PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

List of Chapters

PART I

Chapter 1. FUEL SYSTEM

List of Contents

DESCRIPTION

1. Tanks

(*a*) Fuel is carried in six internal tanks, one in each wing and two front and two rear ranks in the centre fuselage. Each wing tank consists of two cells and is fitted in the forward edge of the wing. The fuselage tanks are of the flexible bag type.

(*b*) Provision is made for carrying either two or four tanks on underwing pylons. The outboard tanks are of 100 gallon capacity and those on the inboard pylons may be either 100 gallon or 230 gallon capacity.

(*c*) The tank capacities are:

		Weight at 7·7lb. per gallon				Galls.
INTERNAL	Front . .	1540	1540	1540	1540	200
	Rear . .	400	400	400	400	52
	Wing . .	1078	1078	1078	1078	140
DROP TANKS	2×100 . .	—	1540	—	1540	200
	2×230 . .	—	—	3542	3542	460
	Total . .	3018	4558	6560	8100	—

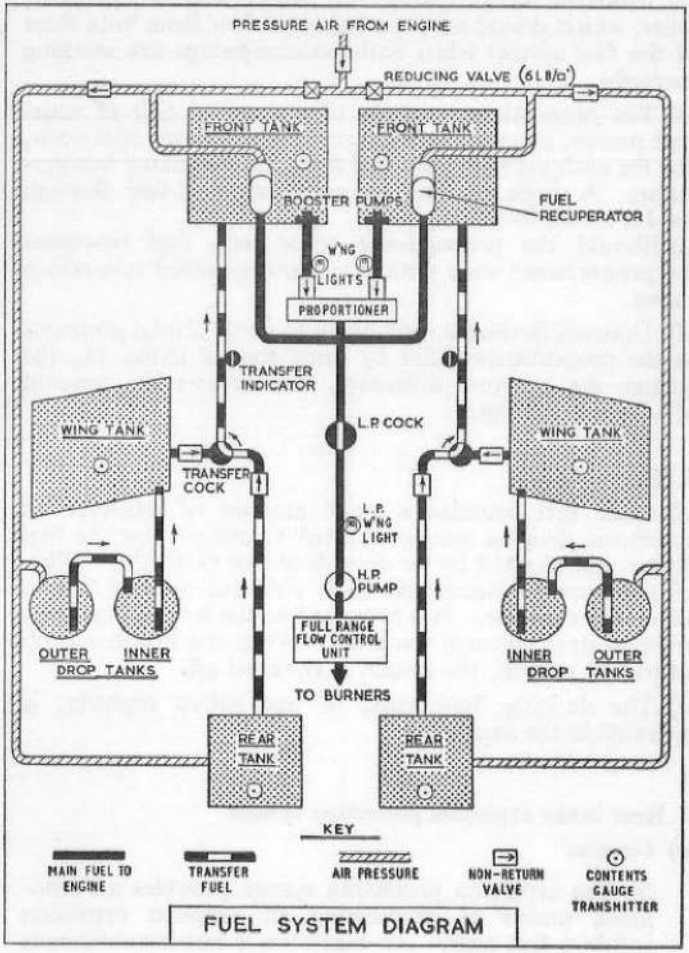
2. **Fuel feed system—general**

Fuel is fed to the engine by a booster pump in each front tank via a fuel proportioner and then through the LP and HP cocks. Fuel is transferred from the wing and rear tanks to the front tanks on the same side by air pressure from a tapping on the engine compressor. When drop tanks are carried fuel transfer is from the outer drop tank to the inner drop tank to the wing tank on the same side.

3. **Booster pumps and fuel recuperator**

(*a*) Each front tank contains a two-speed electrically-driven immersed booster pump and a 3½ gallon capacity fuel recuperator, the contents of which are used when booster pump pressure falls, e.g. during inverted flight. The total contents of the recuperators should be sufficient to provide for 15 seconds flight at full power at sea level.

(*b*) The booster pumps, when switched on, normally run continuously at low speed but each, at high speed, is capable of supplying the maximum fuel demand to the engine. High or low speed operation is automatically controlled by pressure switches. If pressure in the pipelines falls below 8 lb./sq. in. the pumps are switched to high speed; when pressure rises above 12 lb./sq. in. the pumps are switched back to low speed.


PRESSURE AIR FROM ENGINE
REDUCING VALVE (6 LB/□")
FRONT TANK
FRONT TANK
BOOSTER PUMPS
FUEL RECUPERATOR
W'NG LIGHTS
PROPORTIONER
TRANSFER INDICATOR
L.P. COCK
WING TANK
WING TANK
TRANSFER COCK
L.P. W'NG LIGHT
H.P. PUMP
FULL RANGE FLOW CONTROL UNIT
TO BURNERS
OUTER INNER DROP TANKS
INNER OUTER DROP TANKS
REAR TANK
REAR TANK
KEY
MAIN FUEL TO ENGINE
TRANSFER FUEL
AIR PRESSURE
NON-RETURN VALVE
CONTENTS GAUGE TRANSMITTER
FUEL SYSTEM DIAGRAM

4. **Fuel proportioner**

(*a*) From the booster-pumps fuel passes to the fuel proportioner, which should ensure a balanced flow from both sides of the fuel system when both booster-pumps are working correctly.

(*b*) The proportioner consists of a matched pair of vane-type pumps, mounted on a common shaft. Two inlet ports, one for each pump, accept fuel from the associated booster-pump. A single exit port passes the metered fuel through the L.P. cock to the engine.

(*c*) Should the proportioner rotor jam, fuel by-passes the proportioner vane pumps via spring-loaded non-return valves.

(*d*) Unequal feeding is only likely to occur if inlet pressures to the proportioner differ by more than 2 lb./sq. in., the greater the pressure difference, the greater the amount of unequal feeding.

5. **Filter de-icing**

(*a*) Since fuel contains a small amount of moisture an automatic de-icing system is fitted to ensure that the fuel filter is not blocked by ice crystals at low O.A.T.'s. When icing occurs an electric pump is switched on and pumps alcohol to the filter. It is brought into use by the increasing pressure drop through the filter. When the pressure drop returns to normal, the system is switched off.

(*b*) The de-icing fluid tank, of one gallon capacity, is mounted in the engine bay.

6. **Rear tanks explosion protection system**

(*a*) *General*

(i) The explosion protection system provides an automatic means of suppressing an incipient explosion within a fuel tank. An explosion is not instantaneous but requires a measurable time from the moment of ignition to the development of maximum pressure of a destructive nature. In the initial stages the rate of pressure increase is comparatively slow and hence can be suppressed in this period.

(ii) The basic components of the explosion protection system are:—

A detector unit
A suppressor unit
A power pack

(*b*) *Detector unit*
In each rear fuel tank is a highly sensitive photo-electric cell, a detonator firing unit and a suppressor unit. The presence of any light within a fuel tank, such as the initial ignition leading to explosion, causes the photo-electric cell to pass current to the detonator firing unit.

(*c*) *Suppressor unit*
(i) When the detonator firing unit operates it causes a detonator in the centre of the suppressor unit to fire. This bursts the outer casing of the suppressor unit to release the suppressant agent. As the suppressor unit casing is suitably scored, the metal remains attached to the unit after bursting and no large particles of metal are discharged into the tank.
(ii) The suppressant agent is primarily a fuel with a small quantity of extinguishant. When this mixture is released it has the effect of enriching the fuel/air vapour to a non-explosive ratio, thus terminating the explosion and halting the attendant pressure increase.
(iii) Permanent indication that a unit has fired is given by a match-head fuse within a viewing window at each tank. When a unit fires, the fuse operates to ignite the match-head and to disperse red oxide over the viewing window.

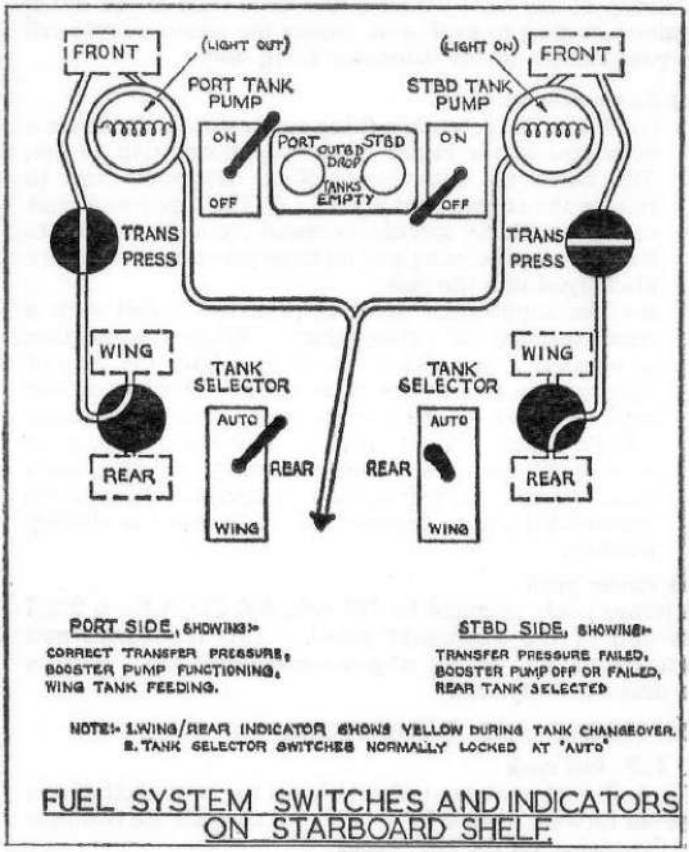
(*d*) *Power pack*
A power pack, operated by 115 volt, 400 C/S.A.C., is fitted forward of the instrument panel. This transforms and rectifies the A.C. supply to give the required D.C. voltages to operate the system.

CONTROLS AND INDICATORS

7. L.P. fuel cock
The L.P. fuel cock control (11) is on the port shelf and is moved forward from OFF to ON. It controls the fuel flow to the engine via the H.P. cock.

8. Booster pump controls and indicators
(*a*) Each booster pump is controlled by an ON-OFF switch (113) on the starboard shelf; a circuit breaker (98, 99) for each pump is also on the starboard shelf.

(*b*) Adjacent to switches are two amber warning lights (114), one for each pump, which come on if the associated booster pump fails or is switched off.
(*c*) A red warning light (67) comes on if fuel delivery pressure from the booster pump falls below a satisfactory minimum.
(*d*) A test switch (104) and an ammeter socket are provided, for servicing purposes, on the starboard shelf.



FUEL SYSTEM SWITCHES AND INDICATORS ON STARBOARD SHELF

9. **Fuel contents gauges**
(*a*) Two electrical fuel contents gauges (84) indicate the total fuel in the PORT and STBD tanks (front, wing and rear). The contents of the 230 or 100 gallon drop tanks are not gauged.

(*b*) The fuel gauges read the weight of fuel in pounds. When all gauged tanks are full (front, wing and rear) each gauge should read 1,500 lb. approx when transfer pressure is available.

(*c*) Each 230 gallon drop tank is fitted with a mechanical contents gauge, visible from the cockpit, which reads the weight of fuel in lb. × 100. Since the gauges are susceptible to fuel surge, their readings are unreliable.

10. **Transfer system controls and indicators**

(*a*) Control of the transfer system is by two TANK SELECTOR switches (110) one for each side of the system. Each switch has three positions, AUTO (forward) REAR (central) and WING (aft). When the switches are set to AUTO the air pressure forces fuel from the rear tanks to the front tanks. When each rear tank is empty, a float switch in the tank operates to alter the setting of the transfer cock, shutting off the rear tank and allowing the drop tanks to feed to the wing tanks and the wing tanks to feed to the front tanks. At the same time, the WING/REAR tank indicator (111) operates to show that this is happening. When changeover from either wing or rear tanks is taking place the indicator shows yellow, the action of the selector cock motoring over is audible over the R/T. and the contents gauges read front tank contents only. Setting either control switch to WING or REAR causes transfer to take place from the respective tank.

(*b*) Although all internal tanks are gauged, and the contents reading should fall when fuel from these tanks is being used, when transfer from the drop tanks (which are ungauged) is taking place the fuel contents gauges should show a constant reading. Should the air pressure fail, very little fuel will transfer from the drop, wing or rear tanks and the TRANS. PRESS indicators (112) will indicate failure by showing cross-line. At the same time the contents gauge transmitters in the rear and wing tanks will become inoperative and the gauges should only indicate the contents of the front tanks, i.e. the amount of fuel available to the engine. If only one side of the air pressure system fails, the appropriate indicator will show cross-line and the associated gauge will indicate the available fuel contents.

11. **Fuel level indicators**

(*a*) Two magnetic indicators (83), one for each outboard

tank, are situated aft of the contents gauges. Each shows white when all fuel has transferred from its associated outboard drop tank.

(*b*) Two amber warning lights (45), labelled FUEL LEVEL 650 lb. on the right of the GGS are operated by float switches in the front tank. Each should come on when the fuel level in its associated front tank falls to 650±50 lb.

12. **Drop tank jettison controls**

(*a*) The inboard drop tanks may be jettisoned by pressing the INBD STORES jettison pushbutton (47), on the left of the G.G.S.

(*b*) Outboard drop tanks may be jettisoned by pressing the OUTBD STORES pushbutton (46), on the left of the G.G.S.

(*c*) All four drop tanks may be simultaneusly jettisoned by pressing down the CLEAR A/C switch bar (48), above the pushbuttons.

13. **Pressure refuelling and defuelling controls**

(*a*) Refuelling is via a connection on the port wheel bay. As each set of tanks is filled, refuelling valves automatically cut off the fuel being supplied to them. During refuelling the L.P. cock must be OFF, the transfer selector cock switch at AUTO and the defuelling cock OFF. A time switch adjacent to the coupling must be ON in order to energise the refuelling circuit. A set of lights adjacent to the fuelling connection indicate when the appropriate tanks are full.

(*b*) Defuelling is via the same coupling. During defuelling the L.P. cock must be OFF, the transfer selector cock switches to AUTO and the defuelling cock ON. An air pressure of 10 lb/sq. in. is necessary to transfer fuel to the front tanks, whence it is either sucked out by the howser pump or pumped out by the booster pumps. The air pressure connection is on top of the centre fuselage.

14. **Explosion protection control**

Located on the starboard wall adjacent to the cockpit lights switches is a NORMAL-RESET switch (86), spring-loaded to the NORMAL position and a neon indicator (87). With the system inoperative the neon indicator glows. When the switch is held down to RESET the power pack becomes active and the indicator is extinguished. The

power pack remains active as long as input voltage is maintained. This supply is obtained from the flight instruments (No. 1) inverter, or from the No. 2 inverter which acts as a standby. If the indicator glows in flight the RESET switch must be operated to bring the system back into use.

NORMAL USE OF THE SYSTEM

15. Pre-flight checks of the system

The H.P. and L.P. cocks must be ON and the booster pumps should normally be ON at all times when the engine is running. Switch the booster-pumps ON when starting, to avoid the recuperator discharging.

16. Use of the system in flight

(*a*) Correct functioning of the system is shown by the fuel contents gauges indicating equal fuel levels, the L.P. warning light out and the "flow plan" indicators reading as follows:—

(i) Booster pump warning lights (114) Out

(ii) Transfer indicators (112) 'In-line" through-out the flight

(iii) Tank changeover indicator (111) reading correctly, i.e. the indicator should change from REAR to WING when fuel contents reduce to approximately 1,300 lb. per side and remain at WING for the remainder of the flight.

(iv) Front tank level lights (45) wink for a few seconds and then remain on when the gauges read 650±50 lb. per side.

(v) The two magnetic indicators (83) on the starboard shelf show white when the *outboard* drop tanks are empty.

NOTE: When the rear tanks are empty auto-selections to REAR will occur if the aircraft is inverted for approximately 5 seconds; on resuming normal flight a reselection to WING will occur automatically. When the aircraft is inverted the level lights will come on irrespective of the fuel state. When normal flight is resumed the lights will go out if the fuel state is above 650 lb. per side

(*b*) The proportioner will maintain accurate fuel balancing with both booster-pumps on or off, provided that the pressures at which the fuel enters the proportioner from the booster-pumps do not differ by more than 2 lb./sq, in. If unequal emptying occurs with all indicators normal, either the proportioner has failed or the inlet differential pressures are greater than 2 lb./ sq. in. in which case fuel balancing must be controlled manually by switching off the pump on the "low" side until the levels become equal and then switching it on again.

17. **Unusable fuel**

(*a*) If a "tank-empty" float in a rear tank becomes saturated its switch will operate before the tank has emptied. It is important to check that the changeover to wing tanks takes place at approximately 1,300 lb. per side. If the changeover occurs at a higher reading set the tank selector switch from AUTO to REAR until the contents reduce to below 1,300 lb. then set the switch to WING. A check that the associated level light comes on at approximately 650 lb. per side will verify that all fuel has been correctly transferred (see para. 20).

(*b*) Provided that a minimum fuel state of 200 lb. per side is indicated, a further circuit may safely be attempted. Below this fuel state care must be taken to restrict excessive attitude or acceleration on over-shoot, which may cause fuel in the tanks to move away from the booster pumps resulting in fuel starvation.

MALFUNCTIONING OF THE SYSTEM

18. **Booster-pump failure**

(*a*) If a booster-pump fails, indicated by a warning light coming on and the corresponding contents gauge reading high, no fuel will be used from that side if the serviceable pump is left on; in this event reduce R.P.M. to 7,200 and reduce altitude to the limits below, according to the aircraft configuration.

With 230 gallon drop tanks	15,000 ft. max.
With 100 gallon drop tanks	20,000 ft. max.
Without drop tanks	25,000 ft. max.

Then switch off both pumps and accept the fuel feed provided by tank pressurisation and gravity. R.P.M. must thereafter be maintained at 7,200 or below. The altitude limit may be increased in emergency by 10,000 feet if absolute range is essential, but in this event the engine must

subsequently be examined for possible damage to the fuel system.

(*b*) With both booster-pumps off, the recuperators will also discharge, negative G manoeuvres must not therefore be carried out. It is important to land while both sides still contain fuel, because the flow proportioner will maintain out-of-balance levels and the engine will not run with one side empty unless the booster-pump in the side containing fuel is serviceable. The serviceable pump may be switched on for landing if a sufficient head of fuel remains on that side, but it should be remembered that with the pump on, fuel will only be used from that side.

(*c*) With both booster-pumps and with less than 600 lb. per side there is a possibility of engine flame-out at low RPM. To prevent this, engine RPM must be kept above 6,000 until a booster-pump is switched on for landing.

19. **Transfer failure**

If one or both transfer indicators shows "cross-line", transfer pressure failure has occured and steep dives should be avoided due to the possibility of collapsing the tanks. Should an indicator show "cross-line" before fuel transfer is complete, any fuel remaining in the rear and wing tanks will be unusable and the associated contents gauge will only indicate the usable fuel in the front tanks (770 lb. maximum per tank). In these circumstances if the gauge registers more than the total contents of a front tank a faulty gauge should be suspected and only the front tank fuel should be relied on as being available to the engine. If air transfer fails on one side, the booster pump on the side with transfer failure should be switched OFF until the contents gauge of the other side indicates an equal amount, then reset the pump ON.

20. **Transfer changeover failure**

If changeover to the wing tanks does not function automatically, shown by the magnetic indicator still pointing to REAR at a fuel state less than approximately 1,300 lb. set the tank selector switch from AUTO to WING. If the magnetic indicator still points to REAR a fault in the changeover system has occured. The amount shown on

the contents gauge will include the unusable fuel in the wing tank, i.e. 539 lb., but only the front tank fuel (770 lb.) should be relied on as being available to the engine. This condition can be verified by noting at what fuel state the amber low-level lights come on.

21. **Fuel gauge errors**

(*a*) The fuel contents gauges have been found to give erroneous indications due to temperature effects on the electrical gauging system. The magnitude of the error depends on both temperature and time. Low temperatures at high altitude give gauge underreading; high temperatures at high speeds at low altitude give gauge overreading.

(*b*) To assess the gauge error the readings of the contents gauges should be checked immediately the front tanks low level warning lights come on. The difference between the total gauge readings and 1,300 lb. indicates the gauge inaccuracy. This figure should be applied to all gauge readings for the remainder of the flight at the same operating conditions. During a descent from altitude, if the assessed inaccuracy was a gauge under-reading, the gauges will progressively become more accurate and may eventually tend to over-read.

PART I

Chapter 2—ENGINE CONTROLS AND INSTRUMENTS

List of Contents

DESCRIPTION

1. Avon 203 engine

(*a*) *General*

The engine is a 15-stage axial-flow gas turbine. The Avon 203 develops 10,000 lb. static thrust at sea level.

The main engine systems include:

Variable swirl vanes (see para. 2).

A liquid fuel starting system (see para. 3).

Relighting facilities (see para. 7)

An anti-icing system (see para. 10)

A high-pressure fuel system controlled by a flow control unit.

Self-contained oil system

(*b*) *High-pressure fuel pumps*

The twin engine-driven H.P. pumps share a common housing. A servo-control system controls the total pump output and a governor limits over-speeding of the engine.

(*c*) *Flow control unit*

The servo-control system is operated by the flow control unit,. The control unit, which contains the throttle valve, H.P. cock, barometric pressure control (B.P.C.), acceleration control unit (A.C.U.), and RPM datum control varies fuel flow to the engine according to throttle position, altitude, forward speed and RPM.

(*d*) *Oil system*

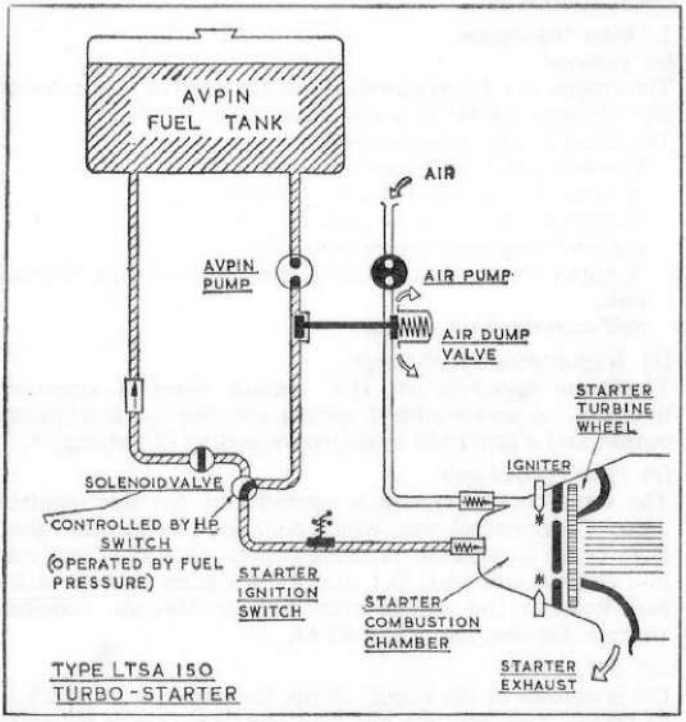
Oil is carried in the engine sump, the capacity of which is 9½ pints. One pressure and four scavenge pumps maintain

a continous circulation through a cooler and filter to the engine bearings and gears. An oil pressure gauge (77) is below the instrument panel.

2. **Variable incidence guide vanes and air bleed valves**

(*a*) The first row of stator blades in the engine consists of variable incidence 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 surge, the surplus air is bled off from the seventh stage through an air bleed valve and the guide vanes are held in the maximum swirl position. The guide vanes ram and the air bleed valve are both controlled by H.P. pump delivery fuel pressure, but the air bleed valve control cannot operate until the guide vane ram has started to move from the maximum swirl position.

(*b*) The guide vanes start to move from the maximum swirl position at about 6,450 RPM and reach the minimum swirl



position at about 7,300 RPM. The bleed valve closes at about 6,550 RPM.

(*c*) The guide vanes and bleed valve positions have no noticeable effect on RPM, but until the guide vanes are in the minimum swirl position and the bleed valve is closed the engine is not operating at maximum efficiency; thrust is reduced and specific fuel consumption is worsened.

3. **Starting system**

(*a*) Starting is by means of a liquid fuel starting system. This type of system is similar in operation to a cartridge starter system in that the gases from the burning monofuel drive the starter turbine and thus rotate the engine. Instead of starter cartridges, liquid isopropylnitrate (AVPIN) stored in a tank, is fed to and ignited within the starter motor.

(*b*) When the starting cycle is initiated, for the first two or three seconds the starter motor combustion chamber is purged by air under pressure. Then AVPIN fuel is fed to the chamber where it is ignited, and causes the motor to turn the engine compressor. At the same time the engine high energy igniter units operate to ignite the fuel spray in the engine combustion chambers. After approximately 7-10 seconds the engine becomes self sustaining and as the starter motor reaches its top speed, a switch operates to shut down the liquid starting system. The engine should then accelerate to the normal idling RPM of 2,500.

(*c*) Should the starter fail to light up, a pressure sensitive switch in the starter fuel line operates to cut off the starter system.

(*d*) It is important that personnel keep clear of the starter exhaust during starting. The exhaust is aft of the engine starter access door beneath the fuselage.

4. **Engine fire-extinguisher**

(*a*) Two fire-extinguisher bottles, stowed between the air intakes just forward of the engine, are together connected to the engine extinguisher inlet connection.

Operation of the system is either by:

(i) A manually-operated pushbutton (56) in the cockpit on the starboard coaming, or

(ii) Two automatically-operated inertia switches, one in the gun-bay and one in the radio bay, connected in series

which operate if a crash landing occurs. Operation of these switches also causes the batteries to be isolated irrespective of the position of the battery master switch.
(*b*) Twelve resetting flame detector switches are situated around the engine and forward part of the jet pipe. Operation of any of the switches causes the ENGINE FIRE warning incorporated in the pushbutton to come on, provided that electrical power is available. When the button is pressed the extinguishers discharge their contents through two spray rings, one round the engine compressor and the other round the turbine nozzle box. If the fire is extinguished, the light goes out as the flame switches cool.
(*c*) The fire warning circuit may be tested by use of the switch (105) on the starboard shelf. If the circuit is serviceable the warning light will come on.
(*d*) When the battery master switch is OFF the fire-extinguishers can be operated only by the inertia switches. The battery master switch must be ON to test the warning light or to operate the system by pushbutton.

CONTROLS AND INDICATORS

5. **Throttle/H.P. fuel cock**

The high-pressure fuel cock is controlled by the throttle lever. When the lever is fully back in the H.P. cock gate the fuel supply to the engine is cut off. When the lever is moved just forward of the gate, sufficient fuel is available to maintain idling RPM. A spring-loaded trigger on the throttle lever prevents the throttle being returned inadvertently through the H.P. cock gate, once it is forward of that position. A throttle damper is aft of the control.

6. **Starting controls**

The main control switches are:
(*a*) *The battery master switch* (76)
(*b*) *The ignition switch* (70) which controls the current to the igniter plugs. It should normally be locked in the ON position.
(*c*) *The engine master switch* (72) *and circuit breaker* (100) which complete the circuit through the starter button, ignition switch and relight switch (34). When the relight switch is at RELIGHT the starter button is isolated. The starter master switch also controls the electrical supply to the engine instruments, and completes the circuits to No. 2 inverter and the booster-pumps. The switch should be ON and the circuit breaker closed at all times when the engine is running.

(*d*) *The starter pushbutton* (71) which initiates the starting sequence.

NOTE: The engine starting procedure is covered in Part III Chapter 2.

7. **Relighting control**

A RELIGHT switch (34) is situated on the port shelf, and when held to RELIGHT for two seconds completes the circuit, through a time delay switch, to the high energy ignition units. The ignition then operates automatically for 30 seconds. The switch is spring-loaded to return to the off position.

NOTE: The relighting procedure is covered in Part IV Chapter 1.

8. **Top temperature control**

(*a*) The top temperature control is brought into use when the switch (29) on the port shelf is set to ON and the nosewheel is retracted. Should the jet pipe temperature then rise above the maximum for full throttle (685°C), an automatic control reduces fuel flow to the engine, thereby reducing the JPT.

(*b*) The switch should normally be ON at all times. If it is suspected that the system has failed, the switch should be set OFF, and JPT must then be controlled by throttle movement.

9. **Engine instruments**

The engine instruments comprise a jet pipe temperature gauge, and oil pressure gauge (77) and an RPM indicator.

10. Engine anti-icing

An engine anti-icing OPEN/SHUT switch (91) and indicator (90) are above the starboard shelf. Hot air is tapped from the engine compressor and with the switch OPEN is ducted to the inlet guide vanes. The system is *not* intended for de-icing, but to prevent ice forming.

11. **Management of the engine anti-icing system**

(*a*) With the system in use, all throttle movements must be made smoothly. There is a loss of thrust (about 7%) and fuel economy, and jpt usually rises about 20°C. At full throttle, RPM may then fall if the top temperature control comes into operation.

(*b*) *Ground running*

In conditions of fog or mist at OAT'S below + 5°C.

switch OPEN anti-icing immediately after starting. Taxy and, if runway length permits, take-off with the system OPEN: otherwise run the engine at 7,000 rpm for one minute immediately before take-off and then switch the system OFF. Switch the system OPEN again as soon as possible after take-off and leave it OPEN until 2 minutes clear of icing conditions.

NOTE: Do not carry out any acceleration checks with the system ON.

(*c*) *Level flight*

If icing conditions are met in level flight, climb or descend out of the icing level (see (d) and (e) below).

(*d*) *Climbing*

Open up to not less than 7,200 RPM and set the anti-icing switch to OPEN. Climb at the maximum practicable rate.

(*e*) *Descending*

Throttle back to not less than 5,500 RPM and set the switch to OPEN. Descend at the maximum practicable rate; maximum anti-icing protection is obtained at the highest practicable RPM.

(*f*) When clear of icing conditions, set the switch to SHUT and wait for about 10 seconds before making any rapid throttle movements. If icing conditions persist down to airfield level keep the switch at OPEN and maintain engine speed above 5,500 RPM until finally committed to a landing.

PART 1

Chapter 3—ELECTRICAL SYSTEM

List of Contents

DESCRIPTION

1. D.C. supplies

(*a*) Two 6,000-watt engine-driven generators supply the whole of the electrical system and charge two 24-volt batteries connected in parallel. Both generators should normally cut in at 1,800 R.P.M. and cut out at 1,606 R.P.M., but this will depend on battery condition.

(*b*) An external ground supply socket is accessible via the radio bay door and is for use when a ground D.C. battery is necessary for servicing purposes.

2. Standby D.C. supplies

A standby battery is located in the radio bay and provides a standby supply for the turn and slip indicator, the emergency lamps, the E2B compass lamp, and if Mod.502 is embodied, the Manual emergency selector circuit.

3. A.C. Supplies

(*a*) The A.C. supplies are provided at 115 volts, 3-phase, 400 cps by No. 1 Type 100A inverter with No. 2 acting as a standby. If No. 1 inverter fails automatic changeover to No.2 occurs.

(*b*) The following are supplied with A.C. and will be inoperative if both inverters fail.

Mk.4F Compass
Artificial horizon
Top temperature control
Oil pressure gauge
Explosion protection system
Jet pipe temperature gauge
Radar ranging

(*c*) A.C. for gun firing is supplied by a Type 300 inverter which is brought into operation when the gun firing safety flap is raised.

CONTROLS AND INDICATORS

4. Generator controls and indicators

(*a*) The generators each have a separate control panel in the radio bay. No pilot-operated controls are fitted.
(*b*) A warning light (69) for each generator, below the instrument panel, comes on when its associated generator is not supplying power.

5. Main battery control

The battery master switch (76) below the instrument panel when set to OFF isolates the aircraft main batteries from all electrical services except the engine fire extinguisher inertia switch circuit.

6. Standby battery controls

(*a*) The supply to the turn and slip indicator is controlled by the TURN & SLIP SUPPLY NORMAL/EMERGY switch (68), adjacent to the instrument. With the switch set to EMERGY the instrument is supplied by the standby battery.

(*b*) The EMERGY LIGHT ON/OFF switch (88) controls the supply to the emergency lamp.
(*c*) The E2B compass NORMAL-OFF-STANDBY switch (89) controls the supply to the compass lamp.

7. A.C. Supply—controls and indicators

(*a*) The engine master switch (72) normally controls the circuit to the inverters but No. 1 inverter does not come into circuit until the engine is started. A magnetic indicator (53) on the instrument panel shows black with No.1 inverter in operation and white when changeover to No. 2 occurs or electrical supply to the inverters is lacking.

(*b*) On the port shelf is an INVERTER SELECT NORMAL/STANDBY switch (5) which may be used by the

pilot to attempt to reset No. 1 inverter if auto-changeover occurs.

(*c*) Located on top of the A.C. junction box at the aft end of the starboard shelf, are two circuit breakers (102, 103), for the Type 100A inverters. In flight these are not visible or accessible. A test panel (101) for the Mk.4F compass is at the end of the starboard shelf.

(*d*) A NORMAL/TEST switch, for servicing purposes, is at the bottom of the generator control panel in the radio bay.

8. Warning indicators

Service	Indication	Function
Fire warning	1 red light (56)	Gives warning when temperature in engine bay exceeds 300± 30°C.
Fuel pressure warning ..	1 red light (67)	Indicates fuel pressure low at engine inlet
Fuel transfer warning ..	2 magnetic indicators (112)	Indicate failure of transfer system
Fuel, front tanks level ..	2 amber lights (45)	Indicate contents of front tanks below approx. 650lb. (each)
Fuel, outboard tanks ..	2 magnetic indicators (83)	Indicate transfer from outboard drop tanks complete
Wing/rear tank transfer	2 magnetic indicators (111)	Indicate transfer from wing/rear tanks
Rear tanks explosion protection	1 amber light (87)	Indicates system inoperative
Generator failure warning	2 red lights (69)	Indicate generator failure due to : (i) Cut-out not closed (ii) Fault in circuit
Inverter changeover ..	1 white magnetic indicator (53)	Indicates changeover to No. 2 inverter

Service	Indication	Function
Braking parachute ..	1 amber light (Mod. 848)	Indicates parachute streamed
Hydraulic failure warning	1 red light (42)	Indicates hydraulic pressure below 600lb./sq. in.
Undercarriage	3 red or green lights (39)	Indicate position of each U/C unit separately No light—unit locked up Red light—unit between locks Green light—unit locked down
Undercarriage warning	1 red light (38)	Indicates when throttle closed and U/C not locked down
Powered controls ..	2 white magnetic indicators (43) (44)	Indicate separately hydraulic failure or Power selected OFF
Airbrake position ..	1 white magnetic indicator (36)	Indicates airbrake not fully in
Cockpit pressure warning	1 red light (63)	Indicates drop of ½lb./sq. in. in cabin pressure differential
Telebriefing	1 amber light (22)	Indicates telebriefing in use

NORMAL USE OF THE SYSTEM

9. Pre-flight procedures

(*a*) Before starting the engine, switch the battery master switch ON and check the functioning of all D.C. operated instruments and indicators.

(*b*) When the starter master switch is set ON check aurally that No. 2 inverter starts up and that the artificial horizon flag shows black.

(*c*) After start up, when the engine is running at idling r.p.m. check that the generator warning lights are both out and that changeover to No. 1 inverter has occurred by noting that the INVERTER CHANGEOVER indicator has turned to black and that the artificial horizon maintains its erected position.

MALFUNCTIONING OF THE SYSTEM

10. **Resetting No. 1 imverter in flight**

If auto-changeover occurs, indicated by the magnetic indicator turning white, set the INVERTER SELECT switch to STANDBY and then return it to NORMAL. If the indicator reverts to black, resetting has been accomplished; if it remains white the standby inverter is still in operation and resetting is not possible.

11. **Single generator failure**

If either generator fails, the output of the other is sufficient for non-combat flying provided that all non-essential electrical services are off and that engine r.p.m. are maintained above 4,000. When the follow-up tailplane is in use an additional heavy electrical load is imposed; use of the interconnection should therefore be limited to manoeuvring at speeds above 0.9M.

12. **Double generator failure**

(*a*) If both generators fail, all electrical services will be supplied by the batteries. These normally should be fully charged about 20 minutes after take-off and then should maintain the following output before they are discharged.

Output-Amps ..	150	125	100	75	50
Time-mins.	7	10	15	20	30

(*b*) To assist the pilot in deciding which loads should be shed, if generator failure occurs, the following table lists the major services and the current they require.

Service	Load (amps.)	Service	Load (amps.)
Booster pumps (two at low speed) . . .	35	D.M.E. . . .	6
Booster pump (one at high speed) . . .	23	Pressure head heater	6
Tailplane actuator . .	12	Starter control (relighting)	6
Hood control. . .	10	Fuel contents gauges .	4·5
A.C. inverters each	7·5	G.G.S. . . .	4
V.H.F. sets each	7·5	All other electrics .	10
IFF set	6·5	Max. flight load . .	157

NOTE : The average flight load is 105 amps.

13. **Double generator and battery failure**

Once the batteries are discharged, no electrical services may be operated, e.g. trim tab actuators, tailplane motors, electro-hydraulic selectors, etc. In addition the fuel gauges, and electrically-operated flight instruments will become unserviceable. The fuel booster-pumps will cease operation which may entail reduction in altitude and engine r,p.m. to ensure satisfactory engine running (see Part I, Chapter 1, para. 18). No relight facilities will be available when the batteries are fully discharged.

PART I

Chapter 4 HYDRAULIC SYSTEM

List of Contents

DESCRIPTION

1. **Hydraulic system**

(*a*) An engine-driven hydraulic pump maintains a live-line pressure of $2{,}850 \pm {}^{150}_{50}$ lb./sq. in. for the normal operation of the:

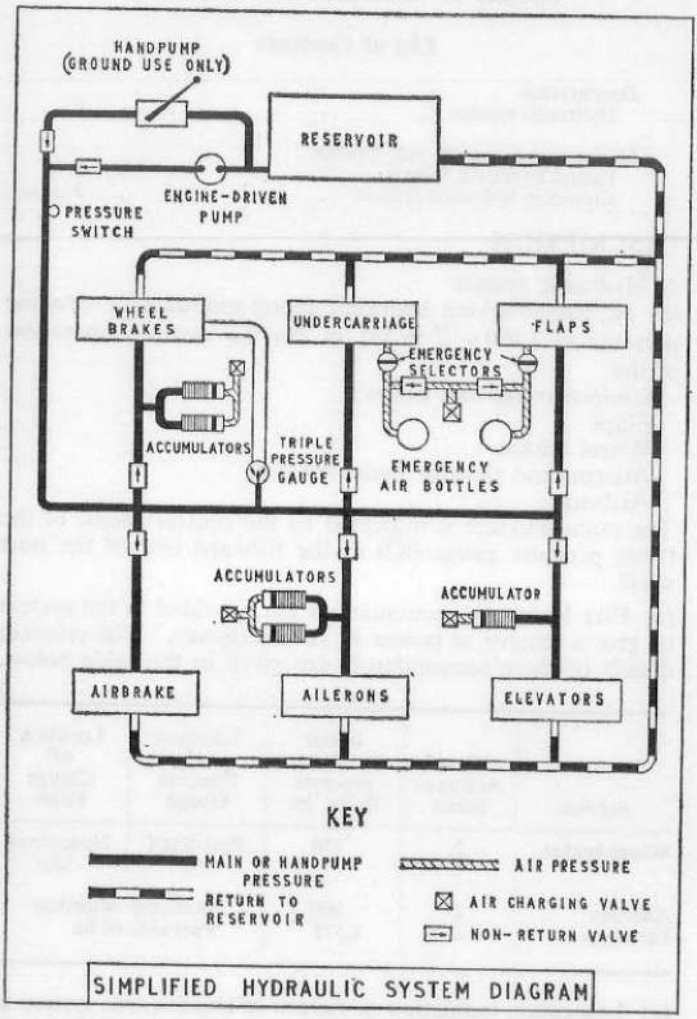
Undercarriage and doors
Flaps
Wheel brakes
Aileron and elevator hydroboosters
Airbrake

The main pressure is indicated by the central needle of the triple pressure gauge (82) at the forward end of the port shelf.

(*b*) Five hydraulic accumulators are provided in the system to give a reserve of power in an emergency. The relevant details of these accumulators are given in the table below.

Service	No. of Accumulators	Initial Air charge pressure lb./sq. in.	Location of Pressure Gauge	Location of Charge Point
Wheel-brakes	2	750	Port Shelf (9)	Nosewheel bay
Ailerons	2	900	Starboard wheelbay	
Elevators	1	1,575	Port side of fin	

(*c*) Immediate indication of failure of the live-line system is given audibly by a high-pitched noise over the pilot's headset, visually by a red light (42) above the undercarriage selector buttons which comes on when pressure in the system



SIMPLIFIED HYDRAULIC SYSTEM DIAGRAM

has fallen to 600 lb./sq. in. and also by the reading of the triple pressure gauge main needle. The audio warning cut-off switch (66) on the starboard side of the instrument panel enables the noise to be silenced once warning has been given.

MALFUNCTIONING OF THE SYSTEM

2. **Partial hydraulic failure**

Partial hydraulic failure can occur due to a type of leak which could cause complete loss of pressure during the operation of a service, but which would allow pressure to build up again when the operation is completed.

3. **Complete hydraulic failure**

(*a*) Check the triple pressure gauge periodically in flight. The central needle should normally read $2{,}850 \pm \frac{150}{50}$ lb./sq . in. If the reading drops substantially below this figure when no service is being operated, then hydraulic failure should be suspected. The red warning light, and the audio warning should come on if the pressure falls below 600 lb./sq in.

(*b*) If the hydraulic supply pressure fails, there may be sufficient reserve in the power controls accumulators for a maximum $3\frac{1}{2}$ full reversals of aileron and elevator, the actual reserve depending on the state of charge of the respective accumulators at the time of failure. However, even if no control movement is made, accumulator pressure will not be maintained for a long period, due to normal hydraulics component seepage. When the accumulators are exhausted the controls will revert automatically to Manual. It is important, therefore, that any asymmetric stores should be jettisoned before Manual reversion occurs.

(See Part III, Chapter 5, 3(b)).

(*c*) A failure in the power controls hydraulic circuit, as distinct from supply failure may lead to immediate and automatic Manual reversion.

PART I

Chapter 5 POWERED FLYING CONTROLS AND TRIMMERS

List of Contents

DESCRIPTION

1. Flying controls—Mod. 686, 687 aircraft

(*a*) *In power*

The ailerons and elevator are power-operated by pressure from the hydraulic system. A hydrobooster consisting of a valve and jack body and a piston is fitted close to each control surface. The control column is connected direct to the valve control rod so that depending on the direction of movement of the control column, the valve opens to admit pressure oil to one side of the jack piston and at the same time the other side is opened to return. The piston is anchored to the aircraft structure. The jack body is directly connected to one end of the control surface. When hydraulic pressure is fed from the valve to one side of the jack piston, the jack body moves relative to the pisron and deflects the control surface. When control column movement ceases, the valve closes causing a hydraulic lock which prohibits further movement of the jack body and control surface.

(*b*) *In Manual*
Manual operation of the controls may be selected deliberately by a switch in the cockpit (see para. 7) provided that electrical power is available, or will happen automatically if hydraulic pressure falls below 200 lb./sq. in. As soon as pressure falls below that figure a bypass valve in the jack opens and allows the residual fluid in the jack to be pumped from one side of the jack piston to the other. When operating in Manual the jack bodies move freely with the control surfaces, but the bypass facility prevents excessively high stick forces which would otherwise exist.

(*c*) When Power is selected ON, the bypass valve closes automatically as hydraulic pressure rises above 400 lb/sq. in. The controls are then in Power; the appropriate magnetic indicator shows black when pressure rises above 600 lb./sq. in. If hydraulic failure occurs or Power is selected OFF, the indicators show white as pressure falls below 600 lb./sq. in. and the bypass valve opens automatically below 200 lb./sq. in., The controls are then in Manual.

2. **Flying controls—Pre-Mod. 686, 687 aircraft**

(*a*) *In Power*
The ailerons and elevator are power-operated, the power being supplied by hydraulic oil under pressure from the aircraft hydraulic system to the ailerons and elevator hydroboosters. The hydrobooster jack piston rods are each anchored to the aircraft structure by spring-loaded hydraulically-operated pawls.

(*b*) *In Manual*

(i) Manual operation of the controls may be selected deliberately by operating a switch in the cockpit to release the locking pawls provided that electrical power is available, or will happen automatically if hydraulic pressure drops below 200 lb./sq. in.

(ii) When operating in Manual, control surface movements are achieved through a mechanical linkage. The controls are heavy in Manual especially the ailerons, but to avoid excessively high stick forces the pawls automatically disengage and release the anchored jack piston rods, allowing them to slide freely with the jack bodies.

3. **Hydraulic power reserve**
Accumulators are fitted in the powered control circuits to provide a reserve of power if the main hydraulic supply fails.

This reserve may be sufficient for a maximum of 3½ complete cycles of aileron and elevator operation before the controls revert automatically to Manual, but even if no control movement is made accumulator pressure will not be maintained for a long period due to seepage through the hydraulic components. With some types of hydraulic failure immediate reversion to Manual will result.

4. **Tailplane and elevator**

(*a*) An electrically-operated variable-incidence tailplane is provided. It is hinged at the rear end, while a projection on the leading edge is connected to an electrically-operated actuator mounted in the dorsal fin below the tailplane. After selecting by feel the required tailplane angle to give zero stick force for a given flight condition, the elevator is trailing with no air load imposed on it.

(*b*) The tailplane actuator is operated by one of two electric motors, the main and standby. The standby motor, which is fitted to meet the case of failure of the main motor or its electrical supply, operates at about one-third the rate of the main motor.

(*c*) The air loads on the elevator are resisted entirely by hydraulic jack effort, no load being felt on the control column. To provide control feel, a spring is fitted in the control circuit between the control column and the variable incidence tailplane. The spring gives an artificial feel to the elevator control circuit by imposing a force proportional to stick deflections but not airspeed (i.e. air loads).

5. **Tailplane and elevator interconnection**

(*a*) *General*

An electrical interconnection enables the variable-incidence tailplane to follow-up elevator movements automatically, giving greater manoeuvrability at high mach numbers.

(*b*) *Function*

(i) Whenever the interconnection is switched ON, and electrical power is available, it functions irrespective of whether the elevator is in Power or in Manual. It is arranged in the form of a follow-up linkage, so that, for a given stick deflection and tailplane trim position, a pre-

determined relationship exists between tailplane and elevator angles. A linkage attached to the elevator carries a switch arm, one end of which moves between two microswitches. Movement of the elevator relative to the tailplane energises one of these switches which operates the tailplane actuator to move the tailplane. When the tailplane reaches the required position the microswitch is de-energised and tailplane movement stops, leaving the elevator deflected relative to the new position of the tailplane.

(ii) To prevent continual hunting of the tailplane actuator, the elevator has a small range of movement over which the microswitches are not selected. Thus if the elevator is deflected and then returned to its original position the trim indication will not return fully to its previous setting.

(iii) A spring-loaded telescopic strut is incorporated in the linkage so that full and unrestricted stick movement is always obtainable. The strut telescopes when either the elevator is moved faster than the rate at which the tailplane actuator can follow up or when the tailplane has reached the end of its travel.

(*c*) *Trimming*

Trimming is carried out by means of the variable-incidence tailplane actuator main motor switch. In addition to altering the tailplane incidence, operation of this switch also resets the datum position of the two micro-switches. During trimming the elevator is kept in line with the tailplane by the centring action of the spring feel strut the switch arm thus following the resetting of the microswitches datum position. The datum setting cannot be altered by means of the standby switch.

6. **Aileron gear change**

(*a*) Provision is made for automatically altering the aileron gear ratio so that for the same stick movement aileron travel in Manual is approximately two-thirds of that obtained in Power.

(*b*) A hydraulic jack is fitted in the aileron control linkage and when extended by aileron hydraulic pressure the aileron control linkage effective arm is altered. When hydraulic pressure is lacking the jack retracts under spring pressure.

CONTROLS AND INDICATORS

7. **Aileron and elevator power—controls and indicators**

(*a*) Two ON/OFF switches (43, 44) are on the instrument panel and control electrically the hydraulic cocks, one for the aileron circuit and the other for the elevator circuit. When the engine is running and a switch is selected ON, hydraulic pressure is fed to that circuit, and, if mods. 686 and 687 are not embodied, to the pawl which engages in the jack piston rod.

(*b*) (i) Two magnetic indicators, one for the aileron circuit and one for the elevator are above the switches and show black when the controls are in Power and white when the controls are in Manual or alternatively when electrical power to the indicator is not available.
(ii) An audio warning over the pilot's headset warns the pilot if the pump is losing pressure. Further warning is given by the red warning light (42) and the reading of the hydraulic pressure gauge.

(*c*) *Mod.* 452

NOTE: This mod does not apply to aircraft embodying mods. 686 and 687.

When mod. 452 is embodied, Manual is automatically selected if any pawl in a circuit disengages even momentarily. The aircraft can therefore be flown only with Power correctly engaged or in Manual. The control switches, POWER OFF—off—POWER ON are spring-loaded to the central (off) position. Deflection upwards to POWER ON allows initial engagement or re-engagement. Deflection downwards immediately selects Manual.

(*d*) Because of the cranked stick, a white datum spot (52) is painted on the instrument panel, adjacent to the ASI, and is for use during spin recovery. (see Part III Chap. 3. Para. II). Alignment of the top of the stick with the spot corresponds to the aileron neutral position.

8. **Manual emergency selector buttons (mod. 502)**

When Mod. 502 is embodied in pre-mod. 686, 687 aircraft two yellow and black striped POWER OFF pushbuttons are fitted at the bottom left-hand corner of the instrument panel to permit the emergency selection of Manual of

either ailerons or elevators or both should the aircraft electrical system have failed. When either button is pressed an electrical supply from an independent dry battery is connected to the appropriate selector cock and the associate controls then revert immediately to Manual.

NOTE: These buttons must not be pressed if normal electric power is available as in this event it is likely that the control circuit fuse will be blown.

9. **Tailplane—controls and indicator**

(*a*) The tailplane main motor is controlled by a thumb switch on top of the control column. Pre-mod. 907 the circuit is protected by a circuit breaker on the port shelf.

(*b*) The standby motor is controlled by a switch (28) under a cover on the port shelf. When the cover is raised to enable operation of the standby switch the main motor circuit is isolated.

(*c*) The setting of the tailplane is shown on an indicator on the port side of the instrument panel above the machmeter.

10. **Tailplane and elevator interconnection—selector and indicator**

(*a*) A TAILPLANE ON/OFF switch (27) by means of which the interconnection may be selected, is fitted on the port shelf. The tailplane indicator is so arranged to indicate when the tailplane is functioning as a flying control, i.e. the indicator moves when the control column is deflected as well as when the trim switch is actuated.

(*b*) The circuit is so arranged that when the cover of the standby trim switch (28) is raised, both the main actuator and the interconnection are isolated.

11. **Aileron feel and trim**

(*a*) The air loads are resisted entirely by the hydraulic jack effort and no load is fed back to the control column. To provide control feel, a spring is fitted in the control circuit and gives an artificial stick force which is proportional to aileron deflection but not to airspeed. A hand wheel on the left-hand side of the control column provides spring feel adjustment and may be used to trim the aircraft when in Power, A white line is inscribed on the handwheel. When the trimmer is neutral the line points forward and the trimmer engages in a spring-loaded detent. Movement from this position is through 300° either to the left or to the

right thereby adjusting the zero force position of the stick. This trimmer should not be used in Manual.

(b) A trim tab is fitted on the port aileron. It is only intended for use in Manual and a guard (32) is placed round the combined rudder/aileron trim control (31) to prevent the inadvertent use of aileron trim when in Power. A trim indicator (30) is forward of the control.

NORMAL USE OF THE POWERED CONTROLS

12. **Pre-flight checks**

(*a*) *Ailerons and elevator—Mod.* 686, 687 *aircraft*

(i) After starting, select the power control switches to ON. Check that the magnetic indicators go black.

(ii) Immediately before take-off, check that the magnetic indicators are black, at not less than 4,500 r.p.m.

(*b*) *Ailerons and elevator—pre-mod.* 686, 687 *aircraft*

(i) After starting select the power control switches to ON and engage the controls by moving the control column through its full traverse (using two hands if necessary) until free movement is felt. Check that the magnetic indicators go black.

(ii) If Mod. 452 is incorporated, hold the selector switch to POWER with the left hand and move the control column with the right hand, laterally when engaging ailerons and fore and aft when engaging elevator, until the corresponding magnetic indicator goes black. The switch can then be released. To engage aileron power more easily it is advisible to either:—

1. Select POWER with the stick held hard over to starboard, then move it to port, or
2. Attempt the engagement immediately after light-up before hydraulic pressure builds up.

If power has not been correctly engaged the controls will revert to Manual when the switch is released.

(iii) Immdeiately before take-off check that the magnetic indicators are black at not less than 4,500 r.p.m.

Warning:— At any stage of a flight, if either automatic Manual reversion or any form of stick jamming occurs with Power selected ON, immediately switch Power OFF (Pre-Mod. 452). Irrespective of the mod. state do not attempt to re-engage Power; return to base and land in Manual.

(*c*) *Follow-up tailplane and tailplane trim*

(i) After starting, check the operation of the main trim over the full range of movement. During this operation, check the function of the standby trim switch cover. Return the trim to the take-off setting, using the standby switch and then ensure that the standby trim switch cover is fully lowered.

(ii) Check that the tailplane interconnection switch is OFF. Note the trim position on the tailplane incidence indicator and trim to a new position at least 1° different. Switch TAILPLANE ON. Check that the tailplane does not move from the new position. Move the stick fore and aft and check that the tailplane follows up correctly. If the standby switch cover is lowered, after checking the standby switch, with the tailplane at a different angle from that when the cover was raised the tailplane will revert automatically to approximately the original trim angle.

13. **Checks after landing — mod. 686, 687 aircraft**

To assist in servicing the bypass boosters after landing in Power, Manual should be selected prior to system pressure being dissipated so that the supply lines to the boosters are closed. This will enable the hand-pump circuit to be used by the ground crew. If the controls are in Power when pressure is dissipated, the supply lines to the boosters will be open and the hand-pump rendered ineffective because it cannot develop enough flow and pressure to shut the bypass valves which offer a path to return. For the same reason sufficient pressure cannot be built up for the electro-hydraulic selector valves to move if selected to Power OFF.

MALFUNCTIONING OF THE POWERED CONTROLS

14. **By-pass booster failures**

(*a*) *By-pass valve fails to open when Power is selected OFF*

(i) The aileron and elevator loads in Manual are slightly increased compared to normal manual due to the elimination of the bypass facility. The increased loads are acceptable however.

(ii) Reselecting Power ON, if this is possible, eliminates the fault but it will probably recur if Power OFF is again selected.

(*b*) *Aileron bypass valve fails to shut when Power is selected ON*

(i) This gives a condition of one aileron in Power and one in Manual.

(ii) It is relatively easy to detect on the ground as the stick judders when moved laterally and operating loads are somewhere between normal Power and bypass Manual.

(iii) In flight there is a wing-low tendency, caused by the upfloat of the Manual aileron, which increases with increased airspeed. The stick force to maintain lateral level does not exceed 20 lb. in level flight.

(iv) Increase of G will increase the out-of-trim condition.

(v) The wing-low tendency is reduced when the flaps are lowered.

(vi) Remedial action is to select Power OFF.

15. **False anchorages—pre-mods. 686, 687 aircraft**

NOTE : The information on false anchorages applies mainly to pre-mod. 452 aircraft. In post-mod. 452 aircraft false anchorages can still occur when re-engaging Power in the air only so long as the selector switch is held at POWER.

(*a*) When a reselection to Power is made in the air, it is possible that the locking pawls will not engage in the slots on the piston rods, but merely clamp on the side of the rods giving a false anchorage: the magnetic indicators remain white. False anchorages can be caused by the pistons "creeping" to full travel during a lengthy period of Manual flying or when the ailerons are deflected appreciable either by the control column or by the presence of aileron up or down float when selecting Power ON or OFF. False anchorages can give two types of restriction (see (c) and (d)).

(*b*) If Power is reselected below 10,000 feet and a false anchorage occurs, *immediately* switch Power OFF and either

1. Return to base and land in Manual, or
2. Climb above 10,000 feet before making any further attempt to re-engage Power.

Warning:— 1. If it is not possible to clear a false anchorage select Manual. Return to base and land in Manual.

2. If, when Manual is selected following a false anchorage, the controls remain jammed (indicating that Manual reselection is not possible) the aircraft must be abandoned.

(*c*) *One-way restriction*

(i) This usually occurs as a result of reselecting Power with the ailerons deflected, e.g. when initiating a turn. The locking pawls clamp on the side of the piston rods in opposite senses relative to the slots, e.g. one rod extended the other retracted. There will be apparent power-operated movement in one direction due to the clamping of the pawls on the rods. Movement of the control column in the other direction is restricted since power assistance is not available and not only has the friction clamp of both pawls to be overcome but the ailerons have to be deflected manually. This type of restriction can also occur as a result of having one pawl correctly engaged and one pawl out of engagement.

(ii) If Power is reselected above 10,000 feet and a one-way restriction occurs, it may be cleared as follows:—

Move the control column rapidly over its full movement in the direction of unrestricted travel. If the airspeed is below 250 knots, this can be done without producing excessive aircraft roll.

(*d*) *Both-ways restriction*

(i) This usually occurs as a result of reselecting power ON with the ailerons floating up or down, e.g. when easing out of a dive. The pawls will grip the piston rods in the same sense relative to their slots, e.g. both rods extended or both retracted, giving jamming of the control column in the neutral position. Movement of the control column in either direction is restricted by the friction clamp of one pawl and the ailerons having to be deflected manually.

(ii) If Power is reselected above 10,000 feet and a both-ways restriction occurs it may be cleared as follows:—

Lower full flap at an airspeed of 250 knots and select aileron Power ON (or hold switch to POWER ON if mod. 452 is embodied). The aileron buffet which occurs in this configuration will probably be sufficient to enable the pawls to engage in the slots, but if necessary move the control column laterally until the magnetic indicator turns black.,

16. **Tailplane malfunctioning**

(*a*) If the follow-up tail malfunctions, either in its capacity as a flying control or in its trimming action, the standby trim switch cover must be lifted immediately. The standby actuator can then be used to obtain satisfactory trim. It is possible that malfunctioning may not affect the main trim actuator with TAILPLANE selected OFF although it might have shown itself during either normal control movement or trimming with TAILPLANE ON. After raising the standby trim switch cover, select TAILPLANE OFF, then reselect the main actuator and check the normal trimming action. If the malfunction is still present, revert to the standby actuator and return to base.

(*b*) If the tailplane trim actuator runs away, lift the standby trim switch cover. Pre-mod. 907, if this fails to stop the runaway, trip the tailplane main actuator circuit-breaker: control can then be regained by use of the standby trim switch. When Mod. 907 is embodied the main circuit breaker is removed and the standby switch cover controls all electrical supplies to the main actuator.

PART I

Chapter 6 OTHER AIRCRAFT CONTROLS

List of Contents

1. Rudder pedals adjustment and rudder trim

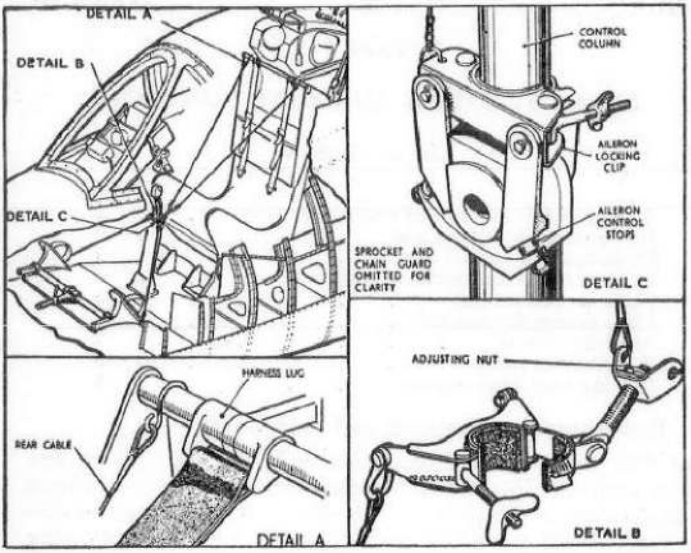
(*a*) The rudder pedals are adjustable for leg reach by means of a control (75) at the bottom centre of the instrument panel. When the control is pulled out, a plunger is disengaged from a hole in the adjusting shaft. thus allowing the rudder pedals to be pushed forward against the pressure of a spring, or to swing aft by spring pressure. When adjustment is complete, releasing the control to allow the plunger to engage in the nearest hole fixes the rudder pedals in the desired position.

(*b*) The rudder trim tab is actuated electrically by the combined aileron/rudder trim control (31) regardless of the position of the trim lock. The tab position indicator (30) is forward of the control.

(*c*) *Autostabiliser*
An ON/STANDBY/OFF switch (58) is on the starboard coaming panel. This switch and the autostabiliser are rendered inoperative by Mod. 873.

2. Flying controls locking gear

(*a*) *Internal locking*
The internal locking device consists of four cables which are joined to a clip, designed to attach to the control column. The other ends of the cables incorporate hooks which should be attached to the safety harness lugs on the ejection seat and to the outboard edges of the rudder pedals. When fitting the cables the rudder pedals should be in the central position and the cables tensioned by movement of the seat backrest pan.



(*b*) *External locking*
Locking clamps are provided for all flying control surfaces.

3. **Undercarriage normal control**

(*a*) The tricycle undercarriage is operated hydraulically after electrical selection by either the UP or DOWN push-button (40) on the port side of the instrument panel.

(*b*) A standard position indicator (39) is fitted to the left of the pushbuttons. A warning light (38) below the push-buttons comes on if the throttle is closed with the under-carriage not locked down.

4. **Undercarriage emergency control**

(*a*) Should electrical or hydraulic failure occur, the under-carriage may be lowered irrespective of the position of the normal selector buttons by pulling the U/C emergency lowering control (37)on the port shelf, after first pushing in the central knob. This admits air from an emergency bottle to the wheel unit jacks, forcing them to lower and lock. The available air pressure is shown on a gauge (6) at the aft end of the port shelf. (2,000lb./sq. in. min.).

(*b*) If it is required to retract the undercarriage *on the ground only* the UP selector pushbutton should be twisted clockwise and then pressed. This is inoperative if the undercarriage emergency system has been used.

5. **Flaps normal control**

(*a*) The flaps are selected electrically, and operated hydraulically. Selection is by means of a lever (79) on the port side of the instrument panel, which provides UP, DOWN (80°) and six intermediate positions (15°, 23°, 30°, 38°, 45°, 60°).

(*b*) The flaps may be selected to any of the above positions but the extent to which they will lower depends upon the air loads. If speed is increased with the flaps extended, the angle will be adjusted to suit the air loads.

(*c*) A flap position indicator (78) is fitted on the instrument panel.

6. **Flaps emergency control**

Should electrical or hydraulic failure occur, the flaps may be lowered *fully down* by air from an emergency air bottle. When the FLAPS EMERGENCY LOWERING control (41) on the instrument panel, is pulled, after first pressing in the central knob, the air is directed to the lowering jacks. The available pressure is shown on a gauge (7) at the aft end of the port shelf. (2,000lb./sq. in. min,).

7. **Airbrake control**

(*a*) An under-fuselage airbrake is provided ; it is electrically selected and hydraulically operated and will extend fully at any speed.

(*b*) Control of the airbrake is by means of a three-position switch (33), spring loaded to the central off position, on the throttle lever. No position other than fully in or fully out can be selected. A magnetic indicator (36) on the instrument panel shows black only when the airbrake is fully in.

(*c*) The airbrake is automatically inoperative when the undercarriage is lowered- If the undercarriage is lowered when the airbrake is out, the airbrake will automatically retract. *Airbrake IN must not normally be obtained by selecting undercarriage DOWN.*

(*d*) A spring-loaded switch (12) on the port wall enables the airbrake to be tested on the ground. When the switch is held to TEST the airbrake extends through 10° only and then retracts with a slight bump. The indicator shows white momentarily when the airbrake is out.

8. **Wheelbrakes control**

(*a*) The wheelbrakes are operated hydraulically by means of a lever attached to the forward face of the control column and a differential relay controlled by the rudder pedals.

(*b*) The live-line pressure ($2{,}850 \pm \frac{150}{50}$lb. / sq. in.) is shown on a triple pressure gauge (82) together with the pressure at each main wheel (1,500-1,650lb./sq. in.).

(*c*) Should the hydraulic system fail, the pressure in the wheelbrakes accumulator, which if fully charged should provide sufficient pressure for about 40 operations of the units, will be sufficient for landing but will leave little in hand for subsequent taxying. The available accumulator pressure is shown on a gauge (9) at the aft end of the port shelf. The brakes will function with reducing effectiveness until accumulator pressure drops to 750lb./sq. in.

(*d*) Maxaret brake units are fitted and permit the use of full braking when necessary without the danger of wheel locking and tyre damage. The units can come into operation only if the wheels are rotating and in no circumstances should the brakes be applied before touchdown. As a safeguard against the wheels locking after landing during a bounce, the units remain inoperative up to a maximum of four seconds, this period depending upon the rate of rotation of the main wheels.

9, **Braking parachute control**

(*a*) The braking parachute, introduced by Mod. 785, is stowed in a container above the tailcone, and is controlled by a two position JETTISON-OFF/STREAM switch on the cockpit port wall. The switch should normally be at JETTISON-OFF.

(*b*) Selection of the switch to STREAM ejects the parachute. Returning the switch to JETTISON-OFF disconnects the parachute from the aircraft.

(*c*) When Mod. 848 is embodied an amber warning panel is above the control switch and lights up when the parachute is streamed either deliberately or inadvertently. It remains

on after the parachute is jettisoned. At the aft end of the port shelf is a TEST switch and circuit breaker. With the circuit breaker made, setting the switch to TEST causes two lights beneath the warning panel to come on, one indicating that the parachute container doors are locked and the other that the electrical circuit is serviceable. It is important to ensure that the circuit breaker is made ; if it is tripped the test switch and both control switches are inoperative. The switch can be operated in the air.

PART I

Chapter 7—GENERAL EQUIPMENT AND CONTROLS

List of Contents

1. Hood control

(*a*) The hood is opened or closed electrically by operation of a three position OPEN-OFF-SHUT switch (16) on the port wall. The hood may be stopped at any position by selecting OFF but in flight the switch must be SHUT, otherwise partial depressurisation may occur. There is a delay of about 5 seconds between selection and operation when the switch is set to OPEN. Above the switch is a clutch lever (15), operation of which to FREE declutches the actuator, locks the switch at OFF and enables the hood to be moved by hand. A circuit breaker (4) is fitted at the aft end of the port shelf.

(*b*) The hood seal is automatically inflated when the hood is fully closed, and deflated when either OPEN is selected or the clutch release is set to FREE.

(*c*) At each side of the cockpit is a triangular-shaped LOCKED plate (13) with a central vertical black line. Alignment of the black dot on the red-painted lock sear pin below the line indicates that the hood rails are locked and are safe for flight.

2. Hood jettisoning

(*a*) The hood and rails are jettisoned by gas pressure from a jettison gun acting on two pistons which release the hood rails and then push the hood upwards. This is initiated by pulling the handle (26) on the port shelf.

(*b*) An external emergency release ring is inside a break panel on the port side of the fuselage below the cockpit. When the release ring is pulled the jettison gun is not fired but the hood rails are released. The hood may then be lifted clear manually.

(*c*) The hood is also jettisoned automatically whenever either the ejection seat blind handle or the seat-pan alternative firing handle is pulled.

3. **Cockpit pressurisation, heating and demisting**

NOTE : This system is inoperative whenever the hood is open.

(*a*) Hot air under pressure is bled from the engine compressor to supply the heating, pressurisation and demisting system. The air supply to the cockpit terminates in spray pipes which provide for windscreen, side panels and hood demisting.

(*b*) The master ON/OFF switch (3) controls the flow to the cockpit. The temperature control lever (1) permits the selection of AUTO or manual HOTTER-COLDER. The TEMP. SELECTOR (2) is for use in AUTO to preselect the desired temperature, which is then maintained by a thermostat. In the manual range, temperature is varied by inching the lever to HOTTER or COLDER from the central position. About 35 seconds is required to obtain full hot from full cold.

(*c*) The cockpit pressure altimeter (62) should indicate in accordance with the following table. Should the cockpit pressure differential drop by more than $\frac{1}{2}$ lb./sq. in. a red light (63) on the right of the instrument panel comes on.

Actual altitude (ft.)	Cockpit altitude (ft.)	Cockpit altitude at which warning light comes on (ft.)
20,000	13,000	13,750
30,000	16,500	18,000
40,000	22,500	24,000
50,000	28,000	30,000

(*d*) (i) A "flood flow" valve is incorporated in the system which may be controlled in AUTO or MANUAL according to the setting of the FLOOD AIR FLOW control switch (10).

(ii) When the switch is set to MANUAL, "flood flow" is brought into operation and is used primarily for clearing any transparency misting.

(iii) When the switch is at AUTO, should loss of cockpit pressure cause the cockpit altitude to exceed 38,000 feet, an altitude switch operates to supply "flood" air to the cockpit.

(*f*) A switch (8) for *ground testing* the visual warning and the flood flow systemis aft of the normal controls. It must not be used in flight.

4. Management of cockpit pressurisation

(*a*) *Pressurisation system*

(i) Before start up, check that the cockpit pressure warning light comes on by operating the cockpit pressure warning test switch to TEST. Then return the switch to NORMAL.

(ii) The cockpit pressurisation switch should be ON for take-off, but if due to high humidity, misting occurs or vapour issues from the gallery pipes, it should be switched OFF until 5000 feet is reached.

(*b*) *Flood flow system*

For all normal conditions of flight the FLOOD AIRFLOW CONTROL switch should be at AUTO. To prevent windscreen misting MANUAL should be selected when necessary. During take-off the increase in airflow is considerable.

5. Internal lighting

Three ON/OFF dimmer switches are provided on the starboard wall for the control of the internal lighting. One (92) controls the U/V lamps and two (93) control the red lamps, port and starboard. An emergency lamps switch (88) is on the starboard wall above the oxygen regulator and controls two red lamps which are supplied by the emergency battery.

6. External lighting

The navigation lights are controlled by an ON/OFF switch (94) on the starboard shelf.

7. **Accelerometer**

The acceleromenter (57) beneath the starboard coaming indicates all accelerations imposed on the aircraft by means of three concentrically mounted pointers. One pointer indicates instantaneous G, the other two register the maximum positive and negative G readings respectively until re-set.

8. **Pressure head heater**

The heater element in the pressure head is controlled by a switch (73) below the centre of the instrument panel.

9. **Emergency equipment**

(*a*) *Crowbar*
This is clipped to the cockpit port wall.

(*b*) *E.2B compass*
This is mounted on the starboard windscreen arch. Large deviations must be expected when the G.G.S. master switch is on or when the hood is open. A three position switch (89) outboard of the emergency lamp switch, controls the illumination of the compass. When set to NORMAL, supply is from the main electrical system; when set to STANDBY the supply is from the emergency battery.

(*c*) *Survival equipment*
A stowage for survival equipment is accessible through a door in the dorsal fin, just aft of the hood.

PART I

Chapter 8
AIRCREW EQUIPMENT ASSEMBLY AND OXYGEN SYSTEM

List of Contents

1. General

The aircrew equipment assembly (AEA) consists of the ejection seat, the flying and safety clothing and associated equipment including oxygen connections. The following items should be worn in addition to the normal aircrew clothing:—

Helmet, Flying, Type G
Protective helmet Mk. 1A
Anti-glare screen
Life-saving jacket Mk. 4A
Emergency knife Mk. 2
Oxygen mask type P1A or Q1A
Leg restraint garters, type QR

2. **Ejection seat Mk. 2H or 3H**

(*a*) A Mk. 2H or 3H ejection seat may be fitted incorporting a safety harness, headrest, parachute container and a seat well for the personal survival pack. The following table lists the safety equipment used in conjunction with each seat.

Item	Mk. 2H seat		Mk. 3H seat	
	Pre ES 1150	Post ES 1150	Pre ES 421	Post ES 421
Safety harness	ZF orZH		ZH	
Parachute	Mk. 13	Mk. 36	Mk. 9	
P.S.P.	J	R	Q	R
P.S.P. Side attachments	Connected to life jacket by aircrew when strapping in.	Connected to parachute harness by ground crew when equipping the seat.		
P.S.P. Lanyard or lowering line	Lanyard connected to life jacket when strapping in. P.S.P. cannot be lowered during parachute descent.	Lowering line. Connected to lifejacket when strapping in. P.S.P. should be lowered by detaching side attachments while parachuting before alighting.		
Emergency Oxygen Set.	4A, in seat pan	7G on starboard seat beam	4A in seat cushion	7A under seat pan

(*b*) The height of either mark of seat may be adjusted by a lever on the starboard side of the seat; the harness release is also on the starboard side.

3. Ejection gun and firing handles

(*a*) An 80 ft./second ejection gun is fitted. The ejection gun is fired by pulling the handle above the headrest or, by the secondary firing handle attached to the forward edge of the seat pan between the pilot's legs. When either firing handle is operated, the hood is jettisoned immediately by gas pressure from the hood jettison cartridge; at the same time a delay unit at the back of the headrest is started. This unit withdraws the sear from the seat one second after the handle is pulled. The seat is then ejected. If G conditions necessitate using the seat pan alternative firing handle, the pilot must sit firmly in the seat and press his head firmly against the headrest to prevent dislocation of the neck on ejection. As no face protection is available the visor should be lowered and the eyes tightly closed when using this handle.

(*b*) All leads incorporate quick releases which are automatically broken on ejection.

4. Barostat /G-stop time delay

(*a*) After ejection, at heights of 10,000 feet and below, a barostat causes an automatic cycle to commence. After 1¼ secs. if the G-stop has not operated (see (b) below) the safety harness is released, as are the face screen, firing handle and headrest pad. An apron attached to the seat drogue then pitches the pilot head-first out of the seat, at the same time opening his parachute.

(*b*) When mod. ES 491 is embodied a G-stop is incorporated to prevent the opening of the main parachute if the speed of the seat after ejection is too high for safe deployment.The stop prevents the operation of the barostatic time delay unit until the speed of the seat has fallen to a safe figure. The seat has a ground-level ejection capability provided that the aircraft's flight path is parallel to the gound and the speed is a minimum of 90 knots. If the aircraft is descending or nosedown more than the minimum altitude will be required.

5. Manual separation control

A manual override D-ring is fitted over the ripcord D-ring and disconnects the parachute withdrawal line from the automatic devices.

6. **Leg restraint cords**

The leg restraint cords ensure that the occupants' legs are drawn back automatically and restrained close to the seat pan during ejection, thus providing leg clearance and preventing the legs being blown apart after ejection. The cords pass through snubbing units at the front of the seat pan. These units allow the cords to pass freely *down* through the unit, but prevent them passing upwards. A release button is provided under each snubbing unit to allow the occupant to adjust the cords to give comfortable leg movement in the aircraft.

ANTI-G SUIT SYSTEM

7. **Anti-G suit system**

(*a*) The purpose of the system is to provide air at low pressure for the pilot's anti-G suit, the connection for which is on the port side of the ejection seat.

(*b*) Air pressure is stored in two air bottles, the contents of which are indicated by a pressure gauge (97) on the starboard wall. When the cock (95) below the gauge is ON and G in excess of approximately 1½ is applied, a spring-loaded valve operates and allows air to pass to and inflate the anti-G suit. The amount of inflation depends on the amount of G applied

(*c*) The system may be tested, with the cock ON, by pressing the ANTI-G-TEST button (96) adjacent to the on/off cock, as gently as possible to avoid severe discomfort due to too rapid inflation.

OXYGEN SYSTEM

8. **Oxygen system—general**

(*a*) Oxygen is carried in two Mk. 5D cylinders (three, post mod. 831). A Mk. 17D or 17E demand regulator (85) controls the supply to the pilot. A contents gauge (64), mounted on the right of the instrument panel, gives an indication of pressure in the cylinders, but is calibrated in fractions of full contents.

(*b*) The oxygen mask is connected into the system by a connector, inlet warning, which permits easy breathing only when fully connected. At other times it offers resistance to inhalation.

9. Mk. 17D or 17E regulator

(*a*) The regulator has an ON/OFF valve which controls the flow of oxygen, an air inlet NORMAL-100% OXYGEN switch, an EMERGENCY three-position switch and a magnetic indicator which shows black when oxygen is not being used or when electrical power is not available and a vertical white line when oxygen is being demanded.

(*b*) When the on/off valve is on and the inlet switch is at NORMAL, an air/oxygen mixture is fed to the pilot's mask, up to 30,000 feet (cabin altitude) above which height 100% oxygen is automatically delivered. When the inlet switch is at 100% OXYGEN, no air is added, irrespective of the height. This position should normally be selected on Mk. 17D regulators. The emergency switch when moved to either right or left admits oxygen under greater pressure.

(*c*) The mask may be tested before flight by firmly pressing in the emergency switch, when in the central position. Oxygen is then supplied under pressure, the firmer the switch is pressed the greater tne pressure (up to 5 times that obtained with the switch in either side position). The mask can then be adjusted until no leaks are present.

(*d*) The regulator pressure gauge measures the pressure between the cylinders and the regulator and should normally read between 250 and 400 lb./sq. in. when the regulator is switched ON.

10. Emergency bottle

(*a*) A manual control (109) inboard of the starboard shelf is pulled up to turn on the emergency oxygen bottle, (provided that the safety pin on the emergency bottle is withdrawn) in conditions where ejection is not contemplated. The emergency oxygen is automatically turned on at ejection.

(*b*) The position of the emergency oxygen bottle depends upon the Mk. of ejection seat and the particular mod. state of the seat. On unmodified seats it is a Mk. 4A in the seat well. On Mk. 2H seats embodying mod. ES 1150 it is a Mk. 7G bottle mounted on the seat starboard beam. On Mk. 3H seats embodying. E.S. 421 a Mk. 7A bottle is fitted beneath the seat well.

11. **Strapping in procedure**

(*a*) Check that the safety pins have been removed from the ejection gun sear, hood jettison unit sear and time delay trip unit and that safety pins are fitted in both handles.

(*b*) Prior to occupying the seat, grasp each lap and shoulder strap in turn and tug smartly to test for security.

(*c*) Fasten the leg restraint garters just below each knee with D rings facing the rear. Tuck surplus strap under each garter.

(*d*) *Type J.p.s.p.*
Connect the p.s.p. lanyard to the life jacket ensuring that the lanyard passes outside the right leg. Connect p.s.p. side couplings to life jacket.

(*e*) *Type Q or R p.s.p.*
Connect the p.s.p. lanyard to the life-saving jacket, ensuring that the lanyard passes outside the left leg. Tuck the surplus line between the pack and the side of the seat pan.

(*f*) Connect the anti-G suit hose to the suit. Route the hose outside the parachute harness straps.

(*g*) Connect and tighten the parachute harness ensuring that the shoulder straps pass under the folds of the life jacket stole and that the quick-release is as high as possible compatible with comfort.

(*h*) Fasten, but do not tighten, the safety harness lap straps.

(*j*) (i) Pass the left restraint cord through the right-leg garter D-ring under the safety harness lap straps and insert the right shoulder harness eye-piece through the loop on the cord. Secure the shoulder harness in the quick release box.

(ii) Repeat for the other cord, passing the right cord through the left-leg garter D-ring and attach the loop to the left shoulder harness. Secure the harness.

(*k*) Tighten the safety harness lap straps, with the quick release as low as possible. Tighten the harness shoulder straps.

(*l*) Adjust the seat height, to position the head in the position for optimum forward vision.

(*m*) Connect the oxygen mask tube assembly to the main supply hose and adjust the hose in its clip for maximum head movement.

(*n*) Connect the mask tube locating chain to the life jacket.

(*o*) (i) Pass the emergency oxygen upper tube assembly over the right thigh and connect it to the mask tube (post mods. E.S. 421 or E.S. 1150)

or (ii) Pass the emergency oxygen Supply hose under the right shoulder strap of the safety harness and connect to oxygen mask tube (pre mods E.S. 421 or E.S. 1150)

(*p*) Connect the mic/tel lead.

(*q*) Check that the main firing handle can be reached with both hands together.

(*r*) Remove and stow the secondary firing handle safety pin and have the face blind safety pin removed and stowed by the ground crew.

12. **Normal exit procedure**

(*a*) Fit the secondary safety pin and have the face blind pin fitted by the ground crew.

(*b*) Disconnect the oxygen supply hose from the mask tube assembly.

(*c*) Disconnect the emergency oxygen supply hose (pre mods. E.S. 421 or E.S. 1150) or disconnect the emergency oxygen upper tube assembly (post mods. E.S. 421 or E.S. 1150).

(*d*) Release the safety harness and free the leg restraint cords. Return the q.r. fitting to the FASTEN position.

(*e*) Release the parachute harness and return the q.r. fitting to the LOCKED position.

(*f*) Disconnect the anti-G hose and fit the blanking plug.

(*g*) Disconnect the p.s.p. lowering line from the life jacket. (Type Q or R p.s.p.) or disconnect the p.s.p. lanyard and side attachments from the life jacket (Type J.p.s.p.)

(*h*) Disconnect the mic/tel lead.

(*j*) If leg restraint garters are normally stowed in the cockpit remove and stow them.

13. **Forced landing**

If it has been decided not to eject, or if the seat has failed to operate and manual bale-out is considered inadvisable the following actions should be taken prior to landing.

(*a*) Release the parachute harness.

(*b*) Disconnect the p.s.p. from the life jacket.

(*c*) Below 10,000 feet disconnect the main and emergency oxygen tubes.

(*d*) Disconnect the anti-G suit hose.

(*e*) Lean back and ensure that the safety harness is locked in the rear position. Retighten safety straps as necessary.

(*f*) Free the leg restraint cords.

(*g*) After landing, release the safety and parachute harnesses and leave the aircraft as soon as possible.

(*h*) After a reasonable time if there are no signs of fire, return and insert the safety pin in the ejection gun sear.

14. Abandoning and ditching

These are fully covered in Part IV, Emergency Handling. (See Part IV, Chapter 3, Paragraphs 1-3 and 7).

EMERGENCY USE OF THE OXYGEN SYSTEM

15. Toxic fumes

If the cockpit becomes contaminated with toxic fumes, check or set the air-dilution switch on the regulator to 100%. OXYGEN and deflect the EMERGENCY switch to either side, to prevent inward leaks on the mask. Descend to below 30,000 feet and depressurise if height permits.

16. Regulator indicator failure

(*a*) If the magnetic indicator ceases to operate check that the main tube is correctly connected, and check or set the air inlet switch to 100% OXYGEN. If it is impossible to breathe in freely, the regulator is faulty.

(*b*) If breathing is normal check that the pressure on the regulator gauge is normal and that the main oxygen contents gauge is indicating that oxygen is still available.

(*c*) If the above indications are satisfactory depress the regulator EMERGENCY switch, when in the central position. A supply of oxygen under increased pressure indicates that the regulator is serviceable but that the indicator is defective.

17. **Regulator failure**

If the regulator is unserviceable, as indicated by no flow, operate the emergency bottle and descend immediately to an altitude (corresponding to a cabin altitude not above 10,000 feet) where oxygen is not required and return to base.

18. **Use of the emergency bottle**

(*a*) If it is necessary to use the emergency oxygen bottle through failure of the regulator or because of exhaustion of the main supply, pull up the emergency control on the right of the seat, and disconnect the mask tube from the main supply point.

(*b*) The duration of supply from the emergency bottle is 10 minutes only: the descent to 10,000 feet cabin altitude must therefore be completed within this time. Upon exhaustion of the bottle, breathing will become difficult due to having inhaled through the connector, inlet warning, on the end of the mask tube. If desired the mask can be slackened off the face.

(*c*) On ejection the main supply tube is automatically released and the emergency set brought into use. In all high altitude ejections the duration of the set will last until the seat has reached 10,000 feet and separation occurs. With the modified Mk. 2H or 3H seat the E.O. set then remains with the seat and the E.O. tube connection to the pilot is automatically broken. He will then need to breathe air through the connector inlet warning on the end of the mask tube, against the warning back-pressure which it produces. To overcome this difficulty—and in any case if descending into water—the oxygen mask should be removed.

(*d*) With unmodified seats, the E.O. set is attached to the parachute harness and remains with the pilot after separation. The onset of difficult breathing will therefore not take place until the E.O. set becomes exhausted—possibly until reaching the ground: but the E.O. connection to the mask tube remains connected and should therefore be manually undone before alighting so that it will not be an embarrassment when the parachute harness is subsequently released.

PART 1

Chapter 9. RADIO AND RADAR CONTROLS

List of Contents

1. V.H.F. equipment

(*a*) *ARI.* 18064

The two 10-channel V.H.F. controllers (14) with an adjacent changeover switch are on the port shelf. A press-to-transmit switch (35) is in the end of the throttle lever handle. The sets are stowed in the starboard equipment bay.

(*b*) *ARI.* 18012

The telebriefing land-line plug is at the underside of the rear fuselage, forward of the tail bumper. When the plug is connected, the V.H.F. circuit is de-energised and an amber warning light(22) on the port shelf indicates that telebriefing is in use. The pilot's press-to-speak switch (21) is adjacent.

(*c*) *Green Salad*

The control switches (17,18, 19) are on the cockpit port wall. The indicator (61) is situated on the starboard side of the instrument panel.

2. I.F.F. Mk. 3

(*a*) The G, G/D, F and D switches (108) are grouped on the starboard shelf.

(*b*) A suppressed aerial is mounted in the leading edge of the fin.

3. I.F.F. Mk. 10 (Mod. 794)

The ON/OFF I.F.F. master switch and the ON/OFF L.P. switch are both on the starboard shelf. The control unit is inboard of the switches. Forward of the oxygen regulator is the coder control unit.

4. **D.M.E.-Rebecca Mk. 7 or Mk. 8**

(*a*) The control unit (107) is on the starboard shelf. A range and heading meter (60), which indicates range and left/right heading from the homing beacon, is on the instrument panel.

(*b*) Two suppressed aerials are fitted in the engine starter and engine access doors.

5. **Radar ranging**

NOTE : The aircraft should not be landed with the system switched ON

(*a*) The radar ranging ON/OFF switch (80) on the port shelf controls the system ; an adjacent magnetic indicator (81) shows white with the system in use and black when its use is discontinued.

(*b*) Radar ranging automatically provides the G.G.S. with target range information within the limits of 200-800 yards. The radar searches from maximum range down to minimum range until a target is found. If no target is found within the search area the search is automatically repeated. When a target is found the radar locks on to it and a blue light on the right of the Mk. 5 GGS lights up. The Mk. 8 GGS has two lights (55) a green and an amber. The green light comes on when the radar is locked on and the amber at a pre-set range from the target.

(*c*) A spring-loaded TARGET REJECT IN-OUT switch (23) is on the port wall. Its function is to unlock the radar from an unwanted target or to check that it is locked on to the correct target. When IN is selected, the radar unlocks from the target and searches inwards to minimum range. If no fresh target is found the normal search cycle commences whether the switch is retained at IN or not. When OUT is selected the radar unlocks from the target and searches outwards to maximum range. It will remain at maximum range if the switch is retained at OUT but when released, the normal search cycle is commenced.

(*d*) A RADAR PRESENTATION ON/OFF switch (24) on the port wall is for selecting manual control of radar ranging when not possible through the throttle twist grip e.g. if window is being used by the target aircraft.

(*e*) Pre-mod.375 a test switch is on the port shelf.

PART 1

Chapter 10—ARMAMENT AND CAMERA INSTALLATION

List of Contents

1. **Gyro gunsight Mk. 5 or Mk. 8**

(*a*) The Mk. 5 G.G.S. is housed in a retractable mounting above the instrument panel. Retraction is controlled by an electric motor in circuit with the G.G.S. on/off switch on the right of the sight. An emergency lowering manual control is on the left of the sight.

(*b*) The Mk. 8 G.G.S. (54) is a non-retractable sight. The G.G.S. master switch (59) is on the starboard coaming panel.

(*c*) Each sight has manual and radar ranging facilities, controlled by the throttle twist grip. Altitude and ballistics units automatically compensate for the time of flight and gravity drop of the particular ammunition in use. The altitude unit is fully automatic, but the ballistics unit must be pre-set before flight.

(*d*) A five-position selector dimmer control (25) is on the port shelf.

(*e*) A circuit breaker is below the starter master switch.

2. **Gun firing**

(*a*) The gun firing switch is on the forward face of the control column handgrip. The circuit is automatically isolated when the undercarriage is locked down. A butt test switch (106) is mounted on the starboard shelf and provides an override of the automatic isolation of the gun firing circuit.

(*b*) The guns are fired by A.C. obtained from a type 300 inverter, which is operative only when the gun switch safety flap is raised and the gun firing circuit is " live ".

(*c*) When the guns are fired, an electrically operated selector is energised to open the gun bay scavenging flap.

This causes air to clear the gases from the gun bay through the link and empty case chutes. When the trigger is released and the scoop closes the air flow is cut off.

3. **Armament safety plug**

A safety plug is fitted behind a panel in the port stub wing. When disconnected the plug renders inoperative all services listed :

Gun firing
Inboard store jettison
Camera operation
Normal undercarriage retraction. (The emergency up-on-the ground circuit is not affected).

4. **G.90 and recorder cameras**

(*a*) The cine and recorder cameras are operated automatically whenever the gun or camera firing switch on the control column is energised, with the camera master switch ON.

(*b*) The camera master switch (74) is on the switch panel below the instrument panel. The aperture switch (65) is on the starboard side of the instrument panel.

5. **Bomb/RP release and drop tank jettisoning (Post Mod. 378)**

(*a*) *Bomb release and jettison*

(i) The armament control panel is beneath the port coaming. When the FUSING switch (50) is set to NOSE or TAIL (as required), the BOMBS/RP switch (51) set to BOMBS the bombs are released by pressing the bomb/RP release pushbutton on top of the control column.

(ii) The bombs may be jettisoned in a safe condition by pressing either the bomb/RP release pushbutton, with the BOMBS/RP switch set to BOMBS, or the INBD STORES jettison pushbutton (47). In both cases the FUSING switch must be set to OFF.

(*b*) *Inboard drop tank jettisoning*

The inboard drop tanks may be jettisoned by pressing either the INBD STORES jettison pushbutton with the fusing switch OFF or the bombs/RP release pushbutton with the BOMBS/RP switch at BOMBS. The setting of the FUSING switch is immaterial in this case.

(*c*) *Outboard drop tank jettisoning*

When the OUTBD PYLON stores pushbutton (46) is pressed, both outboard tanks are jettisoned.

(*d*) *R.P. firing*

With the BOMBS/RP switch set to RP and the RIPPLE/NORMAL (49) and SELECTOR (20) switches set as required, RP's are fired by pressing the bomb/RP release pushbutton. No jettison facilities are available.

6. **Bomb/RP release and drop tank jettisoning—(pre-Mod. 378)**

(*a*) *Bomb release and jettison*

(i) The armament control panel is on the port shelf. When the FUSING switch is set to NOSE or TAIL (as required), the BOMBS/RP switch set to BOMBS the bombs are released by pressing the bomb/RP release pushbutton on top of the control column.

(ii) The bombs may be jettisoned in a safe condition by pressing the bomb/RP release pushbutton ; in this case the FUSING switch must be OFF and the BOMBS/RP switch must be set to BOMBS before pressing the pushbutton.

(*b*) *Inboard drop tank jettisoning*

The inboard drop tanks may be jettisoned by pressing the bombs/RP release pushbutton with the BOMBS/RP switch at BOMBS

(*c*) *Outboard drop tank jettisoning*

When the OUTBD PYLON STORES pushbutton on the armament panel is pressed, both outboard tanks are jettisoned.

(*d*) *RP firing*

With the BOMBS/RP switch set to RP and the RIPPLE/NORMAL and SELECTOR switches (on the left of the GGS) set as required, RP's are fired by pressing the bomb/RP release pushbutton. No jettison facilities are available.

(*e*) " *Clear aircraft* " *pushbutton*

When the bomb fusing switch is OFF, all stores, drop tanks or bombs, carried on the pylons are simultaneously jettisoned by pressing the CLEAR A/C pushbutton on the left coaming panel.