PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

LIST OF CHAPTERS

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

CHAPTER 1—ELECTRICAL SYSTEM

CONTENTS

DESCRIPTION

1. Generators

(a) Power for the electrical, instrument, radio and radar equipment is supplied initially by two, type P3, 6KW engine-driven generators, operating in parallel, which also charge the aircraft battery. They are located in the inboard leading edge of each wing.

(b) Each generator is fitted with a voltage regulator to control output; a master voltage regulator on the main electrical panel balances and maintains the output of both generators at 28 volts. A differential cut-out on each generator operates to bring it on line when generator voltage exceeds battery voltage and to disconnect it from the bus-bar when battery voltage exceeds generator voltage.
(c) Post Mod. 714 the generators cut in at an engine speed of approximately 1,700 RPM and cut out slightly below this figure. Full output is maintained at RPM in excess of 3,000. Pre-Mod. 714 the generators cut in between 3,500-3,900 RPM and full output is maintained at approximately 5,000 RPM.

2. AC supplies—inverters

DC supplies to the system are converted to AC by four inverters. The distribution of supplies is as follows:—

(a) *No. 2 inverter*

This inverter supplies 115v/400 cs 3-phase AC for the G4B compass, artificial horizon, and oil pressure indicators.

(b) *No. 3 inverter*

This inverter acts as a standby to No. 2 inverter and also supplies 115v/400 cs 3-phase AC to:—

Bomb sight head and computer
Radar cooling motors
No. 5 inverter regulator blower motor.

(c) *No. 4 inverter*

No. 4 inverter supplies 115v/1,600 cs single-phase AC. It acts as an emergency standby for No. 5 inverter and can only be used for the Gee receiver *or* Rebecca.

(d) *No. 5 inverter*

No. 5 inverter supplies 115v/1,600 cs single-phase AC for Rebecca, Gee-H, Gee receiver, and rear warning.

3. Aircraft battery

Four 12 volt, 40 amp/hour batteries, connected in series parallel in the lower equipment bay, access to which is through a hinged hatch on the port side of the fuselage.

4. External supply

The external supply plug is on the main electrical panel in the starboard lower equipment bay. It is connected directly to the bus-bar and all services connected to the bus-bar can be operated from the external supply. It is important that the aircraft battery master switch is set OFF before an external supply is connected.

5. Emergency batteries

(a) If Mod. 450 is embodied, two 12 volt, 4 amp.-hour batteries, connected in series, completely independent of the main electrical system, are under the forward end of the pilot's port console. They are utilised to operate the canopy, hatch, and elevator control detonators, and turn-and-slip indicator, in the event of failure of the main system.

(b) A separate 2.4v battery supplies the pilot's instrument panel emergency lighting.

6. Circuit-breakers and fuses

(a) A circuit-breaker (at A.5) marked PILOT'S SERVICES, on the rear face of the electrical control pedestal, protects the supply to:—

External lights and landing lamp.
DV panel heater.
Pressure head heater.
Vent valve heater, if fitted.

All other services are covered in the appropriate paragraphs.

(b) Fuses for individual services are located behind the side panel of the electrical control pedestal and behind the panel marked FUSES to rear of the port console. A list of these fuses is on the back of each panel.

7. Inertia crash switches

Piston-type inertia crash switches are located one each in the port and starboard equipment bays. When triggered off they operate the fire extinguishers and isolate the aircraft battery from the electrical system, with exception of the following emergency circuits, irrespective of the setting of the battery master switch:—

Bomb jettison circuit
Inertia crash-switch circuits
Fire extinguisher circuits (via the crash switches only)
Canopy, Elevator control, Navigator's hatch } detonator circuits

CONTROLS AND INDICATORS

8. Generator controls

(a) Each generator has a guarded ON-OFF switch (A.7, 10), a field circuit breaker (A.5), and a failure warning light (A.6, 11), on the rear face of the ECP. Some aircraft may have duplicate warning lights (C.22, 24) on the engine instrument panel. The warning lights come on when a generator is off line or to indicate a generator failure.

(b) A DC voltmeter (A.9) on the rear face of the ECP registers as follows:—

(i) Generators charging— A nominal 28 volts.
(ii) Generators off, battery on—A nominal 24 volts.
(iii) External power only— A nominal 24 volts.

9. AC supplies—Inverter controls

(a) *No. 2 and No. 3 inverters*

No. 2 and No. 3 inverters are initially controlled by switches coupled to the starboard and port MASTER STARTING switches (C.48) respectively. No. 3 inverter will also start, regardless of the position of the port master starting switch, if No. 5 inverter is switched on. The sequence of operation in starting the inverters is as follows:—

(i) When the port master starting switch is switched on, No. 3 inverter starts up to supply the AC-operated flight instruments. At the same time the EMERGENCY INST. SUPPLY magnetic indicator (C.20) on the flight instrument panel, shows white by day and fluorescent by night.

(ii) Subsequently, when the starboard master starting switch is switched ON, No. 2 inverter starts up and takes over the supply to the AC operated flight instruments from No. 3 inverter. The EMERGENCY INST. SUPPLY indicator then shows black.

(iii) Thereafter if No. 2 inverter fails, No. 3 inverter will take over the supply from No. 2 inverter, the EMERGENCY INST. SUPPLY indicator showing white.

(iv) *Phase-failure indicator* (PFI)

On some aircraft a phase failure indicator is fitted on the flight instrument panel or on the cockpit starboard wall. This registers the output from No. 3 inverter. The face of the instrument is divided into two sectors, red and white. When the inverter is operating normally, the output needle registers in the white sector; failure is indicated by the needle dropping into the red sector.

(b) *Nos.* 4 *and* 5 *inverters*

(i) No. 5 inverter is controlled by two START-STOP push switches and No. 4 inverter is controlled by an ON/OFF switch. A No. 4/No. 5 CHANGEOVER switch is between the two inverter controls, which are (at A.4) on the rear face of the electrical control panel. When No. 4 inverter is operating automatic isolation of the tail warning device and the Gee-H equipment is provided; both the Rebecca and Gee receivers remain operative but the output of No. 4 inverter is sufficient to operate only one of these aids at a time.

(ii) Three ON/OFF switches (at A.3) below the No. 4 and 5 inverter control switches, labelled for their respective services, distribute the output of No. 5 inverter, in addition to DC supply to the individual equipment.
(iii) Of the four circuit-breakers below the rear face of the electrical control panel, three (at A.1) protect the DC supply to No. 2, 3 and 4 inverters and the other (A.2), the 1,600 CS circuit-breaker, protects No. 5 inverter control circuit and the supply to the radar circuits. The input to No. 5 inverter is protected by a circuit-breaker in the starboard lower equipment bay.

10. Aircraft battery controls

The aircraft battery is controlled by a guarded ACCUMULATOR ISOLATOR switch (A.8) on the electrical control panel. With this switch on, the aircraft battery is connected to the bus-bar; when switched off the battery is isolated from all the electrical circuits except the following:—

Bomb jettison circuits
Fire extinguisher circuits (via crash switches only)
Inertia crash-switch circuits
Canopy, Navigator's hatch, Elevator control — detonator circuits

NOTE: The battery isolation switch must be ON before the engine fire-extinguishers can be operated from the cockpit.

11. Emergency battery controls

The supply from the emergency batteries to the emergency lighting is controlled by the EMERG. LIGHTS switch (C.16) on the coaming panel. The emergency supply to the turn-and-slip indicator is controlled by the turn-and-slip NORMAL/EMERGENCY switch adjacent to the indicator.

NORMAL OPERATION

12. Before starting

The pre-starting and starting checks may be carried out using either the aircraft battery or an external power supply. The aircraft batteries should only be used when ◀the battery voltage exceeds 23 volts under nominal load (one LP pump switched ON for 30 secs.) When the battery voltage is less than 23 volts under load an external power▶ supply should be plugged in until ready to start the engines. The battery master switch must be on if the checks are carried out on aircraft batteries and OFF during the period an external power supply is connected. Ensure that the generator circuit breakers, on the ECP, are made.

NOTE: If the aircraft battery voltage is less than 22 volts under load the aircraft must be considered unserviceable.

During the cockpit checks before starting ensure that No. 2 and No. 3 inverter circuit breakers are made. Test No. 2 and No. 3 inverters in the following manner:—

(a) Port engine master starting switch ON ...	EMERGY INST. SUPPLY indicator white; PFI needle in white sector; AC-operated flight instruments functioning.
(b) Starboard engine master starting switch on ...	The EMERGENCY INST. SUPPLY indicator should change from white to black, indicating that No. 2 inverter has taken over from No. 3 Check PFI needle in white sector, and flight instruments still functioning.

13. Starting up

During start-up the generators should cut in at approximately 1,700 RPM (3,500-3,900 Pre-Mod. 714) and the failure warning lights should go out. Maximum output from the generators can be obtained by increasing engine RPM above 3,000 (5,000 Pre-Mod. 714); below this speed there is a drain on the aircraft battery.

14. Before flight

(a) During prolonged taxying the battery voltage may fall, resulting in a fall in No. 2 inverter output and consequent automatic transfer to No. 3 inverter. It is undesirable to take-off with No. 3 inverter supplying the flight instruments and therefore, if the EMERGENCY INST. SUPPLY indicator shows white before take-off, open up the engines until the DC voltmeter shows 28 volts, check No. 2 inverter circuit breaker, switch off the starboard master starting switch for a few seconds and then switch it on again. This should restart No. 2 inverter.

(b) Nos. 4 and 5 inverters should not be run on the ground unless a supply of cooling air is available.

15. During flight

(a) When airborne, check that all services supplied by Nos. 4 and 5 inverters are off, then select No. 5 inverter by means of the No. 4/5 inverter changeover switch. Start No. 5 inverter by pressing its start button (at A.4) Allow 30 seconds for the voltage and frequency to stabilise before selecting a service. No. 4 inverter should be tested in a similar manner, when convenient.

(b) Frequent checks must be made in flight to ensure that both generators are on line maintaining 28 volts and that the EMERGENCY INST. SUPPLY indicator remains black. To prevent corrosion due to lack of use, Nos. 4 and 5 inverters should be run for a period during each flight.

16. After flight

When no longer required, after landing, Nos. 4 and 5 inverters should be switched off. The flight instruments inverters controlled by the engine master starting switches must be left on until reaching the final parking position in dispersal.

MALFUNCTION

17. Generator failure

◀(a) *Single generator failure*

If a generator fails, or if an engine is flamed out, the appropriate generator warning light will come on. The failed generator, No. 5 inverter and radar must be switched off. If necessary, reset the generator field circuit breaker and, after a pause of 30 seconds, switch the generator on again; if the warning light does not go out, repeat this procedure once only and if the generator again fails to cut in, switch it off and trip its field circuit breaker. To avoid over-loading the serviceable generator, subsequently use No. 4 inverter in lieu of No. 5 to supply the navigation radar. ▶

(b) *Double generator failure—general*
In the event of double generator failure or double flame-out, switch off both generators and reduce load to the minimum compatible with aircraft safety. Attempt to regain each generator in turn as in (a) above. If neither generator can be regained confine electrical consumption to essentials only and land at the nearest suitable airfield. Use the tail-plane trimmer as little as possible because of the load it will place on the battery. Switch off No. 3 inverter by tripping its circuit breaker and, if conditions permit, cut off the supply to the compass, artificial horizon and oil pressure gauges by tripping No. 2 inverter circuit breaker. The turn-and-slip indicator will continue to function as long as the master start switches are on. If the main battery fails, on aircraft with Mod. 450 embodied, the turn-and-slip indicator can be supplied from the emergency battery.

(c) *Double generator failure—fuel considerations*
If double generator failure occurs at high altitude height should be reduced because the LP fuel pumps will only function as long as power is available from the aircraft battery. If the battery fails there is imminent danger of flame-out without the ability to re-light. Height should be reduced below 15,000 ft. if possible, so that the engines may continue to obtain fuel by gravity/suction feed if the LP pumps fail. However, if it is necessary to fly at greater altitude in order to reach the nearest suitable airfield, RPM should be restricted to 7,200 (max.), and height to 35,000 ft. (AVTUR) or 25,000 ft. (AVTAG). See also Pt. I, Ch. 2, para. 11).

◀NOTE: There is a risk of double flame-out, when the battery is exhausted, if the LP cocks of an empty tank are left open. Consideration should therefore be given, on aircraft with controllable LP cocks, to conserving sufficient battery power to switch off the LP cocks of tanks which are at low fuel states. ▶

(d) *Failure of the differential cut-out*
If an engine fails or is stopped, its generator should automatically come off-line due to the action of the differential cut-out. If, however, the cut-out is faulty and the generator remains on line, the generator on the live engine will pass current down the faulty generator line as well as providing current for the aircraft services. The serviceable generator will then be overloaded and disconnected from the bus-bar by the tripping of its type-D circuit breaker, on the main

electrical panel, and the battery will be quickly expended due to the back flow down the faulty generator line. Therefore, whenever an engine fails or is stopped:—

(i) Switch off No. 5 inverter.
(ii) Check that the appropriate generator failure warning light comes on.
(iii) Switch off the generator.
(iv) If the failure warning light for the live engine comes on attempt to reset the generator on the live engine using the procedure given at (a) above.

(e) *Overvolting*

Faulty regulation may result in overvolting which in turn, if prolonged, will overcharge and damage the aircraft battery. If overvolting occurs take the following action:—

(i) *After starting.* If after the initial surge up to 32 volts the voltage is:—

28-30 *volts.* Continue with after-starting checks and then if still overvolting keep the engine running and call an electrician, to rectify the fault.

Over 30 *volts.* Shut-down engines immediately and report defect.

(ii) *In flight*

28-29 *volts.* Continue exercise and maintain a close watch on the DC voltmeter.

29-30 *volts.* Return to base and land as soon as possible.

◀*Over* 30 *volts.* 1. Switch off radar and Nos. 4 and 5 inverters. ▶

2. Switch off each generator in turn and check voltage. If one generator gives less than 30 volts isolate the other and return to base using minimum electrics.

3. If after the independent check, voltage is 30-34 volts leave both generators on and switch off the battery except for the landing period. Land at the nearest suitable airfield.

4. If the independent check fails to fault either generator, and the voltage is still over 34, switch off both generators, ensure their field circuit breakers are tripped,

reduce electrical consumption to a minimum, switch on the battery and land at the nearest suitable airfield.

18. Inverter failure

(a) Failure of No. 2 inverter is shown by the EMERGENCY INST. SUPPLY indicator showing white by day or fluorescent by night. When this occurs No. 3 inverter automatically takes over the supply to the compass, artificial horizon and oil pressure indicators. One attempt to regain No. 2 inverter may be made by resetting its circuit breaker, if necessary, and switching the starboard master start switch off for one second.

(b) (i) If No. 3 inverter fails, as shown by the phase failure indicator moving to zero, No. 5 inverter should automatically shut down, but if it does not it should be switched off in the normal manner as there will be no supply of cooling air to its electronic regulator. If the needle of the phase failure indicator moves into the red sector a watch must be kept on the radar screen for symptoms of overheating. If these occur No. 5 inverter must be switched off and the electronic regulator allowed to cool. Under these conditions No. 5 inverter may be used for limited periods up to 10 minutes in duration, but it is preferable to use the restricted facilities available on No. 4 inverter.

(ii) If No. 3 inverter fails an attempt to regain it may be made by resetting its circuit breaker, if necessary.

(c) If No. 5 inverter fails either Rebecca or the Gee receiver may be operated from No. 4 inverter.

19. Electrical loads

Electrical loads imposed by various services are shown in the table below. Those services considered non-essential to the immediate safety of the aircraft in the event of generator failure are marked with an asterisk.

Service	*Load (amps.)*
*No. 5 inverter	110·0
Tailplane trimmer	50·0
*No. 4 inverter	30·0
*No. 3 inverter	20·0

Service	*Load (amps.)*
◀UHF	15·0
Fuel pumps (6)	15·0 each
No. 2 inverter	10·0
*Landing lamp	9·25
DV panel heater	6·0
Pressure head heater	6·0
VHF (2)	6·0 each
Rudder trimmer	5·0
*Bombsight	4·5
*AMU and API	4·0
*Rebecca Mk. 4	4·0 (DC)
Navigation lights	4·0
*F.24 camera	3·5
*Identification lamp	3·0
Anti-collision lights	3·0
Aileron trimmer	2·75
*Taxying lamp	2·0
Instrument lamps (cockpit and cabin)	2·0 total
*Gee—H	2·0 (DC)
Vent valve heater (if fitted)	2·0
Intercomm.	1·5
*Rear warning	0·4 (DC)
G.4B compass	0·2 (DC)▶

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 2—FUEL SYSTEM

Contents

Description

1. Fuel tanks

(a) *Fuselage tanks*

Three fuel tanks, of flexible construction, are fitted in the fuselage above the bomb bay. Numbered 1, 2 and 3 from front to rear, No. 1 and No. 2 tanks are self-sealing while No. 3 tank is a crash-proof collapsible fuel bag. The tanks are vented to atmosphere through a common pipe terminating at an outlet on the fuselage starboard surface under the tailplane. Flush fitting filler caps, one for each tank, are on the port upper surface of the fuselage.

(b) *Wing tip tanks*

(i) Wing tip tanks may be fitted. No controls are provided, except that for jettisoning, as these tanks feed automatically (and together) under air pressure from the engine compressors, through a float valve in No. 3 tank. A flush fitting filler cap is on the outboard upper surface of each tank.

(ii) The wing tip tanks may be jettisoned by pressing-in the guarded FUEL TANK JETTISON button (B.23) on the port console.

(c) *Overload tank*

If Mod. 432 is embodied, provision is made for fitting an overload tank of 300 gallons capacity in the bomb bay. From this tank fuel is fed to No. 3 tank by two booster-pumps through two cocks. Although this fuel is fed in through a float valve, owing to booster-pump pressure the float valve should not be relied upon to prevent flooding. The switches (when fitted) for the interconnected booster-pumps and cocks are on the miscellaneous instrument panel.

2. Fuel-tank capacities

The effective fuel capacities are approximately:—

	Gallons	lb. at 7·7 lb./gall.	lb. at 8·0 lb./gall.
No. 1 tank	520	4,004	4,160
No. 2 tank	317	2,441	2,536
No. 3 tank	540	4,158	4,320
Total	1,377	10,603	11,016
Wing tip tanks (2 at 244 gallons)	488	3,757	3,904
Total, all tanks	1,865	14,360	14,920
Bomb bay overload tank ...	300	2,310	2,400
Total overload	2,165	16,670	17,320

NOTE: The capacity of No. 3 tank may be somewhat less than quoted until the bag stretches with use.

3. Fuel recuperators

(a) *If Mod.* 1480 *has been embodied,* two fuel recuperators, one for each engine, are provided to compensate for negative G conditions.

(b) Each recuperator comprises a flexible bag contained ◀within a casing, the bag being connected, via an electrically controlled cock, to the fuel delivery line between the common collector box and the engine. The recuperator cocks are controlled by two switches on the engine instrument panel.▶ Air is fed from the engine compressor to the casing so that it acts on the flexible bag at a constant pressure. The pressure from the booster-pumps is greater than this air pressure so that the bag is charged with fuel. If the booster-pumps cease to deliver fuel due to negative G conditions, or for any other reasons, the air pressure will collapse the bag which discharges its contents to the engine. The recuperator will recharge as soon as the booster-pumps again start to deliver fuel.

(c) The supply of fuel in each bag will feed an engine for about 10 seconds at full power at sea level.

4. Fuel feed to the engines

Two electrically-driven LP pumps are fitted in each fuselage tank. The pumps on the port side of the fuselage tanks feed fuel through their associated LP cocks and a common collector box to the port engine HP pumps; similarly the pumps on the starboard side of the tanks feed the starboard engine HP pumps.

CONTROLS AND INDICATORS

5. LP cock and pump controls

(a) A pair of electrically-operated LP cocks and a pair of LP pumps are fitted for each fuselage tank. Of each pair, one pump and cock serves the port engine and the other the starboard engine. Control of these pumps and cocks is by switches (C.35, 37) on the engine instrument panel and varies according to the modification state of the aircraft as follows:—

(i) *Unmodified aircraft*

Each LP cock is controlled by its associated LP fuel pump switch so that when the pump is switched on the fuel cock is opened and when the pump is switched off the cock is closed.

(ii) *Bomber Command Mod.* 32 (1*st part*) *embodied* All the fuel cocks are electrically disconnected and permanently locked open.

(iii) *Bomber Command Mod.* 90(*a*) *embodied* (*Mod.* ◀2712)▶

BC Mod. 32 is superseded and each LP cock is controlled by its associated LP fuel pump switch. The switches have three positions:—

Up	...	...	...	Pump on, cock open.
Mid	...	...	...	Pump off, cock open.
Down		...	...	Pump off, cock closed.

However the switches are guarded and the guards wire-locked so that while "up" and "mid" may be selected with the guard locked, the wire lock must be broken before a "down" selection can be made.

(b) Each fuselage tank cock and pump circuit is protected by a circuit breaker (A.12, 13, 14) on the ECP.

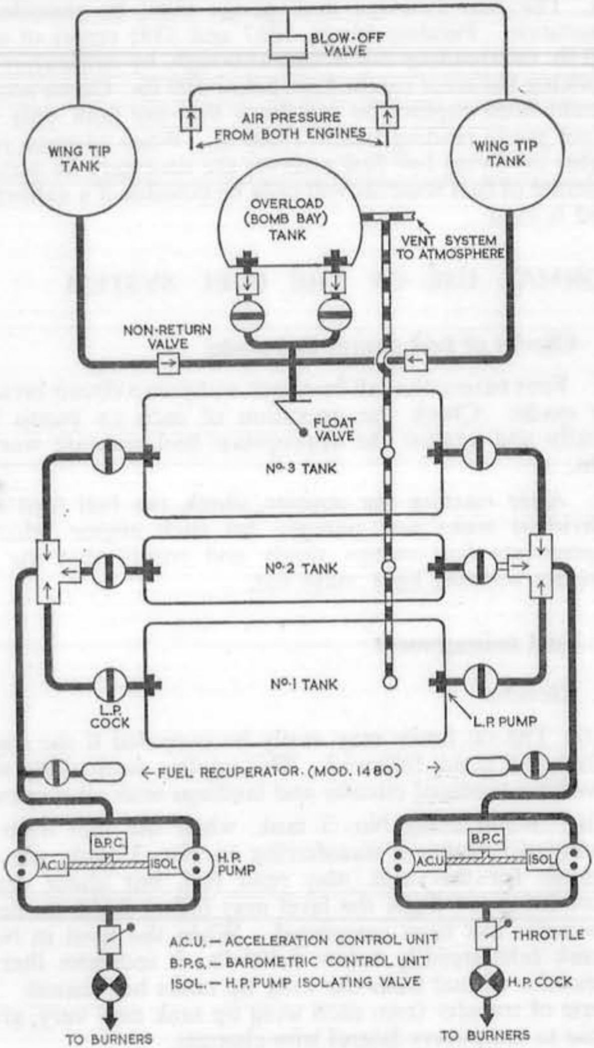
6. Fuel pressure warning lights

(a) Two fuel pressure warning lights C.34, 38) one for each engine, are on the engine instruments panel. They illuminate if fuel delivery pressure from the booster-pumps drops below 3-3½ PSI due to pump failure, negative G or shortage of fuel in the tank(s) in use; little warning of flame-out is given.

◀(b) With Mod. 3545 or 3911 embodied the warning▶ lights illuminate at a higher fuel pressure, and a brief warning of flame-out is given. *If recuperators are fitted* some 10 seconds warning of flame-out will be given while the recuperator(s) discharge.

7. Fuel contents gauges

(a) Three capacitor-type gauges (C.36) calibrated in lb., are



Fuel System Simplified

on the engine instrument panel. They indicate, from top to bottom, the contents of No. 1, No. 2 and No. 3 tanks. No contents gauges are provided for the wing tip tanks.

(b) The rear fuselage tank gauge must be regarded as inaccurate. Pending Mods. 3367 and 3391 errors of up to 700 lb. overreading can occur, although, by calibration and servicing the error can be kept below 500 lb. On no account should both engines be run from the rear tank only with a fuel gauge reading below 1,000 lb. When extreme range flights involving low fuel reserves are necessary an accurate estimate of fuel reserves will only be possible if a calibration card is used.

NORMAL USE OF THE FUEL SYSTEM

8. Checks of fuel pumps and cocks

(a) First ensure that all fuel cock and pump circuit breakers are made. Check the operation of each LP pump both aurally and against the appropriate fuel pressure warning light.

(b) After starting the engines, check the fuel feed from individual tanks and pumps; for each engine select its appropriate fuel pumps singly and ensure that the fuel pressure warning light stays out.

9. Fuel management

(a) *General*

(i) The CG limits may easily be exceeded if the correct fuel drill is not followed. This applies particularly when making repeated circuits and landings with all pumps on.

(ii) When using No. 3 tank, while the fuel from the wing tip tanks is transferring to No. 3 tank, the fuel gauge for this tank may read full, but under certain conditions of flight the level may fall to 3,500 lb. before transfer has been completed. When the level in No. 3 tank falls steadily below 3,500 lb., it indicates that the transfer of fuel from the wing tip tanks has ceased. The rate of transfer from each wing tip tank may vary, giving rise to temporary lateral trim changes.

(iii) In flight, when any booster-pump selection is to be made, switch ON the next pump to be selected before switching OFF the pump no longer required. When a tank is empty its booster-pumps should be switched off.

(iv) When No. 1 and No. 3 tank booster-pumps are on together, the rate of feeding will vary. No. 1 will normally feed faster than No. 3.

(v) Should a fuel pump of the fuel tank in use become uncovered, and no other fuel tank pump is supplying fuel to the engine, air may pass to the engine through the uncovered pump inlet as well as fuel under gravity or suction feed from other tanks. However, if more than one pump is supplying an engine and one of these pumps is uncovered air should not be passed to the engine as long as the remaining pump remains adequately covered by fuel.

(vi) *Fuel surge*
In a steep climb, or when rapid accelerations or manoeuvres are being made, there is a risk of fuel surge uncovering the pumps in No. 1 and No. 3 tanks. When using the normal fuel drill this fuel surge will not be dangerous, as, with the levels in Nos. 1 and 3 tanks so low, No. 2 tank will be on as well. The running of both engines from one tank containing a small amount of fuel should be avoided, particularly at low altitude. Equally, running of each engine from separate tanks where each tank contains less than 500 lb. (1,000 lb. for No. 3 tank) should be avoided. When exercises involve periods of rapid manoeuvring, or concentration on visual flying, consideration should be given to selecting all fuel pumps on for the period as in landing.

(vii) *Fuel aeration or starvation*
Pending Modification 3545, the first indication of fuel aeration or starvation may be a fall in engine RPM, but a rise may occur due to the effect of falling fuel pressure on the swirl vane operating mechanism. If action is taken promptly, a flame-out may be avoided by closing the throttle and restoring fuel pressure by selecting a suitable fuel tank pump. If the engine RPM stabilise at or

near the normal flight idling RPM the engine may be accelerated and used in the normal way. If the RPM continue to drop below normal idling RPM, close the HP cock and relight in the approved way.

(b) *Fuel usage*

Use No. 3 tank for starting-up and taxying. Thereafter, under all normal conditions, control the use of the fuel by means of the booster-pumps, in accordance with the following table:—

	CONDITION	TANK POSITION		
		No. 1 Pumps	No. 2 Pumps	No. 3 Pumps
1.	Start up and taxy	OFF	OFF	ON
2.	Take-off to 2,000 ft.	ON	ON	ON
3.	2,000 ft. until tip tanks empty	OFF	OFF	ON
4.	Tip tanks empty and cruise	Maintain balanced levels in No. 1 and No. 3 tanks. As reqd.	OFF	As reqd.
5.	Top of descent or when No. 1 and 3 tanks read 500 lb. (See Note 2)	ON	ON	ON
6.	Landing	ON	ON	ON

NOTE: 1. In aircraft without BC Mod. 32 (1st part) or Mod. ~~3153~~ 2712 (BC Mod. 90(a)) embodied, if an engine is being fed by one pump only, particular care must be taken when fuel in that tank is getting low as there will be no gravity feed from the other tanks. Therefore, when the tank in use is nearly empty, another booster-pump in a tank containing fuel should be switched ON.

2. Because of fuel gauge unreliability, if Mods. 3367 and 3391 are not embodied, amend condition 5 above to read:

"Top of descent or when No. 1 tank reads 500 lb. and No. 3 tank reads 1,000 lb."

(c) *Reserve fuel*

The last 1,250 lb. in No. 2 tank is the minimum safe allowance for a circuit, an overshoot and a landing. The surge in No. 2 tank does not become dangerous until the level has fallen to 400 lb. but even below this level all fuel can be used provided that all manoeuvres or attitudes which might lead to fuel surge are avoided. In this condition do not rely on the recuperators to compensate for fuel surge caused by mishandling the aircraft.

10. Use of different fuels

If Avon. Mod. 861 is embodied, AVTUR/50 or AVTAG (JP4) may be used without adjusting the engines. Pre-Avon Mod. 687 the same fuel may be used but the engines will have to be adjusted accordingly.

MALFUNCTION

11. Fuel booster-pump failure

(a) If two or three booster-pumps on one side are on, no immediate indication will be given if one pump fails; but if all pumps fail, or if only one pump is on and it fails, the warning light for that side will illuminate. (See para. 6 above.)

(b) The effect of booster-pump failure depends on altitude, engine RPM, type, temperature and condition of the fuel, the head of fuel in the tanks and it may also vary between aircraft.

(c) The HP pumps are designed to operate with a positive inlet pressure; booster-pump failure will cause the HP pumps to obtain fuel by gravity feed and suction only, which may result in a reduction in fuel delivery to the engine. When operating in these conditions, a change in RPM and loss of thrust may be experienced due to swirl vane movement. If the fuel pressure at the engine inlet is sufficiently low, cavitation of the engine pump will occur causing further loss of thrust and reduction in RPM. In an extreme case, engine surge will be experienced as low as 15,000 feet and flame extinction could occur between 20,000 and 30,000 feet depending on the conditions listed at (b) above.

(d) If a booster-pump fails, throttle the affected engine to "idling" immediately, wait for the RPM and JPT to stabilise and then switch on another booster-pump on the same side. Accelerate the engine carefully; satisfactory operation and freedom from compressor stall will be shown by the RPM and JPT rising together. If, however, the JPT and RPM do not stabilise normally, the engine should be shut down and re-lit as described in Part III, Chapter 5, para. 3. Fuel from the tank with the failed pump may be used for the other engine.

(e) If a double booster-pump failure in one tank or the distribution of fuel makes necessary the use of fuel by suction and gravity feed, height should be reduced to 15,000 ft. if possible. The engine which is to be fed by suction should be throttled to "idling," the related pump and cock of the affected tank switched on and the remaining pumps/cocks on that side switched off. Accelerate the engine carefully; cruising RPM should be obtained below 15,000 feet. *Erratic running, which will lead to fuel system failure, must be avoided.* If maximum range is essential level flight may be possible using 7,200 RPM max. up to 35,000 ft. on AVTUR, or 25,000 ft. on AVTAG, but altitude and RPM must be kept as low as possible. Any climbing should be done using fuel from tanks with serviceable pumps; this applies equally when landing, to avoid the possibility of having to overshoot using suction feed, which is undesirable. *Any use of gravity/suction feed must be reported.*

NOTE: 1. On aircraft with BC Mod. 32 (1st part) embodied suction feeding from a particular tank is not possible as the other tanks cannot be shut off.

2. If recuperators are fitted, the recuperator serving the affected engine will discharge, and will not recharge, under gravity/suction feed.

◀12. Bombs hang-up

(a) If a hang-up occurs on a forward station, keep the fuel level in No. 3 tank higher than in No. 1 by 1,000 lb. for each 1,000 lb. of bomb hang-up.

(b) If a hang-up occurs on the rear station, keep the fuel level in No. 1 tank higher than in No. 3 tank by 1,000 lb. for each 1,000 lb. of bomb hang-up.

(c) If all bombs hang-up, or a hang-up occurs on the mid-station, use the normal fuel drill. ▶

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 3—HYDRAULIC SYSTEM

Contents

Description

1. General

A hydraulic pump on each engine draws fluid from a reservoir (capacity 2 galls.) at the starboard side of the upper equipment bay. A hand-pump is installed to the right of the pilot's seat for manual operation of the services. A stack pipe in the reservoir ensures a reserve of fluid for use with the hand-pump. A brake pressure gauge (C.30) is on the miscellaneous instrument panel; a main hydraulic pressure gauge (C.31) may be adjacently fitted (Mod. 887).

2. Pumps and services

(a) The two engine-driven pumps deliver fluid to the system for operating the:—

Undercarriage
Flaps

Wheel brakes
Air brakes
Bomb doors

(b) The hand-pump works in conjunction with the hydraulic GROUND/FLIGHT cock situated near the front of the bomb bay roof on the starboard side. When the cock is at FLIGHT the hand-pump can be used to operate only the undercarriage and the bomb doors and to charge the wheel brakes accumulator. With the cock at GROUND the hand-pump can be used to operate all services. The cock is normally wire-locked in the FLIGHT position. The hand-pump handle can be stowed in clips aft and above the entrance door or under the folding seat; it must be in position on the pump at all times during flight except when the folding seat is occupied, when it should be in position for taxying, take-off and landing only.

3. Accumulators

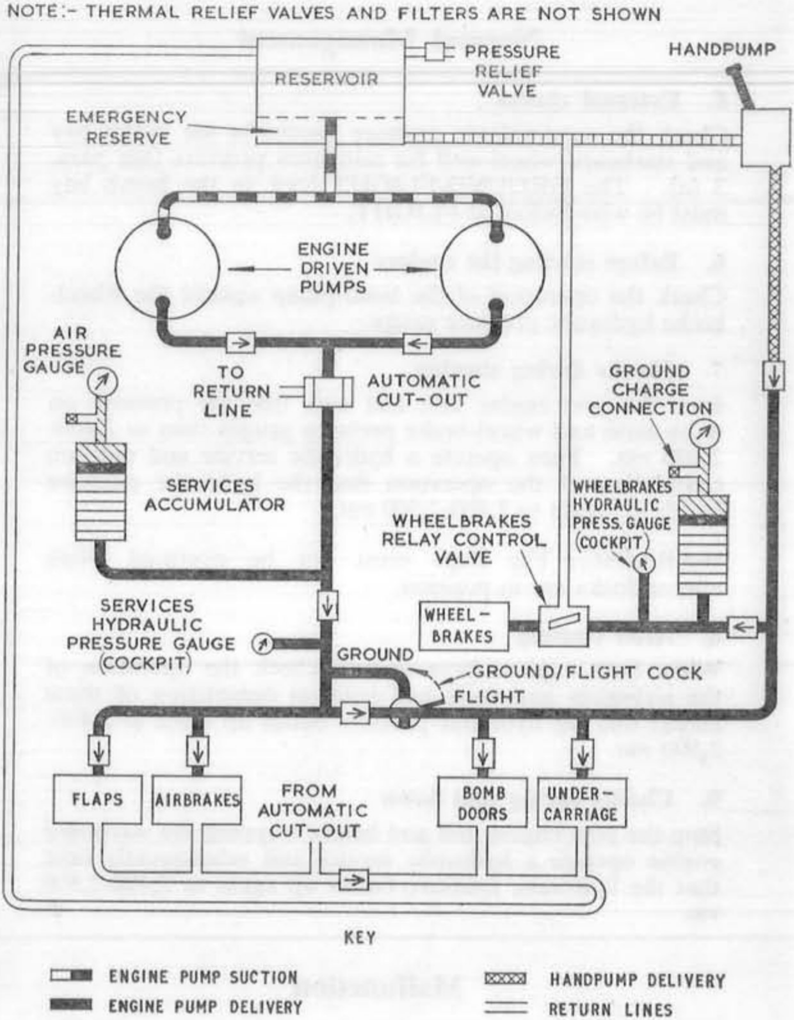
(a) There are two accumulators in the system; one for the wheel brakes is in the fuselage just forward of the bomb bay and that for the undercarriage, flaps, airbrakes and bomb doors is in the starboard wing. The air pressure gauge for the brake accumulator is in the bomb bay on the forward bulkhead and that for the wing-mounted accumulator is in the starboard wheel well. These gauges should read 1,300 (+50, −0) PSI at +5°C., when there is no pressure in the hydraulic system. For correct pressures at higher temperatures see Leading Particulars.

(b) A cut-out in the hydraulic pump delivery circuit maintains the working pressure in the accumulators and system at 2,000 to 2,500 PSI while thermal relief valves in ◀all circuits except the wheel brakes operate when pres-▶ sure in the line to a service increases, for any reason, to more than 3,350 to 3,500 PSI.

Controls

4. Controls

The electrically-actuated selector valves for all services, other than the wheel brakes, which are mechanically operated, are controlled by switches in the cockpit. If electrical failure occurs provision is made for mechanical



HYDRAULIC SYSTEM SIMPLIFIED

selection of undercarriage lowering and bomb doors opening. Details of these controls are given in Chapters 5 and 10.

Normal Management

5. External checks

Check the accumulator pressure gauges in the bomb bay and starboard wheel-well for minimum pressure (see para. 3 (a). The GROUND-FLIGHT cock in the bomb bay must be wire-locked at FLIGHT.

6. Before starting the engines

Check the operation of the hand-pump against the wheel-brake hydraulic pressure gauge.

7. Checks during starting

Start the port engine first and note that the pressure on ◀the main and wheel-brake pressure gauges rises to 2,400-2,500 PSI. Then operate a hydraulic service and note on completion of the operation that the hydraulic pressure builds up again to 2,400-2,500 PSI.

WARNING: The flaps must not be operated when aileron locks are in position.

8. After starting

When both engines have started, check the operation of the airbrakes and flaps and note on completion of these checks that the hydraulic pressure builds up again to 2,400-2,500 PSI.

9. Checks during shut down

Stop the port engine first and before stopping the starboard engine operate a hydraulic service and subsequently note that the hydraulic pressure builds up again to 2,400-2,500 PSI. ▶

Malfunction

10. Hydraulic failure

A failure may be assumed if the reading on the main pressure gauge (Mod. 887) is below 2,000 PSI and fails to build up. If hydraulic failure occurs the flaps and airbrakes will be inoperative. By using the hydraulic hand-pump, after making the appropriate selection, the undercarriage can be lowered and bomb doors opened, and wheelbrake pressure can be obtained. Detailed emergency drills are given in Part IV, Chap. 2.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 4—ENGINE SYSTEMS AND CONTROLS

Contents

1. Avon Mk. 1

The Avon Mk. 1 is a turbo-jet aero-engine having a twelve-stage axial flow compressor directly coupled to a two-stage turbine; it gives 6,500 lb. static thrust at sea level. The engine limitations are given in Part II, Chap. 1.

2. Engine fuel system

(a) *High pressure* (HP) *fuel pumps*

(i) The total output of the dual engine-driven HP fuel pumps on each engine is limited by a servo-control system; a governor on each pump limits overspeeding of the engine.

(ii) Control of the fuel flow is affected by: —

1. The throttle, to meter fuel to the burners.
2. A barometric pressure control (BPC), to vary the pump output in relation to engine intake pressure.
3. An acceleration control unit (ACU), to prevent excess supply of fuel to the engine during periods of engine acceleration.

Both the ACU and BPC are connected to the servo control system.

(b) HP *fuel pumps isolating valve*

(i) A solenoid-operated isolating valve is incorporated in the upper HP pump of each engine. When energised it ensures that a fuel flow equal to at least maximum delivery from one pump is available in the event of a pump failure or a defect in the fuel pump servo control system. Either pump is capable of supplying sufficient fuel at full stroke to permit 60% of take-off thrust to be obtained at low ◀altitudes, rising progressively to full thrust at 12,000 ft. and above. ▶

(ii) The HP pump isolating valve of each engine is energised by setting the appropriate switch (B.15) on the port console panel to ISOL; the use of these switches is covered in Pt. III, Ch. 3, para. 2(c).

3. Variable guide vanes and air bleed valves

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

(b) No noticeable change in RPM or thrust occurs when the bleed valves change over, nor do the guide vanes have any noticeable effect on engine operation. However, until the guide vanes reach the fully open position at about 7,000 RPM the compressor is not operating at maximum efficiency. Better specific fuel consumption, therefore, will be obtained by operating above 7,000 RPM.

4. Throttle controls

The two throttle levers are on the engine controls quadrant. Friction adjustment is by the larger of the two knurled knobs (B.16) (turn clockwise to increase friction) on the side of the quadrant.

5. High presure (HP) fuel cocks

The HP cocks, one for each engine, are controlled by levers (B.14) outboard of the throttles. They may be locked in either the ON (forward) or OFF position by the smaller of the two knurled knobs (B.17) (turn clockwise to lock) on the side of the engine controls quadrant. In the OFF position the fuel supply to the burners is cut off. The levers each incorporate a relighting push button.

6. Engine starting, relighting and stopping controls

(a) *General*

Each engine is fitted with a single-breech cartridge turbo-starter using electrically fired cartridges and high energy ignition units.

(b) *Starter loading*

(i) After checking that the MASTER STARTING switches are OFF, press the spring-loaded stud in the breech cap to release the locking rachet and unscrew the breech-cap. The cartridge case is removed from the cap by depressing the two buttons in the base. A new cartridge is fitted so that the extractor claws grip the base. The cartridge is then inserted into the barrel and the cap screwed home finger-tight only. If screwed too tight it may be difficult to unscrew subsequently and the starter may be damaged.

(ii) On no account may work be carried out on the starter while the engine is turning.

(c) *Starting controls*

The main starting controls are on the starter panel and for each engine consist of a MASTER STARTING switch (C.48), starter push button (C.41, 47) and IGNITION switch (C.42, 46). The MASTER STARTING switch must be ON before either the starter push button or IGNITION switches are operative.

(d) *Ground starting*

With the turbo-starter loaded, HP cock, master starting and ignition switches ON, pressing the starter pushbutton initiates the following sequence:—

(i) Firing the cartridge to accelerate the engine to ~~1,300-1,500 RPM.~~ 1500 - 1800 RPM
AL 1

(ii) Energising the high energy ignition plugs to ignite the fuel spray and make the engine self-sustaining. The time delay switch by-passes the starter pushbutton until the sequence is complete. The engines are stopped by pulling the HP fuel cock levers backwards to the OFF position.

(e) *Relighting in flight*

Relighting in flight is accomplished by pressing the relighting pushbutton on the HP cock levers. Pressing the appropriate button by-passes the normal starting circuit and immediately energises the high energy ignition plugs, provided that the master starting and ignition switches are on.

7. Oil system

Each engine has its own integral oil system of 19 pints capacity. One pressure and two scavenge pumps maintain a continuous circulation through a cooler and filters to the engine bearings and gears. The filler cap is on the port side of the engine accessible through a removable panel in the lower cowling.

8. Engine instruments

The fuel contents gauges, RPM indicators, oil pressure gauges and dual jet pipe temperature gauges are all on the engine instruments panel. The oil pressure gauges operate whenever AC current is available.

9. Engine fire extinguishers and inertia crash switches

See Part I, Chap. 7, para. 1 and 2.

10. Engine handling procedures

Detailed information to cover particular aspects of engine handling on the ground and in flight are given in the relevant chapters in Parts III and IV.

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

CHAPTER 5—AIRCRAFT CONTROLS

CONTENTS

1. Flying controls—general

The flying controls are conventional, and the rudder pedals are adjustable for reach by a central star wheel. The control column carries the wheelbrakes lever, parking catch and airbrakes control switch. The right-hand grip carries the tailplane trimmer and cut-in switch, and a press-to transmit switch. Rudder and aileron trim control switches are mounted on the pilot's port console; the flaps and undercarriage control switches are on the forward sloping part of the port console. Operation of the bomb-doors is covered in Chapter 10.

2. Variable-incidence tailplane and indicator

(a) Changes of tailplane incidence are made by an electrical actuator controlled by two switches (spring-loaded off) on the control column right-hand grip. The tail trim switch (C.17) cannot be operated without first operating the cut-in switch which controls a master relay in the tail trim actuator circuit; this provides a double safety factor against a runaway tailplane actuator. The trimming switch is moved forward to give a nose-down trim and back to give a nose-up trim change. The limits of the tailplane travel are controlled by electric limit switches.

(b) The amount of available tailplane trim is limited so that the aircraft is controllable under any flight conditions within the limitations if the actuator runs away to the fully nose-down trim position. This applies even if the actuator has overrun the electrical limit switches and has reached the mechanical stops.
(c) The elevator trailing edge strips are designed to ensure that even if the tailplane actuator "runs away" to the fully nose-down position the aircraft will be in trim longitudinally at a speed between 425 and 450 knots.
(d) The tailplane position is shown on a trim indicator (C.51) on the left of the main instrument panel.

3. Aileron trimming control and indicator

(a) Both ailerons are fitted with spring tabs. Lateral trimming is by an aileron bias gear, in the form of a spring, to pre-load the control column handwheel in either direction. The required amount of spring loading is applied by an electrical actuator controlled by a 3-position spring-loaded switch (B.21) on the port console.
(b) The aileron trim position indicator (C.8) is on the left of the main instrument panel.

4. Rudder trimming control and indicator

(a) The rudder is fitted with a spring tab which also operates as a trim tab. The trim tab is operated by an electrical actuator controlled by a three-position, LEFT-OFF-RIGHT switch (B.20), mounted on the port console.
(b) The rudder trim position indicator (C.50) is on the left of the main instrument panel.

5. Control column snatch unit

To provide unobstructed exit for the pilot in the ejection seat, when abandoning the aircraft, a spring-operated snatch unit is connected to the control column to move it forward and hold it against the main instrument panel. A lever on the port console shielded by a flap marked DANGER—CONTROL COLUMN RELEASE (B.22), controls the control column snatch unit. Pulling the lever upwards fires an explosive collar which severs the elevator control rod and releases the spring in the snatch unit, which pulls the control column forward against the instrument panel, thus ensuring adequate clearance for the pilot on ejection. Longitudinal control can then only be effected by means of the tail trim switch. *The MASTER SAFETY switch (B.12) on the port console must be ON before the snatch unit control is operative.*

NOTE: 1. In flight, accidental release of the snatch unit spring (without operating the lever and severing the elevator control rod) will have little noticeable effect. It will be indicated by the need for a small amount of nose-up trim and an increased pull force necessary to unstick on take-off.

2. The snatch unit explosive bolts are operative irrespective of the position of the battery master switch; if the aircraft battery fails they will be supplied by the emergency battery, if Mod. 450 is embodied.

6. Flying controls external locking gear and picketing points

(a) *External locks*

All control surfaces are locked by external clamps with red flags attached. When not in use the clamps are stowed in a valise in the rear fuselage accessible through the camera hatch.

(b) *Picketing*

Ring bolts are provided for picketing and are stowed with the control locking clamps. The bolts screw into sockets, covered by flaps labelled PICKETING POINT, on each main undercarriage fairing and below the fuselage aft of the rear skid. A fourth picketing attachment is provided by the radius lugs on the nosewheel strut.

7. Undercarriage controls and indicator

(a) *Controls*

Two UP-DOWN pushbuttons (C.5) on the port front panel control an electrical actuator for the undercarriage selector valve. An electrically-operated lock prevents normal operation of the UP button when the weight of the aircraft is on the wheels but this lock may not function when the weight of the aircraft is low. The lock can be overridden

◀by turning the collar of the UP button clockwise, until it reaches a stop, before selecting undercarriage up in the normal way; the collar on the UP button will turn through 60° or 90° according to the type fitted. At maximum RPM the undercarriage should normally retract in 15 seconds (max.) and at 6,000 RPM it should lower in approximately 12 seconds. After becoming airborne this override should▶ only be used if required in an emergency, e.g. engine failure after take-off, as, if the undercarriage has been damaged subsequent lowering may be prejudiced. An undercarriage MASTER SWITCH (C.4) is fitted adjacent to the normal selector buttons, and it must be on (up) before the undercarriage will retract.

(b) *Undercarriage position indicator*
A standard undercarriage position indicator (C.3) is on the port front panel outboard of the MASTER SWITCH. The red nose-wheel light illuminates in flight if either throttle is less than one-third open with the undercarriage locked up.

(c) *Undercarriage ground locks*
Each main undercarriage leg is locked by a U-shaped sleeve which is fitted to the jack-piston-rod and is secured by quick-release pins. The nose-wheel is locked by a pin inserted in a hole in the lower end of the radius rod. All the locks have red flags attached.

8. Undercarriage emergency lowering control

(a) The undercarriage emergency lowering control is a T-shaped handle (C.6) on top of the port front panel. Pull◀ing the handle fully out until it is locked in position by a spring clip operates the selector valve mechanically to▶ the " down " position. After pulling the handle the undercarriage will lower immediately if the fault is due to electrical failure of the selector valve, but if the failure is hydraulic, the hand-pump must also be operated to lower the undercarriage. (See Part IV, Chapter 2, paragraph 6).

(b) After the emergency toggle has been used it is not possible to retract or unlock the undercarriage until it has been serviced.

9. Flap control and indicator

(a) The electrically-actuated flap selector valve is controlled by a two-position, fully UP or fully DOWN switch lever (C.2) on the port front panel; the position indicator

(C.49) is adjacent to the switch lever. No provision is made for " in flight " operation of the flaps in the event of electrical ◀or hydraulic failure. At 6,000 RPM the flaps should normally retract in approximately 16 seconds and lower fully in 13 seconds. ▶

(b) To prevent inadvertent operation of the flaps, when external locks are fitted, a locking pin is inserted in the switch lever guard. When not in use this pin is stowed in a bag on the lower front face of the electrical control panel.

10. Airbrakes control

A switch (C.10) controlling the electrical actuator for the airbrakes is on top of the control column. It has two positions, airbrakes IN and airbrakes OUT, or three positions, airbrakes IN, airbrakes MID and airbrakes OUT, depending on whether two-position or three-position airbrakes are fitted. No provision is made for operating the airbrakes in flight in the event of electrical or hydraulic failure.

11. Wheelbrakes control

(a) The hydraulic wheelbrakes are operated by a lever on the control column. A parking catch is provided. Differential braking is obtained by movement of the rudder bar.

(b) The brake pressure gauge on the miscellaneous instrument panel shows the available brake pressure in the brake accumulator. Normally 2,000-2,500 PSI, if hydraulic failure occurs the pressure will fall to 1,350 PSI as the brakes are used. At this point the accumulator is discharged of hydraulic fluid and pressure will drop rapidly to zero. Pressure may, however, be restored by means of the hand pump, provided that fluid is available.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 6—FLIGHT INSTRUMENTS, RADIO AND RADAR

Contents

Flight Instruments

1. Compasses

(a) *Mk. 4B Compass*
The Mk. 4B compass is operative whenever AC is supplied by either No. 2 or No. 3 inverter. The master indicator (E.15) is on the navigator's instrument panel while the compass control panel (F.2) is on the cabin starboard wall. The pilot's repeater, on the main instrument panel may also be used as a directional gyro by setting the COMPASS D.GYRO switch (C.40), on the engine starter panel, to D.GYRO. A repeater for the bomb aimer is fitted to the port wall in the fuselage nose.

(b) *Magnetic stand-by compass*
An E.2 standby compass (C.18) is fitted centrally below the forward coaming.

2. Pitot and static pressure system

An electrically-heated pressure head on the nose of the aircraft, and two static vents, one on each side of the nose, supply pitot and static pressure respectively for the machmeter, ASI's, altimeters, rate of climb indicator, bomb sight computor, and the AMU. The heater element in the pressure head is controlled by a switch (B.2) on the port console.

3. Artificial horizon

A Mk. 3, Mk. 3c or Mk. 4 artificial horizon may be fitted on the main instrument panel. The instrument will be operated whenever AC is being supplied by either No. 2 or No. 3 inverter. The Mk. 3c or Mk. 4 instrument has a fast-erection button at the bottom left of the periphery; an OFF flag appears on the face of these instruments in the event of power failure.

4. Turn-and-slip indicator

A turn-and-slip indicator on the main instrument panel is operated from duplicated 24-volt DC supplies having automatic changeover. Both supplies are primarily controlled by the MASTER STARTING switches. Failure of both these supplies will be shown by an OFF flag appearing in the face of the instrument. Should both normal supplies fail, if Mod. 450 is embodied, the instrument may be connected to the emergency battery (see Part 1, Chap. 1, para. 5) by switching the guarded ON/OFF switch beside the indicator to ON; the OFF flag should then disappear.

5. Outside air temperature gauge

An outside air temperature gauge (E.6) is on the port side of the Navigator's instrument panel. The instrument functions in conjunction with a resistance bulb which protrudes from the leading edge of the main plane between the fuselage and the port engine.

Radio and Radar

6. Intercommunication

◀(a) Intercomm. is by amplifier A.1961, with the VHF or UHF installation as an emergency standby. The system is controlled by an ON-OFF switch and I/C NORMAL-EMERGENCY switch on the radio panel above the port console, and an INTERCOM. switch on the navigator's port wall. When the NORMAL-EMERGENCY switch is at NORMAL, intercomm. is provided through the A.1961 amplifier, and when at EMERGENCY through whichever radio set is in use. ▶

(b) There are five mic./tel. sockets, one on the left of each ejection seat, one to the right of the pilot's seat for use with the folding seat and one at the bomb aimer's nose station. An extension lead from the nose station socket is clipped to the oxygen wander lead so that the bomb aimer can remain on intercomm. when moving to and from the nose ◀station. On some aircraft additional mic./tel. sockets are fitted in the upper equipment compartment on the VHF relay panel, and, externally, on the side of the fuselage in the starboard wheel well.

7. Radio installation

(a) *General*

VHF and UHF (Mod. 3905) are fitted. The required system may be selected by moving the VHF-UHF changeover switch on the starboard instrument panel to the desired position; the other system is then completely isolated. A PRESS-TO-MUTE switch on the starboard instrument panel operates only in respect of UHF.

(b) VHF

The VHF installation incorporates two transmitter receivers, TR.1985—TR.1986. The channel selectors for each set, a No. 1—No. 2 changeover switch and the volume control are on the starter panel. To operate VHF the following switch selections must be made:—

UHF/VHF changeover switch	VHF
VHF No. 1—No. 2 changeover switch	As required
Appropriate channel selector	Set to desired frequency
Volume control	As required

(c) UHF

The UHF installation consists of one transmitter/receiver type TR5/ARC52, which can be selected to operate on any one of eighteen automatically pre-set frequencies, 1,750 manually selected frequencies, and one guard channel. Power supplies are DC. The UHF control unit is on the starboard instrument panel and carries all the UHF controls. The UHF control unit provides the following services:—

(i) A four-position function switch labelled OFF/T/R -T/R+G and ADF. At the T/R position the equip-▶

◀ ment is switched on for operational purposes; at the T/R+G position the guard receiver is available in addition to the transmitter/receiver; the ADF position is inoperative.

(ii) CHANNEL selector switch. This has 20 positions. Those numbered 1 to 18 are for selecting the required pre-set frequency. The remaining positions are labelled M and G. M is used to switch frequency selection to manual control, and G enables the transmitter receiver to be used on the guard frequency independent of the guard receiver.

(iii) MANUAL. The four controls in the manual service are used to select any one of the 1,750 channels as required.

(iv) A volume control. ▶

8. Radio compass (AD.7092D)

When installed, the ON-OFF switch (D.5), voice-range filter, controller (D.7) and main indicator (E.1) for the radio compass are at the navigator's rear station, while the pilot's repeater (C.39) and mixer control (C.11) are on the main instrument panel. Power supplies are DC.

9. Gee-H

The controller (E.13) and indicator (E.11) for the Gee-H equipment is at the navigator's rear station. The master switch (A.3) is on the rear face of the electrical control panel, and the pilot's indicator (C.19), consisting of three small lights is on the main instrument panel. Power supplies are from No. 5 inverter with No. 4 as a standby.

NOTE: Either the Gee receiver (D.8) or Rebecca, may be operated from No. 4 inverter.

10. Rebecca

The controller (D.6) and indicator (E.7) for the Rebecca equipment are at the navigator's rear station. The master switch (A.3) is on the rear face of the electrical control panel. Power supplies are from No. 5 inverter with No. 4 as a standby. (See Note to para. 9).

11. Rear warning

When fitted, the control unit is on the cockpit port wall, the visual indicator on the main instrument panel, and a suppressor unit at the navigator's rear station. The main ON/off switch (A.3) is on the ECP. Audible warning is also given on the intercomm. AC power supplies are from No. 5 inverter.

12. IFF

The transmitter-receiver control, coder control, ON/OFF switch and I/P switch may be mounted on the port wall at the navigator's rear station, or above the pilot's port console. Power supplies are from No. 5 inverter.

13. API and AMU

The API (E.9) and AMU (E.14) are on the main instrument panel at the navigator's station. The AMU test panel (E.2) is on the cabin port wall. Power supplies are DC.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 7—GENERAL EQUIPMENT AND CONTROLS

Contents

1. Fire extinguishers and warning lights

(*a*) *Engine fire extinguishers and warning lights*

(i) *Engine bay fire extinguishers*
Two fire-extinguisher bottles are fitted, one in the port wheel well serving the port engine, and one in the starboard wheel well serving the starboard engine. Each ◀ bottle is fully discharged in one operation. Post-Mod. 3773 these extinguishers also serve the fuselage fuel tank bay in crash landing conditions (see para. 1(b)) following. ▶

(ii) *Fire warning lights and pushbuttons*
Fire-extinguisher pushbuttons (C.26) and fire warning lights (C.25), one for each engine, are on the miscellaneous instrument panel. The lights illuminate to indicate an engine fire and remain on until the fire is extinguished by operation of the appropriate extinguishers.

(iii) *Fire extinguisher operation*
A warning light will illuminate when heat from a fire in the engine trips one or more of the re-setting fire detectors in the engine nacelles; pressing the appropriate button will fully discharge the fire extinguisher around the affected engine. When the fire is extinguished the warning light will go out.

(*b*) *Fuselage fire extinguisher*

A fire extinguisher bottle is above the aft end of the bomb bay. It is discharged into the fuselage fuel tank bay and bomb bay if the inertia crash switches are tripped. This is the only method of operation for this extinguisher and only when the inertia crash switches have operated will the TANK FIRE warning light on the miscellaneous instrument panel illuminate. With Mod. 3703 embodied the ◀tank fire warning light is deleted. Post-Mod. 3773 the engine fire extinguishers discharge part of their contents into the fuselage fuel bay if both inertia crash switches are tripped. ▶

(*c*) *Hand-operated fire extinguisher*

A water/glycol hand-operated fire extinguisher is stowed on the cabin starboard wall just aft of the entrance door. The extinguishant is non-toxic. It must not be used on electrical equipment carrying a voltage in excess of 600 volts and, for this reason, all radio and radar equipment must ◀be switched off before dealing with fires in the cabin. The water/glycol extinguisher is being replaced by a Type 34 BCF extinguisher, the contents of which are non-conducting and virtually non-toxic. It may be used on all classes of fires, including electrical fires. ▶

2. Inertia crash switches

Piston-type inertia crash switches are located one each in the port and starboard equipment bays. When triggered off they operate all the fire extinguishers and isolate the aircraft battery from the electrical system, with the exception of the emergency circuits quoted in Pt. I, Chap. 1, para. 7, irrespective of the setting of the battery master switch.

3. Emergency equipment

A crash axe is stowed under the folding seat, and asbestos gloves and a first-aid kit are on the starboard wall just forward of the cabin. Five pressure cabin leak-stoppers in envelopes are on the cabin roof hatch. Three survival pack stowage crates are in the rear fuselage. Access to them is through the rear camera hatch, or, in emergency, by chopping through the fuselage at the points indicated.

4. Cabin window

A small cabin window is provided on the port side of the navigator's station. A black-out curtain provided for the window is rolled up and stowed when not in use.

5. Folding seat

A folding seat is secured to the cockpit starboard wall just aft of the entrance door by a hinged bracket which allows it to be folded against the wall, where it is secured in position by a spring-loaded catch or by a strap. A trigger under the front left-hand corner of the seat releases it from the down position. A lap strap is provided, and on some aircraft a strap is provided to support the occupant's back; this extends from the starboard wall to an attachment forward of the Gee equipment.

6. External lighting

(*a*) The external lighting circuits are protected by the PILOT'S SERVICES circuit breaker (at A.5) on the electrical control panel.
(*b*) All the external lighting switches (all at B.18) are on the pilot's port console. They are, from starboard to port:—
(i) External lighting MASTER switch. This must be ON before any of the external lights will function.
(ii) Identification lights colour selector (RED-GREEN-AMBER).
(iii) Identification lights switch.
(iv) Landing lamp HIGH-LOW-OFF switch.
(v) Taxying lamps switch.
(vi) Navigation lights; this also controls the navigation lights on the nose of each wing tip tank.
(*c*) A morse pushbutton (B.19), just aft of the external lighting switches, works in conjunction with the identification light.
(*d*) The taxying lamps are fitted one on each wing tip, the landing lamp is in the port main plane under-surface and the downward identification light is in the fuselage under-surface just forward of the bomb bay.
◀(*e*) Mod. 3352 introduces white, flashing anti-collision lights on the upper and lower surfaces of the fuselage. They are controlled by an ON-OFF switch on the port console. If the flasher unit fails the lights will remain on and steady until switched off. ▶

7. Internal lighting

(*a*) *Nose station*
A dome lamp, with an integral switch and 2-pin socket,

and a movable lamp, with an adjacent dimmer switch, illuminate the air bomber's nose station.

(*b*) *Cockpit*

(i) *Normal lighting*

The cockpit instrument panels are illuminated by four U/V and six red floodlamps. Two lamps are also provided, one to illuminate the standby compass and the other, No. 3 tank fuel gauge. The lamps are controlled by dimmer switches fitted centrally on the coaming, two for the U/V lamps (C.13, 23) and two (C.14, 21) for the red. The port side of the cockpit is illuminated by four red flood-lamps controlled by a dimmer switch (B.9) above the oxygen regulator.

(ii) *Emergency lighting*

Instrument panel emergency lamps are on either side below the coaming. The ON-OFF switch (C.16) for these is on the coaming; it has a luminous spot for identification in the dark. The emergency lamps are operated from a separate battery. (See Pt. I, Ch. 1, para. 5).

(iii) *Anti-dazzle lighting*

Mod. 2360 introduces two anti-dazzle lamps, one on each side of the cockpit coaming, illuminating the instrument panels. They are controlled by a BRIGHT-OFF-DIM toggle switch with a pyramid-shaped dolly, mounted on the coaming panel, and by an off-BRIGHT switch on the left of the navigator's top instrument panel. Selecting BRIGHT on the navigator's switch overrides any prior selection on the pilot's switch. Owing to the short filament life of the lamps they should only be used when operationally necessary.

(*c*) *Cabin*

The cabin is illuminated by a dome lamp with an integral switch and 2-pin socket, at the navigator's station, and two adjustable lamps, with adjacent dimmer switches, one (F.4) above the bomb control equipment and the other (E.5) above the navigator's instrument panel.

(*d*) *Inspection lamp*

An inspection lamp, which can be plugged into the 2-pin socket of either dome lamp, is stowed in a bag aft of the entrance door on the starboard side of the cabin. An extension lead, for use with the lamp, is stowed in another bag near the lamp.

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

CHAPTER 8—AIR CONDITIONING, PRESSURISING, AND DEMISTING SYSTEMS

CONTENTS

1. Air-conditioning system (Pre-Mod. 5)

(a) The cabin is heated with a controllable mixture of hot air from the engine compressors and cold air from an inlet in the wing leading edge. A COLD-HOT switch (C.32) spring-loaded to the mid (off) position, on the miscellaneous instrument panel, controls the mixture valve setting, which is shown on an indicator (C.27) above the control switch. The upper half of the indicator is divided into two coloured sectors, COLD (blue) and HOT (red).

(b) When the indicator needle is right over to the left in the blue sector, the mixing valve is in the fully cold position and only cold air from the duct in the wing leading edge is admitted to the cabin. When the switch is moved to HOT the mixing valve progressively reduces the amount of cold air and increases the amount of hot air, the indicator needle turning clockwise across the dial. The valve is stopped in any desired position by releasing the switch. When the needle reaches the vertical position the cold air inlet is shut off and only hot air from the engine compressors reaches the cabin, though at this setting most of the hot air is being passed through a cooler in the port wing root. As the needle moves further into the red segment, hot air is coming in at its maximum temperature.

(c) At low altitudes, outside air can be admitted to the cabin through three adjustable on/off louvres below the instrument panel. These shut off automatically when pressurising commences.

2. Air conditioning system (Post-Mod. 5)

(a) The cabin is heated with hot air from the engine compressors. The temperature is controlled by a mixing valve by means of which any desired proportion of the hot air may be passed through coolers in the inner plane leading edges and a cold air unit in the port inner plane. An isolating cock is fitted in the air supply line from each engine. These are operated by two engine air switches (C.33) on the miscellaneous instrument panel. The switches must be set ON before heating or pressurising can be obtained. A COLD-HOT switch, spring-loaded to the mid (off) position, above the engine air switches, controls the mixing valve setting, which is shown on an indicator above the control switch.

(b) When the indicator needle is fully over to the left, the mixing valve is in the fully cold position and all the hot air from the engines is passed through the coolers and the cold air unit. When the switch is moved to HOT the mixing valve progressively reduces the amount of air passed through the cold air unit and increases the amount of hot air passed direct to the cabin, the indicator needle turning clockwise across the dial. When the needle reaches the right of the scale all the hot air from the engines is fed straight to the cabin. The mixing valve is stopped in any desired position by releasing the switch.

(c) Air from the system is passed into the cabin at various points (C.1, E.10, F.1) to supply the pilot and rear crew.

(d) Outside air can be made available as at para. 1 (c) above.

3. Pressurising system

(a) At about 10,000 feet a master unit and a combined valve unit, which regulates the outlet of air from the cabin according to static pressure, work in conjunction to allow the air-conditioning system to build up cabin pressure with increasing altitude until a maximum differential pressure of 3.5 PSI is reached at about 25,000 feet; above this height the differential pressure is constant. The cabin altitude is shown on the altimeter (C.29) on the miscellaneous instrument panel.

(b) Electrical contacts in the master unit operate a warning horn if the cabin pressure drops excessively. A guarded warning horn override switch (C.28) is adjacent to the cabin altimeter.

NOTE: 1. *Pre-Mod. 5.* As the cold air for ventilation is only at ram pressure, full pressurising will not be obtained while the mixing valve is admitting cold air. Therefore, the valve must be adjusted before take-off until the needle of the indicator is in the red sector.

2. *Post-Mod. 5.* No air will be supplied for either air conditioning or pressurising unless the engine air switches are ON.

3. If a fault develops in the air supply from an engine, or if an engine fails, or is closed down, the appropriate engine air switch should be switched OFF.

4. Use of air-conditioning and pressurising systems

(a) *Pre-Mod. 5 aircraft*

(i) Before starting the engines, check the operation of the mixing valve over the full range against the indicator and leave at COLD.

(ii) After starting the engines adjust the mixing valve as required. In the final checks before take-off ensure that the indicator needle is in the red sector to eliminate the risk of canopy misting during take-off. Maintain the needle in the red sector at heights above 10,000 feet so that pressurising is obtained.

(iii) After landing, set the mixing valve to COLD and open the DV panel to relieve any residual cabin pressure before the entrance door is opened. (See para. 8 following).

(b) *Post-Mod. 5 aircraft*

(i) Before starting the engines, with the engine air switches OFF check the operation of the mixing valve over the full range against the indicator, leaving it set to HOT. On the ground, it should always be set to this position as otherwise, with the engine air switches ON, damage can result to the cold air unit if this is operated for more than 10 minutes.

(ii) After starting the engines switch ON the engine air switches and just before take-off adjust the mixing valve as required. In flight it may be adjusted to any position.

(iii) After landing, set the mixing valve to HOT, switch OFF the engine air switches and open the DV panel to relieve any residual cabin pressure before the entrance door is opened.

5. Malfunctioning of the pressurising system

(a) *Loss of cabin pressure*

A fall in cabin pressure will cause the warning horn to sound; this can be isolated by use of the guarded override switch. The following table gives the approximate operating ranges of the warning horn.

Aircraft altitude	Cabin altitude	Cabin altitude at which warning horn sounds
20,000	12,000	15,300
30,000	16,500	21,800
40,000	21,500	28,000
45,000	23,500	31,000

Flight may be continued at a cabin altitude of less than 30,000 ft. but it must be remembered that if the warning horn has been isolated a careful watch must be maintained to ensure further loss of pressure does not cause the cabin altitude to exceed this figure. If range is not of paramount importance, it is recommended that subsequent to a partial pressurisation failure a descent is made to an actual altitude not exceeding 30,000 ft.

(b) *Pressurisation failure above* 40,000 *ft.*

If pressurisation failure occurs at heights above 40,000 ft., altitude must be reduced to the lowest practicable, and in any case to below 30,000 ft. to avoid the effects of decompression sickness. When below 40,000 ft. the engine air switches should be put off to lessen the risk of damage; if the failure was caused by damage to the canopy or cabin, depending on the degree of damage and fuel state, return to base or land at the nearest airfield. Except for the initial descent do not exceed a speed of 0.70M or 300 Kts. The full drill for this emergency is given in Pt. IV, Ch. 2.

6. Camera bay heating

Hot air from the air-conditioning system is ducted to a diffuser in the camera bay through an automatically-operated temperature control valve.

7. Demisting system

(a) *General*

The entire canopy, navigator's window and the transparent nose-fairing are of the "dry-air sandwich" type. Two separate systems are provided to prevent or disperse misting, one to maintain dry air in the inter-space of the transparencies and one to blow hot air from the air-conditioning system onto the internal surface of the canopy.

(b) *Transparency interspace air-driers*
Three interspace air-driers are fitted, one just aft of the nose fairing, one on the starboard coaming and one on the coaming aft of the pilot's seat. Indicator windows in the casing of each air drier enable the drying agent to be seen. When unserviceable this will appear buff-coloured in the units at the nose and at the pilot's seat, and pink in the unit on the cockpit starboard wall. There are static air-drier lines to all three transparencies, but in addition dry air is circulated in the canopy by an electrically-driven fan controlled by a CANOPY DEMISTER switch on the take-off panel; this is switched on before take-off and left on until after landing. There is no restriction on the use of this system.

(c) *Canopy internal demister*
Hot air from the air-conditioning system is fed through a control valve and diffuser on to the forward inner surface of the canopy. The flow may be regulated by means of the knurled knob (C.7) above the port front panel. This system must be used only during descents from high altitude and should be turned off immediately demisting is complete.

(d) *Bombsight window*
Conditioned air is automatically fed on to the bomb-sight window whenever the air-conditioning system is in use.

8. Direct-vision (DV) **panel**
An electrically-heated direct vision panel (C.12) is in the canopy on the port side; the heater switch is on the port console. When the cabin is unpressurised the DV panel can be opened by unscrewing the knurled clamping knob and hinging the frame downwards to engage in the retaining clip. The DV panel heater switch (B.3) is on the port console.

NOTE: Rain entering the cabin via the DV panel has, on occasions, penetrated the bomb door selector switch subsequently causing malfunction in flight. Opening of the panel to relieve cabin pressure after landing should therefore be restricted to a small angle and the panel should then be closed again.

9. Use of de-misting system

(a) *Interspace air drier*
Check that the silica-gel crystals in the drier units are the correct colour, and the operation of the air-drier fan by switching it on then off, and listening for it running during the pre-start checks. There is no restriction on the use of this system.

(b) *Canopy internal demister*

To obtain maximum efficiency from the internal demisting system, start demisting 10 minutes before the descent. *The internal demister should not be on at any other time than that required for the descent.*

10. Air ventilated suits

On some aircraft provision may be made for air ventilated suits (AVS.). A continuous supply of cooling air is passed from the starboard engine through the pressure bulkhead into the cabin where an individual control valve (one at E3) for each crew member is situated to the left of each ejection seat. Quick-release plugs and sockets are used to ensure safe ejection if necessary.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 9—AIRCREW EQUIPMENT ASSEMBLY AND ASSOCIATED SYSTEMS

Contents

Ejection Seats

NOTE: "Safe for parking" on the aircraft when fitted with Mk. 1 series ejection seats is as follows:—
Safety pin in face screen firing handle of each seat.
MASTER SAFETY switch OFF.
Hatch SAFETY switches OFF. ▶

1. General

(*a*) Ejection seats MK. 1C or 1CN are provided for all three crew. The MK. 1C and 1CN seats are basically similar but the MK. 1CN seat has an 80 feet per second ejection gun in lieu of 60 feet per second. With ES Mods. 544, 545 and 577 embodied leg restraint, strengthened thigh-guards, and canopy breakers are provided and the foot rests are deleted. The controls on each type of seat are identical.

(*b*) Automatic facilities are provided to release the safety harness after ejection and to open the parachute at a suitable height. Incorporated in the seat are a type-z safety harness, a seat-type parachute and personal survival pack, and an emergency oxygen bottle (see para. 9).

(*c*) A safety pin, to prevent inadvertent operation of the firing handle, is fitted through a canvas strap on the firing handle. The safety pin may be stowed on the starboard side of the seat.

2. Controls

(*a*) *Firing handle*

The ejection gun is fired by a handle immediately above the headrest, fitted with a flexible blind to protect the face. The blind must be pulled down to the full extent of its travel to fire the ejection gun. No alternative firing handle is fitted.

(*b*) *Seat adjustment lever*
Seat height may be adjusted by the lever fitted with a thumb-operated spring-loaded catch on the starboard side of the seat-pan.

(*c*) *Lean forward release*
The lock on the safety harness may be released by a spring-loaded lever on the starboard thigh-guard to allow the wearer to lean forward. When the lever is released the harness is prevented from going further forward by a ratchet mechanism; as the wearer leans back the harness is locked in the position reached, and to lean forward again the lever must be operated.

(*d*) *Manual parachute controls*
A unit to provide disconnection of the parachute static line from the barometric release, and a manual rip-cord knob are on the waistbelt of the parachute harness.

(i) *Static line disconnect unit*
This allows the parachute static line to be disconnected

so that the wearer can leave the aircraft if the ejection seat fails to fire. To operate the disconnect unit, pull off the brass cap and turn the key. *Once the key has been turned the parachute can only be operated by the manual rip-cord knob.* When strapping in to the parachute harness check that the cap on the disconnect unit is in place. If it has been disturbed ~~and cannot be re-placed~~ the static line disconnection will have to be reset and the parachute re-packed. AL 1

(ii) *Manual rip cord knob*
This is the lower of the two controls on the parachute waist belt and is for use when a manual escape is made or if the parachute fails to stream automatically.

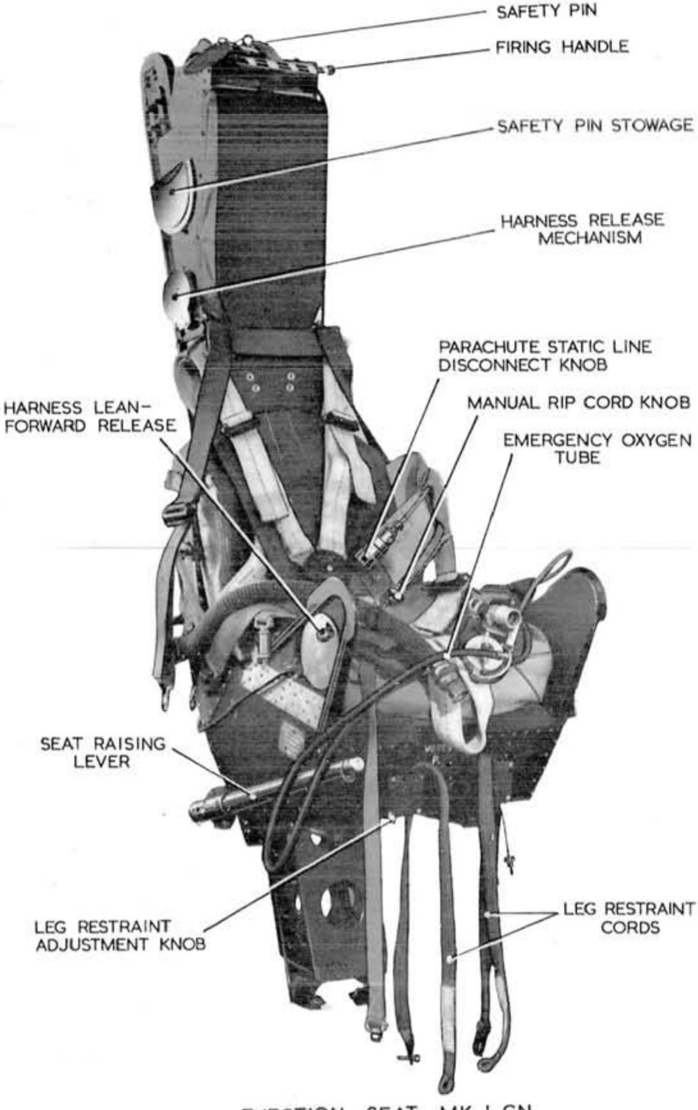
(e) *Leg restraint controls*
Two leg restraint cords, fixed to the floor of the aircraft by shear-bolts, pass through snubbing units on the front of the seat pan, through D-rings on the occupant's calves, to the lugs on the shoulder straps of the seat harness. The length of the restraining cords may be adjusted by pressing the knob under each snubbing unit and pulling the cords up or down. The occupant of the seat is freed from the leg restraint cords by the release of the safety harness.

3. Sequence on ejection
The pilot ejects through the closed canopy after operating the control column snatch unit (See Pt. I, Ch. 5 para. 5). The navigator and bomb-aimer must jettison their hatch before ejection or severe injury may result. The sequence of operations after pulling the firing handle is as follows:—

(a) The ejection gun is fired.

(b) As the seat ascends the guide rail the leg restraint cords are tightened in the snubbing units and freed from the aircraft floor. The emergency oxygen bottle is automatically operated.

(c) When the seat is clear of the aircraft a static line from the drogue gun to the aircraft fires the drogue parachute which slows down and stabilises the seat.



EJECTION SEAT MK. I CN.

(d) The ejection of the seat starts a safety harness release delay mechanism which releases the safety harness after $2 \pm \frac{1}{2}$ seconds. When the shoulder straps of this harness are undone the top ends of the leg restraint cords are free to pass down through the D-rings on the legs. The occupant must then kick himself away from the seat.

(e) A static line from the seat then operates the parachute barometric release which is set to open the parachute at 13,000 feet. If the ejection height is below 13,000 feet the parachute will be opened $2 \pm \frac{1}{2}$ seconds after the separation of seat and occupant.

Detailed abandoning drills, including the use of the manual controls should the automatic systems fail, are given in Part IV Chapter 3.

DOORS AND EMERGENCY EXITS

4. Entrance door

(a) The entrance door is on the starboard side of the fuselage aft of the nose fairing. To open the door from either inside or out press the red painted plunger adjacent to the flush fitting handle; this allows the handle to spring out which is then turned anti-clockwise from the outside and clockwise from the inside. The door should not be opened in this way in flight. The door is supported in the open position by a hinged strut which is attached to the door and located in a socket in the door aperture framing.

(b) The entrance door may be jettisoned by turning the crank fitted centrally above it; this releases the hinge pins allowing the door to fall outwards. The crank may be stiff to operate and four and a half turns are required.

5. Canopy

The canopy is secured to the aircraft by explosive bolts electrically fired. A MASTER SAFETY switch (B.12) and a guarded CANOPY JETTISON SWITCH (B.13) on the pilot's port console outboard of the HP cocks control the electrical circuit to the explosive retaining bolts; when both switches are ON the detonators are fired, allowing the canopy to be blown off.

NOTE: 1. The canopy and hatch (see para. 6 below) detonators are operative irrespective of the position of the battery master switch; if the aircraft battery fails they will be supplied by the emergency battery, if fitted.

2. If the MASTER SAFETY switch and/or hatch SAFETY switch are not put ON before flight, they must not be put ON in the air except in emergency.

6. Navigator's hatch

(a) A hatch fitted to the cabin roof must be jettisoned before the navigator and bomb-aimer eject.

(b) Two pairs of switches are provided to control cabin roof hatch jettisoning. The switches are guarded and marked SAFETY and JETTISON respectively, and each pair is mounted on a yellow-and-black striped panel, one on the cabin port wall (D.2, 3) and one (F.5, 6) on the starboard. In either pair, setting the SAFETY switch ON and then operating the associated JETTISON switch will fire the explosive retaining bolts thus allowing the hatch to jettison.

OXYGEN SYSTEM

DESCRIPTION

7. Oxygen supplies and contents gauges

Oxygen is carried in two 2,250 litre and five 750 litre bottles stowed in the upper equipment bay. A connection in the lower equipment bay, accessible through a hinged hatch on the port side of the fuselage, allows the bottles to be charged in situ. The bottles are arranged in two banks each having a separate supply line; these lines, after passing through stop valves (one at D.1) (normally wire-locked ON), one on each side of the rear pressure bulkhead outboard of the ejection seats, are interconnected through non-return valves so that, while each bank can supply all the regulators independently, fracture of one supply line will not cause a total loss of oxygen. Two gauges above the entrance door, indicate the contents of each bank of cylinders.

8. Oxygen regulators and supply points

(a) The supply of oxygen to the crew supply points is controlled by MK.17D or 17E regulators. The pilot's regulator (B.8) is on the cockpit port wall, the navigator's (E.8) is above the instrument panel at his station and, of the bomb aimer's two, one (F.3) is on the starboard wall at his rear station and the other is on the starboard wall at the nose station.

Each regulator incorporates:—

(i) A regulator pressure gauge (normal pressure 250-400 PSI).

(ii) An ON/OFF valve, normally wire-locked ON.

(iii) A magnetic flow indicator which shows white when inhaling.

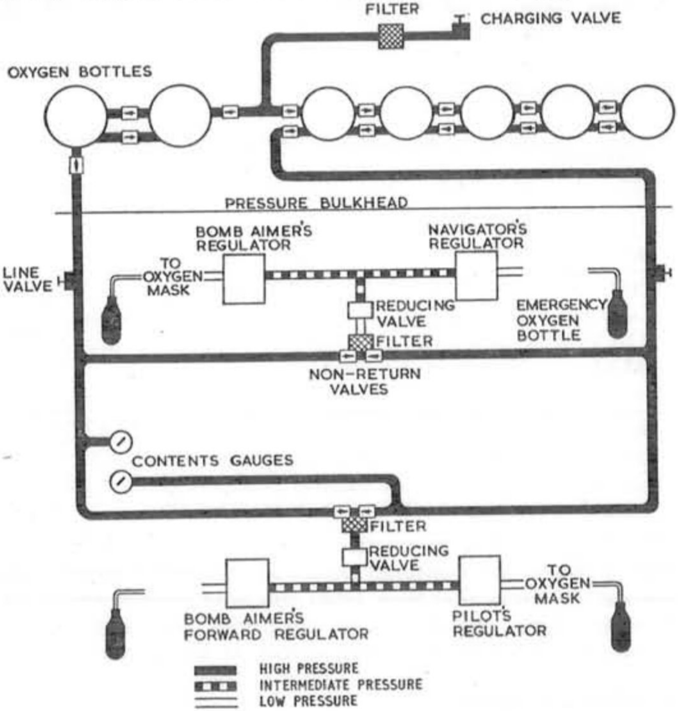
(iv) A NORMAL/100% OXYGEN air inlet switch. (On MK.17D regulators this switch must be at the 100% OXYGEN position. On MK.17E regulators the NORMAL position may be used).

(v) An emergency toggle switch. Moving the switch to left or right gives a safety pressure below 12,000 ft. and an increased safety pressure above this height. Pushing the switch in at the central position gives high pressure for testing mask seal before take-off.

(b) Three remote magnetic indicators may be fitted; one (F.11) below the bombing panel at the bomb aimer's aft station, to show that flow from the nose station regulator is satisfactory, one (C.15) on the pilot's instrument panel shows the pilot whether his supply is being maintained, and one (E.4) at the navigator's (plotter) position to monitor his supply.

(c) *Bomb-aimer's supplies*
In addition to the supplies at the nose and rear stations provision is made for a supply of oxygen to the bomb aimer whilst moving between these stations. The flexible supply tube from the forward regulator terminates at a MK.10A socket incorporating an automatic shut-off valve, in a clip on the starboard wall at the bomb aimer's rear station and thus allows him to disconnect from his ejection seat supply and connect to his nose station supply before leaving his seat.

9. Oxygen emergency supplies
(a) Each ejection seat parachute pack carries an emergency oxygen bottle which is connected by pipe to the



OXYGEN SYSTEM SIMPLIFIED

quick-release socket of the oxygen mask tube before flight. The duration of the emergency bottle is approximately 10 minutes.

(b) An emergency oxygen bottle is also fitted at the bomb aimer's nose station.

10. Associated Equipment

Pressure demand masks must be worn.

OXYGEN SYSTEM-NORMAL OPERATION

11. Checks before flight

Check that the line valves on the front face of the pressure bulkhead are wire-locked on, that the ON-OFF valve at the base of each regulator is also wire-locked ON and that the air inlet switch is at 100% OXYGEN (MK. 17D regulators) or NORMAL (MK.17E regulators). Ensure that the contents gauges show sufficient oxygen for the flight and that the regulator pressure gauge shows 250-400 PSI. With the EMERGENCY selector in the central position the magnetic flow indicators should show white when inhaling. To check the regulator and test the face mask for leaks the toggle on the mask harness must be put to the down position, and the EMERGENCY PRESS TO TEST MASK button on the regulator should be pressed fully in. During this test the breath should be held and an increased pressure should be felt in the mask; if there are no leaks the flow indicators should remain black. If leaks are felt or the indicators show white the mask harness should be tightened by the adjusting screws on either side until a satisfactory seal is made. Return the mask harness toggle to the normal up position and check for leaks when the EMERGENCY button is moved to the right or left. After this test return the button to the central position. If a satisfactory seal cannot be obtained on both of these tests the mask must be considered unserviceable. All four crew-position regulators must be checked as above and the remote oxygen flow indicators checked for correct operation.

12. During flight

During flight frequent checks of contents and crew supply should be made by reference to the contents gauges and flow indicators.

13. Loss of cabin pressure

The oxygen system automatically caters for decreased cabin pressure. It is not therefore necessary to change the selection on the regulator if cabin pressure is lost.

14. Toxic fumes in cockpit

Select 100% OXYGEN, move the selector control to EMERGENCY and tighten oxygen mask by pulling down on the toggle on the mask harness.

15. Flow indicator failure

◀(*a*) *If the blinker remains black*:—

(i) Check contents and confirm 100% OXYGEN is selected.

(ii) Check that pressure is 200-400 PSI and that the indicator needle is oscillating.

(iii) Depress the regulator EMERGENCY switch. Increased flow indicates that the regulator is serviceable: if breathing is unrestricted flight may be continued on 100% OXYGEN.

(iv) If no increase in flow is felt, operate the emergency oxygen bottle, disconnect the mask tube from the main supply and descend to 10,000 ft.

(*b*) *If the blinker remains black and breathing is restricted*:—

Check connections; if all connections are properly made, operate the emergency bottle, disconnect the mask tube from the main supply and descend to 10,000 ft.

(*c*) *If the blinker remains white*:—

Check mask for tight fit. If the blinker remains white and excessive pressure is felt, operate the emergency bottle, disconnect the mask tube from the main supply, and descend to 10,000 ft. ▶

16. Partial system failure

Partial system failure or a leak in one half of the supply system will be indicated by a more rapid fall in the reading of the associated contents gauge. Oxygen will still be available, but the duration of the oxygen supply will be reduced; the flight time must be curtailed accordingly and, if necessary, the flight level adjusted to make a smaller demand on the remaining oxygen supply.

17. Oxygen failure

If symptoms of anoxia are felt indicating lack of oxygen or if oxygen failure occurs at altitude, operate the emergency oxygen bottle and descend to a safe altitude. With the emergency bottle in use the oxygen main connection will have to be disconnected to allow free breathing. In the different crew positions the emergency oxyen bottle is operated as follows:—

(a) *Ejection seat position*

Pull up on the operating cable conduit or down on the ball on the operating cable, both on the right-hand side of the seat pan. As it is more easily accomplished, the former method is recommended. The emergency bottle is operated automatically when the ejection seat is fired.

(b) *Nose position*
Pull the knob or ring on the emergency bottle.

NORMAL USE OF THE AIRCREW EQUIPMENT ASSEMBLY

NOTE: Emergency use of the AEA is covered in Part IV.

18. Strapping-in procedure

1. Prior to entry into the seat check that the safety pin is removed from the emergency oxygen cylinder (right front of survival pack).

2. Check that the safety pin for the seat-firing handle is in position.

3. Check that the cap on the static-line-disconnect of the barometric release is in place. If the cap has been removed try to replace it. If the cap cannot be re-fitted the parachute assembly will not operate automatically and must be replaced.

4. Sit in the seat and adjust seat height to the flying position. Fasten the leg restraint garters just below each knee ensuring the D-rings are to the inside rear. To facilitate easy reach of the restraint cords at a later stage of the strapping-in procedure pass the left-hand cord through

the right garter D-ring and the right-hand cord through the left garter D-ring, and allow them to hang loose temporarily.

5. Connect the survival pack lanyard to the life jacket quick-release connection on the right so that the lanyard lies across the right thigh.

6. Connect the quick-release fittings on the sides of the survival pack to the two corresponding fittings on the life jacket.

7. Connect the parachute harness shoulder straps to the quick-release fitting. Adjust the waist belt.

8. Pass the parachute harness leg straps through the leg loop and attach them to the quick-release box. Adjust the box so that it lies centrally with the waist belt close to the body.

9. Tighten the shoulder straps so that the parachute quick-release box will lie clear of and above the safety harness quick-release fitting when this is assembled. Tighten the parachute harness leg straps. Insert the safety clip behind the disc.

10. Connect the air supply hose to the AVS, if worn.

11. Fasten the lap straps of the safety harness but do not tighten.

12. Ensure that the loop of the right restraining cord is passed through the D-ring on the left garter and threaded under the left-hand side of the safety harness lap-straps. Pass the lug of the left shoulder strap of the safety harness through the loop in the end of the leg restraint cord and insert the lug into the safety harness quick release box.

13. Connect the left restraining cord similarly.

14. Tighten the lap straps of the safety harness ensuring that the quick-release fitting is positioned as low as possible against the body and that it is not covering the parachute harness quick-release box.

15. Tighten the shoulder straps of the safety harness.

16. With assistance from ground crew if necessary, adjust the leg restraint cords in the snubber units to allow full

simultaneous movement of rudder pedals and control column.

17. Put on the helmet and protective helmet, connect the mic-tel lead and fasten the chin straps of both helmets.

18. Connect the oxygen mask tube to the main oxygen supply pipe and adjust the pipe in its clip on the right lap strap of the safety harness to allow full and free movement of the head.

19. Pass the emergency oxygen supply pipe under the lap-strap of the safety harness, and connect it to oxygen mask tube.

20. Connect the oxygen mask tube locating chain to the D-ring on the life jacket.

21. Check that the blind handle can be reached with both hands together.

22. Have the safety pin removed and stowed.

19. Normal exit from the seat

1. Ensure that the firing handle safety pin is re-fitted. (Seat safe for parking).

2. Disconnect the main and emergency oxygen supply and the mic/tel lead.

3. Disconnect the AVS, if worn.

4. Release the safety harness; pull out the safety pin clip and release the parachute harness.

5. Disconnect the personal survival pack from the life jacket and allow the lanyard to drape over the right-hand side of the seat-pan.

6. Remove the leg restraint cords.

7. Leave the seat.

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

CHAPTER 10—ARMAMENT AND CAMERA CONTROLS

CONTENTS

1. Bomb safety switch

A bomb safety switch may be fitted on the pilot's port console; it must be on before any normal bombing circuits can be operated.

2. Bomb controls

The bomb control equipment is on the starboard walls of the bomb-aimer's rear station (F.8, 9, 10) and nose station. The bombs may be released by a pushbutton, on a flexible lead, stowed in a clip on the starboard side of the nose station, or by the bomb release switch (C.9) on the left-hand grip of the control column.

3. Bombsight

The bombsight is mounted on a spigot over the clear view panel in the plastic nose. The bombsight computor and the air control cock are on the port side of the nose station.

4. Bomb jettisoning controls

(a) The pilot may jettison the bombs in the bomb bay by means of a guarded EMERGENCY BOMB JETTISON switch (B.6) on the port console. When this is switched ON the normal bomb doors control circuit is by-passed, the bomb doors are opened and the bombs jettisoned. Switching OFF the jettison switch will remake the normal control circuit and the bomb doors will close.

NOTE: 25 lb. practice bombs carried on light series carriers cannot be jettisoned by means of the EMERGENCY BOMB JETTISON switch.

(b) Should the bomb doors fail to open when the jettison switch is set ON, then by leaving the jettison switch ON and opening the bomb doors as at para. 5 or 6 the bombs will be jettisoned when the bomb doors are fully open.

5. Bomb doors control and indicator

(a) The electrically-actuated bomb doors selector valve is controlled by a two-position OPEN/SHUT switch (B.4) on the port console. A red light (B.5) in front of the control switch, comes on when the bomb doors are fully open.

(b) To prevent inadvertent closing of the bomb doors on the ground a locking pin, stowed in a bag on the lower front face of the electrical control panel when not in use, is inserted in the control switch guard with the switch in the OPEN position.

6. Bomb doors emergency control

(a) Should the bomb doors selector valve fail to operate electrically it may be moved to the "open" position mechanically by pulling down on the gated BOMB DOORS EMERGENCY CONROL lever (B.7) on the cockpit port wall. However, as the bomb doors cannot then be closed again until serviced it must be established that the fault is in the selector valve and not due to hydraulic failure (see Part IV, Chapter 2.)

(b) If the failure is hydraulic, and, provided that fluid is available, the bomb doors may be opened and closed by means of the handpump and normal selection on the control switch. It should be noted, however, that such action by using the emergency reserve fluid may prejudice subsequent lowering of the undercarriage, and wheel braking.

7. Camera controls

A F24 camera may be carried in the rear fuselage. The camera control unit and master switch (F.7) are on the cabin starboard wall.