Green Satin	No stand-by
	Type 153A (Post-Mod. 2756)	Rebecca Mk. 10 (Post-Mod. 2742) Eureka Mk. 10 (Post-Mod. 2741)	No. 3 radar inverter

26 Deleted

27 Instrument master switch

(*a*) The instrument master switch (B28) on the instrument top panel is a guarded three-position switch marked ON (up) and OFF (down) with a central position into which it is spring-loaded. When an external 24-volt supply is plugged in and/or when the 24-volt battery switch is ON, the instrument master switch, when selected to ON, connects a supply to the instrument circuit-breaker and, if the internal control locks are disengaged, to the power controls contactor. When the switch is released it returns to the central position, but the circuit-breaker and contactor remain "made". The instrument circuit-breaker can only be tripped by selecting the instrument master switch to OFF. When the internal control locks are engaged the power controls contactor will trip, but this will not affect the instrument circuit-breaker. When the locks are disengaged the contactor may be re-made by selecting the instrument master switch to ON; the instrument circuit-breaker, if previously energised, will again not be affected. Until Mod. 2089 (WZ403) is fitted, the power controls contactor is tripped when the instrument master switch is selected to OFF.

(*b*) The following circuits are controlled by instrument master switch:

Instrument inverter
Bomb bay heating control and temperature gauge
Cabin temperature control indicator
Pilot's outside air temperature gauge
Undercarriage position indicator
Flap position indicator
Tailplane incidence indicator Feel trim indicators
Elevator trim warning lights
Manual trim tab indicators
Fuel contents gauges Fuel flowmeters
Fuel low pressure warning lights
Fuel filter de-icing control and warning light
Engine starting controls
Airframe anti-icing overheat warning lights
Turn-and-slip indicators
Hydraulic pressure magnetic indicators Hydraulic pumps

28 Instrument inverter control

The Type 100A inverter is operated from the 28-volt system. The instrument master switch (B28) on the instrument top panel, when selected to ON, connects the instrument DC supplies and starts

the instrument inverter. At the same time the inverter failure warning light (M21) on the radio crate will come on; it will go out as soon as the inverter has run up to full speed. The inverter can be shut down by selecting the instrument master switch to OFF, but this is not recommended in flight. If it is necessary to shut down the inverter in flight, this should be done by removing fuse D90.

29 Instrument inverter failure

If the instrument inverter fails, a torque switch will operate to connect the supply from the radar inverter No. 2 to the instruments provided No. 2 inverter is switched on. The supply to the failed inverter will automatically be cut and the inverter failure warning light (M21) will come on.

NOTE: On aircraft prior to WZ 366, until Mod. 1051 is embodied the warning light (M21) is marked "No. 1 inverter," though it does in fact indicate failure of the *instrument* inverter.

30 Radio and radar supplies

The three inverters supplying AC to the radio and radar equipment are operated from the 112-volt system. They supply 3-phase 400 CPS at 115 volts, and single-phase 1,600 CPS at 115 volts.

Radar Inverter No.	400 CPS	1,600 CPS
1	H2S NBC	H2S NBC
2	Tail warning Auto-pilot Auto-stabiliser (Mod. 2252) Instrument inverter stand-by Mk. 4B compass (Post-Mod. 2040) T4 Bombsight (Mod. 1648) Alt store control Oil press (Post-Mod. 1350)	Tail warning Radio altimeter T4 Bombsight Gee H, Mk. II IFF
3	ARI 5910 (PR only)	ARI 5910 (PR only)

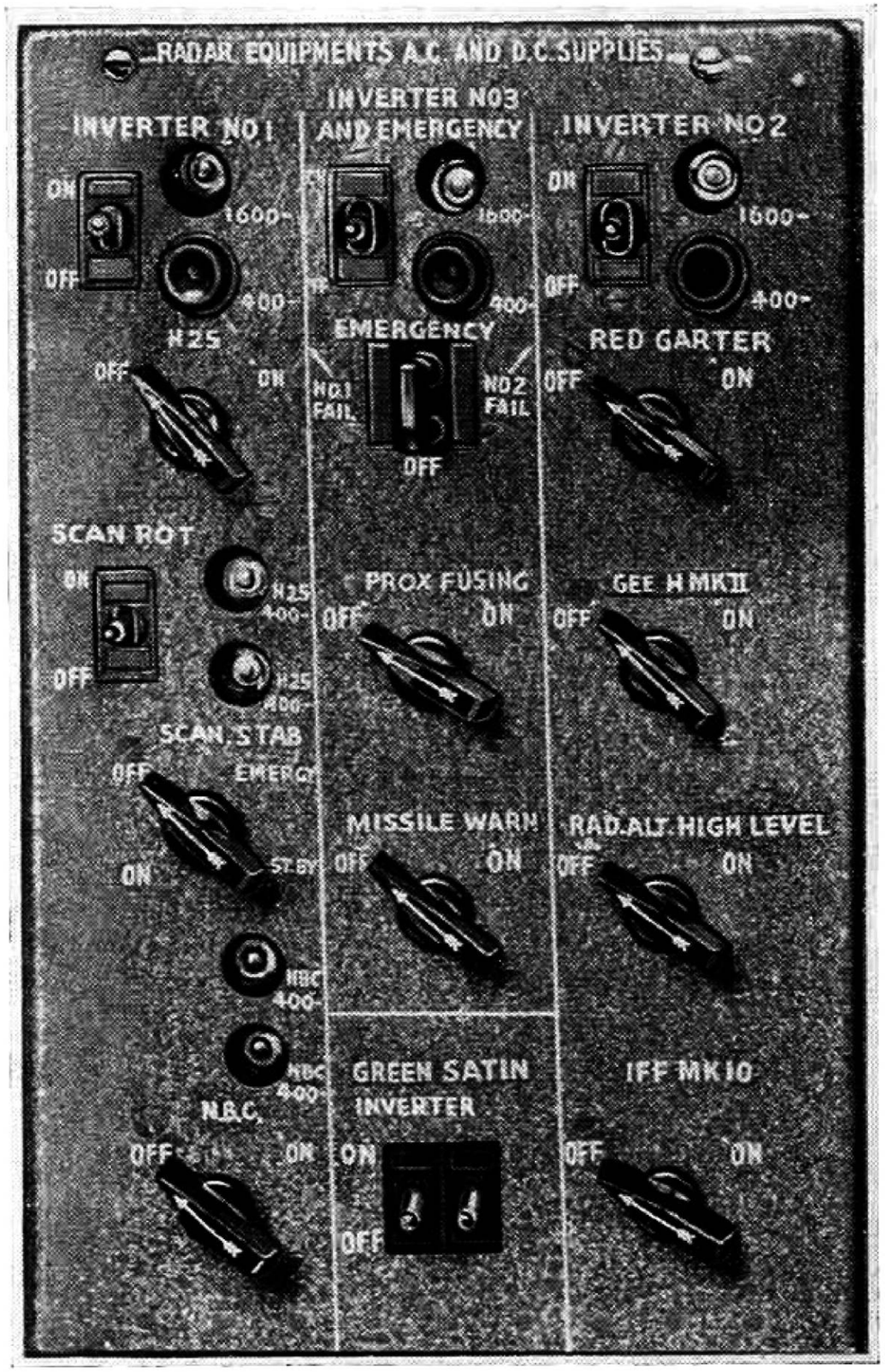


Fig. 7 Radar panel

31 Radio and radar inverter controls and indicators

(*a*) All radar control switches, including the inverter switches and warning lights are on the radar panel (M26) on the radio crate. Each inverter has its own ON/OFF control switch, a green warning light and a neon phase failure indicator (O6, 8 and 9) on the radar panel. The green light is on the 400 CPS side, the neon light is on the 1,600 CPS side. In addition four neon lights (O2 and 4) indicate correct functioning of the A and C phases (phase B is earthed) in the 400 CPS supplies to the H2S and NBC equipment.

(*b*) *Inverter test sockets*

Three test sockets (L9) are provided, one for each of the radio and radar inverters, on the voltage trimmer panel on the cabin port wall.

(*c*) *Green Satin supply*

The 400 CPS supplies to the Green Satin equipment are obtained from a separate Type 153 inverter operated by the 112-volt system. Post-Mod. 2399 the inverter is controlled by an ON/OFF switch (O17) on the radar panel, and the equipment is controlled by an adjacent switch (O16). Pre-Mod. 2399 a single switch controls the inverter and the equipment. There is no indication of failure and there is no stand-by.

(*d*) *Rebecca/Eureka supplies*

The supplies for the Rebecca/Eureka equipment (Mod. 2741 and 2742) are obtained from a separate Type 153A inverter (Mod. 2756) operated by the 112-volt system. The supply is controlled by a NORMAL ON/OFF/EMERGENCY ON switch on the right of the radio crate. In the NORMAL ON position, the 153A inverter is switched on and supplies the Rebecca/Eureka equipment. In the EMERGENCY ON position, the equipment is supplied from the No. 3 radar inverter provided this is running and not being used for something else. A green warning light beside the switch comes on, in the NORMAL ON position only, to show that the 153A inverter is supplying power.

32 Radio and radar DC supplies

The DC supplies to those items of equipment using AC also, are controlled by the same switches on the radar panel. Circuit-breakers for the DC supplies are on the right of the generator panel.

Hydraulic Systems

33 General

(*a*) Hydraulic power, supplied by two electrically-driven hydraulic pumps, is used to operate the mainwheel brakes and the nosewheel steering. Fluid is stored in a double tank in the " attic " behind the pressure cabin.

(*b*) There are two separate and independent services. Service No. 1 supplies the mainwheel brakes through anti-skid (maxaret) units, and the nosewheel steering; service No. 2 supplies the nosewheel steering, and also the brakes direct through a change-over cock (C27). Three hydraulic accumulators are fitted in each service, one for the nosewheel steering and two for the brakes. The steering accumulators are initially charged with air to 1,800 PSI, and the brake accumulators to 1,500 PSI. Air charging valves and pressure gauges are fitted on a panel in the starboard servicing bay. This panel also contains the hydraulic pressure release levers which enable all hydraulic pressure to be released from the accumulators and systems.

34 Normal operation

(*a*) The pumps operate when the 112-volt busbar is live, the instrument master switch is ON, and the nosewheel is down. They are then controlled independently by two pressure switches which switch them on when hydraulic pressure drops to 1,900 PSI, and switch them off when it rises to 2,300 PSI. If a pressure-switch fails, the pump runs continuously, the pressure then being controlled by an automatic cut-out valve which cuts in at 2,000 PSI and cuts out at 2,500 PSI, diverting fluid back to the reservoir. Retraction of the nosewheel cuts the supply to the pumps.

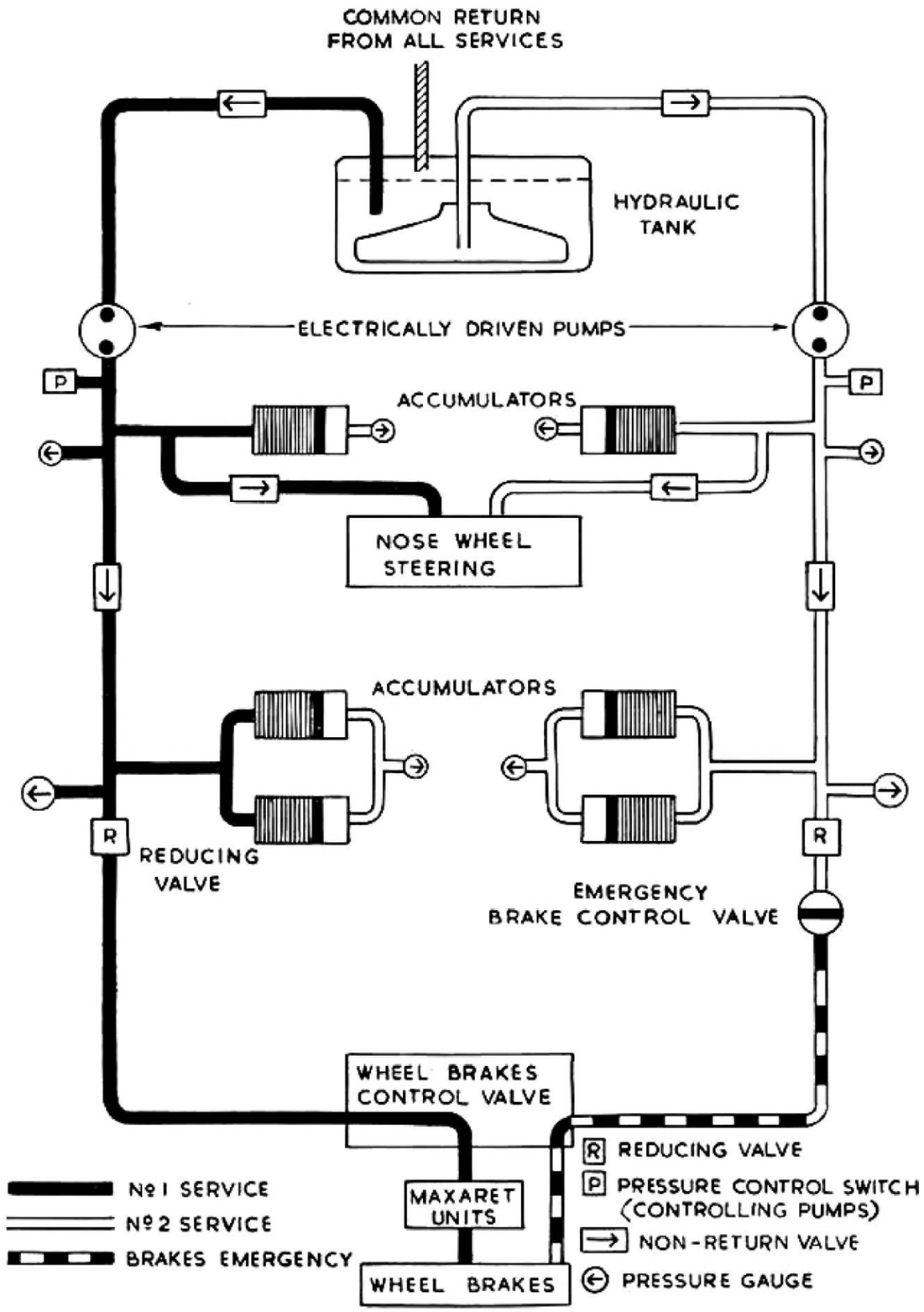


Fig. 8 Hydraulic system (simplified)

(*b*) *Magnetic indicators*

Two magnetic indicators (E21 and 22) on the port coaming panel operate as follows:

(i) *Nosewheel locked down.* When the hydraulic pressure falls below 1,900 PSI the pumps will start to run and the indicators will show white. When the pressure reaches 2,300 PSI the pumps will stop and the indicators will show black.

(ii) *Nosewheel up.* Pre-Mod. 2084 (XD816) the indicators will show white at all times when the nosewheel is up, but Post-Mod. 2084 they will show black.

(iii) *Pump failure.* In the event of pump failure, the relevant indicator will remain white.

(iv) *Electric failure.* In the event of electric failure the indicators will show white.

NOTE: Post-Mod. 1613 (WZ376) but pre-Mod. 2084 (XD816) the indicators show OFF instead of white and ON instead of black.

(*c*) *Pressure gauges*

Four gauges (J4, 5, 6 and 7) on the starboard quarter panel show the pressure supplied by each pump to the brakes and to the nosewheel steering. Normally both gauges in each service will show the same pressure, but if the pump fails they will show the hydraulic pressure available in their respective accumulators.

35 Pump failure

(*a*) Failure of a pump will be indicated by its indicator remaining white or showing OFF when the pressure in the service falls below 1,900 PSI. If No. 1 pump fails, the nosewheel steering will be supplied by No. 2 pump and the brakes will be supplied by the two brake accumulators and the steering accumulator in No. 1 service. No. 2 pump will not recharge any of these accumulators.

(*b*) If No. 2 pump fails, No. 1 pump will supply the brakes in the normal way and will also supply the nosewheel steering. If both

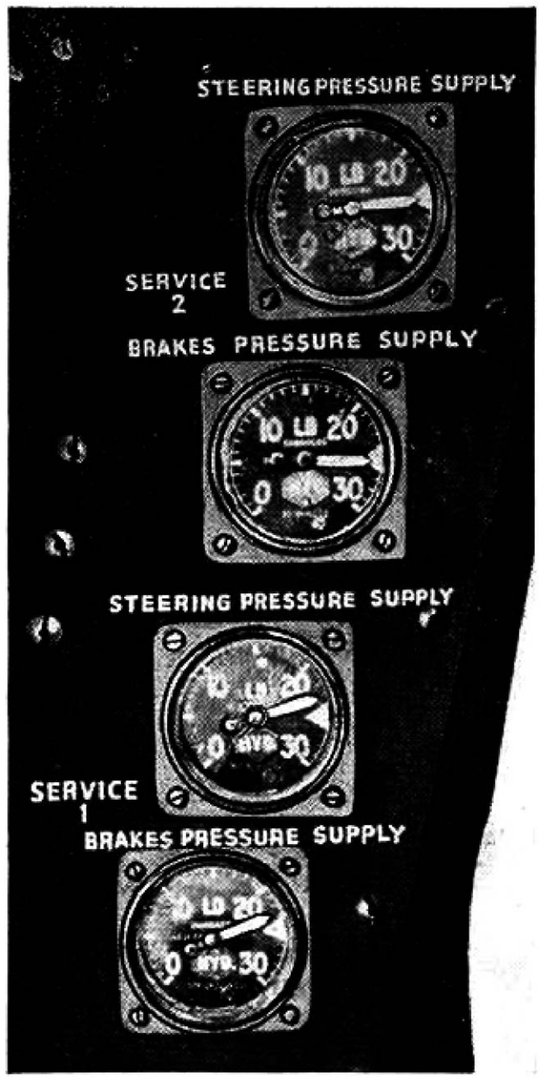


Fig. 9 Hydraulic pressure gauges

pumps fail, the nosewheel steering will be supplied by both steering accumulators and the brakes will be supplied by the two brake accumulators and the steering accumulator in No. 1 service. A changeover lever (C27) on the rear of the central pedestal enables the No. 2 service to be used for the brakes if necessary (see Part I, para. 74(*b*)).

36 External supply

A 112-volt external supply socket is in the nosewheel bay for use when towing. When an electric supply is plugged in to this socket both hydraulic pumps will run continuously, the pressure being controlled by the automatic cut-out valves. At the same time the aircraft intercomm system is connected to the 28-volt "essential services" busbar.

Pneumatic Systems

37 General

Two completely independent pneumatic systems are provided, one for operating the canopy and door seals and one for pressurising the H2S installation. The systems are separately supplied by two air bottles in the starboard servicing bay, where there are also pressure gauges and charging valves.

38 Canopy and door seals

The air for the canopy and door seals is reduced from 450 PSI to 4 PSI by reducing valves and then fed direct to the company seal which is always inflated, and to the door seal valve. This valve admits air to the door seal when the door is closed and exhausts the seal when the door bolts are withdrawn. A cock (M31) on the top of the radio crate may be used to shut off the supply for ground servicing. It is normally wired open.

39 H2S pressurising

The air for pressurising the H2S is reduced from 1,800 PSI and fed to the equipment in the nose. A pressure gauge and shut-off valve, as well as a charging connection, are in the starboard servicing bay, and the system is controlled by a shut-off valve below the starboard console door. A pressure gauge (M3) is on the right of the radio crate.

Engine Controls

40 Throttle controls

The four throttle levers (C12) are on the central pedestal. The throttles also control the HP fuel cocks ; there is a gate at the idling position and the throttles may be brought back through the gate to close the HP cocks after pulling the catches on the top of the levers

Post-Mod. 3225 (204 engines) there is a further gate at the forward end of the throttle quadrant. When the throttles are opened to this gate 8,000 RPM are obtained. After pulling the catches on top of the levers the throttles can be opened fully through the gate to obtain 8,200 RPM. When opening the throttles they can only be moved and pushed forward through the gates after releasing the catches. Each throttle lever also incorporates a relight button. The throttle friction may be adjusted by either of two levers (C10 and 14) one on each side at the front of the central pedestal.

41 Variable pitch guide vanes and air bleed valves

The first row of stator blades in the engine compressor consists of variable pitch inlet guide vanes which assist in imparting swirl to the incoming air. At low RPM the first stages of the compressor deliver more air than is acceptable to the later stages. To prevent instability of flow, i.e. surge, the surplus air is bled off through an air bleed valve, and the guide vanes are held closed to give an angle of flow acceptable to the first stage blades at low RPM. As the normal flight range of RPM is reached, the air bleed valve closes and the guide vanes move progressively to the minimum swirl position.

42 Engine starting controls

(*a*) Each engine is started by its own electric starter motor. Power is normally obtained from a ground supply plugged into the external socket on the port side. The engine starting switches are on the port console panel; a master switch (F1) marked ISOL—SAFE—START, a selector switch (F3) marked 1, 2, 3 and 4, and a starter pushbutton (F2). The master switch must be set to START before any of the engines can be started; when set to ISOL the engines can be turned over on the starters but the igniters will not operate. The master switch must be returned to SAFE after starting the engines. The selector switch is used to select the engine to be started. When the starter button is pressed for a couple of seconds and released, starting is controlled by a time switch through which the igniters and starter motor are operated for 22 seconds or until the engine has run up to speed, whichever is less. When the starter motor stops operating, the starter button will reset, but the full cycle of 36 seconds must elapse before it can be operated again. The green warning light (F24) on the port console panel will be on until the engine runs up to speed, or until switched off by the time switch (in 22 seconds), in the case of motoring over or failure to light up.

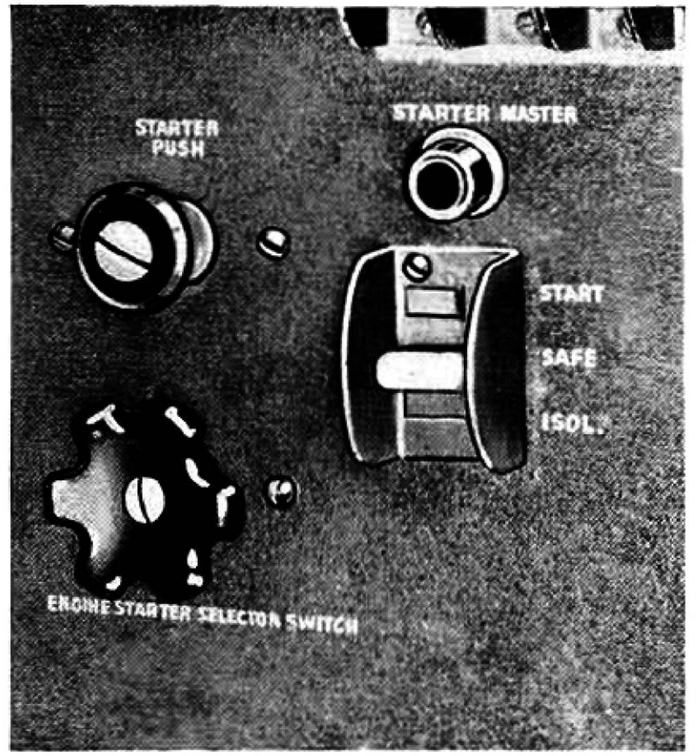


Fig. 10 Engine starting controls

(*b*) To reduce the time interval between starting and take-off the following items are connected via quick release couplings to tethered ground installations, and are automatically released as soon as the aircraft commences to move:

Engine start connections	(Mod. 3087)
Electrical supply . . .	(Mod. 3088)
Telescramble . . .	(Mod. 3089)
True earth	(Mod. 3090)
Feel unit static vent plugs and pitot static vent cover .	(Mod. 3091)
Ground air-conditioning equipment . . .	(Mod. 3107)

43 Engine relighting system

The high energy igniters may be used to relight an engine in flight by pressing the relight pushbutton in the head of the appropriate throttle lever.

44 Engine instruments

Oil pressure gauges (B50 and 59), RPM indicators (B17) and JPT gauges (B20) are on the instrument centre panel. Fuel contents gauges are on the fuel panel and fuel low pressure warning lights are on the instrument top panel.

45 JPT fuel control

(*a*) If the jet pipe temperature rises above the maximum at full throttle, an automatic control reduces the fuel flow to the engines, so reducing the jet pipe temperature. Each engine is separately controlled by identical systems which are operated electrically. A single switch (B34) on the right of the instrument top panel, when set to ISOLATE, cuts out the automatic operation of all control units. It should usually be set at NORMAL, the ISOLATE position only being used for take-off in case one of the units fails and prevents full take-off power being obtained. When the switch is at ISOLATE the jet pipe temperatures are controlled only by the throttles.

NOTE: If Mod. 1106 is not embodied, the system is not operative. Jet pipe temperatures are then controlled only by the throttles.

(*b*) Considerable loss of power may occur if the engines are at high RPM with the JPT controller at NORMAL, and No. 3 inverter is switched ON following a failure of No. 2 inverter. To prevent this loss of power the following drill should be adhered to should the No. 2 inverter fail.

(i) Switch the JPT controller to ISOLATE.

(ii) Switch No. 3 inverter ON, and No. 2 inverter OFF.

(iii) Allow 30 seconds to elapse and switch the JPT controller to NORMAL.

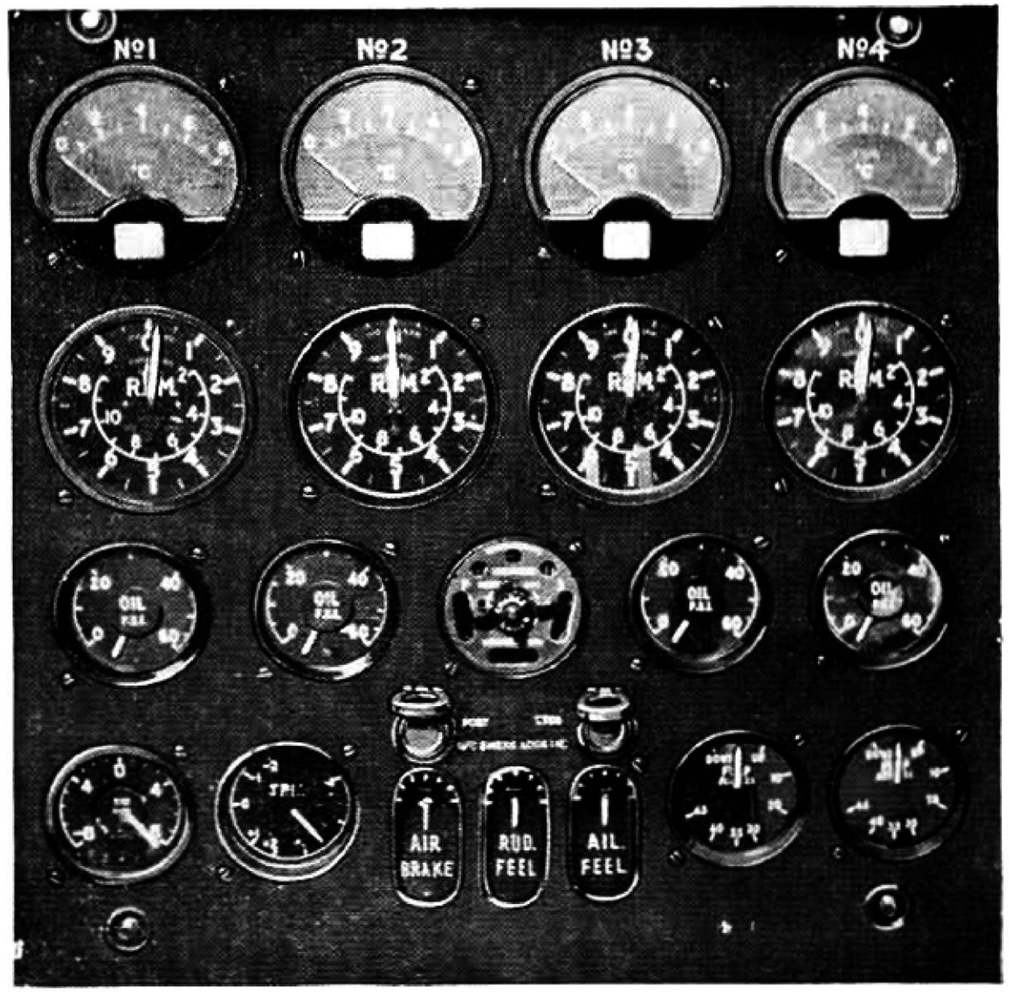


Fig. 11 Engine instruments

46 Engine overheat warning

(*a*) When Mod. 3094 is embodied heat detectors are fitted in the LP cooling discharge air duct of each engine to give warning of rear bearing failure, thereby minimising a possible fire hazard.

(*b*) Four red warning lights, one for each engine, are mounted on a panel above the engine fire extinguisher pushbuttons, to warn the pilots of dangerously high temperatures at the engine rear bearings.

(*c*) Each lamp is controlled, via a relay on fuse panel E, by two heat detectors wired in parallel.

(*d*) Two filament test switches, one at each end of the bank of four lights, when depressed connect a supply to the warning lamp filaments. Each switch serves two lights.

Thrust Augmenting Systems

47 Water-methanol system

(*a*) *General*

(i) Water-methanol is carried in a light-alloy tank, of 145 gallons usable capacity, in the fuselage forward of the transfer tank. The tank consists of two interconnected cells. A refuelling connection is on the starboard side of the fuselage aft of the wing trailing edge, and a vent system has its outlet in the fuselage belly just aft of the rear access hatch.

(ii) Water-methanol is pumped to the engines by four air-turbine-driven pumps, one for each engine; the air for operating the pump is taken through two shut-off cocks from the tail port and starboard anti-icing ducts on the engine side of the anti-icing shut-off valves. The engine gate valves (see para. 76) must be open (switches J1, 14, 15, 16) at NORMAL for the air to be available. A water-methanol shut-off cock is in the line from each pump to the engine.

(iii) At the maximum rate of flow, the water-methanol will last for about 45 seconds. The increase in thrust is about 1,000 lb per engine.

(*b*) *Controls and indicators*

(i) *A master switch* on a small bracket at the forward end of the starboard coaming panel. This is a ganged double-toggle on/off switch which controls the supply to the two air shut-off cocks ; it also connects a supply to the engine minimum speed switches, the four water-methanol shut-off cocks and a tank low-level switch, when these function as described in sub-para. (*c*). When Mod. 3004 is embodied the master switch is repositioned at the starboard side of the top instrument panel to avoid fouling the anti-flash screens.

(ii) *Two indicator lights* on the extreme right-hand side of the instrument top panel. These come on to indicate that the air shut-off cocks are open and that air pressure is sufficient to drive the pumps. The lights are not of the press-to-test type.

(*c*) *Functioning of the system*

When the master switch is selected on, the air shut-off cocks are opened and the indicator lights should come on to show that there is adequate air pressure. The pumps should now be running. Provided that the engines are running at over 6,700 to 7,500 RPM, depending on ambient temperature and altitude, and provided that the tank is full, the minimum speed switches and the tank low level switch will close, thus connecting an electrical supply to the water-methanol shut-off cocks which will then open. Water-methanol will now be injected into the engine combustion chambers. At the same time the engine speed governors will be re-set by the water-methanol pressure to allow the engine speed to rise to 8,300 RPM maximum. When the level in the tank has fallen to the unusable quantity of about $6\frac{1}{4}$ gallons, the low level switch will cause the water-methanol shut-off cocks to close. At the same time the engine speed governor is re-set to the normal 8,000 RPM maximum. When engine RPM drop to this figure the master switch must be set off, thus closing the air shut-off cocks and isolating the complete system.

48 Deleted

Aircraft Controls

49 General

Dual controls are fitted for the side-by-side seated pilots. Electro-hydraulically operated power controls with automatic and selective manual reversion are fitted for all surfaces, and an artificial feel system is incorporated. Provision is made for an electric Mk. 10 auto-pilot and an auto-stabiliser. Internal control locks are provided which, when engaged, also restrict the throttle opening, though allowing sufficient power for taxying.

50 Control handwheels

(*a*) Each control handwheel is on a curved arm which slides backwards and forwards on a bar at each side of the cockpit. The handwheels are adjustable for reach by a starwheel (F13 and H2) below the outboard end of each arm. Each handwheel may be disconnected from the elevator controls by pulling out and turning the knob (F9 and H9) at the rear of each slide-bar; the handwheel may then be pushed forward out of the way. The elevators may be re-engaged by turning and releasing the knob and then pulling the handwheel slowly back until the controls re-engage.

(*b*) Both handwheels incorporate twin brake levers, tailplane incidence and master switches, a press-to-transmit pushbutton and an auto-pilot instinctive cut-out switch. The left handwheel carries, in addition, a brake parking catch and a RATOG firing pushbutton. On a few early aircraft a bomb release pushbutton is on the arm carrying the left handwheel; the switch is not operative, and is deleted by Mod. 1197 (WP216).

(*c*) For abandoning the aircraft, both control handwheels are disconnected from the elevator controls, and moved fully forward to clear the pilots' knees during ejection. This is done by operating the canopy jettison levers (F22 and H15) but, although either lever will jettison the hood, the two levers disconnect their respective handwheels only, i.e. the port lever only disconnects the port handwheel.

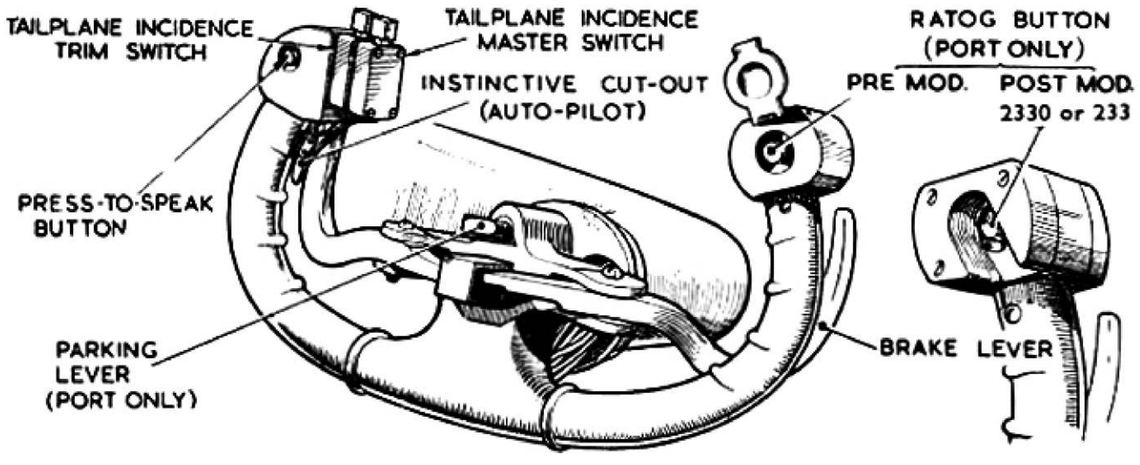


Fig. 12 Control handwheel

51 Rudder pedals

Each pair of rudder pedals incorporates a pair of brake toe pedals and is adjustable for reach by a starwheel immediately forward of the pilot's feet.

52 Flying control locks

The flying controls are locked by a built-in locking system operated by a lever (C23) on the central pedestal. The locking lever also operates a micro-switch which stops the power control motors when the controls are locked. Mod. 1976 (WZ400) introduces a lock in the form of a spring clip to hold the locking lever in the unlocked position.

53 Power controls

(*a*) The power controls are operated by four electrically-driven hydraulic pumps, two for the ailerons, and two for the rudder and elevators. The systems are so arranged that if one aileron pump motor fails the ailerons will still operate, but only at half rate ; rudder and elevators are not affected. If one of the rudder and elevator pump motors fails, the rudder and elevators will operate at half rate ; ailerons are not affected. Any further motor failure will cause the affected controls to revert automatically to manual.

NOTE: The maximum rate at which control deflection can be applied is considerably greater than would normally be required, even at half rate.

Consequently failure to half rate of any control surfaces will not have any noticeable effect on handling unless an abnormally high rate of control deflection is required.

(*b*) The four pumps are controlled by the instrument master switch (B28) on the instrument top panel. The pumps will not operate if the internal control lock lever is engaged. If the power control motors are running, they will automatically be stopped as soon as the internal control lock lever is engaged (but see Part III, para. 45) ; the pumps will not start running again when the lever is disengaged, until the instrument master switch is re-selected ON. When the power control motors have been tripped it takes about 12 seconds for the hydraulic pressure to dissipate and to cause reversion to manual control. This period will be reduced if the controls are moved after tripping the motors. The motors can only be tripped by operating the control locking lever or the individual trip pushbutton (see (*c*) below).

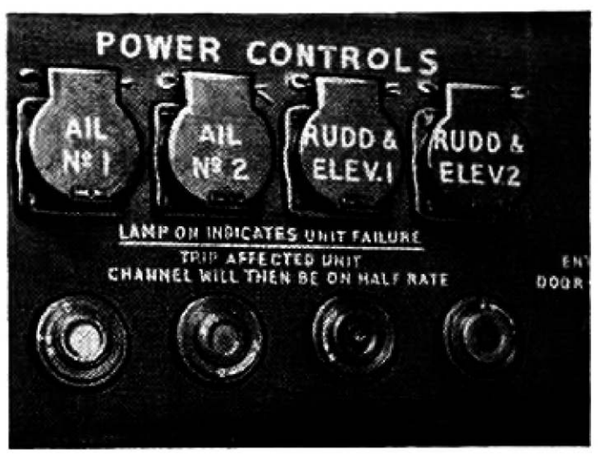


Fig. 13 Power controls

(*c*) Four warning lights (E26, 27, 28 and 29) on the port coaming panel give individual warning of low pressure delivery by any pump. If any of these lights come on, the appropriate pump motor must be tripped without delay by pressing the pushbutton (E7, 8, 9 and 10) above the light. The light will remain on when the motor is tripped.

(*d*) A master warning light (B11) on the port instrument flying panel gives warning of low pressure delivery by any one or more of the pumps. If this light comes on, the immediate action should be to check the four warning lights on the port coaming panel and then trip the relevant pump motor ; the master warning light will then go out. If one of the four lights comes on and the master light stays out, check the operation of the filament by pressing the master light. If this is all right, contactor failure is indicated (as opposed to pump failure) and an attempt may be made to re-set it by selecting the instrument master switch on. If it fails to re-set and the light stays on the motor must be tripped. If one of the other motors has previously been tripped due to failure this should again be tripped after releasing the instrument master switch.

54 Feel units

(*a*) As the power controls are irreversible and therefore have no feedback it is necessary to provide some form of feel. This is provided through three units which get a ram air supply from an inlet at the root of the fin leading edge. They also get a static supply from vents in the top of the rear fuselage. The feel is a

function of indicated air speed and control deflection and thus, although it is artificial, is similar to that obtained on a manually controlled aircraft.

(b) Feel unit heaters

The feel units are heated electrically by thermostatically controlled muffs. The switches are on Panel E (Mod. 3058; Command Mod. 61).

(c) Feel unit release

If any of the feel units should jam or be damaged, they must be disconnected from the controls system by pulling back the relevant one of the three cut-off levers (C3, 7 and 9) on the left of the central pedestal. If a feel unit has been disconnected accidentally, it can be reconnected in flight by putting the lever forward and making small movements of the controls until the unit re-engages ; the elevator feel can, however, only be reconnected if the release lever is moved forward under the same speed and flight conditions as when it was released. A locking button is in the top of each cut-off lever; Pre-Mod. 2814 this button must be pressed before the lever can be moved forward, Post-Mod. 2814 the button must be pressed before the lever can be moved either way.

55 Trimming

(a) General

There are two separate methods of trimming, one for use when flying with the power controls operating, and one for use if the power controls have failed. Under normal conditions the variable incidence tailplane is used for longitudinal trimming and the aileron and rudder feel unit trimmers are used for lateral and directional trim. When the power controls have failed and control has reverted to manual, conventional trimming tabs are used for lateral and directional trim, and the variable incidence tailplane is used for longitudinal trimming, in conjunction with the conventional elevator trimming tab. When flying in power, it is important that the aileron and rudder manual trimmers are left at neutral, and when flying in manual the feel trimmers must not be moved.

(b) Variable incidence tailplane

(i) The incidence of the tailplane is varied by two electric motors controlled by one or other of two incidence switches one on each control wheel. Two " master " switches, one on each control wheel, are mounted inboard of, and side-by-side with, the incidence switches. They control a master relay in the power supply to the tailplane actuator. All four switches are three-position and spring-loaded to the central (off) position.

(ii) Only one incidence switch is operative at a time, according to the setting of a guarded selector switch (C6), on the central pedestal, marked 1st PILOT and 2nd PILOT. When the selector switch is set to 1st PILOT, only the incidence switch on the left hand wheel will operate the tailplane. This selector switch does not control the two " master " switches. Only one motor is used at a time, this being selected by a guarded switch (C4), marked COARSE and FINE, on the central pedestal. When this is set to COARSE the fast motor will operate the tailplane incidence at about three seconds per degree, full travel being obtained in 24 seconds. When the switch is set to FINE, the slower motor will operate the tailplane incidence at about six seconds per degree, full travel being obtained in 45 seconds.

(iii) When either master switch is moved either forward or back the master relay is energised and the tailplane circuit is made live. Operation of the selected incidence switch while the master switch is being held on will energise the tailplane actuator motor and change the tailplane incidence. When the master switch is released and returns to the central position the master relay is tripped, causing the tailplane circuit to become dead and the actuator motor to stop, even if the incidence switch is still held on. When the selected incidence switch is held back, the trailing edge of the tailplane is raised, giving a nose-up change of trim. The motor will run until the incidence switch or the master switch or both are released or until the tailplane actuator reaches the end of its travel.

(iv) If the limit switches at either end of the travel of either motor fail, an overtravel micro-switch will operate to trip the contactor and stop the motor. The tailplane can be moved on the other motor, and when it is brought back within limits the tripped contactor will automatically reset.

(v) When trimming, the selected incidence switch an adjacent master switch must be operated and released simultaneously. The master switch must not be held on in anticipation of trimming.

(vi) An indicator (B58) on the instrument centre panel shows the position of the tailplane at all times when electrical power is available. On aircraft prior to WP214, until Mod. 1200 is embodied the indicator is at (B60).

(*c*) *Feel unit trimming*

The feel units for the rudder and ailerons may be trimmed to relieve the foot and hand loads by operating the trimming switch (C15) on the central pedestal. Sideways movement of the switch trims the aileron feel unit, and rotary movement trims the rudder feel unit. Indicators (B53 and 55) are on the instrument centre panel. The elevator feel unit cannot be trimmed. The trim indicators do not show applied trim, but show neutral when the controls are in trim. When the controls are moved, without being re-trimmed, the indicators will be displaced.

(*d*) *Trimming tabs*

Trimming tabs are fitted on the rudder and starboard ailerons, for use when flying in manual, and on the starboard elevator to enable the elevators to be kept in trim with the tailplane when flying in power or in manual (see sub-para. (*e*)). They are operated by electric actuators controlled by three master switches (F20, 21 and 23) and a single trimming switch (F19), all on the port console panel. The rudder tab is operated by turning the trimming switch in the required direction ; the aileron tab by moving the switch to either side ; and the elevator tab by moving the switch forwards or backwards. In all cases the actuators operate until the switch is released or until they reach the limit of their travel. Position indicators (F11 and 18) for all three tabs are on the port console panel.

NOTE: Until Mod. 1958 (WZ390) is embodied the Rudder and Elevator trim master switches are transposed. Thus they are not in line with the indicators, and care must be taken to avoid confusion.

(*e*) *Elevator trimming*

Owing to the power controls having no feed-back, it is possible, due to variations in speed, CG and weight, for the elevators to be

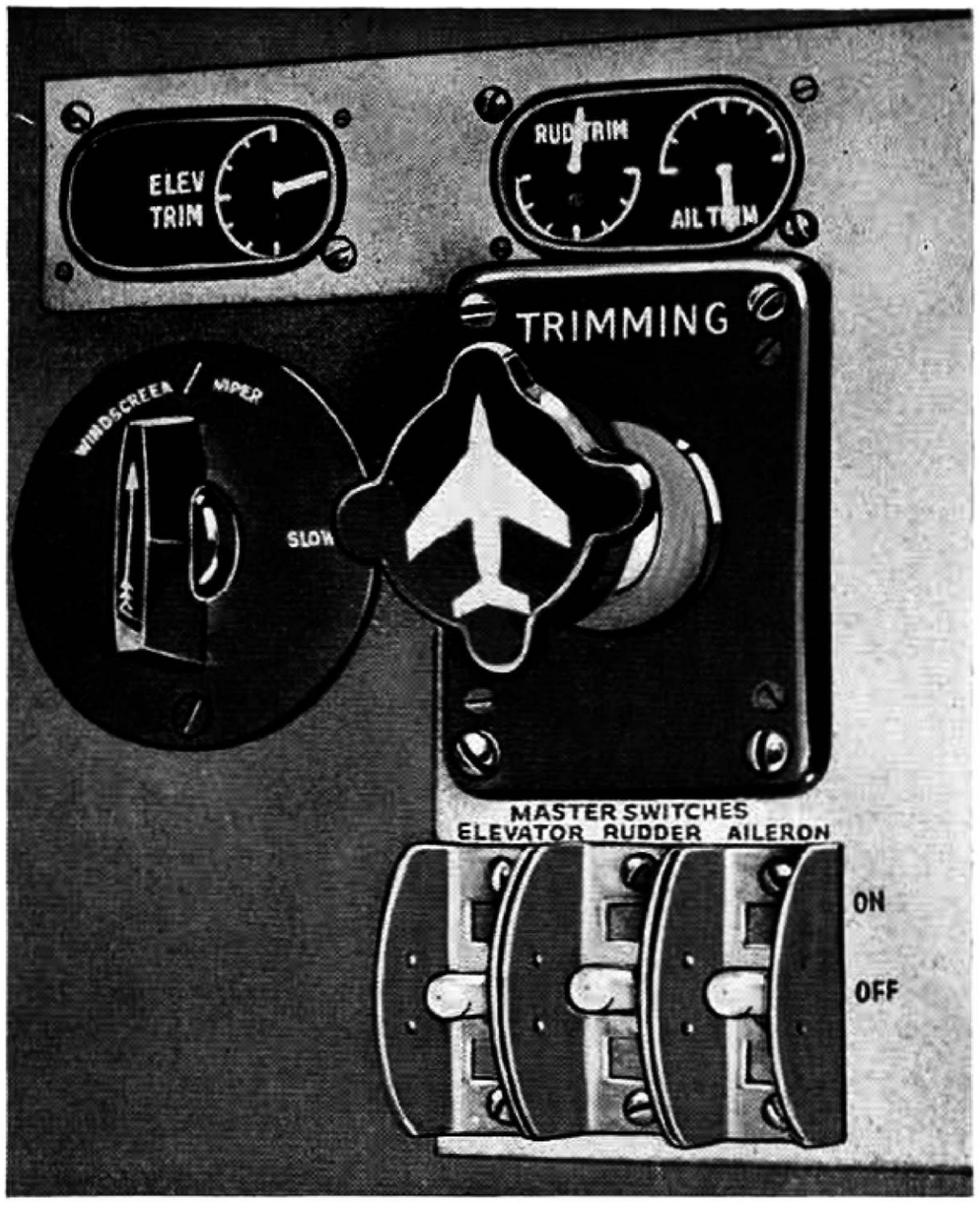


Fig. 14 Trimming controls

considerably out of trim without there being any corresponding force felt on the controls. If the elevators were greatly out of trim at the time of failure of the power controls, with consequent automatic reversion to manual control, the forces on the control handwheel could be higher than the pilot could hold. To avoid this risk, it is necessary during normal flight to keep the elevators trimmed within the limits of acceptable stick force. It is also necessary to keep the elevator in trim when flying in manual, to avoid unnecessary loads in the control run and to avoid the consequent trim change when re-engaging power. An elevator trimming indicator (B9), in the form of two lights on the left of the instrument top panel, shows when the elevator is out of trim by a certain amount. The DOWN light comes on when a nose-down trim change is required, and goes out when the force has been trimmed out. Similarly the UP light comes on when a nose-up trim change is required. If the lights are out, the stick force on reversion to manual control will be light.

56 Trim tab settings

(a) Elevator trim tab

The elevator trim tab movement is nine degrees up and two degrees down. The trim tab position indicator has not been recalibrated.

(b) Aileron trim tab

The aileron trim tab movement is reduced from 4·45 inches each way to 1·39 inches each way by STI/Valiant/5 (August, 1955) or by Mod. 1808 (WZ400). The STI did not call for recalibration of the trim tab position indicator but when Mod. 1808 is embodied the indicator is recalibrated.

(c) Rudder trim tab

The rudder trim tab movement is reduced from 2·1 inches each way to 0·48 inches each way by STI/Valiant/6 (August, 1955) or

by Mod. 1809 (WZ400). The STI did not call for recalibration of the trim tab position indicator, but when Mod. 1809 is embodied the indicator is recalibrated.

57 Flap control and indicators

(*a*) The flaps are operated by an electric motor controlled by a lever (C13) on the central pedestal. The lever has three positions, UP, OFF and DOWN and is spring-loaded to the central (OFF) position. The normal range of movement of the flaps is down to 58 degrees on the main motor and 45 degrees on the emergency motor.

(*b*) To lower the flaps the lever should be held in the DOWN position. The motor will then run to lower the flaps until either the lever is released or the flaps reach the fully down position when the motor will automatically be stopped. To raise the flaps the lever should be held in the UP position, the motor again being stopped by releasing the lever or when the flaps reach fully up. If the normal motor fails, the flaps can be operated by an independent emergency motor. This is controlled by the three-position switch (C5), labelled UP—OFF—DOWN, on the central pedestal.

(*c*) Should the limit switches at either end of the flap travel fail, an overtravel micro-switch will operate to trip the main contactor and stop the motor ; at the same time a contactor reset warning light (P7) on the starboard console door will come on. The contactor may be reset by pressing the push-button below the warning light, but before this is done the direction of flap travel should be reversed by setting the emergency selector switch (C5) on the central pedestal to UP or DOWN according to whether the flaps have overrun the down or up limit switches. It is not necessary to let the flaps complete their travel; as soon as the flaps are back within the normal range, the emergency motor can be stopped by returning the emergency switch to OFF. The main contactor may then be reset.

(*d*) If, while the flaps are moving up or down on the normal motor, it is decided to reverse their movement, it is not necessary to wait until they reach the end of their travel. The lever may be moved from one selection to the other and the flaps will change their direction of movement after only a slight delay while the motor slows down and reverses.

(*e*) If, while the flaps are moving up or down on the emergency motor, it is decided to reverse their movement, the switch must be moved to OFF and left there for two seconds before making the new selection.

(*f*) The emergency motor incorporates overrun micro-switches which operate in the same way as those for the normal motor, the emergency contactor reset warning light (N4) and pushbutton (N3) being on the port console door. If the flaps overrun on the emergency motor and flap movement cannot be reversed by the normal motor they will remain immovable. The normal motor cannot be operated while the emergency motor is running because when the emergency motor is operated the normal contactor is tripped.

(*g*) In the event of a run-away motor, the main or emergency contactors may be tripped by operating the relevant one of two pushbuttons (B29 and 30) on the instrument top panel, and reset by pressing the relevant one of the two reset pushbuttons, the normal one (P7) on the starboard console door, and the emergency one (N3) on the port console door.

(*h*) Two indicators (B49 and 51) on the instrument centre panel show the position of the flaps at all times.

(*j*) The times of full movement of the flaps, from one extreme to the other, are as follows:

NORMAL		*EMERGENCY*
34 to 42 secs	UP	$7\frac{1}{2}$ to $9\frac{1}{2}$ mins
34 to 42 secs	DOWN	$6\frac{3}{4}$ to $8\frac{3}{4}$ mins

58 Airbrakes

(*a*) The airbrakes are operated by an electric motor controlled by a lever (C/11) on the central pedestal ; they have two positions, IN and OUT. No emergency control is provided. Mod 1608 (WZ 390) introduces a position indicator (B/56) at the foot of the centre instrument panel.

(*b*) Should the limit switches at either end of the air-brake travel fail, an overtravel micro-switch will operate to trip the main contactor and stop the motor ; at the same time a contactor reset warning light (P/6) on the starboard console door will come on. To reset the contactor the airbrake selector lever must first be placed in the opposite position to the airbrakes, and then the reset button below the warning light should be pressed. When the reset button is pressed the light will go out ; if it stays out when the button is released, the contactor will have been reset. The button should only be held in momentarily.

59 Automatic pilot

(*a*) A Mk 10 automatic pilot is installed and is operated by the control unit (C/24) on the central pedestal. A heading selector (F/15) is on the port console, thus the main control is accessible to both pilots while the heading selector can only be operated by the first pilot. An auto-pilot cut-out trigger switch is fitted to each pilot's control handwheel. AC for the auto-pilot is supplied by No. 2 radar inverter and DC is supplied from the 28-volt system.

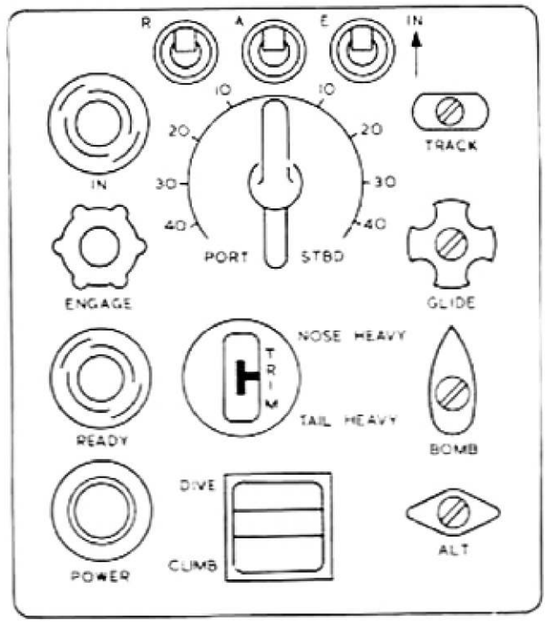


FIG 15 *Auto-Pilot Controller*

(*b*) *Control unit*

(i) The control unit has the following controls and indicators located on it:

POWER switch and associated READY magnetic indicator

ENGAGE switch and associated IN magnetic indicator

Rudder, Aileron, and Elevator channel switches

Trim indicator

NBS link switch, marked BOMB

ILS link switch, marked TRACK (localiser beam)

ILS link switch, marked GLIDE (glide path beam)

Height lock switch, marked ALT

Bank control knob and scale

Pitch switch, marked CLIMB and DIVE

(ii) The bank control knob is not spring-loaded, but has a zero bank location (central position). The pitch control switch is a five-position switch spring-loaded to the middle (off) position. The rudder, aileron and elevator channel switches are conventional two-position (IN forward) toggle switches. The remainder of the switches are of the pull (on)—push (off) type.

(*c*) The controls on the control unit function as follows:

(i) *POWER switch.* When the POWER switch is pulled, electric power is connected to the auto-pilot. After approximately 60 seconds the READY magnetic indicator (in front of the power switch) will change from black to black and white stripes, indicating that the auto-pilot is ready to be coupled to the aircraft controls.

(ii) *ENGAGE switch.* Providing the rudder, aileron and elevator channel switches are IN, pulling the ENGAGE switch will couple the auto-pilot to all three control surfaces, whereupon the IN magnetic indicator will show white and the READY magnetic indicator will go black. The controls can be disengaged from the auto-pilot by pushing the ENGAGE switch in, although this will normally be done by depressing the instinctive cut-out on the hand-wheel.

(iii) *Channel switches.* If a control channel switch is selected off, its particular control surface will be disengaged from the auto-pilot. The IN magnetic indicator will remain white and the READY indicator will show black and white stripes. Re-engagement can be achieved by putting the channel switch IN again, when the READY indicator will show black. If all three channel switches are off at the same time their control surfaces cannot be reconnected to the auto-pilot simply by putting them on again, and the normal engage procedure (by pulling out the ENGAGE switch when any one of the three channel switches is IN) will have to be used.

NOTE: Until Auto-pilot Mod E30 is embodied, the READY indicator shows amber in place of black and white stripes, and the IN indicator shows green in place of white. The black (off) conditions are unchanged.

(iv) *Trim indicator.* The indicator shows any out-of-trim load being carried by the auto-pilot elevator servo-motor. The pointer must be within the centre $\frac{3}{4}$ of the white sector before the auto-pilot is engaged. It must be kept within the centre $\frac{3}{4}$ of the white sector during flight by adjusting the aircraft trim as necessary, on the tail-plane trimmer. Post-Mod 2062, a remote trim indicator is on the bottom left corner of the instrument centre panel, in place of the OAT gauge (B/60).

(v) *Height lock switch.* When this switch is pulled the auto-pilot will lock on to the barometic height prevailing.

(vi) *Bomb, Track and Glide path switches.* The bomb switch, when pulled out, links the NBS equipment to the auto-pilot, which then controls the aircraft heading according to the signals produced by the NBS. The other two switches, when pulled on, link their respective ILS signals to the automatic pilot which then controls the aircraft according to the ILS localiser and glide path beams.

(vii) *Bank control*. The aircraft can be turned at a pre-set angle of bank by selecting the control knob to the bank required. The knob will remain on the selected angle and the aircraft will maintain the turn at that angle of bank until a different angle is selected, or the knob returned to the central position, when the aircraft will resume straight flight.

(viii) *Pitch control*. The pitch control switch is operated in the natural sense, i.e. moving the switch forward produces nose-down pitch, and vice-versa. The switch is spring-loaded to the centre (off) position. Movement of the switch is opposed by two spring rates so that initial movement against a weak spring produces a slow rate of change of aircraft attitude whilst further movement against a stronger spring will cause a fast rate of attitude change.

(*d*) *Heading selector*

The heading selector (F15) comprises a compass repeater, course setting knob and pre-select turn engagement button. With the TRACK switch on the control unit off, courses can be pre-selected on the heading selector and the aircraft will turn on to the selected heading when the pre-select turn button is depressed. The angle of bank when using the heading selector for turns is restricted to 30 degrees. With the ILS on, the runway heading (or the ILS localiser QDM if the beam is offset) should be pre-selected on the heading selector before pulling the TRACK switch on.

(*e*) *Torque limiting devices*

Torque-switches are fitted in the circuits of the auto-pilot to guard against auto-pilot runaway; they will operate in the event of a runaway occurring and thus prevent any danger from the sudden or over-application of the control. Pre-Mod. 2424 the aileron circuit is not fitted with a safety device; should a roll runaway occur, the auto-pilot will have to be cut out by the operation of the control column cut-out switch, the engage switch or the power switch.

60 Auto-stabiliser (Mod. 2252)

The auto-stabiliser suppresses any tendency of the aircraft to oscillate in yaw, or to dutch roll, by increasing the directional damping. It functions in all conditions of flight and is controlled by an ON/STANDBY/OFF switch on the central pedestal. Prior to switching ON or OFF, the auto-stabiliser *must* be switched to STAND-BY for *at least* five seconds.

Flight Instruments

61 Compasses

(*a*) *Mk. 4B Compass*

(i) The Mk. 4B compass master indicator (M19) is on the radio crate and a repeater (B46 and 66) is on each instrument flying panel. Each repeater embodies caging and setting knobs. The control panel (F17) is on the port console panel. It incorporates a switch marked PORT—OFF—STARBOARD which is used to select either the port or starboard repeater to compass, the repeater not selected being automatically set to DG. Mod. 1818 provides a repeater at the prone station on PR aircraft.

(ii) Mod. 2190 or 2533 introduces a switch, marked DG/G4B, at the navigator's station. This enables the compass to be selected to directional gyro in lieu of magnetic monitoring so as to reduce compass errors in turns when using H2S. When the switch is set to DG the compass is automatically switched to directional gyro by the H2S when the angle of bank exceeds six degrees. With the switch at G4B the compass is always monitored, whatever the angle of bank. This switch is only operative post-Mod. 2190 when H2S and NBC are switched on, or post-Mod. 2533 when H2S is switched on.

(iii) Mod. 2982 introduces a switch box on the cabin port wall above the voltage trimmer panel. This box contains two power failure indicators (AC voltmeters), one each in the power supply circuits to the Mk. 4B compass and the artificial horizon, and also a NORMAL/EMERGENCY change-over switch. (See Part III, para. 21(*e*).)

(*b*) *Magnetic standby compass*

Pre-Mod. 2791, a P12 magnetic standby compass is mounted below the front centre of the canopy, below the fuel panel. Post-Mod. 2791 the P12 compass is replaced by two E2B compasses, one on each side, suspended below the fuel panel.

62 Turn-and-slip indicators

Each turn-and-slip indicator has two independent and separately fused DC supplies controlled by the instrument master switch. If one supply fails for any reason the feed to the indicator is automatically changed over to the other supply by a relay.

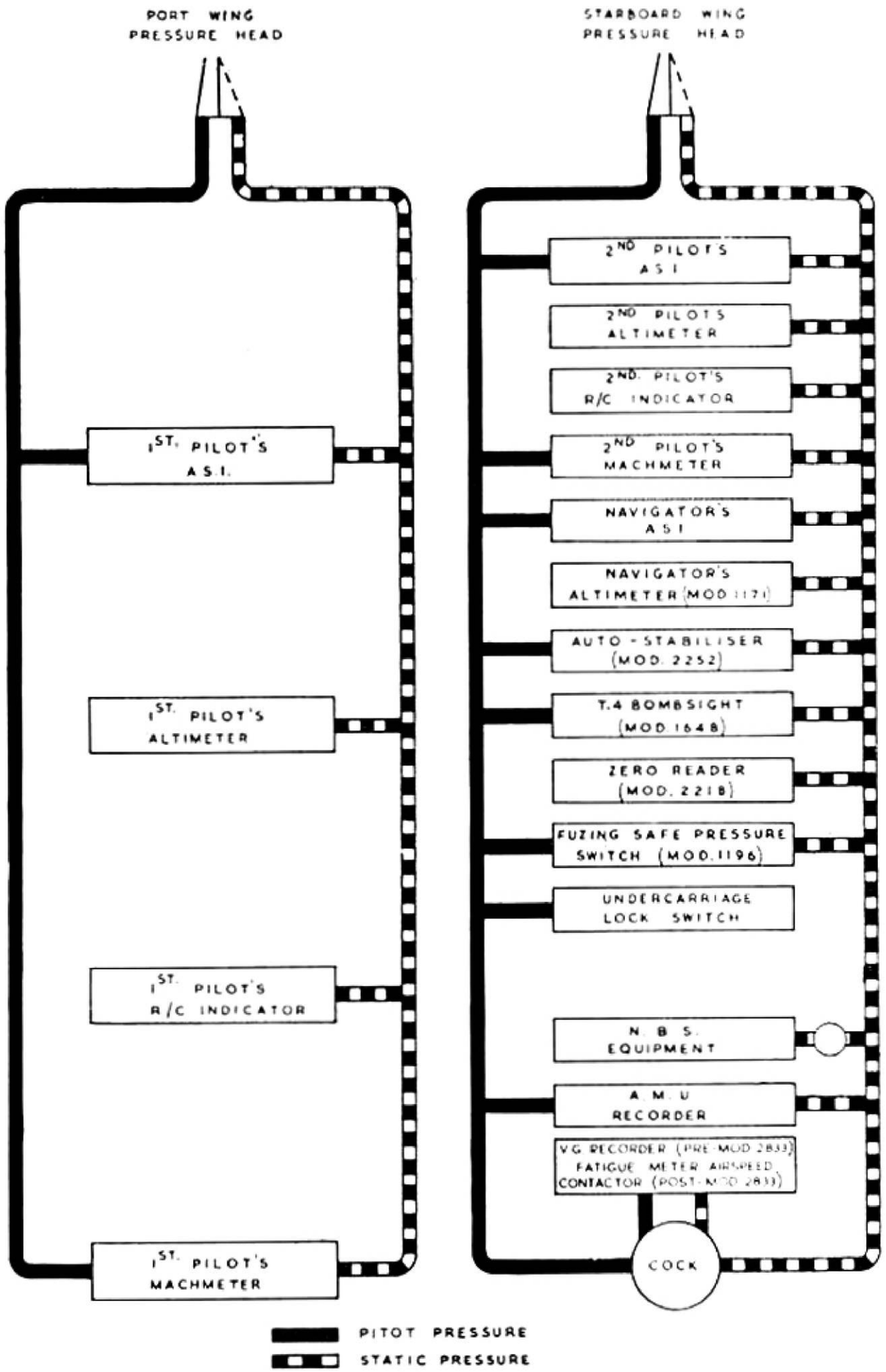


Fig. 16 Pitot-static systems

63 ASI systems

(*a*) Two pitot/static heads are fitted, one at each wing tip. The port head supplies the first pilot's airspeed indicator, machmeter, altimeter and rate of climb indicator. The starboard head supplies similar instruments on the second pilot's instrument flying panel and also supplies the navigator's airspeed indicator and altimeter, as well as the instruments and equipment shown in Fig. 16. There is no connection whatever between the two systems.

(*b*) A shut-off cock (M2) on the radio crate enables the VG recorder to be turned off as desired.

(*c*) A heater is incorporated in each pitot/static head; each has a switch (B5 and 36) on the relevant instrument flying panel.

64 Machmeter

The machmeter is subject to error and should be checked periodically against IAS and altitude, using the graph in Fig. 17.

65 Accelerometer

A Mk. 2 accelerometer (B6) is introduced by Mod. 1656 (WZ380). It is in front of the pilot to the left of the instrument flying panel.

66 Artificial horizons

Each artificial horizon has a fast erection pushbutton (B3 and 33) below and to the left of it. The instrument is not self-erecting when first switched on, unless the horizon bar is within 10 degrees of horizontal in the roll sense. After the engines have been started the fast erection button must, therefore, be pushed in and held until the horizon bar falls within these limits. This may take some 10 seconds. Self-erection within the 10 degrees limits is slow; about 5 degrees per minute. If the gyro is toppled in flight, the aircraft must be flown level by reference to the other instruments before the fast erection button is pressed. The gyro has full freedom of movement in the rolling plane, but will topple if more than 80° of climb or dive is exceeded. (See also para. 61(*a*)(iii).)

Undercarriage Controls and Indicators

67 General

The mainwheel units and outer doors, and the nosewheel unit, are retracted and extended by electric actuators each incorporating independent main and emergency motors.

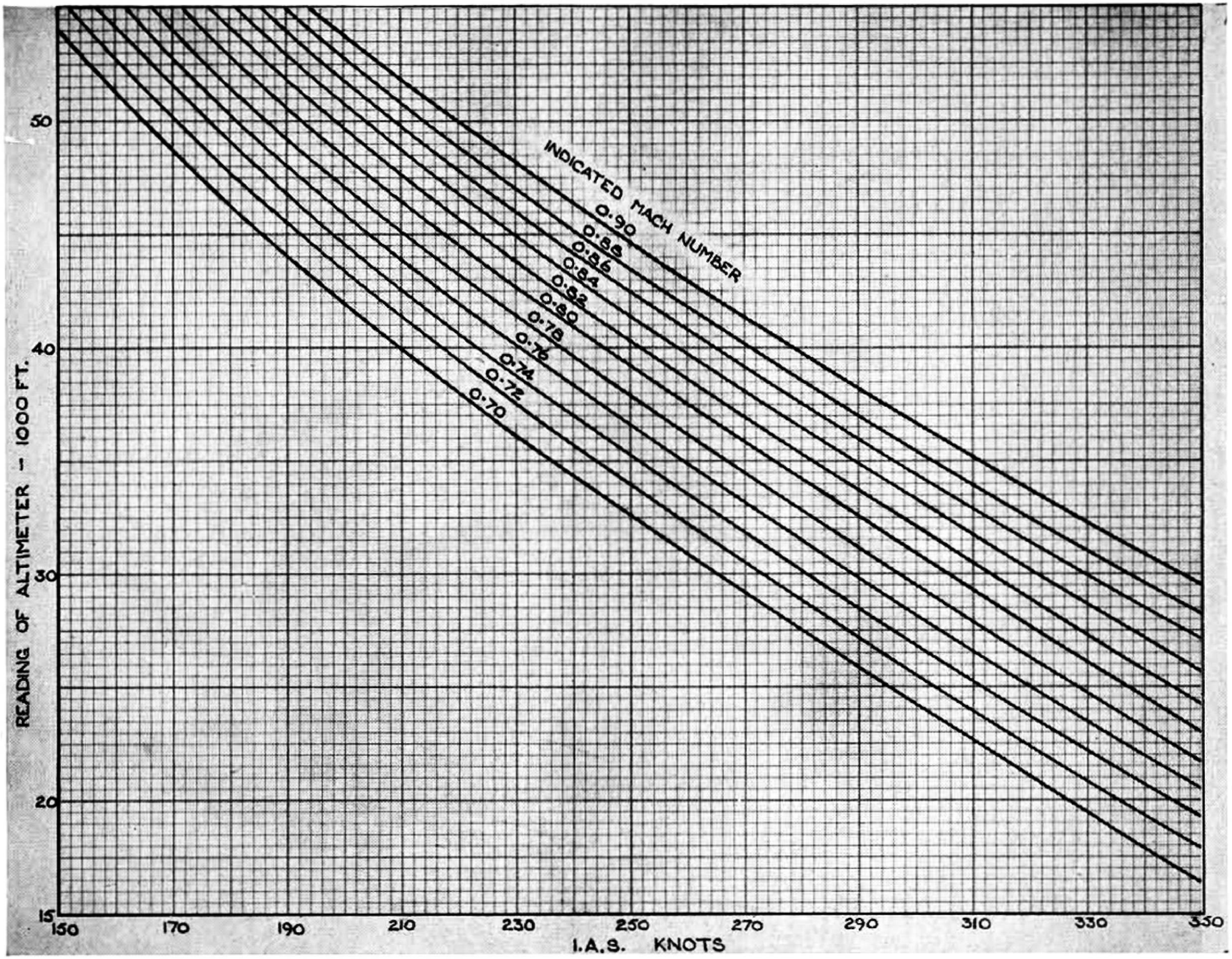


FIG. 17. *I.A.S./I.M.N. Conversion Chart*

68. Normal operation

Two pushbuttons (C/17 and 18) marked UP and DOWN, on the central pedestal, are used to raise and lower the undercarriage. The UP button is locked against inadvertent operation by an airspeed-operated switch set to release at 80 to 85 knots. In emergency the lock can be overriden by turning the ring round the UP button and then pressing the button.

NOTE: Selection *must not* be reversed until travel is complete. (See also Part V.)

69. Emergency operation

An EMERGENCY pushbutton (C/19), aft of the normal buttons, enables the undercarriage to be lowered if the normal circuit has failed. It will not retract the undercarriage (see Part V, para. 7 and 8).

70. Extreme emergency operation

Two two-position switches, shielded by a flap (H/11), on the starboard console panel may be used if mechanical damage prevents operation, or in the event of failure of the normal and emergency circuits. Operation of these switches fires explosive bolts to release the main-wheel units and doors, which will then lower until the down locks engage. These switches operate the main-wheel units only. If only one main-wheel unit fails to lower, it is of course necessary to operate only the one EXTREME EMERGENCY switch. Two circuit-breakers (P/3 and 4) are on the starboard console door. It is essential that these are made before the extreme emergency switches are operated, also, the main contactors for the main-wheel units must be reset before the main wheels can be lowered by the EXTREME EMERGENCY switches. (See Part V, para. 7 and 8.)

71. Contactor trip and reset

Three lights (P/9, 10 and 11) on the starboard console door come on if the main contactors for the three undercarriage units trip due to a fault. This may also happen due to operation of a clutch slip device which trips the contactor after 10 revolutions of clutch slip, thus protecting the motors from overload. If any light comes on, the contactor may be reset by pressing the reset button below the light, but it is important to do this in the manner laid down in Part V, para. 7 and 8.

72. Undercarriage position indicators

(*a*) A standard undercarriage position indicator (B/54) is on the centre instrument panel. The lights are duplicated and a night screen is fitted. The indicator will operate when the instrument master switch has been selected ON.

(*b*) Two amber lights (B/52 and 57) are on the centre instrument panel. These come on when the main undercarriage secondary locks are made, and give, in conjunction with the standard position indicator, visual indication that all down locks are home. If these two lights are on, but the main-wheel green lights are not on, it is quite safe to land the aircraft.

(*c*) The position of the main-wheel doors is indicated by two red lights (G/2 and 3) on the starboard coaming panel. These come on when the doors are not fully closed.

73. Undercarriage warning horn

A warning horn in the cabin sounds if all four throttles are closed below about 5,000 to 5,500 engine r.p.m. if all undercarriage units are not locked down. A warning horn test push-button (H/10) is on the starboard console panel.

74. Wheel brakes

(*a*) Equal braking on all main wheels is obtained by operating either of the twin levers on each control handwheel. A parking catch is on the left handwheel. If fully serviceable, the brakes are capable of holding full power on all engines. Differential braking is obtained by using the rudder bar toe pedals independently. Anti-skid (Maxaret) units are fitted which allow the maximum braking power to be used without the risk of locking the wheels.

(*b*) *Supply change-over*

The brakes are normally supplied from No. 1 hydraulic service through the anti-skid units. If No. 1 service or the anti-skid units fail, the lever (C/27) on the rear of the central pedestal should be set over to port. When this is done the brakes will be operated direct from No. 2 hydraulic service, the anti-skid units being by-passed.

(*c*) *Pressure gauges*

The pressure in both hydraulic systems is shown on four pressure gauges (J/4, 5, 6 and 7) on the starboard quarter panel, two for the brakes and two for the nose-wheel steering. The bottom gauge (J/7) and the second gauge from the top (J/5) show the pressure available for the brakes in No. 1 service and No. 2 service, respectively.

75. Nose-wheel steering

(*a*) Hydraulic power from both hydraulic systems is used to operate the nose-wheel steering jacks. Steering is controlled by a handwheel (F/8) on the port side above the port console panel. The maximum steering angle is 50 degrees each side of neutral and the wheel will travel from neutral to full lock in a maximum of two seconds.

(*b*) When the weight is taken off the nose-wheel it automatically centres, thus operating a micro-switch to allow it to retract. While the nose-wheel is retracted the steering hand-wheel will be locked in the central position. If the automatic centring fails to operate the micro-switch, the hand-wheel may be used to overcome any slight sticking (but see Part V, para. 6).

(*c*) *Pressure gauges*

The pressure in the hydraulic systems is shown on four gauges (J/4, 5, 6 and 7) on the starboard quarter panel, two for the brakes and two for the nose-wheel steering. The top (J/4) and third (J/6) gauges show the hydraulic pressure available for steering in No. 2 service and No. 1 service respectively.

Cabin Air Conditioning and Pressurising

76. General

(*a*) Hot air for pressurising and air conditioning the cabin is taken from a bleed on the starboard side of the compressor casing of each engine. Each bleed is controlled by a gate valve. Each gate valve is operated by a switch (J/1, 14, 15 and 16) on the starboard quarter panel, marked NORMAL and EMERGENCY CLOSE. This operation is overridden by a throttle-operated micro-switch. When the switches are at NORMAL, the gate valves will open as soon as the H.P. cocks are open.

(*b*) From the gate valves the cabin air is divided into two systems, normal and flood flow (emergency increased air supply).

NOTE: Until Mod. 984 (WP.209) is embodied, the gate valve switches are transposed from the normal system of numbering engines; i.e. they are numbered No. 4, No. 3, No. 2, No. 1 from port to starboard. Post-Mod. 984 they are in the logical order.

77. Air conditioning

(*a*) Air from both engines on each side passes through a constant flow valve to a shut-off valve. The shut-off valves are controlled by two CABIN AIR SUPPLY switches (H/5) on the starboard console panel, labelled ON and OFF; when the switches are ON, the valves are open. The air then combines from both sides of the aircraft and is admitted to the cabin either hot (direct from the engines) or cooled by passing it through an inter-cooler, or cooler still by passing it through the inter-cooler and a cold air unit. An inter-cooler valve is used to direct the hot air from the engines either direct to the cabin or through the inter-cooler. Intermediate positions of the valve determine the degree of cooling by varying the proportion of air passed through the inter-cooler, the rest passing direct to the cabin. From the inter-cooler the air is passed by a refrigerator valve either direct to the cabin or through the cold air unit, intermediate positions of the valve again being obtainable.

(*b*) Both valves are controlled by a single switch (H/12) on the starboard console panel. It is marked RAISE – LOWER and is spring-loaded to the central (off) position. Assuming that all the hot air is passing direct to the cabin, when the switch is held at LOWER the inter-cooler valve is progressively opened, passing more and more air through the inter-cooler. When the inter-cooler valve is fully open, if the switch is still held at LOWER, the refrigerator valve is progressively opened, passing more and more air through the cold air unit. When the switch is held to RAISE, the reverse happens; first the refrigerator valve closes progressively, then the inter-cooler valve closes progressively, both gradually increasing the temperature of the air supplied to the cabin. A dual indicator (H/12) on the starboard console panel shows the position of the two valves.

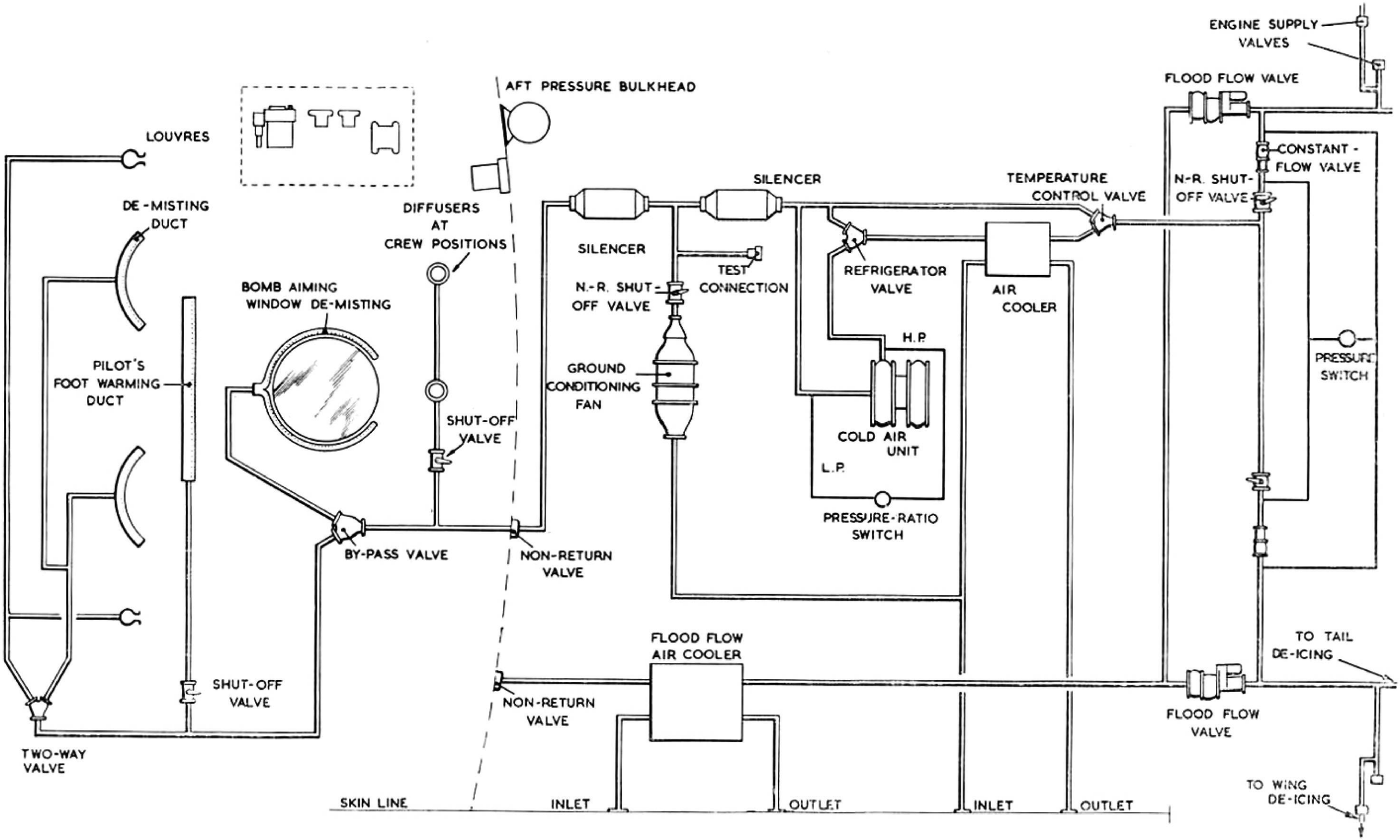


FIG. 18. *Air Conditioning System (Simplified)*

(*c*) Either valve may be stopped in any intermediate position by letting the switch return to OFF: the refrigerator valve will not open until the inter-cooler valve is fully open, nor will the inter-cooler valve close until the refrigerator valve is fully closed.

(*d*) The air in the cabin is distributed through two diffusers in the floor at the rear of the cabin, de-misting ducts for the windscreen, louvres (E/13) and (G/4) and foot-warmers for the pilots and a de-misting duct over the bomb-aimer's window. The latter is normally shut off, but may be turned on by a lever at the bomb-aimer's station ; when this lever is operated the air to the diffusers and foot-warmers is shut off, and the supply to the windscreens is restricted, thus giving the bomb-aimer's window the maximum supply. A control (E/19) at the front of the port coaming panel enables the restricted air supply to be passed to the windscreens or to the louvres, or to both. Mod 2023, on B(PR)1 and BK(PR)1 only, provides an additional heating supply in the prone bombing position. This is controlled by an ON/OFF lever on the port side of the prone bombing station.

(*e*) *Low pressure switches*
At very high altitude the air pressure from the engines may be insufficient to drive the cold air unit and to pass an adequate supply to the cabin. If this should happen, a pressure switch, operated by the pressure drop across the contant flow valves, closes the refrigerator valve sufficiently to ensure adequate ventilation. Full control of the inter-cooler valve is still possible when this happens. A similar pressure switch across the cold air unit operates in the same way to protect the system.

(*f*) *Ground ventilation and unpressurised flight*
On the ground, or when flying unpressurised, cold air may be admitted to the cabin from an intake in the leading edge of the port wing. A shut-off valve in the duct is controlled by an ON—OFF switch (H/6) on the starboard console panel. When the switch is placed to ON the valve will open and cold air at ram pressure will be admitted to the cabin. An electric fan in the duct is controlled by a GROUND VENT FAN switch (H/8) on the starboard console panel, marked ON and OFF. Before the fan is switched ON, the ram air shut-off valve must be opened. The fan must not be used in flight. Until Mod 2362 (B1 and B(K)1) or 2446 (B(PR) 1 and B(PR)K1) is fitted, a circuit-breaker (P/5) is on the starboard console door.

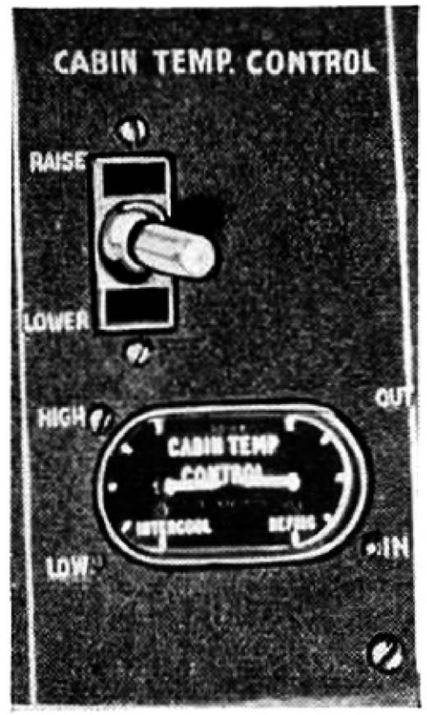


FIG 19 *Cabin Temperature Control*

78 Pressurising

(*a*) Cabin pressure is regulated by a pressure controller on the starboard wall at the rear of the cabin. A pressure selector switch (H/4) on the starboard console panel is marked CRUISE, COMBAT and NO PRESSURE. When Mod 1202 is fitted the switch is gated and incorporates a safety catch. When the switch is set to CRUISE, pressurisation starts at an altitude of 8,000 feet. The pressure controller maintains the cabin at 8,000 feet until the maximum differential pressure of 9 lb/sq in. is reached, when the controller maintains this differential. Similarly, when the switch is set to COMBAT pressurisation starts at 25,000 feet, this being maintained up to the maximum altitude.

(*b*) When the pressure selector switch is moved from CRUISE to COMBAT, the pressure will drop from 9 lb/sq in. differential to 25,000 feet in about 35 to 40 seconds. It will rise from COMBAT to CRUISE in about six minutes.

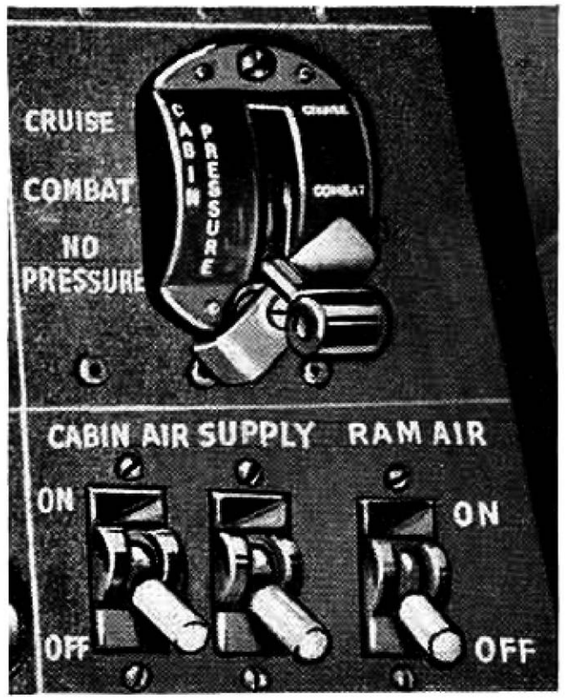


FIG 20 *Cabin Pressure Control*

(*c*) There is an emergency de-pressurising switch (F/12) on the port console panel, and a cock handle (M/24) above the radio crate, which enable the cabin to be de-pressurised quickly in emergency. When either of these controls is operated, two deflation valves open to de-pressurise the cabin. The differential pressure will drop from 9 lb/sq in. to $3\frac{1}{2}$ lb/sq in. in about six seconds. This differential pressure of $3\frac{1}{2}$ lb/sq in. is the maximum *safe* pressure for jettisoning the cockpit canopy. It should be noted that if the gate valve switches are at EMERGENCY CLOSE there will be no pressurising and no ventilation in the cabin.

(*d*) *Cabin altimeters and pressure warning light*

(i) *Cabin altimeters*. An altimeter (B/1 and 43) showing the cabin altitude, is on each instrument flying panel.

(ii) *Pressure warning light*. Post-Mod 2490 a cabin pressure warning light, which gives warning of cabin over-pressurisation, is on the starboard instrument flying panel above the pressure head heater switch (B/36). The pressure switch controlling the light is connected to cabin pressure and to the starboard static line. The light comes on if the cabin differential pressure rises to 9·5 lb/ sq in.; after appropriate action has been taken (see Part V, para 4) and the cabin pressure falls, the light will go out when a differential pressure of 9·1 lb sq in. has been reached.

79 Flood flow system

(*a*) Air is taken from the engine side of the constant flow valves, via two flood flow (or emergency increased air supply) valves to a common duct which passes it straight to the cabin through a separate cooler. The system provides a very high flow of air from the engines to cater for a high rate of leakage due to damage to the pressure cabin.

(*b*) The flood flow valves are operated automatically by pressure switches which operate if the cabin altitude rises to 29,000 feet. The valves will remain open, irrespective of the cabin pressure, until the flood flow switches (H/7) are set to DECREASE, but even then the valves will only close if the pressure switches have opened again due to the cabin altitude having fallen below 29,000 feet. When the valves open, a scoop in the port side of the aircraft aft of the cabin is opened, and an oval plate further aft is jettisoned to provide an adequate flow of air through the separate cooler. The flood flow system will not operate, whatever the cabin altitude, if either emergency de-pressurising control (see para 78 (*c*)) is operated or if the cabin pressure selector switch (H/4) is set to NO PRESSURE.

(*c*) The flood flow valves can also be operated by the two double-pole EMERGENCY INCREASED AIR SUPPLY switches (H/7) on the starboard console panel, labelled INCREASE, OFF, DECREASE. They are spring-loaded to the OFF position. Pre mod 2386 they are single-pole switches and are *not* spring-loaded to the OFF position. The valves are opened when the switches are set to INCREASE, and closed when set to DECREASE.

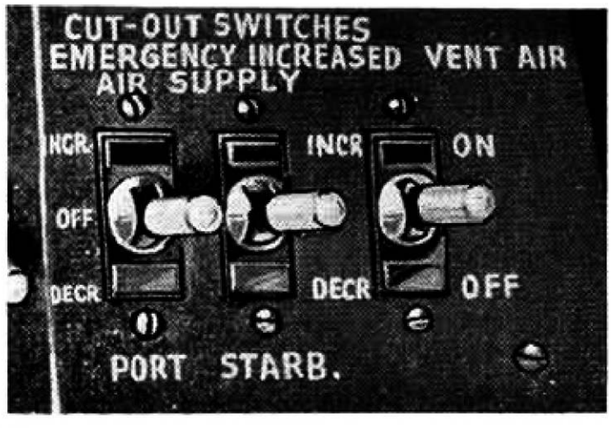


FIG 21 *Flood Flow Switches (Pre-Mod 2386)*

80 Inward vent valves

An inward vent valve is incorporated in the discharge valve to prevent a negative cabin pressure during a rapid descent.

81 Pressure failure warning

A pressure switch in the controller closes to operate a warning bell if the cabin pressure falls excessively below the selected pressure.

Oxygen Systems

NOTE: Pressure demand masks Type A.13A/1 or Type A.13A/2 *must* be worn.

82 Normal supply

(*a*) Oxygen is supplied by seven, eight or nine cylinders, four forward of the front pressure bulkhead and three, four or five in the roof of the "attic". The number depends on the aircraft type and Mod state (see Fig 22). Two HP valves, normally wire-locked open, are fitted, one under each console panel. Two contents gauges (M/34 and 35) are on the port side of the radio crate. The starboard HP valve controls the supply from two of the forward bottles and two of the attic bottles, the contents being shown on the upper gauge (M/34). The port HP valve controls the remaining bottles, their contents being shown on the lower gauge (M/35). Either HP valve supplies all regulators. An external charging valve is at the rear of the port servicing bay.

(*b*) Oxygen regulators are fitted as follows, according to the Mod state:

(i) *Original fit.* Six Mk 17 regulators, one for each pilot (F/14 and H/1) at the front of their respective console panels; three (M/1, 33 and 50) for the crew members on the radio crate; and one on the starboard side of the bomb aimer's prone station.

(ii) *Mod* 1604. The two Mk 17 regulators for the pilots are replaced by Mk 17C regulators, and a separate magnetic blinker indicator (B/8 and 35), one for each regulator, is on each instrument flying panel above and outboard of the artificial horizons.

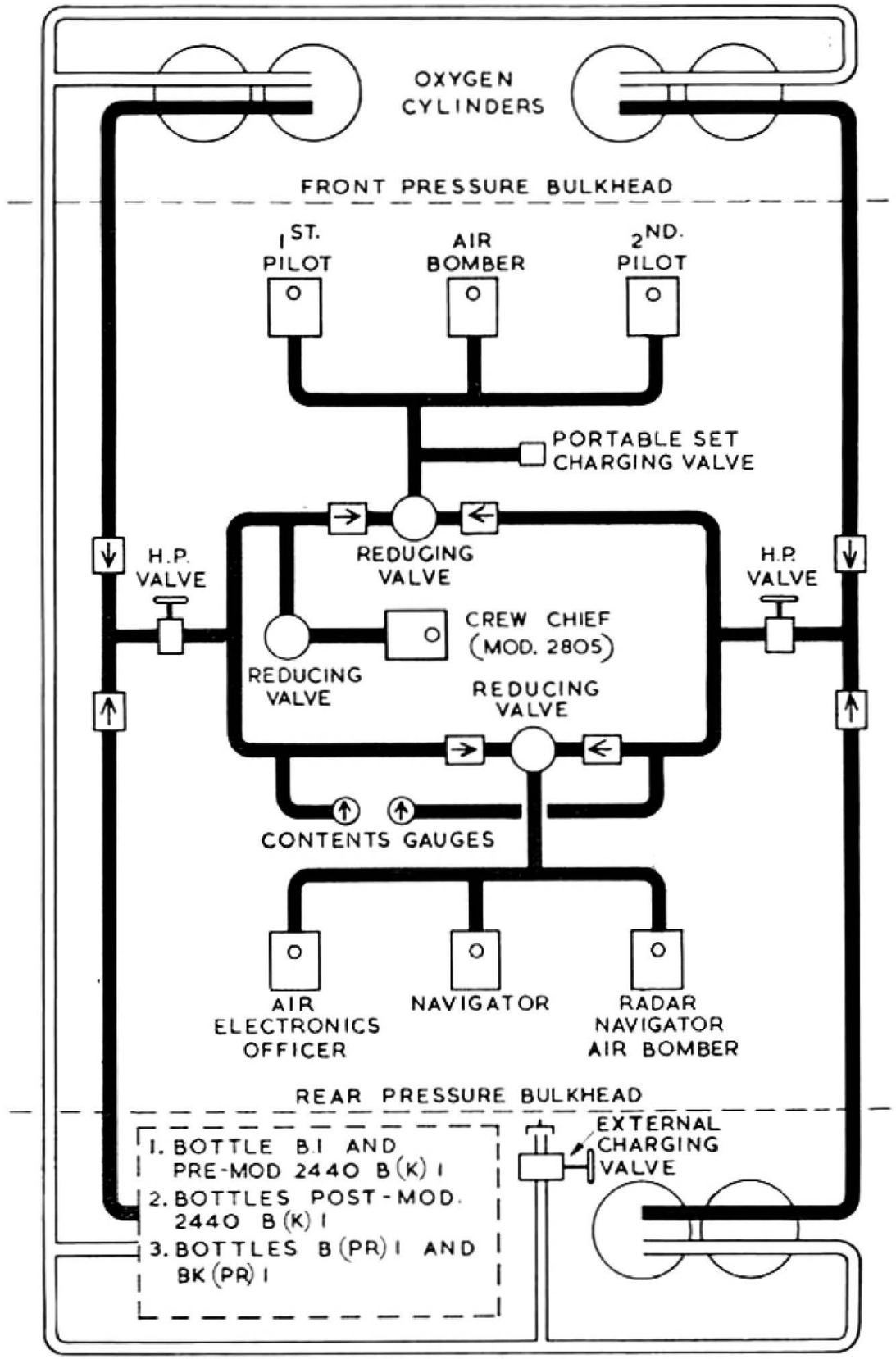


FIG 22 *Oxygen System (Simplified)*

(iii) *Mod.* 2398. All six regulators are changed to the Mk 17D type, the pilot's remote indicators being retained.

(iv) *Mod* 2805 *or Command Mod* 40. An additional Mk 17D regulator is provided for the occupant of the occasional seat.

(v) *Mod* 2967. All regulators are changed to the Mk 17E type, remote indicators being retained.

(vi) *Mod* 3003 (*Command Mod* 74). A remote indicator for the regulator at the bomb aimer's prone station is fitted on the radio crate at the Navigation Plotter's station.

(*c*) Each regulator comprises:

A regulator pressure gauge.
A visual flow indicator.
An ON/OFF valve.
An air inlet switch, marked NORMAL and 100% OXYGEN.
An emergency three-position switch which can also be pressed in when in the central position. Normally set central.

On the Mk 17 and 17C regulators, the visual indicator is combined with the pressure gauge; on the 17D and 17E it is a separate magnetic indicator on the regulator panel. When oxygen flow ceases, the relevant indicator, and also the remote indicator (if fitted) will remain black.

(*d*) The ON/OFF valve is normally wire-locked ON, and must remain ON at all times. On Mk 17, 17C and 17D regulators, the air inlet switch must always be at 100% OXYGEN, and pure oxygen is then supplied at all altitudes. On the Mk 17E regulators the air inlet switch may be at NORMAL: the regulator then functions automatically, providing a mixture of oxygen and air at low altitudes, the amount of oxygen being increased as height is gained until, at about 30,000 feet cabin altitude, pure oxygen is being supplied. Above about 12,000 feet cabin altitude the supply is at a slight positive pressure, thus aiding breathing and preventing inward leakage at the mask. Pure oxygen may be obtained at any altitude by moving the air inlet switch from NORMAL to 100% OXYGEN: this should be done in the event of smoke or fuel fumes entering the cabin, or if symptoms of anoxia are apparent. In the event of cabin pressurisation failure, the pressure of the supply may be increased by setting the emergency switch to the right or left. In the event of oxygen flow ceasing, for whatever reason, the air inlet switch should be set to NORMAL (this applies to Mk 17, 17C and 17D regulators) or the mask tube disconnected, and an immediate descent made if necessary.

(*e*) Before flight the mask should be checked for fit by pushing the emergency switch in fully in the central position. This will supply oxygen under pressure and the mask can be adjusted until no leaks are apparent. The firmer the switch is pressed the greater the oxygen pressure ; when fully in, the pressure is five times as great as with the switch in either of the side positions.

NOTE: When an oxygen point is not being used it is essential that the blanking plug is fitted in the tube to prevent waste of oxygen, unless modified sockets are fitted.

83 "Walk-round" and stand-by facilities

(*a*) *Extension tube and dual feed coupling*

Mod 2735 introduces a 3-foot extension oxygen tube, complete with extension intercomm. cable, and a dual feed coupling. They are stowed in a bag on the port side of the cabin above the entrance door. The extension tube and cable can be plugged in to any crew position, the mask tube and intercomm. lead being connected to the other end, enabling that crew member to move about the cabin. The equipment can also be used to provide an alternative oxygen supply to any one of the crew in the event of regulator failure, as follows:

(i) If one of the pilots' regulators fails, the extension tube can be used to enable that pilot to couple up to the prone bomb-aimer's regulator.

(ii) If one of the crew members' regulators fails, the dual feed coupling should be connected to one of the other serviceable regulators, the affected crew member and the one whose regulator is being used both connecting up to the dual feed coupling.

(*b*) *Portable oxygen set*
When Mod. 2735 (see (*a*) above) is not fitted, a single portable oxygen set Mk. 4 is stowed on the rear of the centre crew seat. It may be recharged from the aircraft system by a charging connection and cock at the rear of the pilot's platform. When fully charged, the set lasts for about 10 minutes. It is not fitted on aircraft prior to WP209 unless Mod. 848 is incorporated.

84 Emergency supply

(*a*) Each pilot has an emergency oxygen cylinder in his seat cushion. The supply can be made available manually by pulling up the yellow ball at the outboard side of each seat, or will be made available automatically as soon as the seat is ejected.
(*b*) When ejection seat Mods. 385/386 are embodied, each pilot's emergency bottle is removed to the inboard rear side of his seat. Additionally Mod. 1306 moves each pilot's emergency oxygen control to the inboard side of the respective seat. The seat-mounted emergency bottles remain with the seats after separation occurs following ejection.
(*c*) Each of the crew members also has an emergency oxygen cylinder in his parachute pack. The supply is made available by pulling the manual release.
(*d*) Whenever the emergency oxygen cylinder is brought into use, the mask tube must be disconnected from the main supply.
(*e*) When Mod. 2799 is embodied a stowage for the emergency oxygen bottle pins is attached by a bracket to the aft end of the signal cartridge centre rack.

Anti-Icing Systems

85 Engine anti-icing

Hot air for anti-icing the engines is taken from a gate valve on the left of each engine and directed into the front of each engine. The gate valves are controlled directly by the ENGINE AND AIRFRAME DE-ICING MASTER switch (H/19) on the starboard console panel and will open as soon as the switch is put ON. There are no other controls and no indicators for the engine anti-icing system.

FIG 23 *Anti-Icing Controls*

86 Airframe anti-icing

(*a*) The leading edges of the wings, engine intakes, tailplane and fin are anti-iced by hot air taken from a gate valve on the right of each engine. These gate valves also supply air for cabin heating and pressurising and are controlled by four NORMAL and EMERGENCY CLOSE switches (J/1, 14, 15 and 16) on the starboard quarter panel, and also by throttle-operated micro-switches. With the switches at NORMAL the gate valves will open when the HP cocks are opened and will close when the HP cocks are shut. When the switches are set to EMERGENCY CLOSE the gate valves will close even if the HP cocks are open.

(*b*) Hot air is then led through four shut-off valves, one for each wing and two for the tail, controlled by four switches (H/14) on

the starboard console panel. The shut-off valves can only be opened when the ENGINE AND AIRFRAME DE-ICING MASTER switch is ON. They will automatically shut when the master switch is put OFF (unless Mod. 701 is not fitted (see Part III, para. 37)).

(*c*) From the shut-off valves hot air is taken to the leading edges through mixing valves which are thermostatically controlled. If a fault occurs in the mixing valve or thermostat, warning of overheating will be given by one of the three overheat warning lights (H/16, 17 and 18) on the starboard console panel, one for each wing and one for the tail. When one of these lights comes on the appropriate shut-off valve should be closed.

86A Modified anti-icing system

(*a*) On aircraft embodying Mods. 605, 925, 2599, 2637, 2708, 2807, 2808, 2889, 2890, 2939, 2940, 3034, 3035, 3037, 3070, 3073, and 3132 a revised airframe anti-icing system is fitted, giving greater protection for the engine air intake lips ; spraymats are introduced for the intake splitter vanes. The mainplane de-icing system is deleted.

(*b*) The system is manually selected ON by a master switch and four individual switches at the second pilot's station. The master switch controls both engine and airframe supplies while the individual switches control as follows: —

No. 1—Port engine intakes

No. 4—Stbd. engine intakes

Nos. 2 and 3—Tail unit and feel intakes

(*c*) *Engine de-icing spraymat heaters*

(i) Spraymat de-icing heaters forming an integral part of the outer engine air intake splitter vanes are introduced by Mod. 2939. The heaters, operated from the aircraft 112 volt dc supply, are individually controlled by thermistors embedded in the heaters and a twin channel thermal controller. The heaters are brought into operation when the ENGINE AND AIRFRAME DE-ICING MASTER switch is selected ON.

(ii) With the DE-ICING MASTER switch selected ON a 112 volt dc supply is routed to the spraymat heaters and operation of the system is automatic. Temperatures in excess of the operating point are sensed by the thermistors in the individual heaters and the overheated spraymat is switched off. To prevent hunting a wide differential temperature is covered before the cooling spraymat is switched on again.

(*d*) *De-icing temperature indicator*

(i) Indication that the airframe thermal de-icing system is operating is provided post-Mod. 2708 by an electrical thermometer which, by means of a selector switch, gives a continuous indication of the temperature in any one of the three air diffusers in the de-icing system on a temperature indicator adjacent to the system controls on the starboard console.

(ii) Temperature sensitive resistance bulbs fitted to the port mainplane, the starboard mainplane and the tail unit de-icing system diffusers are connected through the selector switch to the temperature indicator.

(iii) The selector switch, a six position rotary switch, three positions of which are not used, adjacent to the indicator enables selection of any one of the three temperature bulbs, and the temperature in that part of the system is shown on the indicator.

(*e*) *Ice detector*

(i) Warning of icing conditions is provided post-Mod. 2599 by an ice detector, mounted in the lower fuselage forward of the bomb-aimer's fairing, with the sensing elements protruding through the aircraft skin operating a red ICING warning indicator lamp on the starboard console. A three position test switch TEST OFF/AUTO/TEST ON is mounted adjacent to the indicator and should normally be selected to AUTO.

(ii) With the test switch selected to AUTO, system operation is controlled by selecting the starboard pressure head heater switch

ON. A pitot operated switch prevents operation of the system below 80 kts.

(iii) The TEST ON/TEST OFF positions of the switch can be used to test the serviceability of the system in flight or on the ground. TEST ON brings on the red indicator lamp indicating that the system is serviceable and TEST OFF extinguishes it.

87 Windscreen and bomb-aimer's window de-icing

(*a*) Fluid for de-icing the pilots' windscreens and the bomb-aimer's window is carried in two tanks on the starboard side of the cabin, both having a common filler cap in the fuselage skin. The tank supplying the pilots' windscreens has a capacity of $4\frac{1}{2}$ gallons, and that supplying the bomb-aimer's window, $2\frac{1}{2}$ gallons.

(*b*) *Pilots' windscreens*

Two electrically driven pumps supply fluid to spray nozzles forward of the windscreens. They are controlled by two switches (H20 and 22) on the starboard console panel and may be used separately or together. Mod. 3071 introduces a guard for the switches. The slow pump (No. 2) delivers 7·2 pints per hour, the fast one (No. 1) delivers 15 pints per hour. This gives an endurance, running continuously, of 5 hours and $2\frac{1}{2}$ hours respectively or just over $1\frac{1}{2}$ hours if both pumps are used together continuously.

(*c*) *Bomb-aimer's window.* A single twin-delivery electrically driven pump supplies fluid to spray nozzles forward of the bomb-aimer's window. It is controlled by a master switch and a rheostat on the bomb-aimer's panel, the rheostat being used to control the flow. The maximum rate of flow is 26 pints per hour, giving a minimum endurance, running continuously, of about 35 minutes. Until Mod. 2188 is fitted, there is no master switch ; the rheostat has ON and OFF positions.

88 Windscreen wipers

A windscreen wiper on each windscreen is operated by its own closed-circuit electro-hydraulic pump. The pumps are controlled by two four-position switches (F10) and (H3), marked FAST, MEDIUM, SLOW, OFF, one on each console panel. Until Mod. 1393 (WP219) is incorporated, the FAST setting is inoperative. Pre-Mod. 2361 there are also two circuit-breakers (N2) and (P2), one on each console door. A lever on each windscreen pillar is used to PARK or START the wipers. To start them, move the levers to START, and then set the rotary switches to SLOW. To stop the wipers, first turn OFF the switches then move the levers to PARK. The two wipers may be operated quite independently of each other.

89 Bomb bay heating

(*a*) Hot air for heating the bomb bay is taken from the tail anti-icing supply, on the engine side of the shut-off valves, and fed to the bomb bay through diffusers on each side. Hot air is obtained whether anti-icing is on or not.

(*b*) Two shut-off valves, one on each side, are controlled by two switches (H13) on the starboard console panel, and continuous indication of the bomb bay temperature is given by a temperature gauge beside the switches. The temperature should be kept at +5 to +30 degrees indicated.

Fig. 24 Bomb bay heating controls

Cockpit Equipment

90 Access

Entrance to the cabin is through the door on the port side, which is hinged at the top. The door is opened from outside by a flush-fitting handle below the door, and from inside by a handle (L17) above and aft of the door. A magnetic indicator (E25) on the port console panel shows white when the door is open or unlocked, and black when the door is locked securely.

91 Emergency operation of the entrance door

(*a*) The normal handle (L17) must not be used to open the door in flight. The entrance door can be jettisoned in flight, after depressurising, for use as a parachute exit by the three crew members. The black-and-yellow striped handle (L16) above and aft of the door should be turned anti-clockwise; this withdraws the hinge-pins and locking bolts and allows the door to fall away. At the same time a windshield at the forward edge of the door aperture is projected out into the airstream, where it forms a wind break to facilitate the crew's escape. The door should be jettisoned by the signaller who should remain strapped in his seat while operating the jettison handle.

(*b*) Operation, or even partial rotation, of the normal handle will prevent the windshield from extending. Consequently, should the normal handle be partially rotated inadvertently, it must be returned to the fully closed position before the door is jettisoned.

92 Ejection seats—Mk. 3A

WARNING: Both ejection seats must be rendered safe for parking whenever the aircraft is on the ground by inserting safety pins in the:

Seat pan handle (Post-Mod. ES2157)
Ejection gun-firing unit sear

(*a*) Fully automatic Mk. 3A ejection seats are provided for the pilot and co-pilot. Each seat incorporates a ZF harness, a headrest, two folding armrests, a container for the Mk. 9 parachute, a seat pan which contains an SS dinghy in a Q-type survival pack and 10-minute emergency oxygen bottle, and leg restraining cords (see (*l*) overleaf). The seats may be adjusted for height by a lever, incorporating a thumb-operated spring-loaded catch, on the outboard side of each seat.

(*b*) The harness lock may be released by a spring-loaded lever on the inboard side, to allow the wearer to lean forward. Four alterative positions are provided, the lever having to be operated to move forward from each position. When moving back it is only necessary to operate the lever to release from the second forward position. It is safe to eject with the harness in the second forward position, but normally the fully back position should be used for ejection.

(*c*) The main oxygen tube is connected to the outboard lap strap of the safety harness, and the intercomm plug is connected to the inboard shoulder strap. These incorporate quick release connections which break on ejection.

(*d*) Leg restraining cords pass through D-rings on a pair of leg-straps and are then fastened to the safety harness. This ensures that the legs are drawn together close to the seat pan during ejection, thus providing leg clearance and preventing the legs being blown apart after ejection.

(*e*) The leg restraining cords are fastened to the floor with rivets which shear at 400 lb load. The cords pass through snubbing units at the front of the seat pan. These allow the cords to pass freely *down* through them, but prevent the cords passing *upwards*. Thus on ejection when the cords are pulled downwards the legs are pulled in close to the seat pan. The legs are held there until the harness is released, when the cords are pulled through the leg-strap D-rings and free the legs.

(*f*) Martin Baker Mod. 225 provides for a vertical safety pin fitted through the face blind strap. This pin is attached to the canopy by

a lanyard, thus ensuring that the face blind cannot be operated until the canopy has been jettisoned.

(*g*) The ejection seat is fired by pulling the handle above the headrest, or by pulling the alternative handle, if fitted (see (*l*) below). After ½ second a drogue gun fires, releasing a pair of drogues which stabilise and slow down the seat. When the seat and occupant have fallen to 10,000 feet a barometric capsule starts a time delay. (This starts on ejection if the ejection height is less than 10,000 feet.) After three seconds the safety harness is unlocked and the drogue main rope is unshackled from the seat top. The drogue then pulls on a lifting line which disconnects the face blind and headrest pad from the seat. The apron attached to the headrest pad straightens and pushes the occupant forward in the seat. He is prevented momentarily, from leaving the seat (by two parachute harness restraining straps clipped on to the seat pan) until an extension of the drogue lifting line draws his parachute canopy from its pack and its subsequent development lifts him clear of the seat to descend in the normal way. By this arrangement the possibility of a collision between the seat and the occupant after separation is eliminated.

NOTE 1: The time of free fall from 40,000 feet to 10,000 feet is about three minutes.

NOTE 2: A 5,000 metre barometric capsule can be fitted for flights over mountainous terrain.

(*h*) *Manual override*

If necessary, due to damage, or if the seat does not eject when the ejection control is operated, or if the automatic gear does not operate, the parachute pack can be disconnected from the seat, enabling the occupant to operate the parachute manually.

(*j*) To do this the occupant must first pull the outer D-ring. This action disconnects the parachute from the seat and uncovers the inner D-ring by which the parachute rip-cord is pulled. This arrangement ensures that the controls are operated in the correct sequence and there is no danger of the parachute rip-cord being pulled manually while the parachute is still connected to the seat.

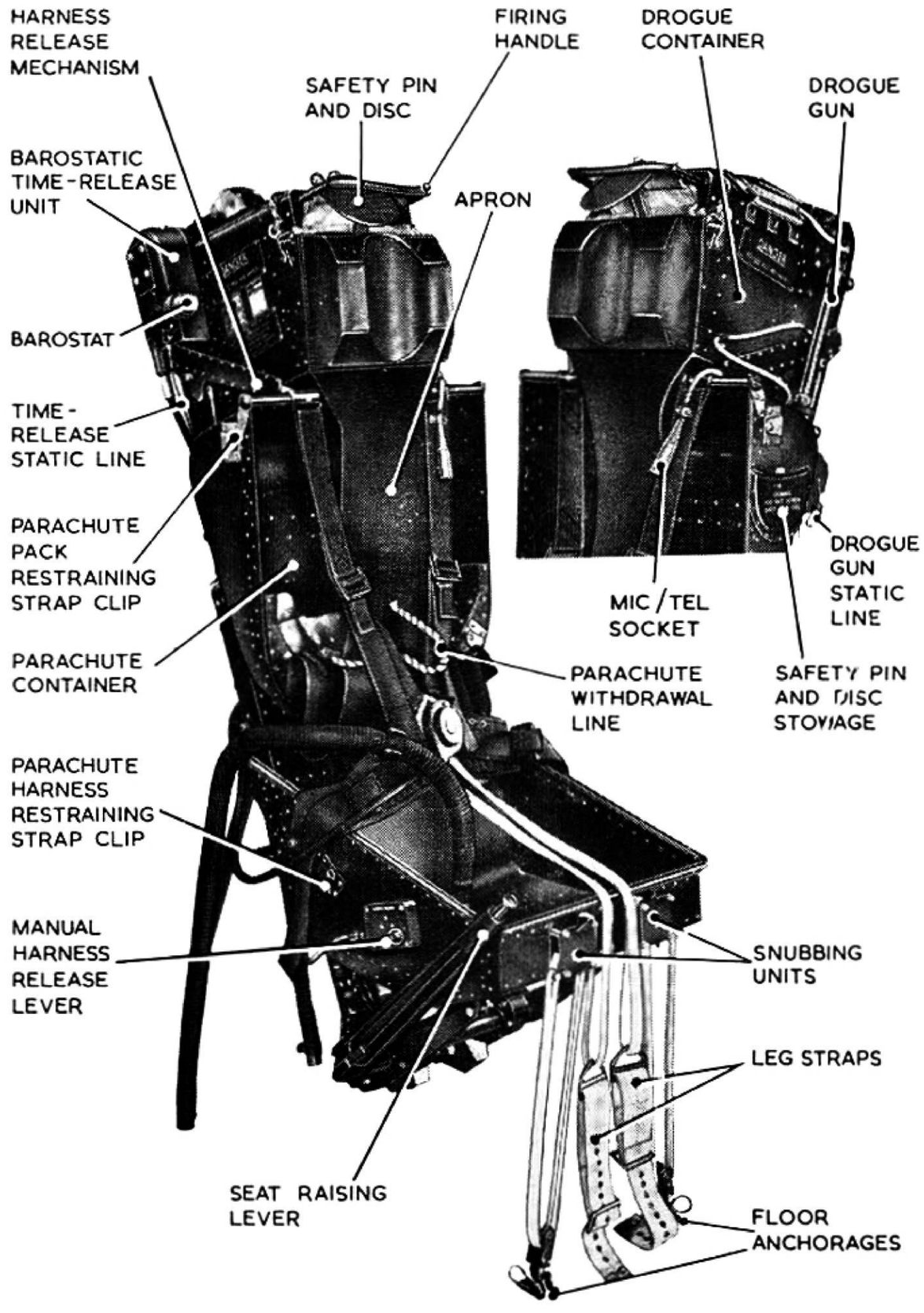


Fig. 25 Ejection seat Mk. 3A

(*k*) The occupant then manually unfastens the seat safety harness and leaves the seat, later opening his parachute by pulling the rip-cord D-ring.

(*l*) *Seat modifications*

The following ES modifications alter the basic ejection seat and affect its operation as shown below:

ES Mod	*Title*	*Effect on seat*
276	"B" shaped firing handle and new headrest	Enables use of protective helmets
293 387 491	22" pilot drogue Solid drogue gun piston $1\frac{1}{4}$ second time delay and G stop	All three together give the seat a ground-level ejection capability in flight parallel to ground and above 90 knots. The G stop prevents main parachute opening if speed at ejection is too high for safe deployment
385 386	1st pilot's emy oxygen repositioned 2nd pilot's emy oxygen repositioned	Bottles repositioned on seat inboard beams. Type R PSP must be used instead of Q. (Mod. 1306 is embodied concurrently —see para. 84)
2157	Introduction of alternative firing handle	Handle fitted to front of seat pan. There is no safety device to prevent its use before the canopy has jettisoned

93 Crew seats, parachutes and survival packs

(*a*) Three straight-backed light alloy seats facing aft are mounted side-by-side on sets of twin rails immediately inside the main entrance door.

(*b*) The seats can be locked in any one of five positions fore and aft by pushing down a handle on the rear right leg of each seat. Post-Mod. 2879 the centre seat has a duplicate handle on the rear left leg ; either handle may be used to lock or unlock the seat. Post-Mod. 2878 the AEO's seat (nearest the door) incorporates a spring-loaded catch which engages and locks the seat automatically when

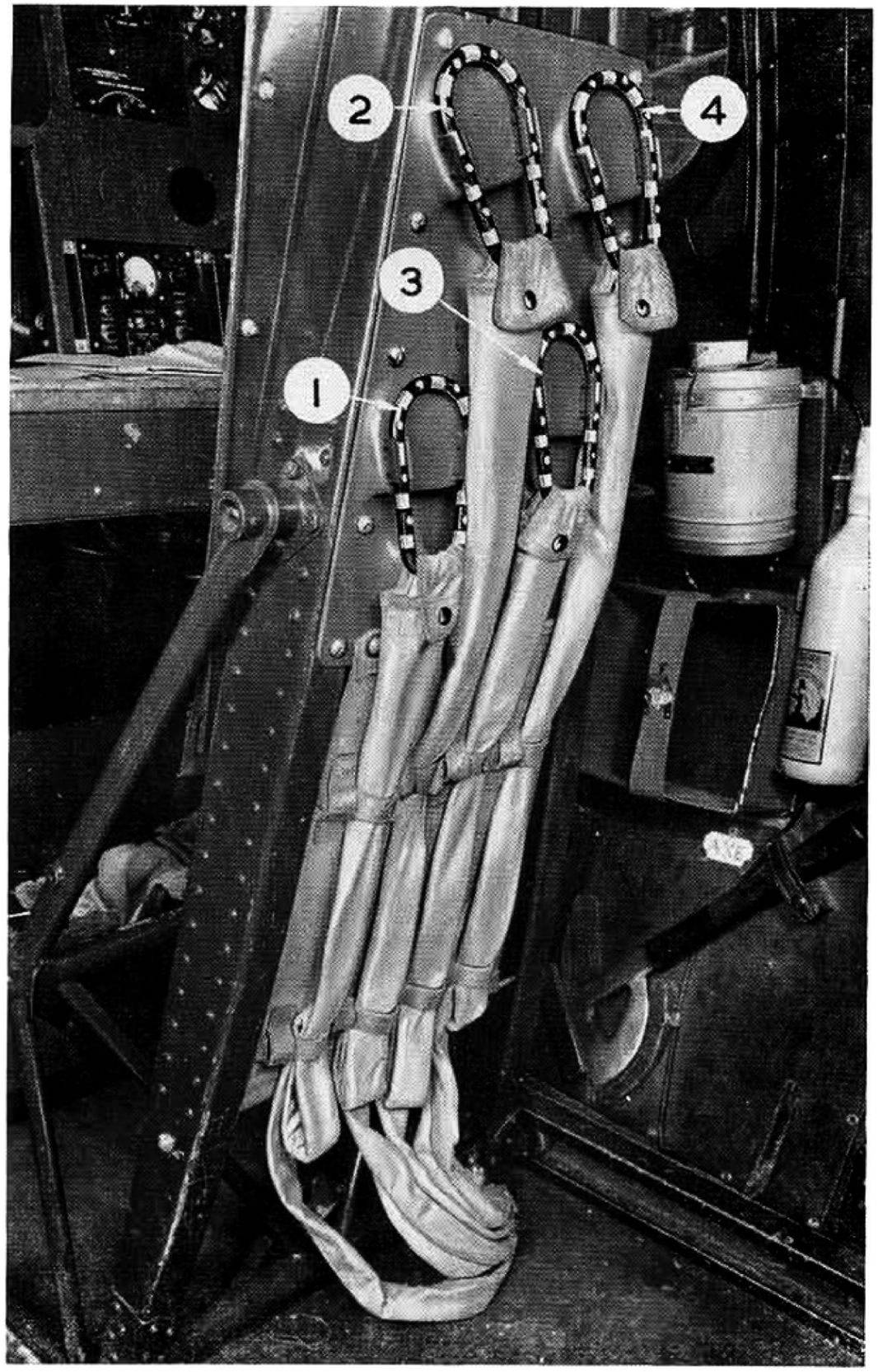


Fig. 26 Static lines on signaller's seat

the seat is pushed fully aft. The headrest of each seat is adjustable for height. The seat pan accommodates a survival pack containing an SS dinghy. A "Z"-type lap strap safety harness is fitted. Either a Mk. 17 or 20 automatic back-type parachute may be worn by all rear crew members.

(*c*) The Mk. 17 parachute pack contains a 24-foot canopy and is fitted with a quick-adjustment harness. An emergency oxygen bottle is fitted in the pack and is operated by a red knob on the harness. There is a quick-release connection for the dinghy pack on each side of the lower harness. A barometric release, fitted inside the pack, is set to operate instantaneously below 10,000 feet. This release is actuated by a D-ring on the parachute harness. There is a black and yellow override knob also fitted to the parachute harness; this knob requires a 40 lb pull and will open the parachute immediately irrespective of height.

(*d*) The Mk. 20 is an automatic parachute designed to be operated by static line. As with the Mk. 17 parachute the release is set at 10,000 feet and a manual override knob is fitted. Mod. 2539 introduces four static lines to be used with the Mk. 20 parachute. These lines are mounted on a panel attached to the back of the signaller's seat, i.e. the seat nearest the door. When abandoning the aircraft the static lines must be used in the correct order as shown in Fig. 26.

(*e*) *Occasional seat*

Mod. 2341 (XD862) introduces an occasional seat in the cabin. This is a rearward-facing folding seat situated behind and between the navigator and the radar navigator/bomber's seats.

93A Swivel seats (Post-Mod. 3193)

(*a*) Each rear crew member is provided with a swivel seat incorporating an assister cushion and a Mk. 40 parachute with a demand emergency oxygen set. The two navigators' seats swivel clockwise and the AEO's seat swivels anti-clockwise.

(*b*) The seats are mounted on rails which allow them to be slid fore and aft and locked in any one of five positions. The seat rails are reinforced to take crash landing loads. Fore and aft movement of the seats is controlled by either a lever at the base of the rear of each seat (move to the right to unlock) or by the rearward movement (in relation to occupant) of the yellow and black lever on the left of the seat.

(*c*) (i) Swivelling of the seats is controlled by either a lever at the top of the rear of each seat (move right to swivel) or by forward movement of the yellow and black lever on the left of the seat. When the seat is in its normal position, i.e. occupant facing the table, the crew member may adjust the rake of the seat back by pushing the yellow and black lever forward and then pressing against the back of the seat (against spring pressure). Once the seat has been swivelled it cannot be moved on the rails, except by the lever at the base of the seat.

(ii) When it is required to swivel the seat, the first movement of the lever forward causes the seat back to spring to an upright position forcing the occupant forward and then the seat is free to swivel. When the seat is rotated by the occupant to the limit of its travel (up to 180°) the seat locks in that position and the lever returns to its neutral position. When abandoning the aircraft it is vital that the seat is locked in this position, as failure to do so may result in the seat turning round if another crew member attempts to pull himself up by gripping the back rest.

(iii) Before swivelling the seat it must be fully back on the rails to ensure that the back rest does not jam against the table.

(*d*) The yellow and black swivelling lever incorporates a handle into which the individual parachute static line is clipped when leaving the seat prior to abandoning aircraft.

(*e*) (i) The assister cushion is inflated by CO_2 stored in a bottle at the back of the seat, at a pressure of 1,200 PSI. A pressure gauge is incorporated in the bottle.

(ii) The CO_2 is released to the cushion by pulling up a yellow and black knob, at the right of the seat, to the full extent of its travel. Additionally this action also releases the harness lap strap anchorages thereby freeing the occupant from the seat.

(*f*) The seat thigh supports can be adjusted for individual comfort by means of a star wheel mounted under the supports centrally.

(*g*) Two lugs are fitted to the top of the seat back rest and pockets on the parachute shoulder harness straps enable them to be locked onto the lugs during flight.

(*h*) The back type Mk. 40 parachute is fitted in the swivel seat and is normally operated by the crew member attaching its static line to the hook on the swivelling lever before leaving the aircraft. This arms the barostat unit, which delays deployment until either the escaper has fallen freely to 13,000 feet or, if already below that height, for two seconds so as to be clear of the aircraft. This unit can be overridden by the yellow and black knob on the left shoulder strap. Static line operation should always be chosen as it automatically ensures deployment, even if the escaper is injured during the escape; the override is a safeguard in case of failure of the automatics, or of inability to hook on the static line for any reason.

(*j*) (i) This parachute embodies a demand EO set, normally initiated automatically by the static line. A red loop on the harness provides direct manual initiation if required.

(ii) The set consists of a small storage cylinder fitted with an operating head which turns on the supply when the release is operated and reduces the output to a steady medium pressure. This is stowed at the top of the parachute pack. A tube delivers the medium pressure oxygen to the demand regulator stowed in the pocket at the back of the right half-belt. From the regulator, a breathing pressure hose is connected to the Hose Assembly while " strapping in."

(iii) The endurance of the set is approximately 10 minutes. It should be noted that although this is a demand set, the cylinder will rapidly exhaust itself if it is accidentally initiated and the outlet is not connected to a mask. The set will discharge itself in an attempt to produce safety-pressure. The set must therefore be replaced if accidentally initiated while strapping-in.

(iv) In the case of failure of a main oxygen regulator, rear crew should normally transfer, if possible, to the sixth crew member's regulator rather than use the EO set. This will enable the flight to be continued without reducing altitude.

94 Adjustable stool

Mod. 1308 introduces an adjustable stool for use at the sextant station. When in use, the stool stands on the navigators' table and it is adjustable for height. Its stowed position is under the NBC crates aft of the second pilot's seat.

95 Canopy, DV panels, and de-misting

(*a*) The jettisonable canopy cannot be opened on the ground or in flight. It is a light-alloy structure extending from the top of the windscreens to behind the pilots' seats, and across the cockpit from the top of the side windows. It is secured all round by explosive bolts.

(*b*) Two direct vision panels are fitted in the windscreen corner panels. When the cabin is not pressurised the windows can be opened by pulling and lifting the locking bar and then hingeing the window downwards. They must always be closed and tightly secured before the cabin is pressurised. When flying de-pressurised the DV panels may be open up to the limiting speed of the aircraft, but at and approaching this speed the noise level is extremely high.

(*c*) The windscreens are de-misted from the air-conditioning system through two ducts. When Mod. 2400 is embodied, the centre windscreen is also de-misted. When the bomb-aimer's window

de-misting control is operated the supply to the windscreen and pilots' louvres is restricted; a control (E19) on the port coaming panel enables all or part of this restricted supply to be passed to the windscreens. Unless the cabin air-conditioning is shut off there will always be some air directed on to the windscreens.

96 Canopy jettisoning and control parking

(*a*) The shielded levers (F22) and (H15) between the pilots' seats and the console panels are for jettisoning the canopy and for disconnecting the control handwheels from the elevator circuit and throwing them forward to clear the pilots' knees on ejection. Both levers jettison the canopy but each lever disconnects and throws forward only the handwheel on the same side.

(*b*) Before operating either jettison lever the cabin must be de-pressurised (see Part I, para. 78 (*c*)). Then, when either lever is operated, after the first $\frac{3}{4}$ inch of lever travel the canopy explosive bolts are fired from the main electrical system. At the full travel position a supply from the canopy jettison emergency battery, in the roof at the rear of the cabin, will be connected to the explosive bolts to fire them if they have not already fired. At full travel of the lever, also, the control column on the same side will be disconnected and thrown forward. Operation of the other lever will then only disconnect and throw forward the other control handwheel. If the levers are not pulled all the way, the canopy will be jettisoned but the control handwheels will not be disconnected ; it is important, therefore, that the levers are pulled to full travel before ejection.

(*c*) Once a control handwheel has been disconnected by this method, it is not possible to re-connect it in flight. When both control handwheels are disconnected, control of the elevators will be lost except through the auto-pilot. The variable incidence tailplane and the elevator trimmers will still be operative.

(*d*) Post-Mod. 3182 a canopy detonator master switch is fitted in the cabin roof. When this switch is in the OFF position the canopy explosive bolts cannot be fired either by the main electrical system or the emergency battery. When the aircraft is on the ground the switch must be OFF and the safety pin fitted.

97 Anti-flash screens

NOTE: It is important that the methods of fitting the screens are strictly followed.

(*a*) When Mod. 2744 is embodied, anti-flash blinds and screens are provided for all windows in the cockpit, cabin and prone bombing station.

(*b*) *Pilots' windscreens*

(i) Five roll-up blinds are provided for the pilots' windscreens and side windows. The blinds are secured in the rolled-up position by two straps each, which are fastened with quick-release clips. To fit them, the straps should be released, the blinds rolled down and fastened along their bottom edges with the press clips, and then the zips between adjacent blinds and at the rear ends of the end blinds should be fastened. The zips must not be fastened until the blinds have been clipped in position. When removing the blinds they must first be unzipped, then unclipped, and then rolled up with the black side showing and fastened with the straps.

(ii) For the two windows in the canopy, metal screens are provided which are stowed in a canvas bag on the cabin starboard wall. To fit the screens, each one should be slid into position and locked with the handle.

(*c*) *Cabin windows*

The two windows in the cabin are provided with blinds similar to those for the pilots' windscreens. When fitting them they must be clipped in position before the zips are fastened. When removing them they must be unzipped, then unclipped, and then rolled up with the black side showing and fastened with the straps.

(d) Prone bombing station

The two side windows are provided with metal screens which are slid into position and then locked with the handles. The port screen must be slid under the T4 bombsight bracket. The centre window is provided with a blind at the rear edge of the window which is fitted and removed as described for the other blinds.

98 Cockpit lighting

(a) All panels in the cockpit are illuminated by red floodlights. In addition, the main instrument panels and the accelerometer are provided with ultra-violet lights. All red and ultra-violet lights are controlled by dimmer switches as detailed in the following table:

Panel	*Illuminated by*	*Controlled by*
Top panel and instrument panels (Fig. B)	Four UV lights, one on each coaming panel (E11) and (G6), one for the accelerometer, above the port side of the top panel, and one for the RATOG lights panel	One dimmer switch (A14) on the fuel panel
	Twin UV lights plugged in on the top panel (B23) and stowed on the starboard side (J3)	One dimmer switch (A17) on the fuel panel
	Six red lights below the top panel and one red light, for the accelerometer, on the port side	Two dimmer switches (A2 and 34), one on each side of the fuel panel. The port switch also controls the accelerometer light
	Two red lights in the canopy	One dimmer switch (A3) on the left of the fuel panel
Fuel panel (Fig. A)	Buried lights for the fuel panel and a strip light for the small panel below the fuel panel	One dimmer switch (A21) on the fuel panel
	Two twin lights on adjustable mountings	One dimmer switch (A23) on the fuel panel
Port coaming and quarter panels (Fig. D and E)	Three red lights, mounted behind the coaming panel and showing through the transparent lettering. One light (D3) on the rear of the coaming panel, for the quarter panel	One dimmer switch (E18) on the forward end of the port coaming panel
Port console panel. (Fig. F)	Three red lights above the panel	One dimmer switch (A1) on the left of the fuel panel
Starboard coaming and quarter panels. (Fig. G and J)	Three red lights, mounted behind the coaming panel and showing through the transparent lettering. One light (J2), on the rear of the coaming panel, for the quarter panel	One dimmer switch (G1) on the forward end of the starboard coaming panel
Starboard console panel. (Fig. H)	Three red lights above the panel	One dimmer switch (A35) on the right of the fuel panel
Central pedestal (Fig. C)	Four red lights, one at the rear of the pedestal and three under a shield round the trimming switch. Also a tubular red light above and forward of the autopilot control panel	One dimmer switch (A33) on the right of the fuel panel
Magnetic standby compass(es)	One red light (each) One red light for PDI	One dimmer switch (A19) on the fuel panel

(*b*) *Wander light*

A retractable wander light (C25) on a long lead is in a mounting on the right side of the rear of the central pedestal. The light can be withdrawn from its mounting and used as required. To retract the light a button on the mounting should be depressed, when the cable will be wound in by a spring. The light automatically comes on when it is withdrawn from its mounting, and goes out when the button is pressed to retract the lamp.

(*c*) *Instrument panel emergency lights*

Three emergency white lights, one for each instrument flying panel and one for the machmeter, are controlled by two ON/OFF switches (E15) and (G24), one on each coaming panel. Each switch controls the light for the instrument flying panel on its own side, and the port switch also controls the machmeter light. Each switch has a luminous spot on it.

(*d*) *High-intensity cockpit lights*

Post-Mod. 1965, two high-intensity lights are mounted on each side, on the rear pillar of each side window. Each pair of lights is focussed directly on the artificial horizon on the same side. All four lights are controlled by a single DIM—OFF—BRIGHT switch (C1) on the central pedestal. An ON (bright) OFF switch is on the radio crate ; this switch overrides the one on the central pedestal.

(*e*) *General lighting*

(i) A single white light in the centre of the canopy is controlled by an ON/OFF switch (E16) on the port coaming panel.

(ii) A single white light in the cabin roof is controlled by an on/off switch (N6) on the port console door.

(*f*) *Navigators' crate lighting*

The navigators' crate is illuminated by tubular red lights above the crate, and four anglepoise red lights, one at each end and two near the centre of the crate. All lights are controlled by dimmer switches on the navigators' crate near the bases of the anglepoise lights.

(*g*) *Starboard console door lighting*

Lighting for the starboard console door, the ration heater switches and nearby equipment is provided by an anglepoise red light, with associated dimmer switch (P15), mounted on the starboard console door.

(*h*) *Emergency lamps for crew escape*

When Mod. 2876 is embodied, four lamps are fitted in the cabin roof and are controlled by two EMERGENCY LIGHTING switches on the forward edge of the radio crate table or by the ABANDON AIRCRAFT switch (Mod. 2828). Power supply is from two 12v batteries in series.

99 External lights

(*a*) An EXTERNAL LIGHTS MASTER switch (G5) on the starboard coaming panel controls the supplies to the external lights. It does not control the supplies to the landing/taxying lamps actuators, and these may be extended and retracted when the master switch is OFF, though their filaments will not light unless the master switch is ON.

(*b*) The navigation lights are controlled by a BRIGHT—DIM—OFF switch (G8) on the starboard coaming panel, and, Post-Mod. 2593, by a FLASH—STEADY switch on the same panel. Pre-Mod. 2232 the navigation lights are steady when on, but Post-Mod. 2232 they are flashing; when the FLASH—STEADY switch is fitted either can be selected for both the BRIGHT and DIM positions. Mod. 2638 on B(K)1 and B(K)PR1 aircraft only, introduces a tail lights ON-OFF switch (G23) on the starboard coaming panel (see Appendix A, para. 17(*e*)).

(*c*) An amber downward identification light is in the bomb aimer's fairing. It is controlled by a STEADY—OFF—MORSE switch (G7) on the starboard coaming panel. With the switch at MORSE, the light may be used for signalling by using either of the two morse keys (F16) and (H21), one on each console panel.

(*d*) A combined landing and taxying lamp is fitted under each wing, near the wing tip. Both are controlled by a single spring-loaded four-position IN—LAND—TAXI and OFF switch (B13) on the left of the instrument top panel, and two filament switches (B12 and 14) on either side of the four-position switch. When the switch is held to TAXI, the lamps are fully extended, and when held to LAND the lamps are partially extended. Intermediate positions can also be obtained by releasing the switch as soon as the required position is reached. The filaments can be switched on with the lamps in any position.

Fig. 27 Landing lamp controls

(*e*) On aircraft prior to WP209 until Mod. 392 is embodied there are no filament switches for the landing/taxying lamps. Each is controlled by a spring-loaded four-position IN—LAND—TAXI and OFF switch on the left of the instrument top panel. When TAXI is selected the lamp is fully extended, and when LAND is selected the lamp is partly extended. The lamp will light as soon as it has left the fully " in " position, and will go out as soon as it returns to fully " in ".

100 Periscope and rear view mirrors

Mod. 664 introduces a periscope to enable condensation trails to be detected. Mod. 1521 (WZ395) provides two rear viewing mirrors, one on each side aft of the DV panels.

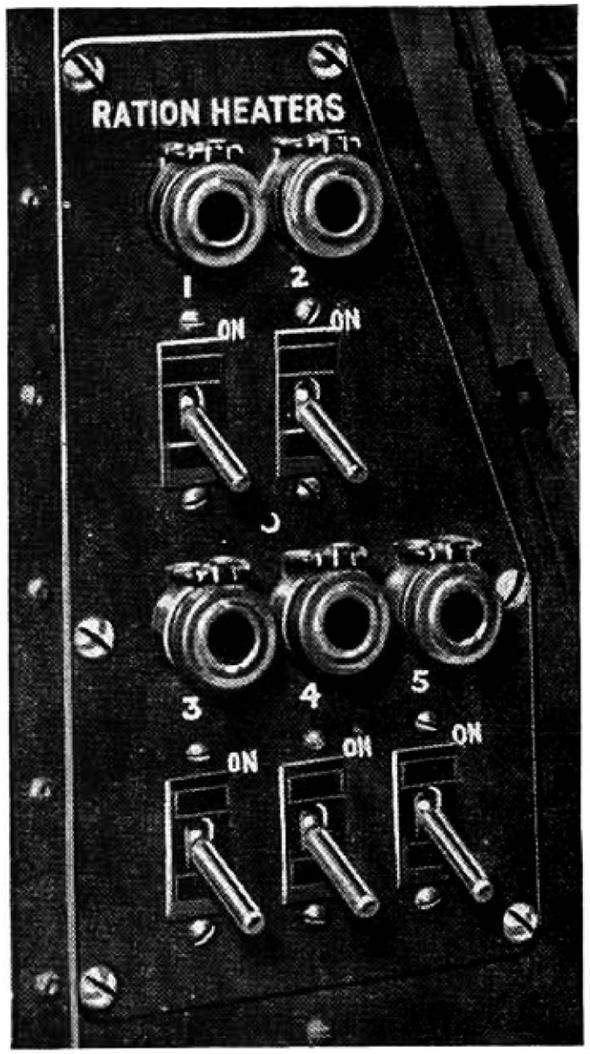


Fig. 28 Ration heater controls

101 Loose equipment stowage

Mod. 1334 introduces a pannier in the cabin for the stowage of loose equipment.

102 Leak stoppers

When Mod. 911 (WZ366) is fitted, five leak stoppers are stowed on the cabin port wall above the voltage trimmer panel.

103 Ration heaters

There are five ration heaters in the cabin, one on the inboard side of each pilot's seat, one on the starboard wall (K8), one on the

Fig. 29 Engine fire-extinguisher controls

port wall (L19) and one on the rear of the pilots' floor. They are electrically heated from five switches (P13 and 14) on the starboard console door. Each switch has a warning light above it which comes on when the heater is on.

Fire-Extinguishers

104 Engine fire-extinguishers

(*a*) There are four fire-extinguisher bottles in each wing, one for each engine and one for each jet pipe. Four fire-extinguisher push-buttons (B22) each incorporating a warning light, are on the instrument top panel. When any of the fire detector switches in the engine or jet pipe bays closes due to fire, the appropriate warning light will come on. Both fire extinguisher bottles for that engine are discharged, one into the engine bay and one into the jet pipe bay, by pressing the pushbutton. The warning light should go out when the fire is extinguished. Once the bottles for any engine have been discharged, there is no means of extinguishing a further out-break in the same engine, and therefore no attempt should be made to re-start an engine once its fire-extinguisher bottles have been discharged.

(*b*) The warning lights may be tested by gently pulling out the fire-extinguisher pushbuttons, when the lights should come on. These pushbuttons must be treated with care as they are very sensitive. When Mod. 1919 (WZ395) is fitted, two test pushbuttons (B18 and 19) are below the fire-extinguisher pushbuttons. These should be pressed to test the lights, each one operating two lights.

(*c*) All fire-extinguisher bottles will be automatically discharged when the crash switches operate in the event of a crash landing.

105 Fuel bay fire-extinguishers

Two fire-extinguisher bottles in each wing and twelve bottles in the " attic " supply the fuel tank bays in the wings and fuselage respectively. All bottles will be automatically discharged when the crash

switches operate in the event of a crash landing. There is no indication in the cabin of fire breaking out in any fuel tank bay: the bottles will *not* discharge automatically in this event nor is there any means of discharging them.

105A Firewire detection system

(*a*) When Mods. 1669 (B1) and 3019 (B(PR)1, B(PR)K1 and B(K)1) are embodied additional fire protection for the bomb bay and forward servicing bay is provided by a Firewire detection system. Power supplies are of 115 volts, 400 CPS AC and 28 volts DC and provided from the AC relay box and panel Z respectively. The system uses the fire extinguisher bottles in the forward servicing bay ; the operation of the existing systems remains the same but the bottle extinguishant distribution is revised.

(*b*) Remote test push-switches and Test/Fire warning lamps are provided below the fuel panels.

(*c*) Bottles 3, 4, 7 and 12 are controlled by the detector element encircling the forward servicing bay and the port and starboard bays immediately below. Crash relays operate bottles 3, 4, 9, 10, 11 and 12.

(*d*) Firewire loops are provided in the forward and rear ends of the bomb bay.

(*e*) *Fuel tank fire extinguisher system*

The fuel tank fire extinguisher system, which operates when the crash switches are operated, controls fire bottles No. 1, 2, 5, 6, 7 and 8 plus the two fire bottles in each main undercarriage bay.

(*f*) *Fire extinguishers and spray pipes*

The spray pipes are arranged to direct the fire extinguishant to cover the areas where fires may occur. Spray pipes are fitted and use fire bottles as follows: —

(a) Top of Bomb Bay Wall (port) Bottle No. 7
(b) Bottom of Bomb Bay Wall (port) Bottle No. 8
(c) Bomb bay roof (port) Bottles No. 6, 9 and 10
(d) Fuselage tanks (port) Bottle No. 1
(e) Fuselage tanks (stbd.) Bottle No. 2
(f) Bomb bay roof (stbd.) Bottles No. 8, 10 and 11
(g) Bottom of bomb bay wall (stbd.) Bottle No. 5
(h) Top of bomb bay wall (stbd.) Bottle No. 6
(j) Forward servicing bays (port and stbd.) Bottles No. 7 and 12
(k) Forward servicing bay (forward and aft) Bottles No. 3 and 4

NOTE: Bottles No. 6, 7, 8 and 10 are fitted with dual heads and serve either one of two functions according to the location of a fire.

106 Hand fire-extinguishers

There are five hand fire-extinguishers in the cabin, one on the back of each pilot's seat, two (K5) on the cabin starboard wall and one (L18) on the port wall immediately aft of the entrance door.

Miscellaneous Emergency Equipment

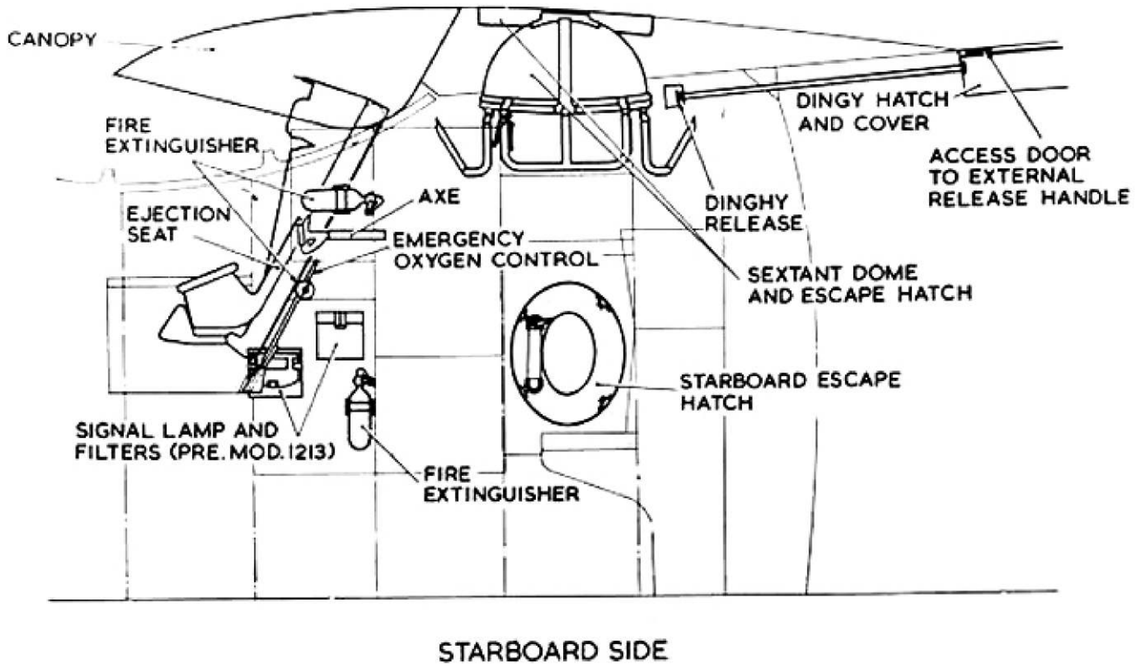
107 Abandon aircraft signs and emergency exits

(*a*) Mod. 2828 provides two flashing ABANDON AIRCRAFT signs, one at the 1st navigator's station and one at the bomb aimer's prone position. The flasher units and emergency lamps are controlled by an ABANDON AIRCRAFT ON/OFF switch on the 1st pilot's fuel panel. Power supply is from two 12v batteries in series, mounted below the pilot's platform, port side.

(*b*) The pilots' canopy and the entrance door are used for abandoning the aircraft in flight (see Part I, para. 91 and 96). In addition there are two other exits for use after a crash landing, when the entrance door might have jammed, or after ditching.

(*c*) *Crash landing exit.* The window on the starboard side of the rear of the cabin may be used as an emergency exit after a crash landing by turning the yellow and black striped handle (K6) clockwise and pulling in the window. The window can also be pushed in from outside after depressing the heel of the flush handle, pulling out the handle and turning it clockwise.

(*d*) *Ditching exit.* The sextant dome may be used as a ditching exit by squeezing the two yellow and black striped handles at each side of the dome and then pulling the dome inwards. The dome is heavy and cumbersome.



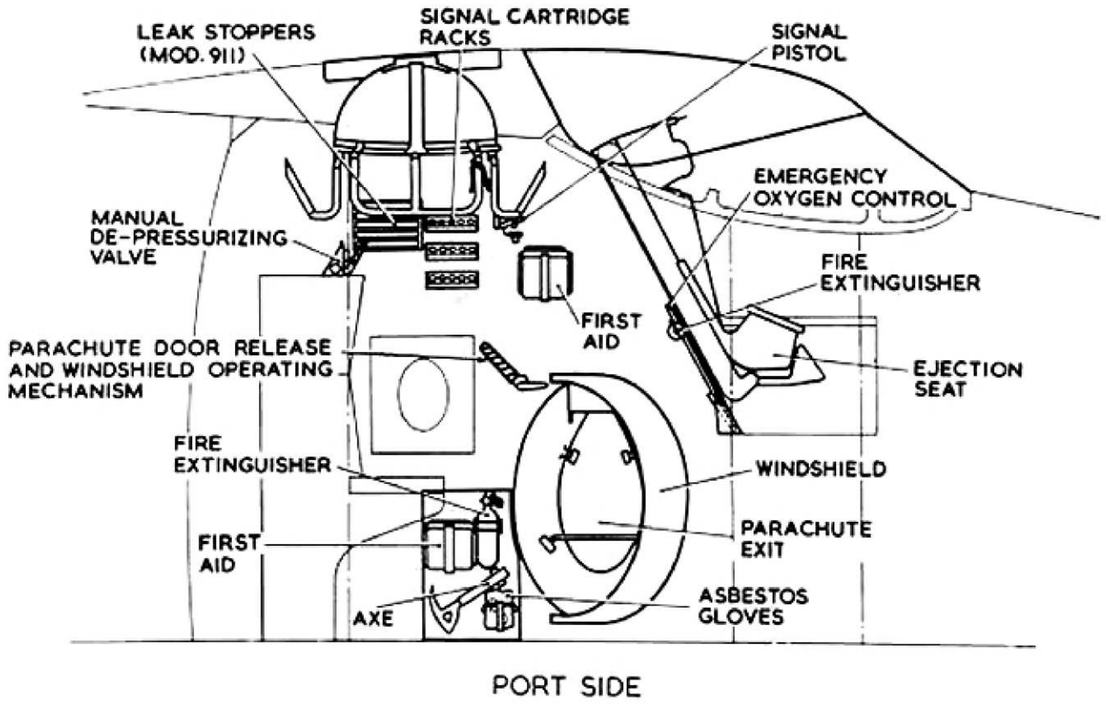


Fig. 30 Emergency equipment

108 Dinghy

An MS 5 inflatable dinghy, complete with auxiliary equipment, is stowed in a compartment in the roof of the " attic ", immediately aft of the cabin. The dinghy release is immediately aft of the sextant dome in the roof of the cabin, and consists of a shielded toggle. When this toggle is pulled to its full extent the dinghy is automatically inflated and released from its container. It remains moored by a painter to an anchor ring in the container. The dinghy may also be released from outside the aircraft by lifting a hinged cover in the lid of the dinghy container and then pulling the red handle.

109 Aircraft survival pack

(To be issued later.)

110 Crash axes

Two crash axes are stowed in the cabin, one (K4) on the starboard wall, and one on the port wall aft of the entrance door.

111 Asbestos gloves

A pair of asbestos gloves is stowed on the cabin port wall aft of the entrance door.

112 First-aid kit

A first-aid kit (L12) is on the cabin port wall above the entrance door, and another (K2) on the cabin starboard wall.

113 Signal pistol

A signal pistol (L10) is in a pressure-tight mounting in the cabin port wall above the entrance door. Cartridges are stowed in three racks on the wall near the pistol.

114 Signal lamp

A signal lamp (K1) is on the cabin starboard wall, the filters being in a stowage beside the lamp. A supply socket (L21) for the signal

lamp is at the extreme port side of the radio crate desk. There is no separate switch. The signal lamp and stowage are deleted by Mod. 1213 (WP223) but the supply socket will remain.

Navigational and Radio Equipment

115 Radio compass

The radio compass control unit (M40) and indicator (M51) are on the radio crate. A bearing indicator (B48) is on the starboard instrument flying panel, and Post-Mod. 2218 there is a second indicator (B2) on the port instrument flying panel.

116 Radio altimeters

(*a*) *High level.* A high level radio altimeter (M10) will be fitted later on the radio crate. The twin aerials are in the fuselage immediately forward of the bomb bay.

(*b*) *Low level.* Post-Mod. 1005 a low level radio altimeter (B2 and 41) with limit lights (B42 and 68) is on each instrument flying panel. Mod. 2218 removes the altimeter on the port panel, but the limit lights are retained. The aerials are in the bottom of the fuselage below the fin. An ON/OFF switch (C30) is on the central pedestal. When Mod. 2437 is embodied the switch is moved to the 1st pilot's coaming panel.

117 VHF/UHF installation

(*a*) The VHF installation incorporates two transmitter-receivers TR 1985—TR 1986, both 10-channel sets. On the rear of the central pedestal are two control units (C26 and 31), a volume control (C29) and a change-over switch (C28). A press-to-transmit pushbutton is on each control handwheel. Until Mod. 1636 is fitted the VHF sets are TR 1934—TR 1935.

(*b*) (i) Mod. 2437 introduces a UHF installation, and retains the present VHF facilities. No. 2 VHF set controller is moved to the AEO's station adjacent to the morse key.

(ii) On the rear of the centre pedestal are the following:

No. 1 VHF controller
VHF volume control
UHF control unit
VHF/UHF selector switch
No. 1 VHF/No. 2 VHF selector switch
UHF aerial change-over switch
UHF tone switch

(iii) It should be noted that in modified aircraft, the pilot selects the channels on No. 1 VHF set and the AEO selects those on No. 2 VHF set (see also para. 118(*b*)).

118 Intercommunication

(*a*) Intercommunication is by amplifier A1961 (L4) which, with the control unit, is on the port side of the radio crate. On the control unit on the radio crate is an ON/OFF switch (L2) and a NORMAL/EMERGENCY change-over switch (L3). The latter, when set to EMERGENCY, provides intercomm through the VHF circuit. Mic/Tel sockets are provided at each crew station, in the nosewheel bay, under the port wing root leading edge and in the port servicing bay. Mod. 1496 (WZ381) introduces a socket beside the sextant mounting in the sextant dome.

(*b*) *Mod.* 2874

(i) This modification provides additional intercommunication facilities, in lieu of ARI 18089, as follows:

VHF/UHF transmit, receive and volume control facilities for the AEO in isolation.

Radio compass audio output to the 1st and 2nd pilot's positions.

Intercomm conference facilities for the navigators.

1st pilot's emergency override.

1st pilot's call facilities to the navigators and AEO, by call lamp.

AEO's call pilot facility.

(ii) On the 1st pilot's coaming panel between items (E4) and (E5) are three switches:

RC/IC, to connect 1st pilot's telephones to radio compass or intercomm output.
CALL CREW, energises two lights, one at the AEO's station and one at the nav/plotter's station.
NORMAL/EMERGENCY. In the NORMAL position any crew member may select any available facility. In the EMERGENCY position all crew members are returned to normal intercomm.

The 2nd pilot is also provided with an RC/IC switch below item (G3).

(iii) At the AEO's station are the following:

VHF ISOLATION OFF/ON switch which when set to ON gives VHF facilities to the AEO only.
PRESS TO TRANSMIT switch, in parallel with the pilots' switches when the AEO is in ISOLATION.
CALL LIGHT energised by the 1st pilot's CALL CREW switch.
CALL PILOT SWITCH enables the AEO to call the 1st pilot at all times.
VHF VOLUME CONTROL

(iv) At the nav/plotter's station are the following:

CALL CREW light energised by the 1st pilot's " call crew " switch.
OFF/ON CONFERENCE switch. When set to ON an additional A1961 amplifier is switched on.
NORM/CONF AMP switch. When set to CONF the navigators are in isolation from the other crew members.

119 Gee H, Mk. 2

The Gee H control units (M44 and 45) and indicator (M47) are all on the radio crate. The pilot's indicator lights (B7) are on the top of the port instrument flying panel. The H function of the Gee H, and the pilot's indicator lights, are rendered inoperative by Mod. 1957 and are removed by Mod. 2537. When Mod. 3165 or 3166 is embodied the installation is deleted.

120 ILS

The ILS controller (D1) and master switch (D4) are on the port quarter panel. Mod. 1945 (WZ400) introduces a volume control (E20) on the port coaming panel. An ILS indicator (B45 and 61), with a marker warning light (B47 and 63) beside it, is on each instrument flying panel. Mod. 2218 replaces the port indicator with a zero reader flight director; Mod. 3032 re-introduces the port ILS indicator at the position previously occupied by the 1st pilot's clock.

121 Zero reader (Mod. 2218)

A zero reader indicator is on each instrument flying panel. The control panel and course selector are below the centre of the fuel panel. When the zero reader is fitted the 1st pilot's ILS indicator is removed until Mod. 3032 is embodied.

122 Green Satin

This equipment is used to measure the ground speed and drift angle of the aircraft in flight. The power supply is obtained from a separate Type 153 inverter which is controlled by a switch (O17) on the radar panel. Pre-Mod. 2399 this switch also controls the equipment. Post-Mod. 2399, an additional switch (O16), which controls the equipment, is fitted. The Green Satin control box (M46) is on the radio crate and incorporates an indicator showing ground speed, drift angle and distance flown. The GPI (M49), which is used in conjunction with the Green Satin, is beside the Green Satin set. The aerial system is in the bomb bay deflector.

123 Tone release

(*a*) Mod. 2456 introduces tone release facilities for simulated bombing practice which may be obtained from either VHF or UHF. The NBS operator has an ON/OFF and an OFF/BIASED switch

together with an indicator light. When the ON/OFF switch is ON and the OFF/BIASED switch is set to BIASED the indicator light comes on and an audio tone is produced and transmitted over the VHF or UHF set. This continues until bomb release.

(*b*) If the practice run is abandoned after the OFF/BIASED switch has been set to BIASED, the tone may be stopped by setting the ON/OFF switch to OFF.

(*c*) At the AEO's station are two SIMBOMB TONE OVERRIDE NORMAL/EMERGENCY switches, one for VHF and one for UHF. Setting the system to EMERGENCY stops the tones and reverts the system to either normal VHF or UHF.

123A HF STR 18B

HF communication is by STR 18B, and the control unit which carries a function switch, a channel selector, volume and fine tuning controls is at the AEO's station. R/T transmissions can be made, if required. The power supply is 28 volt DC.

123B Tacan and Collins UHF/DF

(*a*) *Post-Mod.* 3165. Tacan is fitted. The control unit and indicator are fitted at the navigator's station. The pilot's repeater indicator is above his instrument flying panel. The equipment takes about $1\frac{1}{2}$ minutes to warm up.

(*b*) *Post-Mod.* 3166. Collins UHF/DF is fitted in tanker aircraft and, in conjunction with a modified Tacan installation, provides the range and relative bearing of the receiver aircraft from the tanker. The indicator is fitted adjacent to the Tacan indicator.

(*c*) A Type 153A inverter provides power (115-volt, 3-phase, 400 CPS) for both Tacan and Collins UHF/DF.

123C NBC and H2S

(*a*) The navigational bombing system is installed. The controls and indicators are all at the nav. radar's position.

(*b*) Signals from the NBS are fed into the auto-pilot when the BOMB switch is pulled out.

(*c*) Power is supplied by No. 1 Type 350 inverter.

123D IFF Mk. 10

IFF Mk. 10, with SIF and I/P facilities, is fitted and the controls are at the AEO's station. Power is supplied by the No. 2 Type 350 inverter.

Bombing Controls (B1 and BK1)

124 General

(*a*) Bombs are carried in the bomb bay in the fuselage. The bomb doors are operated electrically and there is a deflector at the rear of the bomb bay which, when raised, reduces the buffeting with the bomb doors open. The system is so arranged that the bomb doors will not open until the deflector is raised, nor will the deflector lower until the bomb doors are closed.

(*b*) All bombs may be dropped manually by the air bomber from either of his stations, or automatically by the NBC. All bombs may be jettisoned in emergency.

125 Bomb door control

The bomb doors are controlled by a switch (C8) on the central pedestal, marked OPEN, CLOSE and AUTO. When the switch is set to OPEN the deflector will rise and, as soon as it reaches the fully up position, the bomb doors will open. The bomb release circuits are not operative until the bomb doors are fully open. When the switch is set to AUTO the deflector will rise and, when it reaches the fully up position, will make a connection between the bomb door opening circuit and the NBC. The bomb doors will not open until the circuit is completed by the controller, this being fully automatic. To close the bomb doors, whether they have been

opened by using the OPEN or the AUTO position, the switch must be set to CLOSE. The bomb doors will then close, and as soon as they have reached the fully closed position the deflector will lower. Bomber Command Mod 20 provides a pin fitting in the switch guard to prevent the switch being inadvertently selected to AUTO (see also Part II, para 4 (*k*)).

126 Indicators

There are two magnetic indicators on the central pedestal forward of the trimmer switch which show the position of the deflector and bomb doors. The front one shows black when the deflector is fully down (closed) and white when it is in any other position ; the rear one shows white when both doors are fully open and black when they are in any other position.

127 Jettisoning bombs

A switch (C/16) on the central pedestal, marked NORMAL and JETTISON, may be used to jettison all bombs in an emergency. When this switch is set to JETTISON the deflector will first rise, then the fuselage doors will open. As soon as the doors are fully open (in about seven seconds) the bombs will drop. The doors will start to close again in the normal manner about 30 seconds after JETTISON has been selected. The cycle is complete in about 40 seconds. There is also a " live jettison " push-button at the bomb-aimer's prone station, at the starboard side of his window. This can be used to jettison all bombs " live " provided the bomb doors are open.

NOTE: The doors will close at the end of the jettison cycle, whatever the selection of the normal bomb door switch, but when the jettison switch is returned to NORMAL the doors will go to the selected position.

128 Ground safety switches

(*a*) On the port side of the battery compartment are two isolating switches, one for each fuselage bomb door. These switches are for use during ground servicing and, when they are set to ISOLATE, the doors can be opened from the cockpit but cannot be closed. The doors *will* close at the completion of the time cycle if the jettison switch is set to JETTISON. It is essential that the isolating switches are returned to NORMAL before flight.

(*b*) Between the isolating switches is a single NORMAL/TRIP switch and a green light. When this switch is set to TRIP, the green light will come on and the doors cannot be operated by the normal circuit. The bomb jettison switch will operate the bomb doors, and the bombs can be dropped by either the normal or jettison circuits.

129 Weapon in-flight safety locks

Mod 2996 introduces two in-flight safety lock switches on the left of the port coaming panel. They are marked LOCKED and UNLOCKED and are sealed in the LOCKED position. Beneath each switch are two lights, a green and an amber. The green light is on with the switch at LOCKED and the amber comes on when the switch is set to UNLOCKED.

130 Air spoiler control

An air spoiler in the form of four vertical slats at the front of the bomb bay, has to be extended to break up the airflow over the bomb bay prior to releasing the 10,000 lb bombs. It has only two positions, fully extended and retracted, and is controlled by an IN/OUT switch on the bombing panel on the radio crate. Two magnetic indicators (A/46) below the fuel panel show white when the air spoilers are extended and black when they are in or selected in.

Camera and Photoflash Controls (B(PR)1 and BK(PR)1)

131 General

The PR aircraft are standard B1 aircraft modified to enable them to be converted for photographic duties in either a day role or a night role.

132 Day role

(*a*) For the day role the aircraft carries up to eight main fan cameras, three cameras for the tri-installation for wide angle cover, and one survey camera. The main cameras and the centre tri-installation camera are mounted in the camera crate in the bomb bay ; after of these, in a rear fairing, is the survey camera and above this are mounted the two oblique cameras of the tri-installation.

(*b*) The special PR bomb doors contain camera windows each with a door, and cannot be opened from the cockpit (see also para 134). An auxiliary fuel tank may be carried in the forward part of the bomb bay.

(*c*) There are two camera control panels in the cabin, one on the starboard wall and one at the air bomber's prone station. A reconnaissance sight may be fitted at the air bomber's prone station.

(*d*) All cameras are controlled by either one of two controllers, one on the cabin starboard wall and one at the prone station. Ratio selector switches on the day role panel on the cabin starboard wall enable the survey and tri-installation cameras to be pulsed in a ratio of 1 to 1, 1 to 4 or 1 to 8 exposures of the main cameras. The camera window doors are all controlled by a single OPEN—CLOSE switch on each control panel. Until one of these switches is set to OPEN, none of the main cameras can operate. Each camera can be individually selected by switches on the cabin control panel. Indicator lamps above the switches pulse as the selected cameras operate. These lamps (but not the switches) are duplicated at the prone station.

(*e*) Mod 2099 and 2122 introduce a survey camera pulse indicator (B/21) at the top centre of the centre instrument panel. This is a green light which comes on three seconds before the survey camera is pulsed and remains on until the camera has pulsed. This is a warning to the pilot to level the wings, as the camera can be corrected for drift and pitch but not for bank.

133 Night role

(*a*) In the night role the aircraft carries five or six cameras in the camera crate in the bomb bay, and five or six photo-cell units. Photo-flashes are carried in a flash crate at the rear of the bomb bay.

(*b*) The special PR bomb doors contain camera windows, each with a door, and cannot be opened from the cockpit (see also para 134). An auxiliary fuel tank may be carried in the forward part of the bomb bay.

(*c*) There are two camera control panels in the cabin, one on the starboard wall and one at the air bomber's prone station. A reconnaissance sight may be fitted at the prone station.

(*d*) All cameras and photo-cells are controlled from either of the two control panels. The camera window doors are all controlled by a single OPEN—CLOSE switch on each control panel. The flash crate doors are controlled by the bomb doors selector switch (C/8) on the central pedestal ; door OPEN and CLOSED indicators (A/46) are below the fuel panel and on each control panel. Pre-Mod 2800 all indicators show the position of the doors ; Post-Mod 2800 the pilot's indicators remain the same, but the other indicators only show OPEN when the doors are open and the flash fusing strips are energised. The cameras cannot operate until the camera window doors and flash crate doors are open. Each camera can be individually selected by switches on the starboard wall control panel only. Camera pulse indicators, an exposure counter and a flashes released counter are on each control panel.

(*e*) Two of the cameras are known as master cameras and supply pulses for releasing the photo flashes. A selector switch on the control panel enables the selection of either master camera according to the group of cameras being used. Provided that the camera window doors and flash crate doors are open, operation of the CAMERA START AND FLASH RELEASE switch (one on each control panel) will energise the selected cameras and start the predetermined flash release cycle. Each time a flash bursts, the

photo-cells are energised and the cameras are operated. A CAMERA STOP and a FLASH STOP switch are on each control panel. Normally when photography is to be stopped the FLASH STOP switch should be operated first ; when all the flashes which had been released at this time have burst, the cameras should be stopped by operating the CAMERA STOP switch. The flash crate doors must not be closed while the cameras are operating.

(*f*) All photo-flashes may be jettisoned, live only, by the pilot's NORMAL/JETTISON switch (C/16) on the central pedestal. When JETTISON is selected, the flash crate doors operate and the flashes drop in exactly the same way as described for jettisoning bombs (see para 127).

134 PR bomb doors

The special bomb doors fitted in the PR role cannot be operated from the cockpit. There is an OPEN/CLOSE switch on the external electrical panel and a LOCK IN/LOCK OUT switch, with a mechanical indicator, at the front of the starboard door near the hinge line. To open the doors the lock switch must be set to LOCK OUT until the indicator shows that the lock is withdrawn, then the OPEN/CLOSE switch should be set to OPEN. To close the doors the switch should be set to CLOSE ; when the doors are shut, the lock switch should be set to LOCK IN until the indicator shows that the lock is fully engaged.

Aircraft Destructors

135 General

Two aircraft destructors are stowed in containers on the outside of the pressure cabin under the canopy fairing and just aft of the sextant dome. Access to them is obtained by removing the sextant dome.

136 Position of application

The most effective position of application of the destructors is on the top of the fuselage over the fuselage fuel tanks, choosing tanks which are still fairly full of fuel. The destructors should not both be positioned above the same cell, and each should be about 2 to 3 feet from the aircraft centre line. The positions of the cells can be judged from the relative position of the bomb hoists ; No. 1 hoist (forward) is towards the rear of No. 1 cells, No. 2 hoist midway along the rear half of No. 2 cells, No. 3 and 4 hoists midway along No. 3 cells, No. 5 hoist at the rear of No. 3 cells, and No. 6 hoist about a foot forward of the transfer tank. The reserve tank is about 2 feet aft of the DF loop. The method of application is covered in Part V, para 21.